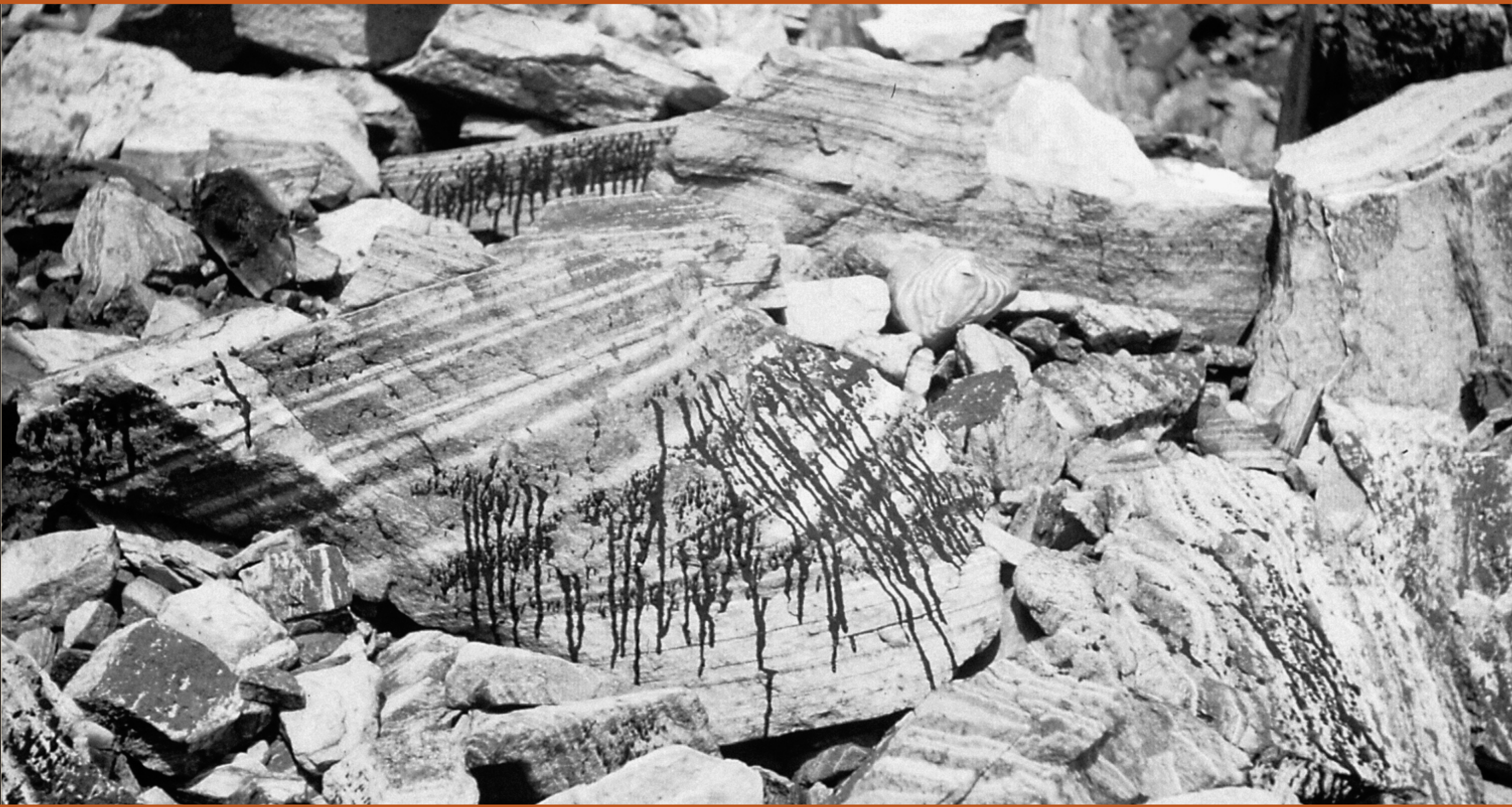
ANNOTATED BIBLIOGRAPHY OF UTAH TAR SAND DEPOSITS

By
J. Wallace Gwynn and Francis V. Hanson



OPEN-FILE REPORT 503
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This publication was originally released in 2007. Additional references were added, and the publication was updated in 2009.

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ANNOTATED BIBLIOGRAPHY OF UTAH TAR SAND DEPOSITS

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INTRODUCTION

Purpose of the Project

The purpose of this publication is to provide the reader with annotations of Utah's tar sand literature and technical information related to individual deposits as well as extraction and upgrading processes. Some other references related to patents, oil shale, and other hydrocarbon resources are also included. We intend that this compilation will be valuable to those interested in the exploration for, and development of, Utah's tar sand resources. A brief introductory section describes the past, present, and future of Utah's tar sand industry. An earlier version of this report was published in 2007 with the same title and report number.

Definition of Tar Sands

Tar sand deposits are defined as consolidated or unconsolidated sedimentary deposits containing in-situ hydrocarbon with a viscosity greater than 10,000 centipoises or an API gravity less than 10° at reservoir conditions. The hydrocarbon has little mobility at reservoir conditions and cannot be produced by conventional techniques. Tar sand is a catch-all term; this material has also been called asphaltic sandstone, bituminous sandstone, pitch rock, tar-impregnated sandstone, tar sandstone, and tar sands.

Background

The exploitation of Utah's tar sand deposits has been the subject of intense interest whenever crude oil prices rise in response to economic pressures and/or geopolitical events. There is a special concern now because of the high price of crude oil, and because a significant fraction of the petroleum processed in domestic U.S. refineries is imported from nations that belong to the Organization of Petroleum Exporting Countries (OPEC). The dependence of the U.S. economy on liquid fuels (imported crude oil and refined products) is likely to expand in the near future. Furthermore, it is unlikely that high benchmark crude oil prices will decline substantially in the future as the emerging, energy-consuming economies of China and India continue to expand. Therefore, it is essential that the potential of Utah's tar sands for the economic recovery of hydrocarbons be carefully evaluated, including technical, commercial, and environmental considerations.

The tar sands, oil shale, and heavy oils of the Uinta Basin have taken on greater significance with the increase in the price of crude oil to a range above $60 per barrel. This increase has had a significant impact on the United States' balance of payments (the payments that flow between any individual country and all other countries) due to the ever-increasing role that imported oil has in filling domestic refinery runs, currently 54 percent. The increased price of foreign oil is important to Utah because Canadian tar-sand-derived syncrudes now make up approximately 20–25 percent, or about 30,000 barrels per day, of the refinery crude runs in the Salt Lake City area. The production of syncrudes from Uinta Basin tar sands, oil shale, and heavy oil resources may help to alleviate U.S. dependence on foreign sources. To ensure that sufficient and sustainable production levels of syncrude can be maintained, the co-development of tar sand, oil shale, and heavy oil resources may be necessary.

Previous Work

The technical, commercial, economic, and environmental aspects of the development of Utah's tar sands depend upon an accurate geological description of the individual deposits, reasonable resource and reserve estimates, and reliable characterization of the deposits and the native bitumens contained in Utah's tar-impregnated sands. It is interesting to note that during the late 1970s and early 1980s, when interest in developing Utah's tar sands initially spiked, the resource estimates found in many publications resembled an inverted pyramid, such that one could trace these resource estimates back to one original source, which was the Utah Geological and Mineralogical Survey's Map 47 (Ritzma, 1979). The data base for Utah's tar sand deposits at that time was assembled by the Utah Geological and Mineralogical Survey through the field and laboratory efforts of geologists such as Ritzma, Campbell, Byrd, Kayser, Gwynn, and others, and by the Laramie Energy Technology Center geologists and engineers, such as Peterson and Marchant. Ritzma, Campbell, Byrd, Kayser, Gwynn, and their colleagues worked on the major and minor deposits of the entire state of Utah, whereas Peterson, Marchant, and their colleagues focused primarily on the Uinta Basin deposits. Reports by these authors are found in the annotated bibliography that follows.

Engineering Studies and Pilot Tests

The Laramie Energy Technology Center conducted an in-situ combustion pilot study on the NW Asphalt Ridge deposit; however, upon completion of the test there was no attempt to undertake actual production of the bitumen or bitumen-derived hydrocarbon liquids. Shell attempted an in-situ steam injection pilot test on the Sunnyside tar sand deposit; however, the test was not successful due to vertical fractures in the reservoir through which the steam was diverted. Kirkwood Tar and Gas Exploration and Production intended to conduct an in-situ combustion pilot test in the Tar Sand Triangle deposit; the pilot test was never carried out in spite of an extensive core-drilling program on the planned site. Several in-situ operations were proposed for the P.R. Spring tar sand deposit in the mid-1980s, but none of the projects were ever conducted.

The P.R. Spring and Asphalt Ridge tar sand deposits were the subject of intense activity during the late 1970s and early to mid-1980s. Unfortunately, very few on-site extraction operations were actually conducted. A 200-barrel per day surface mining/extraction plant was operated on the P.R. Spring deposit during 1983 by the UTAR Division of Big Horn Tar. The process involved the use of diesel fuel as a solvent to extract the bitumen. A number of surface mining/extraction processes including aqueous extraction, solvent extraction, and pyrolysis were investigated to recover the bitumen and/or a bitumen-derived liquid from the Asphalt Ridge, P.R. Spring, Whiterocks, and Sunnyside tar sands. Enercor built and operated a modified, hot water extraction process pilot plant in North Salt Lake to validate the Miller process developed at the University of Utah in 1981. Crown Energy operated a small scale, solvent extraction process at the Asphalt Ridge deposit; however, there have been no technical publications regarding the results of the test run. Lurgi-Ruhrgas conducted a successful pilot plant test in Germany using the Lurgi-Ruhrgas rotating kiln while processing Utah tar sands. There have been no on-site mining/pyrolysis pilot tests reported to date involving Utah tar sands deposits.

UTAH TAR SAND DEPOSITS

Utah's Tar Sand Resources

Utah has both the largest number of tar sand occurrences and the largest individual deposits in the United States. The deposits are located mainly in two areas of Utah: the Uinta Basin of northeastern Utah, and central southeastern Utah (figure 1). Within these areas, there are more than 50 identified tar sand deposits, which contain an estimated total of 19 to 29.2 billion barrels of oil in place (Ritzma and Campbell, 1979; IOCC, 1984).

The Uinta Basin contains 25 known tar sand deposits (figure 1). Of these, the seven largest, in terms of measured and indicated tar-in-place are, in descending order, the P.R. Spring, Sunnyside, Hill Creek, Asphalt Ridge, NW Asphalt Ridge, Raven Ridge, and Whiterocks (Ritzma, 1979). In central southeastern Utah the two largest deposits are, in descending order, the Tar Sand Triangle in eastern Wayne and Garfield Counties, and Circle Cliffs in eastern Garfield County. Some deposits, like the San Rafael Swell deposit in Emery County, consist of numerous smaller deposits. The central-southeastern tar sand deposits are found in a variety of structural and stratigraphic settings.

Ninety-six percent of Utah's total tar sand resource is found in the P.R. Spring, Sunnyside, Hill Creek, Asphalt Ridge, Tar Sand Triangle, and Circle Cliffs deposits (figure 1). Good overviews of Utah's tar sand deposits can be found in Ritzma (1979), Ritzma and Campbell (1979), Utah Geological and Mineral Survey (1983), and Blackett (1996).

General Characteristics of Utah Tar Sands

The Uinta Basin bitumens are of non-marine origin and contain approximately 1 weight percent organic nitrogen, approximately 0.5 weight percent organic sulfur, and are generally naphthenic in character. The central southeast region deposits are of marine origin. The Tar Sand Triangle and Circle Cliffs deposits contain approximately 1 weight percent organic nitrogen, approximately 5 weight percent organic sulfur, and are generally aromatic in character. These deposits more closely resemble the Canadian Athabasca bitumens than those of the Uinta Basin. Unfortunately, the bitumen saturations of the Tar Sand Triangle and Circle Cliffs tar sands range from only 4 to 6 weight percent which may severely limit recovery options for these two deposits.

Comparison of Utah and Canadian Tar Sands

The Utah and Canadian tar sands differ significantly in the size of the resource and in character. The Canadian resource is approximately 30 to 40 times larger than that in Utah, and individual Canadian deposits are generally much larger. Furthermore, the oil saturations of the Canadian deposits are frequently twice those of the Utah deposits. Therefore, significantly less ore must be processed in Canada than in Utah to produce a barrel of tar. The nature of the tar sands is also significantly different; Canadian tar sands have water-wet grains whereas the Utah tar sands are tar wet. This difference may dictate the type of recovery technology that can be applied to Utah's tar sands, and may preclude the direct application of the Canadian surface-recovery technology to Utah tar sands.

FUTURE TAR SAND DEVELOPMENT

The development of the hydrocarbon resources of the Uinta Basin may need to include tar sands, oil shale, and heavy oils to ensure sustainable production levels required to justify investment in the recovery and upgrading operations.

The primary hydrocarbon recovery strategies for the recovery of hydrocarbon values from Utah's tar sand deposits include in-situ thermal processes, surface mining/bitumen extraction, and tar sand pyrolysis processes. Because of limited coring of the Utah tar sand deposits, there are limited data on reservoir properties, and thus it has not been feasible to apply screening parameters to the individual deposits to determine the appropriate in-situ method to optimize production potential.

The successful siting and commercial development of any of the Utah's tar sand deposits will require assembly of the following reservoir properties: bitumen saturation, water saturation, porosity, permeability, sand-particle size distribution, mineralogy of the sands, mechanical strength of the consolidated sands, characteristics of the bitumen, pay zone thickness, and depth of the overburden.

BIBLIOGRAPHICAL DATA

Sources of Data

This open-file report includes annotated references and descriptions of other data (chemical analyses, geophysical and lithologic logs, photographs, and other sources), collected from July 1, 2004, through June 30, 2009. References have been gathered from the Utah Geological Survey files; numerous printed and on-line publications; the files of Dr. Francis V.

Hanson; and significant contributions from Dr. Jan Miller, Department of Metallurgical Engineering, University of Utah; Dr. James Bunger, Bunger and Associates; and Mr. Keith Clem, petroleum geologist.

Organization of Data

The annotations in this bibliography are not of uniform format, and include, for example, tables of contents for theses, dissertations, and experimental procedures, and listings of major and secondary article headings. In some cases, a more customary abstract is given. Articles are listed in alphabetical order by authors, and then chronologically. At the beginning of the annotation, following the reference, the tar sand area(s), or deposits addressed in a given article are indicated by bold words in parentheses, followed by a comma.

Search Procedure

This annotated bibliography is in PDF format, and is searchable. To search for all references dealing with a particular tar sand deposit, execute the following procedure. First, go to **Edit** on the tool bar, and then to **Find**. Enter the name of the deposit exactly as it is shown in the attached list of deposit names (table 1), including the beginning and ending parentheses and the comma that follows, as in the following example: (Asphalt Ridge),. Then, hit **Find Next**. This procedure will find only the bold deposit names at the beginning of the annotation. The bibliography is also searchable on any other key word(s) such as logs or author's last name by following the above procedure, but omitting the parentheses and comma. This procedure will find all occurrences of the word, whether in the reference or the annotation paragraph.

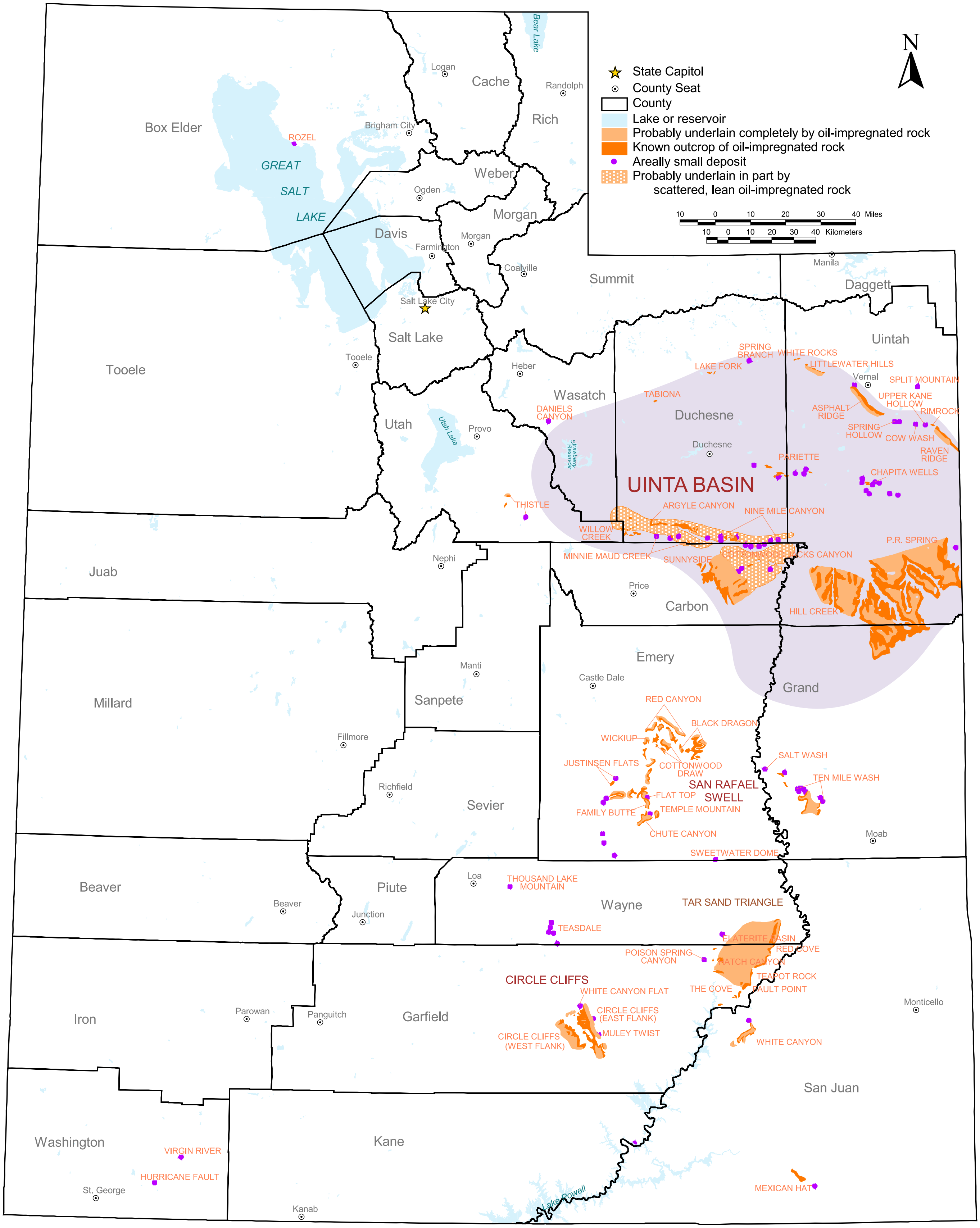

Figure 1. *Locations of tar sand deposits in the State of Utah. Source of information is from Utah Geological Survey Map 68 (1983). Map drawn by Sharon Wakefield, 2007.*

Table 1. Names of searchable Utah tar sand deposits. Names must be entered in parentheses, followed by a comma. Example: (Whiterocks), The parentheses and the comma are essential for a successful search. Other key words can be searched for simply by entering them in the search box.

(Argyle Canyon),
(Asphalt Ridge),
(Asphalt Wash),
(Athabasca),
(Avintaquin Canyon),
(Black Dragon),
(Black Rock Canyon),
(Bonanza),
(Capitol Reef),
(Chapita Wells),
(Chute Canyon),
(Circle Cliffs),
(Cottonwood Draw),
(Cottonwood-Jacks Canyon),
(Cove),
(Cow Wash),
(Daniel Canyon),
(Deep Creek Nose),
(Dragon),
(Elaterite Basin),
(Evacuation Creek),
(Family Butte),
(Flat Rock Mesa),
(Flat Top),
(French Seep),
(Gilsonite),
(Gordon Corral),
(Gould Ranch),
(Green River Desert),
(Hatch Canyon),
(Hay Canyon),
(Hill Creek),
(Hurricane Cliffs),
(Indian Canyon),
(Jackass Bench),
(John Starr Flat),
(Justensen Flats),
(Lake Canyon),
(Lake Fork),
(Littlewater Hills),
(Lower Green River Desert),
(Mexican Hat),
(Mill Fork),
(Miners Mountain),
(Minnie Maud Creek),
(Mosby Creek),
(Muley Twist),
(Myton Bench),
(Nequoia Arch),
(Nine Mile Canyon),
(No Specific Deposit),
(North Creek),
(North Seep Ridge),
(Numerous Utah Deposits),
(NW Asphalt Ridge),
(Oil Hollow),
(Oil Shale),
(Others),
(P.R. Spring),
(Pariette),
(Patent),
(Pleasant Valley),
(Poison Spring Canyon),
(Rainbow),
(Raven Ridge),
(Red Canyon),
(Red Wash Area),
(Reservation Ridge),
(Rim Rock),
(Rozel Hills),
(Rozel Point),
(Salt Wash),
(San Rafael Swell),
(Santa Rosa NM),
(South Seep Ridge),
(Special Tar Sand Areas),
(Split Mountain),
(Spring Branch),
(Spring Hollow),
(Stud Horse Peaks),
(Sunnyside),
(Sweetwater Dome),
(Tabiona),
(Tar Baby mine),
(Tar Cliff),
(Tar Sand Triangle),
(Teapot Rock),
(Teasdale),
(Temple Mountain),
(Ten-Mile Wash),
(Thistle),
(Thousand Lake Mountain),
(Three-Mile Canyon),
(Timpoweap Canyon),
(Uinta Basin),
(Upper Cane Hollow),
(Uteland Butte),
(Wagon Box Mesa),
(White Canyon Flat),
(White Canyon),
(Whiterocks),
(Wickiup),
(Willow Creek),
(Winter Ridge),
(Yellowstone River),

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Abraham, Herbert, 1960, Asphalts and allied substances - their occurrence, modes of production, uses in the arts, and methods of testing (volume 1 - historical review and natural raw materials) (6th edition): New York, D. Van Nostrand Company, Inc., p. 97-279.

(No Specific Deposits), This selection from the book includes the following: Chapter 5 - Annual production of bituminous substances and their manufactured products; Chapter 7 - Mineral waxes; Chapter 8 - Native asphalts occurring in a fairly pure state; Chapter 9 - Native asphalts associated with mineral matter (Utah occurrences discussed pages 162-164); Chapter 10 – Asphaltites; Chapter 11 - Asphaltic pyrobitumens; Bibliography.

Alford, H.E., and Derby, R.E., 1981, Utah tar sands to be developed: Hydrocarbon Processing, p. 127-130.

(Asphalt Ridge), This article contains: introduction (water resources; scope and schedule); process description (overall recovery, conditioning, and extraction).

Alford, H.E., and Saunders, J.C., Jr., 1978, Tar sands recovery process, United States Patent No. 4,067,796.

(Patent), The patent describes an improved process for the recovery of bitumen from tar sand by employing a vessel containing a liquid comprising an organic phase consisting of a hydrocarbon solvent, which is immiscible in water and an aqueous phase. The tar sand, optionally containing water, is introduced into the organic phase and then subsequently passes into the aqueous phase. Six claims, two figures.

Allen, J.C., 1976, Recovery of bitumens by imbibition flooding, United States Patent No. 3,978,926, 6 p.

(Patent), (Utah Tar Sands), A method for recovering bitumen from tar sand deposits by imbibition flooding at ambient temperature wherein thte bitumen is sequentially contacted with a paraffin liquid hydrocarbon followed by a soak period to allow imbibition of the solvent, after which the bitumen and solvent mixture is produced, and the cycle is repeated.

Allen, J.C., Gillespie, R.E., and Burnett, D.B., 1984, Superheated solvent method for recovering viscous petroleum, United States Patent No. 4,450,913, 8 p.

(Patent), (Utah Tar Sands), The disclosed invention is a method for efficiently recovering viscous petroleum from hydrocarbon formations, particularly consolidated tar sand formations. A superheated paraffinic solvent under elevated pressure and temperature is injected into the formation. Thereafter, the formation is rapidly produced until pressure is depleted. The injection and production depletion cycle is then repeated.

Altringer, P.B., McDonough, P.J., and Brook, P.T., 1982, Characterization and beneficiation of bitumen-free domestic tar sands: U.S. Bureau of Mines Open-File Report 11-85, 12 p.

(Asphalt Ridge), (P.R. Spring), (Hill Creek), (Whiterocks), (Raven Ridge), (Sunnyside), (Circle Cliffs), (Tar Sand Triangle), (Santa Rosa NM), and (Others), This paper presents the following: Foreword; Abstract; Introduction; Description of the resource and analysis of the deposits; Beneficiation results; Conclusions; One illustration and six tables.

The U.S. Bureau of Mines conducted a study to determine if residues from fractional distillation represent a potential source of mineral values. A literature review and discussions with tar sand specialists failed to disclose the mineralogical nature of residues remaining after bitumen extraction. To develop this information, pilot plant tar sand residues or toluene-cleaned tar sands from 23 deposits were examined. The nature of the residues was determined by standard mineralogical methods and the chemical compositions were determined by x-ray and inductively-coupled plasma spectroscopy. None of the sands or concentrates examined contained sufficient

valuable minerals to be economically important.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980a, Argyle Canyon--Willow Creek Designated Tar Sand Area, Duchesne, Wasatch, and Utah County, Utah, containing 21,863 acres: Minutes of the Mineral Land Evaluation Committee, 8 p.

(Argyle Canyon), (Willow Creek), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980b, Asphalt Ridge-Whiterocks and vicinity Designated Tar Sand Area, Uintah County, Utah, containing 41,395 acres: Minutes of the Mineral Land Evaluation Committee, 27 p.

(Tar Sand Triangle), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory Analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980c, Circle Cliffs and West Flanks Designated Tar Sand Area, Garfield County, Utah, containing 91,080 acres: Minutes of the Mineral Land Evaluation Committee, 17 p.

(Circle Cliffs), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory Analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980d, Hill Creek Designated Tar Sand Area, Uintah County, Utah, containing 107,249 acres: Minutes of the Mineral Land Evaluation Committee, 12 p.

(Hill Creek), This report includes the following: Size and location of designated area; Surface Features; Regional Stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory Analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980e, P.R. Spring Designated Tar Sand Area, Uintah and Grand Counties, Utah, containing 273,950 acres: Minutes of the Mineral Land Evaluation Committee, 18 p.

(P.R. Spring), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980f, Pariette Designated Tar Sand Area, Duchesne and Counties, Utah, containing 22,071 acres: Minutes of the Mineral Land Evaluation Committee, 8 p.

(Pariette), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980g, Raven Ridge-Rim Rock and vicinity Designated Tar Sand Area, Uintah County, Utah, containing 16,258 acres: Minutes of the Mineral Land Evaluation Committee, 12 p.

(Raven Ridge), (Rim Rock), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980h, San Rafael Swell Designated Tar Sand Area, Emery County, Utah, containing 130,292 acres: Minutes of the Mineral Land Evaluation Committee, 28 p.

(San Rafael Swell), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980i, Sunnyside and vicinity Designated Tar Sand Area, Carbon and Duchesne Counties, Utah, containing 157,445 acres: Minutes of the Mineral Land Evaluation Committee, 17 p.

(Sunnyside), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

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Alvord, D.C., Moffitt, J.W., Guynn, E.W., and Smedley, J.E., 1980k, White Canyon Designated Tar Sand Area, San Juan County, Utah, containing 10,469 acres: Minutes of the Mineral Land Evaluation Committee, 17 p.

(White Canyon), This report includes the following: Size and location of designated area; Surface features; Regional stratigraphy; Geologic structure; Extent and thickness of the deposit; Depth of oil-impregnated rock; Laboratory analyses; Resource estimates; Mining considerations; References.

Amirijafari, Bahram, 1981, Brief description of the mining, material handling, processing and economics of the Western Tar Sands Pilot Plant Project: Science Applications, Inc., unpublished report, variously paginated.

(Raven Ridge), This brief description contains: Introduction; Mining (general, geology, exploration, alternate mining concepts, phase one details, mining regulations); Material handling (transport from mine site and initial screening, primary crushing, secondary crushing, final screening and weighing); Processing (general, process design criteria, process description); Economic analysis (introduction, operating cost, effect of bitumen content on the economics, effect of mining cost on total operating cost); Appendix A.

AMOCO Minerals Company, about 1984, AMOCO core holes nos. 49-63, Sunnyside Cliffs, Carbon County, Utah.

(Sunnyside), This three-ring binder of information contains letters, Soxhlet extraction data, location maps, and others. Geophysical and lithologic logs and some miscellaneous information are also included.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 1

(Sunnyside), The following is an abbreviated inventory of box 1 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Geologic summary reports 1987 (volumes I-II), 1988 (volumes I, IIA, IIB, III), 1989 (volume II); Socioeconomic analysis, 1984; Special Core Analysis, 1990; K-Ar determination, 1988; Summary coring program, 1988; special core analyses for RCT, TCT, BP, WCT, RC and other wells; 1984

exploration plans; Tar sand technology status report, 1990; Alberta oil sands technology and research authority annual reports for 1989, 1992, and 1993; Geotechnical investigation of proposed tailings disposal and plant site, 1987; Soxhlet oil extractions for 139 samples, 1986, and 94 samples for 1988; Map of the Sunnyside tar sands project.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 2

(Sunnyside), The following is an abbreviated inventory of box 2 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Sunnyside tar sands project 1990 mining studies volumes I, II, III; Proceedings of the seventh World Petroleum Congress; Exploration for heavy crude oil and bitumen, 1984, volumes I and II.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 3

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AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 4

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AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 6

(Sunnyside), The following is an abbreviated inventory of box 6 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Final environmental impact statements, Uintah Basin Synfuels Development, volumes 1 and 2, 1983; Diamond Mountain resource area resource management plan, volumes I and II, 1981 drill hole data base (13-33C); Drill hole data base 1984 exploration program (49-63); Sunnyside tar sands geology final draft, 1980; Amoco production core hole logs 1-7; Amoco minerals drill hole geophysical logs for holes 4, 11, 23-29, 37-38, 41, 60-61, and 63; Regional map of Sunnyside tar sands, 1990.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 7

(Sunnyside), The following is an abbreviated inventory of box 7 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Geologic summary reports for 1981, 1982, 1984, 1986, 1987-1990; Environments of deposition study, 1988; Comments on source degradation and maturity of the heavy oil, 1988;

Report on the composition, texture, diagenesis, and provenance, 1984; Mono Power geophysical logs for RCT-1, 2, 4, 10, and 12; Mono Power core analyses for CH-1 and CH-2; Special core analysis study, 1989, for RCT and other core holes.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 8

(Sunnyside), The following is an abbreviated inventory of box 8 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Five metal photo boxes containing a total of 3000 slides for 1980-81, 1982 and 1984, 1985-1987, 1988 and 1990; Three project area photos, 1985, and other photos.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 9

(Sunnyside), The following is an abbreviated inventory of box 9 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Arco data on Sunnyside drill holes 1, 2, 3, and 5; Shell core holes 1-6 data; Logs for 30 drill holes; Analytical service reports on Kaiser 1 and 2; Seismic data for 1965, Regional drill hole data (Signal, Arco, Texaco); Core analysis Mono Power holes RCT (13, 3A, 10, 4), and 1); Size analysis data for drill holes 1-11; Strip logs for 12 holes, and measured sections for 3 locations; Fourteen Sunnyside tar sand prospect maps; Abundance and concentration reports.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 10

(Sunnyside), The following is an abbreviated inventory of box 10 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Report and dissertation by Robert Remy; Three Mono Power geologic evaluations for 1982, 1983, and 1984; Geologic summary reports, V. III for 1982, 84, 86, 87, and 89; Core analysis data for core holes 1, 2, 3, and 5; Hole completion record drilling log for holes WCT3A, and WCT4; List of columnar sections, measured sections 1-11, Amoco drill holes 1-26, Shell drill holes 1- 3, Signal drill hole 1, and Pan American-Nutter hole 1; Final report on 1989 update of the computerized geologic model, 1988; Hole data, Sunnyside tar sands; Soxhlet oil extractions; Twelve project-related maps; Printouts for 25 wells; Logs for 12 wells.

AMOCO Minerals Company, 1987, Inventory of AMOCO's Sunnyside Tar Sands Data – Box 11

(Sunnyside), The following is an abbreviated inventory of box 11 of Amoco reports, logs, and other data related to their Sunnyside tar sand deposit investigations. Logs for 12 Amoco wells; Logs, hole completion records, drillers logs, analysis reports for 14 holes; Fifteen Mono Power logs; Measured sections for locations 1 to 61; Standard Oil Co. of Indiana Sunnyside tar sand project, 1983, 1984 Exploration report; Digital tape 112M Sunnyside; STS Geochemistry, 1987-88; Mineralogy-lithology data; Sieve analysis report for Amoco holes 1-15, 18-20; Size analysis and mineral composition, 1980; Study contract for comparison of Utah and Athabasca oil sands, 1976-78; Bituminous sandstone quarry.

Anders, D.E., and Gerrild, P.M., 1984, Hydrocarbon generation in lacustrine rocks of Tertiary age, Uinta Basin, Utah - organic carbon, pyrolysis yield, and light hydrocarbons, *in* Woodward, Jane, Meissner, F.F., and Clayton, J.L., editors, Hydrocarbon Source Rocks of the Greater Rocky Mountain Region: Denver, Rocky Mountain Association of Geologists, p. 513-529.

(No Specific Deposits), This article contains: Abstract; Introduction; Samples; Geologic setting (stratigraphic framework, sediment fracturing); Analytical methods (chromatographic analysis, organic-carbon analysis, Rock-Eval source-rock evaluation); Results (light hydrocarbon (C_1-C_4), gasoline-range hydrocarbons (C_5-C_7), organic carbon, Rock-Eval pyrolysis); Discussion (thermal maturity and hydrocarbon generation, variation in organic matter content, quantitative evolution of hydrocarbon generation, expelled oil by organic-geochemical material balance calculations, expelled oil by extractable organic matter calculations); Summary and conclusions; References.

Anders, D.E., Palacas, J.G., and Johnson, R.C., 1992, Thermal maturity of rocks and hydrocarbon deposits, Uinta Basin, Utah, *in* Fouch, T.D., Nuccio, V.F., and Chidsey, T.C., Jr., editors, Hydrocarbon and mineral resources of the Uinta Basin, Utah and Colorado: Utah Geological Association Guidebook 20, p. 53-76.

(Asphalt Ridge), (Raven Ridge), (P.R. Spring), (Sunnyside), (Gilsonite), This paper includes the following: Abstract; Introduction; Geologic setting; Thermal maturity indicators (vitrinite reflectance and vitrinite reflectance equivalence, Rock-Eval phyrolytic and chemical evidence of thermal maturity, hydrogen/carbon ratio, light hydrocarbon yield, biological marker maturity indices, thermal effects of geothermal gradients, time-temperature index of maturity); Conclusions; Acknowledgments; References. Biological marker compound maturity ratios are given for some gilsonite samples, and for Asphalt Ridge, Raven Ridge, P.R. Spring, and Sunnyside samples.

Anderson, D.J., Kirkvold, C.F., and Pisio, Peter, 1976, Method of recovering viscous petroleum from tar sand, United States Patent No. 3,994,340, 13 p.

(Patent), (No Specific Deposit), Recovery of viscous petroleum such as from tar sands is assisted using a substantially vertical passage from the earth's surface which penetrates the tar sand and has extending therefrom a lateral hole containing a flow path isolated from the tar sand for circulating a hot fluid to and from the vertical passage to develop a potential flow path into which a drive fluid is injected to promote movement of the petroleum to a production position.

Anderson, D.J., Kirkvold, C.F., Pisio, Peter, and Lishman, J.R., 1976, Recovering viscous petroleum from thick tar sand, United States Patent 3,994,341, 9 p.

(Patent), (No Specific deposit), Recovery of viscous petroleum such as from thick tar sands is assisted using a closed-loop flow path from the earht's surface through a substantial portion of the formation for conducting hot fluid to reduce the viscosity of the petroleum in the formation to develop a potential passage in the formation outside the flow path into which a drive fluid is injected to promote movement of the petroleum to a production position.

Anonymous, no date, Domestic tar sands (section on Analysis of the Sunnyside tar sand deposit only): Prepared for the U.S. Department of Energy under contract no. 9014-018-021-22004, Appendix b.3, p. B31-B42.

(Sunnyside), This section includes the following: Analysis of the Sunnyside tar sand deposit (location and areal extent, estimated size of the resource, measurement and definition of the resource, general characteristics of resource, specific characteristics of the resource); Technical analysis of the deposit (size, technical potential for in-situ recovery, economic and net energy analysis for in-situ recovery, feasibility for mining). Table 1 gives selected properties of the Sunnyside tar sand deposit, including area, depth to top, porosity, oil saturation, B/AF in place, gross recoverable B/AF (steam and in-situ), oil content, net pay, gross pay, and overburden to net pay. Table 2 gives recovery analysis for the Sunnyside tar deposit for north, central, and south areas.

Anonymous, no date, Tar sand/EOR bibliography (appendix IV): Unpublished bibliography from F.V. Hanson, 27 p.

(Numerous Utah Deposits), This bibliography breaks references into the following sections: Bibliographies; Geology; Resources; Bitumen characterization; Bitumen recovery technology (screening guides for EOR processes, thermal in-situ recoveryprocesses, cyclic steam injection, steam drive, steam injection-drive/gas injection, in-situ combustion, in-situ wet combustion (COFCAW), novel EOR processes – electrical resistance heating, microwave heating).

Anonymous, 1897, The Uinta and the Uncompahgre asphaltites of Utah: The Engineering and Mining Journal, July 3 edition, p. 10-11.

(No Specific Deposits), This article discusses the various asphaltites found in the Uinta Basin, and their development, uses, and other topics.

Anonymous, 1943, Whiterock River bituminous sandstone deposit, Uintah County, Utah: War Minerals Report - Report of the Bureau of Mines to Secretary of the Interior, Harold L. Ickes, 16 p.

(Whiterocks), This report includes the following: Summary; Introduction; History; Location; Labor and living conditions; Topography and climate; Geology and stratigraphy; Description of the deposit; Samples and products; Results of tests; Other (method of extraction, method of mining, reserves, plans for company operations, and proposed exploration by the U.S. Bureau of Mines; Conclusions).

Anonymous, 1957, Coring and testing wells Asphalt Ridge, Utah: Received from Gulf Oil Company – U.S., Exploration Department, Casper area, 13 p.

(Asphalt Ridge), This report contains: Summary; Discussion; Six attachments (Attachment 1 = Drilling and testing program-Palmer Wells #1 and #2, Attachment 2 = Core analysis results for the No. 2 Palmer, Utah, Attachment 3 = Injection and production test at Palmer Wells, Asphalt Ridge, Attachments 4 = Injection tests G.R. & D.C. Palmer Well -Asphalt Ridge, Utah, Attachment 5 = Permeability and saturation profiles for Palmer Well #1, Asphalt Ridge, Utah, Attachment 6 = Permeability and saturation profiles for Palmer well #2 Asphalt Ridge, Utah.

Anonymous, 1967, Interest quickening in Utah tar sands: Oil and Gas Journal, December 18, p. 49-50.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), (Hatch Canyon), (Elaterite Basin), (Teapot Rock), (Cove), (Circle Cliffs), (Wagon Box Mesa), This short article contains: Introduction; Suit pending; The deposits; U.S. Bureau of Mines.

Anonymous, 1971 or 1974, Two oil sand semi-work plants set for Utah: Syn-fuels News/Western Oil Reporter, p. 8-9.

(Asphalt Ridge), This article contains: Introduction; Oil sands before oil shale; Fairbrim plans 100 barrels per day; August 28 hearing set; Processes similar; Major oil management changed; Sohio provides land; In-situ projects also planned.

Anonymous, 1974, Fairbrim & Arizona Fuels to begin oil sands recovery tests on Sohio property in Utah: Synthetic Fuels, September, p. 3-26 to 3-30.

(Asphalt Ridge), This article contains: Introduction; Water rights; Data indicate low grade reserves; Table 1 (Sohio corehole analyses); Arizona Fuels and Fairbrim history; Comment.

Anonymous, 1983, Chevron, GNC project described: Synthetic Fuels Report, p. 3-14 to 3-16.

(Sunnyside), This article contains: Capacity of the project; Chevron Resources/GNC partnership; Description of deposit; Process flow chart; Consumption of diesel oil; Upgrading; Hydrotreating.

Arentz, S.S., 1960, Report on the Utah Rock Asphalt property, Sunnyside bituminous sandstone deposit, Carbon County, Utah: Unpublished report, 10 p.

(Sunnyside), This report contains: Introduction; Summary; Location and property description; Geology; Reserves; Separation of bitumen; Utilization of bitumen; Conclusions.

Argonne National Laboratory, 2006, Summary of public scoping comments for the oil shale and tar sands resources leasing programmatic environmental impact statement: Argonne National Laboratory, 16 p.

(Numerous Utah Deposits), This report contains the following: Introduction; Scoping process (approach, scoping statistics); Summary of scoping comments (environmental concerns, socioeconomics, resource and technology concerns, stakeholder involvement, cumulative impacts, mitigation and reclamation, policy, land use planning, alternatives, other issues); Interagency cooperation and government-to-government consultation; Future opportunities for public involvement; One figure.

Arscott, R.L., and David, A., 1977, An evaluation of in-situ recovery of tar sands: In Situ, v. 1, no. 3, p. 249-266.

(NW Asphalt Ridge), (Athabasca), This paper includes the following: Abstract; Introduction; Summary of selected field pilot test (Bellamy field, Northwest Asphalt Ridge, Athabasca, Oxnard field, Cold Lake, Peace River); General comments on current efforts; Economic considerations (combustion, cost of wells, cost of surface piping, steam, cost of upgrading); Economic considerations for resource requirements; Conclusions; Acknowledgment; References.

Auld, T.W., 1976, Facies analysis of the Virgin Limestone Member, Moenkopi Formation, northwest Arizona and southwest Utah: Flagstaff, Northern Arizona University M.S. Thesis, p. 64-69.

(No Specific Deposits), The petroleum potential section of this thesis contains; Introduction; Source rock; Thermal maturation; Migration paths; Reservoir rocks; Traps; Erosional problems; Future exploration targets in the Virgin Limestone.

Baillie, R.A., Schmoyer, L.F., and Skarada, T.E., 1976, Process for recovering hydrocarbons and heavy minerals from a tar sand hot water process waste stream: United States Patent 3,990,885, 7 p.

(Patent), (No Specific Deposit), A method for removing bitumen from mineral particles recovered from bituminous froth recovered as a product of aqueous extraction of tar sands which method comprises scrubbing the minerals with a liquid hydrocarbon solvent containing at least 10 weight percent aromatics and thereafter seqarating the minerals from the solvent and subsequently drying the minerals. Seven claims, two drawing figures.

Ball Associates Ltd. (compilers), 1965, Surface and shallow oil-impregnated rocks and shallow oil fields in the United States: U.S. Bureau of Mines Monograph 12, 375 p.

(Numerous Utah Deposits), This book discusses the surface and shallow petroleum-impregnated rock deposits, county by county, for the State of Utah. With this publication being a very early work, the data are rather sketchy, being a bit more complete on the major or better-known deposits.

Ball, Douglas, 1982, United States tar sands, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC Monograph Series—Tar Sands: Oklahoma City, Interstate Oil Compact Commission, p. 13-17.

(No Specific Deposits), This paper contains: Introduction to tar sands; Very brief discussion of reserves; Interest in tar sands and compilation of data; Penetration charts; Discussion of deposits by age.

Ball, J.O., 1944, Survey of bitumen analyses and extraction methods: Golden, Quarterly of the Colorado School of Mines, v. 39, no. 1, p. 68-115.

(Asphalt Ridge), This selection contains: Introduction; Oil shale (history and reserves); Oil content of shale; Cost of proposed mining methods; Physical and chemical properties of oil shale; Solubility of shale; Analyses of oil shale; Carbon-hydrogen ratio of shale oil; Retorting of oil shale; Cracking of oils; Laboratory retorting and tests; Constituents of shale oil; Products from shale; Some hydrocarbons from the Uinta Basin (gilsonite, wurtzilite, ozocerite); Bituminous sands of Vernal, Utah and the bitumen extracted from them; Recent investigations; Laboratory method of isolating constituents; Analyses by the author; Deductions; Suggested uses; Bibliography. (**Reference in Utah Department of Natural Resources Library)**

Ball, Max 1951, The synthetic liquid fuel potential of Utah, *in* Oil-impregnated strippable deposits in Utah (Appendix D): U.S. Bureau of Mines, variously paginated.

(Whiterocks), (Asphalt Ridge), (Sunnyside), (P.R. Spring), (Gilsonite), This appendix D includes the following: Summary; Introduction (authorization and purpose, scope, sources of information, definitions, geography, and geology); General areas of raw material availability (Sunnyside deposit, P.R. Spring deposit); Conclusions; Bibliography. Max Ball was with Ford, Bacon & Davis Engineers.

Banks, E.Y., 1981, Petrographic characteristics and provenance of fluvial sandstone, Sunnyside oil-impregnated sandstone deposit, Carbon County, Utah: Salt Lake City, University of Utah, M.S. Thesis, 93 p.

(Sunnyside), This thesis includes the following: Abstract; Acknowledgments; Introduction (definitions, procedure, location, previous work, paleogeographical setting); Stratigraphy (thickness, age, fossils, correlation); Petrology (texture, composition, quartz, feldspar, rock fragments, heavy minerals, allochemical constituents, cement, porosity and bitumen, relationship between texture and bitumen); Diagenesis; Paleocurrent analysis; Depositional environments; Provenance; Conclusions; Appendix A (refluxion procedure); Appendix B (results of microprobe analysis of detrital feldspar); References.

Barb, C.F., 1942, Rubber from the Uinta Basin of Utah: The Mines Magazine, v. 32, no. 10, p. 521-524.

(Asphalt Ridge), (Whiterocks), This article contains a general description of the Uinta Basin, its geology, gilsonite, tar sands (Asphalt Ridge and Whiterocks), argulite, albertite, wurtzilite, ozokerite, and a list of references.

Barb, C.F., and Ball, J.O., 1944, Hydrocarbons of the Uinta Basin of Utah and Colorado: Golden, Quarterly of the Colorado School of Mines, v. 39, no. 1, p. 1-65.

(Asphalt Ridge), This selection contains: Introduction; Geology; Oil shales; Coal; Oil and gas; Bituminous sands of Vernal, Utah (references, geography, and geology, bituminous deposit at Vernal, mining operations, uses, markets); Bibliography; Appendix (well logs, cost estimate for 300-barrel plant).

Barbour, R.V., Dorrence, S.M., Vollmer, T.L., and Harris, J.D., 1976, Pyrolysis of Utah tar sands – products and kinetics: American Chemical Society, Division of Fuel Chemistry, v. 21, no. 6, p. 278-283.

(NW Asphalt Ridge), (P.R. Spring), (Tar Sand Triangle), (Sunnyside), (Athabasca), This paper includes the following: Introduction; Experimental (tar sand samples, pyrolysis experiments, kinetic experiments); Results and discussion (pyrolysis products, pyrolysis kinetics); Summary; References; Five tables and two figures.

Barbour, F.A., and Guffey, F.D., 1980, Organic and inorganic analysis of constituents in water produced during in situ combustion experiments for the recovery of tar sands: American Society for Testing and Materials, special technical publication, v. 720 (symposium on analysis of waters associated with alternative fuel production, Pittsburgh, PA), 26 p.

(NW Asphalt Ridge), This report contains the following: Abstract; Introduction; Experimental (experimental site, collection of water samples, separation and identification of organic components); Results and discussion (water quality analysis, trace element analyses); Summary; References; Ten tables and one figure.

Bardwell, Carlos, Berryman, B.A., Brighton, T.B., and Kuhre, K.D., 1913, The hydrocarbons of Utah: Journal of Industrial and Engineering Chemistry, v. 5, no. 12, p. 1-9.

(Numerous Utah Deposits), About fifteen kinds of hydrocarbons occur in Utah; the five of these occurring most abundantly – gilsonite, tabbyite, wurtzilite, ozocerite, and rock asphalt - are the ones selected for this investigation. The contents of this paper include: Introduction; Historical; Uses of Utah hydrocarbons; Experimental results; Conclusions.

Barrett, R.J., 1980, Projected cost of the combustion process in Utah tar sand: Systems analysis and assessment

division, Los Alamos Scientific Laboratory (Presented at the Spring Meeting of the Interstate Oil Compact Commission, Vail, Colorado, June 16), 14 p.

(No Specific Deposit), This paper includes the following: Introduction; The combustion process; Assumptions; Cost calculations; Process cost – breakdown and sensitivity; Crude oil price; Conclusions; References.

Bassler, Harvey, and Reeside, J.B., Jr., 1921, Oil prospects in Washington County, Utah, *in* White, David, and Campbell, M.R., editors, U. S. Geological Survey Bulletin 726, p. 87-107.

(No Specific Deposits), This chapter includes the following: Introduction; Geology (stratigraphy, structure); Oil prospects in the district east of the Hurricane fault (field near Virgin, other favorable locations, higher oil sand, prospects for future production); Oil prospects in the district west of the Hurricane fault (Virgin anticline, other anticlines, evidences of oil, ground water, prospects of commercial production); Difficulties of exploration; Recommendations for drilling.

Bell, K.G., 1960, Uranium and other trace elements in petroleum and rock asphalts: U.S. Geological Survey Professional Paper 356-B, p. 45-65.

(Asphalt Ridge), (Sunnyside), (P.R. Spring), This paper contains: Abstract; Introduction; Definitions; Sources of samples and sampling methods; Analytical procedures; Distribution of uranium in petroleum and natural asphalts; Significance of uranium content of petroliferous substances; Sources of uranium; Mode of occurrence of uranium; Hypothetical role of petroleum in the genesis of uranium deposits in sedimentary rocks; Uraniferous organic substances; Petroleum and rock asphalts as source materials for uranium, References, Index.

Bell, K.G., and Hunt, J.M., 1963, Native bitumens associated with oil shales, *in* Breger, I.A, editor, Organic Geochemistry: New York, Pergamon Press, p. 333-366.

(Sunnyside), (P.R. Spring), (Asphalt Ridge), (Raven Ridge), (Gilsonite), This article contains: Introduction; Oil Shales; Characteristics of some oil shale bitumens; Bitumen deposits; Composition of the bitumens of the Uinta Basin; References.

Berry, C.J., 1977, Problems facing tar sand development: The Interstate Oil Compact Commission Committee Bulletin, v. 19, no. 1, p. 60-63.

(Tar Sand Triangle), This article discussuses: the major problems facing the development of known heavy oil deposits, particularly those located in the south-central part of Utah.

Bezama, R.J., 1983, An energy-efficient method for thermal processing of Utah tar sands: Salt Lake City, University of Utah Ph.D. Dissertation, 244 p.

(No Specific Deposits), This dissertation contains: Abstract; Notation; Acknowledgments; Introduction; Objectives; Background and process development in thermal processing of tar sands (literature review, previous developments of the University of Utah thermal process, new developments of the University of Utah thermal process); Thermodynamic analysis of thermal recovery (the basic equations, the pyrolysis reactor, the combustion reactor, transferring energy from the combustion reactor to the pyrolysis reactor); Development of a dynamic model (the conservation equation for a heat exchanger stage, the conservation equations for the reactor stage, five-stage dynamic model, the heat pipe model, the solid flow/valve-controller model, simplified energy model); Equipment and experimental procedure (description of the laboratory unit, description of the data acquisition system, data management); Results and discussion (dynamic characterization of the laboratory unit, thermal dynamic simulation using the two-stage energy model, stability of the proposed process, data analysis using the five-stage model); Conclusions and recommendations; Appendices (thermodynamic data base for thermal processing of tar sands, five-stage model program, steady-state simulator program for the maximum heat flow in a potassium heat pipe, mass flow simulator program, two-stage energy model applied to the University of Utah

laboratory unit, listing of data acquisition algorithm, program listing of data processing and display); References.

Bidlack, D.L., no date, Systems analysis of two stage thermal recovery of oil from tar sands using heat pipes: Laramie, EG&G Washington Analytical Services Center, Inc., 83 p.

(Sunnyside), (Whiterocks), (P.R. Spring), This report contains the following: Summary; Introduction; Two stage thermal recovery of oil from tar sands using heat pipes process description; Sensitivity analysis; Conclusions; References; Appendix A – Experimental test results; Appendix B – ASPEN coding for sensitivity run HP69; Appendix C – ASPEN coding for sensitivity run HP61; Appendix D – Fortran listing for program to calculate minimum and maximum superficial velocity in a fluidized bed; Appendix E – Material and energy balance for sensitivity run HP 69; Appendix F – Results of sensitivity analysis.

Bishop, C.E., 1985, A reconnaissance evaluation of heavy hydrocarbons in the Tar Sand Triangle, Utah: Utah Geological Survey unpublished document, 37 p.

(Tar Sand Triangle), (White Canyon), (Poison Spring Canyon), This publication includes the following: Abstract; Introduction to the area; Method of study; Geologic history and structure; Stratigraphy; Use of well logs; Properties of heavy hydrocarbons; Economic geology (including sections on White Canyon, Poison Spring Canyon, and unnamed minor occurrences); Surface mining; In-situ recovery; Summary and conclusions; References. Table 1 gives the mass fraction of the bitumen (oil and water), grain density, natural bulk density, and gallons per ton.

Bishop, C.E., 1992, Report on geological potential of the areas adjacent to the proposed Ouray-Interstate 70 highway: Utah Geological Survey unpublished report, 12 p.

(P.R. Spring), (Hill Creek), This report contains: Introduction; Geological setting; Tar Sands (P.R. Spring, Hill Creek, potential and previous work); Oil shale; Natural gas; Coal and coalbed methane (Sego coal field); Other resources (Gilsonite, minerals); Summary; References.

Bishop, C.E., and Tripp, B.T., 1993, An overview of tar sand of Utah: Utah Geological Survey unpublished report, 28 p.

(Numerous Utah Deposits), This publication contains: Introduction; Development; Geochemical characterization; Special tar sand areas; Ownership of tar sand lands; Leasing state tar sand lands; Selected bibliography. This publication reviews 35 deposits. Table 1 gives the formations, dominant lithologies, and the range of resource estimates. Figures 2-7 show the locations and relative sizes of the deposits, and geological cross-sections of the Asphalt Ridge, Sunnyside, Whiterocks, Tar Sand Triangle, and Circle Cliffs deposits. Figure 8 and table 2 give the tar sand development efforts in Utah. Figures 9 and 10 give the geochemical characteristics of Asphalt Ridge and Tar Sand Triangle bitumen. Table 3 gives ownership of tar sand lands within Special Tar Sand Leasing Areas of Utah.

Blackett, R.E., 1996, Tar-sand resources of the Uinta Basin, Utah (a catalog of deposits): Utah Geological Survey Open-File Report 335, 122 p.

(Numerous Utah deposits), This publication contains: Abstract; Introduction; Physical environment; Geology; Summaries of principal tar-sand deposits (Asphalt Ridge, NW Asphalt Ridge, P.R. Spring, Hill Creek, and Sunnyside); Summaries of secondary tar-sand deposits (Argyle Canyon, Chapita Wells, Cow Wash, Daniels Canyon, Lake Fork, Littlewater Hills, Minnie Maud Canyon, Nine-Mile Canyon, Oil Hollow, Pariette, Raven Ridge, Rimrock, Split Mountain, Spring Branch, Spring Hollow, Tabiona, Thistle Area, Upper Kane Hollow, Whiterocks, Whiterocks South, and Willow Creek); Acknowledgments; References.

Blaine, N. F., 1977, Solvent extraction of oil from tar sands utilizing a chlorinated ethane solvent: United States Patent 4,057,485, 3 p.

(Patent), (No Specific Deposit), Oil is efficiently solvent extracted from tar sands using a trichloroethane solvent at mild conditions. The process preferably includes minor amounts of surfactant and polyelectrolytes. The process has resulted in unexpectedly high yields of oil with unexpectedly low solvent loss. Three claims, no drawings.

Blakey, R.C., no date, Oil-impregnated deposits of the Hurricane area and local carbonate petrology of the Timpoweap Member of the Moenkopi Formation, Utah and Arizona: Utah Geological Survey unpublished report, 19 p.

(Timpoweap Canyon), (Gould Ranch), (Hurricane Cliffs), (Tar Baby Mine), (North Creek), (Black Rock Canyon), This report contains: Abstract; Introduction; Petroliferous rocks and deposits (Timpoweap Canyon, Gould Ranch, Hurricane Cliffs, Tar Baby mine, North Creek, Black Rock Canyon, other possible occurrences of hydrocarbons); Lithosome analysis of the Timpoweap Member (basal conglomerate, algal carbonate, recrystallized dolomite, skeletal and oolitic calcarenite, facies analysis); Conclusions; References cited.

Blakey, R.C., 1973, Stratigraphy and origin of the Moenkopi Formation (Triassic) of southeastern Utah: The Mountain Geologist, v. 10, no. 1, p. 1-17.

(San Rafael Swell), (Circle Cliffs), This publication contains: Introduction; Stratigraphy (regional relationships, regional stratigraphy of southeastern Utah); Depositional environments (Hoskinnini episode, lower marine and paralic episode, deltaic episode, upper marine and paralic episode); pre-Chinle erosion; Conclusions; Acknowledgments; References.

Blakey, R.C., 1977, Petroliferous lithosomes in the Moenkopi Formation, southern Utah: Utah Geology, v. 4, no. 2, p. 67-84.

(San Rafael Swell), (Circle Cliffs), This article contains: Abstract; Introduction; Stratigraphy and origin of Moenkopi Formation (regional Triassic tectonics, Black Dragon Member, Sinbad and Timpoweap Members, Torrey Member and equivalents, Moody Canyon Member and equivalents, distribution of red and non-red rocks); Hydrocarbons in the Moenkopi Formation (distribution and origin – Black Dragon Member, Sinbad and Timpoweap Members, Torrey Member, possible sources of Moenkopi hydrocarbons, areas of future exploration); Conclusions; References.

Blakey, R.C., 1979, Oil impregnated carbonate rocks of the Timpoweap Member, Moenkopi Formation, Hurricane Cliffs area, Utah and Arizona: Utah Geology, v. 6, no. 1, p. 45-53.

(Timpoweap Canyon), (Gould Ranch), (Hurricane Cliffs), (Tar Baby Mine), (North Creek), (Black Rock Canyon), This paper includes the following: Abstract; Introduction; Petroliferous rocks and deposits (Timpoweap Canyon, Gould Ranch, Hurricane Cliffs, Tar Baby mine, North Creek, Black Rock Canyon, other possible occurrences of hydrocarbons); Lithosome analysis of the Timpoweap Member (basal conglomerate, algal carbonate - birdseye pisolite calcarenite, recrystallized dolomite - dolomitic micrite and dolomitic siltstone, skeletal and oolitic calcarenite - oolitic fossiliferous calcarenite, facies analysis); Conclusions, References.

Blakey, R.C., and Berninni, Dave, 1970, Preliminary report of oil impregnated sediments of the San Rafael Swell: Utah Geological Survey unpublished report based on field work, 14 p.

(San Rafael Swell), (Black Dragon), (Jackass Bench), (Cottonwood Draw), (Red Canyon), (Family Butte), This report contains: Introduction (purpose of work, location); Stratigraphy (Permian System - White Rim Sandstone, Kaibab Limestone); Triassic System (Moenkopi Formation, Chinle Formation); Triassic and Jurassic Systems - Glen Canyon Group (Wingate Sandstone, Kayenta Formation, Navajo Sandstone); Petroliferous deposits (Black Dragon - location, stratigraphy, geometry, and significance), (Jackass Bench and Cottonwood - location, stratigraphy and geometry, significance), (Red Canyon - location, stratigraphy, significance), (Family Butte - location, stratigraphy, and significance); Other areas of petroleum occurrence (Straight Wash, Sulphur

Springs, Muddy River, and Copper Globe); Addition to Black Dragon deposit - Sulphur Springs; The Chute deposit (location, stratigraphy, and significance).

Blakey, R.C., and Quigley, Sam, no date, Report of oil-impregnated sandstone in the Hoskinnini of the White Canyon area, Utah: Utah Geological Survey unpublished report.

(White Canyon), This report includes the following: Location; Stratigraphy; Description of the deposit.

Bon, R.L., and Bishop, C.E., 1995, Energy News - Welcome to the 90s! - Is tar sand development part of our future?: Utah Geological Survey Survey Notes, v. 27, no. 2, p. 6.

(Asphalt Ridge), This article discusses the Buena Ventura Resources demonstration plant at Asphalt Ridge.

Bostwick, J.M., (revised by Bradbury, J.C.), 1983, Bituminous materials, *in* Lefond, S.J., editor-in-chief, Industrial Minerals and Rocks (non-metallics other than fuels, fifth edition, v. 1: New York, Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., p. 529-532.

(No Specific Deposits), This article includes: Petroleum asphalts; Native asphalts; Asphaltites (gilsonite, grahamite, glance pitch); Mineral waxes (ozokerite, montan wax); Pyrobitumens (wurtzilite, elaterite, albertite, impsonite); References.

Boutwell, J.M., 1904, Oil and asphalt prospects in Salt Lake Basin, Utah, *in* Emmons, S.F., and Hayes, C.W., editors, Contributions to economic geology: United States Geological Survey Bulletin 260, p. 468-479.

(Rozel Hills), This article contains: Introduction; General geography and geology; Oil; Asphalt (Rozel Hills); Miscellaneous prospects; Conclusions.

Bowman, J.L., 1969, Oil-impregnated sandstone between Dirty Devil and Colorado and Green Rivers, Garfield and Wayne Counties, Utah: American Association of Petroleum Geologists Bulletin, v. 53, p. 218.

(Tar Sand Triangle), Paper gives text of the talk, but there are no images of the slides that were shown except for two maps in the back that show the contents of slide two (geologic map), and slide 11 (isopach map).

Branthaver, J.F., and Dorrence, S.M., 1978, Organometallic complexes in domestic tar sands, in Uden, P.C. and Siggia, Sidney, editors, Analytical chemistry of liquid fuel sources: American Chemical Society, Advances in Chemistry series, 170, p. 143-149.

(Numerous Utah Deposits), (Athabasca), This article contains the following: Abstract; Introduction; Experimental; Results and discussion; Conclusions; Literature cited.

Branthaver, J.F., Thomas, K.P., Dorrence, S.M., Heppner, R.A., and Ryan, M.J., 1983, An investigation of waxes isolated from heavy oils produced from northwest Asphalt Ridge, *in* Speight, J.G., editor, Liquid Fuels Technology: New York, Marcel Dekker, Inc., v. 1, no. 2, p. 127-146.

(NW Asphalt Ridge), This paper contains the following: Abstract; Introduction; Experimental (origin of samples, further processing of materials TSCF-77-15 and -16, materials, spectroscopic methods); Results and discussion; References, Eight figures and one table.

Brechtel, C.E., 1981, Hydrotreating Utah tar sand products: Salt Lake City, University of Utah M.S. Thesis, 102 p.

(Asphalt Ridge), This thesis contains: Abstract; Acknowledgments; Introduction and objectives; Literature review (the hydrotreating process, process variables, catalysts, HDN kinetic considerations, the role of primary product hydrotreating, bitumen and product characteristics); Experimental procedure (stirred batch autoclave, trickle bed reactor, experimental methodology, analysis); Results and discussion (autoclave process variable survey, catalyst comparison study, KDN kinetics study in the trickle bed reactor, feedstock hydrotreating response comparison); Conclusions; Appendices (temperature-time profile for a typical autoclave run, trickle bed reactor catalyst bed temperature profile, preliminary deactivation study, coking run, error analysis); References.

Bridges, J.E., Sresty, G.C., and Dev, Harsh, 1985, In-situ RF heating for oil sand and heavy-oil deposits: Chicago, IIT Research Institute unpublished report, 11 p.

(NW Asphalt Ridge), This report contains: Summary; Background; Conduction heating applications; Heating pattern studies; Laboratory scale-model tests; In-situ upgrading; Reservoir pressurization; Facility configuration; Economic factors; Acknowledgments; References.

Bridges, J.E., Sresty, G.C., Taflove, A., and Snow R.H., 1979, Radio-frequency heating to recover oil from Utah tar sands, *in* Meyers, R.F. and Steele, C.T., editors, The future of heavy crude oils and tar sands: New York, Mining Informational Services, McGraw-Hill, Inc., p. 396-409.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Hill Creek), (Asphalt Ridge), This article contains: Abstract; Introduction; The Utah tar sand resource; The RF heating concept (past attempts, deposition efficiency, the RF heating step of the IITRI process, RF properties of Utah tar sands, large sample RF heating studies); The recovery step of the IITRI process (fluid replacement, gravity drive); Net energy ratio analysis; Economic considerations; Conclusions; Acknowledgment; References.

Bridges, J., Sresty, G., Taflove, A., Genge, M., Snow, R., and Kornfeld, J., 1980, RF heating of Utah tar sands (Final report for the period October 1978 to December 1979). Work was done under DOE contract No. DE-AT02-76CH90035): Chicago, IIT Research Institute, variously paginated.

(Sunnyside), This report contains the following: Acknowledgement; Foreword; Abstract; Tables and figures; Introduction; The Utah tar sand resource; The RF heating concept (historical background, deposition efficiency, the RF heating step); RF properties of Utah tar sands; Heating uniformity and energy containment; Production options for the RF process (fluid replacement, gravity drive); Net energy ratio analysis; Economic considerations; References; Appendix I – construction of RF reactors; Appendix II – Resource sample collection; Parameter measurements; RF viscosity reductions and fluid displacement recovery; Tar sands fuel recovery by pyrolysis and gasification of residual chars; RF viscosity reduction by in-situ combustion recovery; Energy deposition efficiency; Large sample laboratory demonstration; Appendix III – Energy, economics and environment; Summary; Net energy recovery; The resource; Process description; Site description; Economic assumptions and criteria; Capital investment requirements; Operating costs; Total costs of bitumen recovery; Unique environmental aspects; Exhibit A – AC and RF energy requirements and costs; The RF electrical system and electrodes; Exhibit B – AC power equipment and cost study; Exhibit C – Capital equipment-gravity drainage; Exhibit D – Mining and drilling costs; Description of the mining plan; Costs; Exhibit E – Preliminary design and capital costs for recovery of bitumen by fluid replacement; References.

Brown, W.A., and Pasini, E.E., editors, 1989, Morgantown Energy Technology Center publications list, FY88: U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, 73 p.

(No Specific Deposits), This book includes bibliographic references to several oil shale and tar sand publications.

Bruhn, A.F., Elias, D.W., and Van De Graaf, F., 1963, Road Log No. 2 - St. George, Utah, via Zion National Park and Cedar Breaks National Monument, *in* Heylmun, E.B., editor, Guidebook to the geology of southwestern Utah – transition between Basin-Range and Colorado Plateau provinces: Intermountain Association of Petroleum Geologists, p. 207-221.

(No Specific Deposits), This report mentions an oil slick and tar sand outcrops at stops that are 29.3 and 30.1

miles from St. George towards Zions National Park, information is on page 209.

Bukka, Krishna, Hanson, F.V., Miller, J.D., and Oblad, A.G., 1992, Fractionation and characterization of Whiterocks tar sand bitumen: Energy & Fuels, v. 6, p. 160-165.

(Whiterocks), (Asphalt Ridge), (Sunnyside), This article contains: Introduction; Experimental section; Results and discussion (physical properties, fractionation, chemical characterization, molecular weights, FTIR characterization of the fractions, comparison of Uinta Basin bitumens); Conclusions.

Bukka, Krishna, and Miller, J.D., Hanson, F.V., and Oblad, A.G., 1991, Mineral matter distribution during the hot water processing of Utah tar sand: AOSTRA Journal of Research, v. 7, p. 101-109.

(Whiterocks), This article contains: Abstract; Introduction; Experimental methods (bitumen separation, ethylene glycol expansion test, acid treatment of the solids from feed, concentrate and tailings, spectroscopic characterization of solids); Results and discussion; Conclusions; Acknowledgments; References; Seven tables and seven figures.

Bukka, Krishna, Miller, J.D., Hanson, F.V., Misra, Manoranjan., and Oblad, A.G., 1994, The influence of carboxylic acid content on bitumen viscosity: Fuel, v. 73, no. 2, p. 257-268.

(Asphalt Ridge), (Sunnyside), (Whiterocks), (Athabasca), This paper contains: Abstract; Introduction; Experimental procedure (viscosity, elemental analysis and molecular weight determination, FTIR transmission and specular reflectance spectroscopy, potentiometric titrations of the resin fractions, sequential hydrolysis of the resin fractions); Results and discussion (viscosity, elemental analysis, and molecular weight, fractionation, FTIR characterization of bitumen fractions, potentiometric titrations of the resin carboxylic acids, sequential hydrolysis of the Athabasca resin fraction, SR-FTIR spectra of asphaltenes); Conclusions; Acknowledgement, References; Six tables and ten figures.

Bukka, Krishna, Miller, J.D., Hanson, F.V., and Oblad, A.G., 1994, Characterization of Circle Cliffs oil sands of Utah: Fuel Processing Technology, v. 38, p. 111-125.

(Circle Cliffs), This article contains: Abstract; Introduction; Experimental procedure; Results and discussion (mineralogical analysis, viscosity of bitumen, elemental analysis of the bitumen, fractional analysis of bitumen, infrared spectroscopic analysis, oil sand processing considerations); Conclusions; Acknowledgments; References.

Bukka, Krishna, Miller, J.D., and Oblad, A.G., 1991, Fractionation and characterization of Utah tar sand bitumens - influence of chemical composition on bitumen viscosity: Energy & Fuels, v. 5, p. 330-340.

(Asphalt Ridge), (Sunnyside), This paper gives the following: Introduction; Experimental section (materials, fractionation, elemental analysis and molecular weight determinations, ^{13}C NMR spectroscopy, FTIR spectroscopy); Results (fractionation, molecular weights, ^{13}C NMR spectroscopy, FTIR spectroscopy); Discussion, Conclusions; Acknowledgments.

Bunger, J.W., 1976, Characterization of a Utah tar sand bitumen, Chapter 10: American Chemical Society, Advances in Chemistry Series, no. 151, p. 121-136.

(P.R. Spring), This article contains: Introduction; Experimental procedure (description of bitumen sample from P.R. Spring, simulated distillation of bitumen sample, separation of the bitumen into defined fractions, analysis of defined fractions); Results and discussion (properties of the bitumen, boiling-point distribution - simulated distillation, separation of the bitumen, analysis of defined fractions); Conclusions; Acknowledgment; References.

Bunger, J.W., 1976, Characterization of a Utah tar sand bitumen, in Yen, T.F., editor, Shale oil, tar sands, and related fuel sources: American Chemical Society, Advances in Chemistry Series 151, p. 121-136.

(P.R. Spring), This paper includes the following: Abstract; Introduction; Experimental (simulated distillation of bitumen sample, separation of the bitumen into defined fractions, analysis of defined fractions); Results and discussion (properties of the bitumen, boiling point distribution – simulated distillation, separation of the bitumen, the nitrogen and sulfur analysis of defined fractions); Conclusions; Acknowledgments; Literature cited.

Bunger, J.W., 1977a, Development of Utah tar sands—a status report: Salt Lake City, University of Utah, Mines and Minerals Reporter, no. 5, 10 p.

(Asphalt Ridge), (Hill Creek), (Sunnyside), (P.R. Spring), (Circle Cliffs), (Tar Sand Triangle), This report covers the following: Introduction; Origin and reserves; Bitumen properties; Research in above-ground recovery; In-situ recovery; Processing and utilization; Commercial development; References.

Bunger, J.W., 1977b, Techniques of analysis of tar sand bitumens: American Chemical Society, Division of Petroleum Chemistry, v. 22, no. 2, p. 716-726.

(NW Asphalt Ridge), (Tar Sand Triangle), (Athabasca), This paper contains: Introduction; Extraction and recovery of bitumen; Property measurement (molecular weight determination); Separation of bitumen (primary separation techniques, secondary separation techniques, infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy); Non-spectroscopic techniques; Discussion (pages 724-725 missing).

Bunger, J.W., 1979, Processing Utah tar sand bitumen: Salt Lake City, University of Utah Ph.D. Dissertation, 217 p.

(No Specific Deposits), This dissertation contains; Abstract; Acknowledgments; Foreword; Introduction; Objectives; Background and development; Literature survey (reviews, geology and reserves, bitumen chemistry and characterization, recovery and extraction technology, processing and utilization technology, commercial operations); Experimental methods (sources and preparation of bitumen samples, physical properties and elemental analysis, bitumen and product characterization, processing and utilization, asphalt specifications); Results and discussion (reservoir characteristics and geochemistry, gross bitumen properties, molecular character of bitumen, effect of deposit source on bitumen coking, effect of variables on coking, catalytic cracking, hydropyrolysis, visbreaking, asphalt); Chemistry of conversion processes (reaction kinetics, mechanism of sequential reactions, mechanisms of concerted reactions, implications of thermal processing results to conversion mechanisms); Comparison of primary processes (analytical characterization of products, simulated distillation, compound type analysis, discussion of major utilization options); Conclusions; Appendices A-D, References, Vita.

Bunger, J.W., and Cogswell, D.E., 1979, Characteristics of tar sand bitumen asphaltenes and the effect of asphaltenes on conversion of bitumen by hydropyrolysis, *in* Bunger, J.W., and Grasselli, R.K. (co-chairmen), Symposium on the chemistry of asphaltenes, (presented before the Division of Petroleum Chemistry, Inc., American Chemical Society, Washington meeting, September 9-14): American Chemical Society, v. 24, no. 4, p. 1017-1027.

(Sunnyside), This article contains: Introduction; Experimental procedure (sample source and preparation, elemental analysis and physical properties, carbon-13 NMR spectroscopy, hydropyrolysis process), Results (feedstock characteristics, hydropyrolysis results, characterization of hydropyrolysis products, gas analysis, ^{13}C-nmr of products, simulated distillation of products); Discussion; Conclusions; Acknowledgments; Literature cited.

Bunger, J.W., and Cogswell, D.E., 1981, Characteristics of tar sand bitumen asphaltenes as studied by conversion of bitumen by hydropyrolysis, *in* Bunger, J.W., and Li, N. C., editors, Chemistry of Asphaltenes: (based on a symposium sponsored by the Division of Petroleum Chemistry at the 178th meeting of the American Chemical Society, Washington, D.C., September 10-11, 1979), p. 219-239.

(Sunnyside), This paper includes the following: Abstract; Introduction; Experimental (sample source and preparation, elemental analysis and physical properties, carbon-13 NMR spectroscopy, hydropyrolysis process); Results (feedstock characteristics, simulated distillation results, hydropyrolysis results, characterization of hydropyrolysis products, gas analysis, 13C NMR of products, simulated distillation of products); Discussion; Conclusion; Acknowledgments; Literature cited.

Bunger, J.W., Cogswell, D.E., and Oblad, A.G., 1977, Thermal processing of a Utah tar sand, in Oil Sands of Canada-Venezuela-1977, CIM Special Volume 17, p. 178-182.

(Asphalt Ridge), This paper contains: Introduction; Experimental procedure (extraction of bitumen, isothermal cracking of bitumen, visbreaking of bitumen, evaluation of properties of products); Results and discussion (characteristics of feed bitumen, destructive distillation of tar sand bitumen, isothermal cracking of Asphalt Ridge bitumen, visbreaking of Asphalt Ridge bitumen); Conclusions; Acknowledgement; References.

Bunger, J.W., Cogswell, D.E., and Oblad, A.G., 1978, Influence of chemical factors on primary processing of Utah tar sand bitumen, *in* Radding, S.B., editor, Extraction and upgrading of tar sand and oil shale liquids, U.S. Energy Policy Situation, 1978: Henry H. Storch Award Symposium, Fundamental Studies in Fuel Science: American Chemical Society – Division of Fuel Chemistry, p. 98-109.

(Asphalt Ridge), This article contains: Introduction; Experimental procedure (analytical methods, coking, catalytic cracking, hydropyrolysis); Results and discussion (coking, catalytic cracking, hydropyrolysis, simulated distillation, and separation into compound types); Acknowledgments; References, Nine tables.

Bunger, J.W., Cogswell, D.E., and Oblad, A.G., 1979, Catalytic cracking of Asphalt Ridge bitumen, *in* Gorbaty, M.L., and Harney, B.M., editors, Refining of Synthetic Crudes, based on a symposium sponsored by the Division of Petroleum chemistry at the 174th meeting of the American Chemical Society, Chicago, IL, August 29-September 1, 1977: American Chemical Society, p. 67-84.

(Asphalt Ridge), This article contains: Introduction; Experimental procedure (bitumen and product feedstocks, batch-type catalytic cracking, semi-batch catalytic cracking, product evaluation); Results and discussion (characterization of feedstock and catalysts, gravimetric results of catalytic cracking, characterization of products); Conclusions; Acknowledgments; Literature cited, Ten tables.

Bunger, J.W., Cogswell, D.E., Shaikh, M.S., and Oblad, A.G., 1977, Processing of tar sand bitumens – Part II. Catalytic cracking of Asphalt Ridge bitumen, *in* Gorbaty, M.L., and Harney, B., (co chairmen), Symposium on refining of synthetic crudes: presented before the Division of Petroleum Chemistry, Inc., Chicago meeting, August 29 to September 2, p. 1008-1012.

(Asphalt Ridge), This paper contains: Introduction; Experimental (bitumen sample, batch-type catalytic cracking, semi-batch catalytic cracking, catalyst specifications, product evaluation); Results and discussion; Conclusions; Acknowledgments; Literature cited; Four tables.

Bunger, J.W., Cogswell, D.E., Wood, R.E., and Oblad, A.G., 1981, Hydropyrolysis – the potential for primary upgrading of tar sand bitumen, *in* Stauffer, H.C., editor, oil shale, tar sands, and related materials: Washington, D.C., American Chemical Society – Symposium Series 163, p. 369-380.

(Sunnyside), (Asphalt Ridge), This paper contains: Abstract; Experimental procedure (feedstock source, elemental analysis and physical properties, hydropyrolysis process); Results; Discussion; Summary; Literature cited, Four tables and 1 figure.

Bunger, J.W., Mori, S., and Oblad, A.G., 1976, Processing of tar sand bitumens, Part I, Thermal cracking of Utah and Athabasca tar sand bitumens, *in* Radding, S.B., director of publications, Symposium on oil shale, tar sands, and related materials – production and utilization of synfuels: American Chemical Society – Division

of Fuel Chemistry, v. 21, no. 6, preprints of papers presented at San Francisco, CA, August 29-September 3, p. 147-158.

(P.R. Spring), (Asphalt Ridge), (Tar Sand Triangle), (Athabasca), This paper contains: Introduction; Experimental procedure (description of samples, description of apparatus, description of procedure, analysis of bitumen and products); Results and discussion (bitumen composition and properties, quantitative results of pyrolysis, characterization of products, discussion of results); Conclusions; Acknowledgments; References. This article contains eight tables.

Bunger, J.W., and Oblad, A.G., 1988, Upgrading of bitumen by hydropyrolysis – a process for low coke and high syncrude yields, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy Crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 1257-1262.

(NW Asphalt Ridge), This article contains: Introduction; Description of apparatus; Feedstock properties; Process results; Discussion; Conclusions; Acknowledgments; References; Three figures and four tables.

Bunger, J.W., Thomas, K.P., and Dorrence, S.M., 1979, Compound types and properties of Utah and Athabasca tar sand bitumens, *in* Fuel—the science and technology of fuel and energy: IPC Science and Technology Press Ltd., v. 58, p. 183-195.

(Tar Sand Triangle), (P.R. Spring), (NW Asphalt Ridge), This paper contains: Introduction; Experimental procedures (sources and preparation of bitumen samples, analysis of bitumens and fractions); Results and discussion (bitumen extraction and sample preparation, bitumen properties and elemental analysis, separation of bitumens into defined fractions, discussion of the infrared analyses of the fractions, analytical results of the infrared analyses of the fractions, potentiometric titration of base fractions, elemental analysis of the separated fractions, simulated distillation of hydrocarbon fractions and analysis of fractions obtained); Disclaimer, References.

Bunger, J.W., Tsai, C.H., and Russell, C.P., 1986, Competing reactions during hydropyrolysis upgrading of tar sand bitumen and residual materials, in Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 502-507.

(No Specific Deposit), This article contains the following: Abstract; Introduction; Experimental design (treatment of kinetic data); Results and discussion; Summary; Matrix of reaction conditions.

Bunger, J.W., Tsai, C.H., Ryu, Hoil, and Devineni, P.A.V., 1988, Developments in upgrading of bitumen by hydropyrolysis, *in* Meyer, R.F., and Wiggins, E.J., editors, The Fourth UNITAR/UNDP Conference on Heavy Crude and Tar Sands proceedings, nolume 5, extraction, upgrading, transportation: Alberta, Alberta Oil Sands Technology and Research Authority, p. 171-176.

(Asphalt Ridge), This article contains: Abstract; Introduction; Background chemistry; Reaction pathway and kinetics (small-bore, semi-continuous reactor, two-liter/hour process development unit (PDU), tar sand feedstock, Wilmington distillate), Results (hydropyrolysis of Wilmington distillate, hydrogen consumption and utilization, HP-PDU studies); Commercial aspects; Summary; References.

Bunger, J.W., Tsai, C.H., Ryu, Hoil, and Devineni, P.A.V, 1989, Developments in upgrading of bitumen by hydropyrolysis, *in* Myer, R.F., and Wiggins, E.J., editors, The fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands proceedings, volume 5, extraction, upgrading, and transportation: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 169-176.

(Asphalt Ridge), This article contains: Abstract; Introduction; Background chemistry; Reaction pathway and kinetics; Apparatus and materials (small bore semi-continuous reactor, two liter/hour process development unit (PDU), tar sand feedstock, Wilmington distillate); Results (hydropyrolysis of Wilmington distillate, hydrogen consumption and utilization); HP-PDU studies; Commercial aspects; Summary; References; Two tables and five figures.

Bunger, J.W., and Wells, H.M., 1981, Economic evaluation of oil shale and tar sand resources located in the State of Utah (Phase 1, Final Report): Salt Lake City, University of Utah, Utah Engineering Experiment Station, 220 p.

(P.R. Spring), This book includes the following: Introduction; Economic model; Information and retrieval system; Resource characterization; Acknowledgments; References. Appendices include; description and operating instructions for computer valuation program DOSLØL, basis for cost estimating for model evaluation, operating procedure from a terminal, operating procedure from card deck, work sheet pro formas for database, program listing, codes for data identification, tar sand reserves - P.R. Spring deposit, and state lands containing oil shale and tar sand resources.

Bunger, J.W., Wells, H.M., and Jensen, G.F., 1982, Economic evaluation of oil shale and tar sands resources located in the state of Utah: Salt Lake City, University of Utah, Utah Engineering Experiment Station, 20 p.

(No Specific Deposits), This report includes the following: Introduction; Data acquisition; Development of computer base and evaluation model (the computer system, the base module, reserves module); Cost estimation module (mining costs, tar sand bitumen recovery and upgrading costs, the variable module); Application to state issues (leasing fees, royalties and bonuses, impact of taxation or regulation, delineation of leasing tracts, socio-economic impact assessment); Conclusion; Acknowledgments; Appendix.

Bunger, J.W., Wiser, J.W., Russell, C.P., and Devineni, P.A.V., 1989, Asphalt from Utah tar sands – a JWBA project sponsored by the U.S. Department of Energy, *in* Lazar, D.J., editor, 1989 Eastern Oil Shale Symposium proceedings (November 15-17, 1989, Mariott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 79-85.

(Asphalt Ridge), (P.R. Spring), (Sunnyside), (Whiterocks), This paper includes the following: Abstract; Introduction; Results of feasibility study (Technology, resource, market, financial analysis); Technical discussion of phase-II project (resources, mining, extraction, process development unit, project optimization); Commercial development plan; References; Six figures.

Byrd, W.D., II, 1967, Geology of the bituminous sandstone deposits, southeastern Uinta Basin, Uintah and Grand Counties, Utah: Salt Lake City, University of Utah M.S. Thesis, 45 p.

(P.R. Spring), This thesis addresses the following: Abstract; Acknowledgments; List of illustrations; Introduction (location, topography, extent of the area, accessibility, purpose, previous work, methods of study); Stratigraphy (general statement, Tertiary), Tertiary structure; Bituminous saturation (tar seeps); Fortran IV application; Economic features; Conclusions; References; Vita. It also includes 38 measured sections distributed throughout the P.R. Spring area. Table 1 gives outcrop sample analyses, including: sample depth, permeability before and after extraction, porosity, residual liquid saturation (percent volume, pore, and weight of oil), total water as percent of pore space, and gallons per ton), for 33 samples. Table 2 gives core analysis results including the following: depth, permeability, porosity, and residual saturation percent pore of oil and water. Table 3 gives the history of gas wells drilled on anticlinal structures in the southeastern Uinta Basin.

Byrd, W.D., II, 1970, P.R. Spring oil-impregnated sandstone deposit, Uintah and Grand Counties, Utah: Utah Geological and Mineralogical Survey Special Studies 31, 34 p.

(P.R. Spring), See Byrd (1967) for materials included in this publication.

Calkin, W.S., 1981, Geologic summary report of the Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 64 p.

(Sunnyside), This report includes the following: Summary and conclusions; Recommendations; Introduction; Geographic setting (location, access, infrastructure); Land status; Standard Oil Company (Indiana) property; Regional environment considerations; History and previous work; Regional geology (San Rafael Swell, Uinta Basin); Geology of the project area (Green River Formation, Sunnyside delta complex, Parachute Creek Member, Garden Gulch Member, Douglas Creek Member); References; Appendix.

Calkin, W.S., 1982, Geologic summary report of the 1981 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 81 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendations; Introduction; Geographic setting (location, access, infrastructure); Land status; Environment considerations; History and previous work; Regional geology (San Rafael Swell, Uinta Basin – Piceance Creek area, southeast Uinta Basin, Sunnyside area, western Uinta Basin, oil and gas fields); Geology of the project area (preview, Green River Formation, Parachute Creek Member, Garden Gulch Member, Douglas Creek Member, Sunnyside delta complex, tar sands); References; Appendix.

Calkin, W.S., 1983, Geologic summary report of the 1982 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 127 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendations; Introduction; Geologic setting (location, access, infrastructure); Land status; Environmental considerations; History and previous work; Regional geology (San Rafael Swell, Uinta Basin – Piceance Creek area, southeast Uinta Basin, Sunnyside area, western Uinta Basin, oil and gas fields); Geology of the project area (preview, Green River Formation, Parachute Creek Member, Garden Gulch Member, Douglas Creek Member, Sunnyside delta complex, tar sands, shales, rock mechanics); Deltaic environments; Sunnyside delta complex (Bruin Point subdelta, Dry Canyon subdelta, Whitmore Canyon subdelta, Lake Uinta, biostratigraphy); Geophysics (gamma-density-caliper, multi-channel sonic, focused electric, tar sand analysis, electric log interpretation); References; Appendix (photos, figures, tables).

Calkin, W. S., 1983, Geologic summary report of the 1982 exploration program, Sunnyside tar sand project, Carbon County, Utah: Unpublished report for the AMOCO Minerals Company, Volume II, Englewood, Colorado, 2 p.

(Sunnyside), This volume contains a list of maps (land, tar sand isopach, regional, geologic map north half, geologic map south half, survey control map, geologic baseline strike sections, geologic 4,000 NE strike sections, geologic dip sections).

Calkin, Wm. S., 1983, Geologic summary report of the 1982 exploration program, Sunnyside tar sand project, Carbon County, Utah: Unpublished report for the AMOCO Minerals Company, Volume III, Englewood, Colorado, 2 p.

(Sunnyside), This volume contains a list of columnar sections (measured sections 12-17, and Amoco Drill Hole 27-48).

Calkin, W.S., 1985, Geologic summary report of the 1984 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 166 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendations; Introduction; Geologic setting (location, access, and infrastructure); Land status; Environmental considerations; History and previous work; Regional geology (San Rafael Swell, Uinta Basin – Eocene Lake Uinta, Piceance Creek basin, southeast Uinta Basin, western Uinta Basin, northeast Uinta Basin, oil and gas fields, Sunnyside area); Geology of the project area (preview, structure, Green River Formation, Parachute Creek Member, Garden Gulch Member, Douglas Creek Member, tar sands overview, depositional environments, tar zones, base of tar sands, grain size and mineralogy, porosity and permeability, shales, limestones, fossils and paleoclimate, rock mechanics); Deltaic environments; Sunnyside delta complex (Bruin Point subdelta, Dry Canyon subdelta, Whitmore Canyon subdelta); Geophysics (gamma-density-caliper, multi-channel sonic, focused electric, tar sand analysis, electric log interpretation); References; Appendix (photos, figures, tables).

Calkin, W.S., 1987, Geologic summary report of the 1986 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 90 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendations, Introduction; Geographic setting (location, access); Regional geologic setting; Geology of project area (structure, Green River Formation – Parachute Creek, Garden Gulch, and Douglas Creek Members, Sunnyside Delta complex – Bruin Point, Dry Canyon, and Whitmore Canyon subdeltas); Peripheral hydrocarbon leases; Measured section synthesis; Tar sands; Surface geophysics; References, Appendices (photos, figures, tables).

Calkin, W.S., 1988, Geologic summary report of the 1987 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 152 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendation; Introduction; Geographic setting (location, access); Regional setting (geology, geophysics – aeromagnetics, gravity, seismic); Geology of project area (structure, Green River Formation - Parachute Creek, Garden Gulch, and Douglas Creek Members, Sunnyside delta complex – Bruin Point, Dry Canyon, and Whitmore Canyon subdeltas, shales, carbonates; Tar sands (sheet sands and channel sands, depositional environments, sedimentary structures, lag deposits, textures, mineral composition, interpretation); Measured section and drill core synthesis (measured sections 1-56, measured sections 45-56, relogged drill core); Surface gamma ray logs; Peripheral hydrocarbon leases; References; Appendix (photos, figures, tables).

Calkin, W.S., 1989, Geologic summary report of the 1988 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, 157 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendation; Introduction; Geographic setting (location and access); Land status; Regional setting (geology, geophysics – aeromagnetics, gravity, seismic); Geology of project area (structure – structure contour map of blue marker, Green River Formation, Sunnyside delta complex); Tar sands (maps and sections, sheet sands and channel sands, depositional environments, interpretation); Drill hole and measured section synthesis (drill hole data, measured section data); Well logs (gamma-density-caliper, multi-channel sonic, focused electric, tar sand analysis, well log interpretation); Surface gamma ray logs, References, Appendices (photos, figures, tables).

Calkin, W.S., 1990, Geologic summary report of the 1989 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, 189 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendation; Introduction; Geographic setting (location, access); Land status; Historical perspective and project chronology; Regional setting (geology, structural setting, regional framework, geophysics – aeromagnetics, gravity, seismic); Geology of project area (structure – Mt. Bartles-Bruin Point flexure, structure contour map of blue marker, Green River Formation – Parachute Creek Member, Garden Gulch Member, Douglas Creek Member, Sunnyside delta complex – Bruin Point, Dry Canyon, and Whitmore Canyon subdeltas, shales and limestones, rock data – porosity and permeability, compressive strength); Tar sands (maps and cross sections, sheet sands and channel sands, depositional environments, interpretation); Drill hole and measured section synthesis; Well logs; Surface gamma ray logs; Geochemistry (kerogen type, project evidence, formation of oil shale, biodegradation of bitumen, thermal maturity); References; Appendices (photos, figures, tables).

Calkin, W.S., 1991, Geologic summary report of the 1990 exploration program, Sunnyside tar sands project, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, 133 p.

(Sunnyside), This report contains: Summary and conclusions; Recommendations; Introduction; Location and infrastructure (Price, Sunnyside, Bruin Point areas, water, coal mines in Sunnyside area); Geology (Mancos Shale, Blackhawk Formation, Castlegate Sandstone, Price River Formation, North Horn Formation, Flagstaff Limestone, Colton Formation, Green River Formation – Parachute Creek, Garden Gulch, and Douglas Creek Members); Tar sands (general, controls, correlation, tar zone isopachs – upper, middle, lower, bottom groups, interpretation, synopsis); Measured sections; Structure (Book Cliffs, Roan Cliffs); Engineering geology (major and minor factors, conveyor routes); References; Appendix (photos, figures, tables).

Cameron Engineers, 1974, Fairbrim & Arizona Fuels to begin oil sands recovery tests on Sohio property in Utah: Synthetic Fuels, p. 3-26 to 3-29.

(Asphalt Ridge), This article includes the following: Introduction; Water rights; Data indicate low grade reserves; Arizona Fuels and Fairbrim historically related; Comment. Also has three figures and one data table.

Camp, F.W., 1982, Technology of the recovery of values from tar sands, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, Tar sands: The Interstate Oil Compact Commission, p. 97-121.

(Asphalt Ridge), (Sunnyside), This paper includes the following: In-situ processes (thermal methods of recovery, combination of forward combustion and water flood [COFCAW process], emulsion-steam drive process, and nuclear stimulation), Mining; Processing of mined tar sands for bitumen recovery (anhydrous solvent extraction process, cold water separation processes, and the hot water process), Upgrading the value of bitumen (froth cleanup processes, conversion, visbreaking, hydrovisbreaking, and refining of bitumen: - distillate treatment).

Campbell, J.A., 1975a, Oil-impregnated sandstone deposits of Utah: Utah Geological and Mineral Survey Reprint 99 (reprinted from Mining Engineering, v. 27, no. 5, May 1975, p. 47-53).

(Tabiona), (Whiterocks), (Asphalt Ridge), (Raven Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), (San Rafael Swell), (Teasdale), (Circle Cliffs), (Tar Sand Triangle), This paper discusses the following: Utah Tar sands (Tabiona, Whiterocks, Asphalt Ridge, Raven Ridge, P.R. Spring, Hill Creek, Sunnyside from the Uinta Basin, and San Rafael Swell, Teasdale, Circle Cliffs, and Tar Sand Triangle from central Southeast Utah); References. Table 1 gives the characteristics of Utah's major oil-impregnated sandstone deposits.

Campbell, J.A., 1975b, Structural geology and petroleum potential of the south flank of the Uinta Mountain uplift, northeastern Utah; Utah Geology, v. 2, no. 2, p. 129-132.

(Asphalt Ridge), This article contains: Abstract; Introduction - regional structural geology; Uinta uplift (Asphalt Ridge, Asphalt Ridge fault - geophysical data, Asphalt Ridge - well data, basin-mountain boundary fault, petroleum occurrence); Conclusions; Acknowledgments; References.

Campbell, J.A., 1978, Field investigation of oil-impregnated rock deposits and solid bitumens in the Uinta Basin, Utah, August 15 through 18, 1978: Utah Geological and Mineral Survey memo to file, 6 p.

(Gilsonite), (P.R. Spring), This memo contains discussions of the following: Gilsonite occurrences (Dragon mine, Eureka or Cowboy vein, Independent vein, wurtzilite, ozokerite, coal, albertite, tabbyite); A short paragraph on northeastern P.R. Spring; References. Mr. Campbell was accompanied on this field trip by Dr. H. Jacob, Geological Survey of Hannover, Germany, and Dr. N.H. Bostick, U.S. Geological Survey, Denver, Colorado.

Campbell, J.A., and Bacon, R.S., 1974, Oil-impregnated rocks and other evidences of petroleum southwest of Duchesne, Utah (T. 4 S., R. 6 W., USM): Utah Geological Survey unpublished report, 6 p. (Investigation results from map dating from 1921 contributed by Howard Price of Price, Utah)

(No Specific Deposits), This report includes the following: General geology; Oil-impregnated sandstone, Oil seeps; Oil shales; Sulfur springs; Solid hydrocarbons; Field notes.

Campbell, J.A., and Dixon, C.R., 1977, Measured section, Green River Formation: Utah Geological Survey unpublished report in UGS files, 17 p.

(Sunnyside), This measured section was located in the Sunnyside Asphalt quarry area, Carbon County, Utah. Section begins in SE¼ NW¼ NE¼, section 9, T. 14 S., R. 14 E., on a spur protruding southwesterly from the Roan Cliffs, and lying on the north side of Water Canyon. Measurement starts within the Colton Tongue at the top of a resistant ledge of maroon calcareous siltstone.

Campbell, J.A., and Ritzma, H.R., 1979, Geology and petroleum resources of the major oil-impregnated sandstone deposits of Utah: Utah Geological and Mineral Survey Special Studies 50, 24 p. [Also, as Chapter 28, *in* Meyer, R.F. and Steele, C.T., editors, The future of heavy crude oils and tar sands, 1979, New York, McGraw-Hill, Inc., Mining Informational Services, p. 237-253.]

(Asphalt Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), This paper contains; Abstract; Introduction; Uinta Basin (Asphalt Ridge and NW Asphalt Ridge, P.R. Spring, Hill Creek, and Sunnyside); Central southeast (the Tar Sand Triangle and Circle Cliffs); References. Twelve tables give technical data on these deposits.

Campbell, J.A., and Ritzma, H.R., 1982, Geology and petroleum resources of the major oil-impregnated sandstone deposits of Utah, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC monograph Series-Tar Sands: Interstate Oil Compact Commission, p. 27-43.

(Asphalt Ridge), (NW Asphalt Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), This chapter includes the following: Abstract; Introduction; Uinta Basin (Asphalt Ridge and NW Asphalt Ridge, P.R. Spring, Hill Creek, Sunnyside); Central southeast (Tar Sand Triangle, Circle Cliffs). For each deposit, maps, cross-sections, and tables provide technical information.

Carlson, R.D., Blasé, E.F., and McLendon, T.R., 1981, Development of the IIT Research Institute RF heating process for *in-situ* oil shale/tar sand fuel extraction—an overview: Chicago, Illinois, IIT Research Institute, 9 p.

(Avintaquin Canyon), (Asphalt Ridge), This article includes the following: Abstract; Introduction; Description of the process; Early studies of the RF technique; Present program activities (oil shale field tests, tar sand field tests, supporting laboratory and analytical studies); Future plans; References.

Carman, E.P., and Bayes, F.S., 1961, Occurrence, properties, and uses of some natural bitumens: U.S Bureau of Mines Information Circular 7997, 42 p.

(No Specific Deposits), This paper contains: Introduction and summary; Acknowledgments; Definitions and classification systems; Description of bitumens (36 types are described, including gilsonite).

Cashion, W.B., 1964, Other bituminous substances, *in* Hilpert, L.S., editor, Mineral and Water Resources of Utah: Utah Geological and Mineralogical Survey Bulletin 73, p. 63-70.

(Asphalt Ridge), (Sunnyside), (P.R. Spring), (Evacuation Creek), (Others), These sections contain the following: Oil shale; Other bituminous substances (solid hydrocarbons including gilsonite, ozokerite, wurtzilite, rock asphalts – some information given for Asphalt Ridge, Sunnyside, P.R. Springs, and miscellaneous deposits).

Cashion, W.B., 1967, Geology and fuel resources of the Green River Formation southeastern Uinta Basin, Utah and Colorado: Geological Survey Professional Paper 548, 48 p.

(Raven Ridge), (P.R. Spring), This publication covers the following: Abstract; Introduction; Geography; Stratigraphy; Structure; Economic geology (oil shale, gilsonite; bituminous sandstones, oil and gas); References; Index. Very little deposit-specific information is given.

Cha, C.Y., and Guffey, F.D., 1988, Recycle oil pyrolysis and extraction of tar sand, *in* Meyer, R.F., and Wiggins, E.J., editors, Fourth UNITAR/UNDP Conference on Heavy Crude and Tar Sands proceedings, Volume 5, extraction, upgrading, transportation: Alberta, Alberta Oil Sands Technology and Research Authority, p. 449-456.

(Asphalt Ridge), (Sunnyside), (Athabasca), This paper includes the following: Abstract; Introduction; Experimental apparatus and procedure (screw pyrolysis reactor system – process development unit, analytical procedure); Results and discussion (Asphalt Ridge tar sand tests, Sunnyside tar sand test, evaluation of products from Asphalt Ridge and Sunnyside tar sands, Athabasca oil sand test, use of Athabasca product oil as a bitumen diluent, co-processing of syncrude bitumen, and Athabasca oil sand); Conclusions; Acknowledgment; References.

Cha, C.Y., and Guffey, F.D., 1989, Recycle oil pyrolysis and extraction of tar sand, *in* Myer, R.F., and Wiggins, E.J., editors, The fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands proceedings, volume 5, extraction, upgrading, and transportation: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 449-456.

(Asphalt Ridge), (Sunnyside), (Athabasca), This article contains: Abstract; Introduction; Experimental apparatus and procedure (screw pyrolysis reactor system – process development unit, analytical procedure); Results and discussion (Asphalt Ridge tar sand tests, Sunnyside tar sand test, evaluation of products from Asphalt Ridge and Sunnyside tar sands, Athabasca oil sand test, use of Athabasca product oil as a bitumen diluent, co-processing of syncrude bitumen and Athabasca oil sand); Conclusions; Acknowledgment; References; Two figures and eight tables.

Cha, C.Y., Guffey, F.D., and Fahy, L.J., 1988, Recovering oil from tar sand using the (ROPE®) process, *in* 1988 eastern oil shale symposium proceedings (November 30 - December 2, 1988 at the Marriott Griffin Gate Resort, Lexington, Kentucky): Institute for Mining and Minerals Research, p. 31-40.

(Asphalt Ridge), (Sunnyside), (Athabasca), This article contains: Abstract; Introduction; Experimental apparatus and procedure (objectives, screw pyrolysis reactor system, process development unit test, BSU test); Results and discussion (process results, product oil use evaluation); Conclusions; Acknowledgments; Reference.

Cha, C.Y., Johnson, L.A., Jr., and Guffey, F.D., 1990, Investigation of the (ROPE©) process performance on Sunnyside tar sand: Laramie, Western Research Institute, 24 p.

(Sunnyside), This report contains: Summary; Introduction; Objectives; Experimental apparatus and procedure (screw pyrolysis reactor systems, operational procedures); Results and discussion (test results, end-use evaluation of product oil); Tables; Conclusions and recommendations; Acknowledgments; References.

Cha, Soonman, 1991, Pyrolysis of oil sands from the Whiterocks tar sand deposit in a rotary kiln: Salt Lake City, University of Utah Ph.D. Dissertation, 254 p.

(Whiterocks), This dissertation contains: Abstract; Nomenclature; Acknowledgments; Introduction (research objectives); Literature survey (definition of tar sand, world and U.S. reserves of oil sands, origin and geology of oil sands, nature of oil sands and native bitumen, oil sands recovery); Experimental apparatus and procedures (rotary-kiln reactor assembly, spent sand receiving system, liquid product recovery system, feed preparation, experimental procedures, product analysis, material balance calculations); Results and discussion (nature of the feed oil sand bitumen, preliminary process study, reproducibility of rotary kiln pyrolysis experiments, effect of reactor temperature on product yields, effect of solids retention time on product yields, effect of sweep gas flow

rate on product yields, effect of bitumen content and properties on product yields, effect of reactor temperature on the quality of the liquid products, effect of solids retention time on the quality of the liquid products, extent of upgrading of liquid products, kinetics study of oil sand pyrolysis); Conclusion and recommendations; Appendices (A-Rotary kiln pyrolysis experiment data, B-Analytical gas yield calculation, C-Rotary kiln temperature profiles, D-Experimental error analysis); References; Vita.

Cha, Soonman, Hanson, F.V., Longstaff, D.C., and Oblad, A.G., 1991, Pyrolysis of bitumen-impregnated sandstones – a comparison of fluidized bed and rotary kiln reactors: Fuel, v. 70, p. 1357-1361.

(Whiterocks), This article contains: Abstract; Experimental procedures (rotary kiln reactor system, nature of the feed bitumen, feed preparation; Effect of solids retention time on product yield; Effect of solids retention time on the chemical composition of produced liquids); Discussion; Conclusions; Acknowledgments; References; Seven tables.

Chakraborti, N., Hupka, Jan, Das, A., Hupka, M., and Miller, J.D., 1995, A dimensional analysis of dissolutions of a bitumen concentrate derived from Utah tar sand: Fuel Science & Technology, v. 13, p. 639-654.

(Whiterocks), This paper contains: Abstract; Introduction; Experimental procedures; Dimensional analysis; Results and discussion; Final comments; Acknowledgments; Nomenclature; References; Seven figures.

Chatfield, John, 1965, Petroleum geology of the greater Red Wash Area, Uintah County, Utah: The Mountain Geologist, v. 4, no. 3, p. 115-121.

(Red Wash), This article contains: Abstract; Introduction; Stratigraphy (Wasatch Formation, Green River Formation – Douglas Creek, Garden Gulch, Parachute Creek, and Evacuation Creek Members, Uinta Formation); Reservoir rocks; Subsurface mapping; Structure; Production; Lower Green River geologic history; References; Acknowledgments.

Chevron Oil, 1987, Transmittal of geochemical results for Tar Sand Triangle, Circle Cliffs, and San Rafael Swell outcrop samples: Unpublished information from Chevron Oil Field Research Company, La Habra, California, 38 p.

(Tar Sand Triangle), (Circle Cliffs), (San Rafael Swell), These data include the following information for all or some of twelve selected outcrop samples (weight percent extract, sulfur concentration, stable carbon isotope ratio, capillary chromatography, saturate, aromatic, NSO, and asphaltene compounds, porphyrin content, PPGC fingerprint of the asphaltene, and the GCMSD fingerprint of the saturate fraction. Data are summarized in Tables 1 and 2, and on the attached plots.

Chilingarian, G.V., and Yen, T.F., editors, 1978, Bitumens, asphalts, and tar sands: New York, Elsevier Scientific Publishing Company, 331 p.

(Athabasca), (No Specific Deposit), This book contains the following: Foreword; Contributors; Introduction – organic matter and origin of oil and tar sands; Geochemistry and origin of natural heavy-oil deposits; Thermal evolution of natural asphalts; Major tar-sand deposits of the world; Athabasca tar sands – occurrence and commercial projects; Thermal cracking of Athabasca bitumen; Properties and structure of bitumens; In-situ recovery of oil from oil sands; Vanadium – key to Venezuelan fossil hydrocarbons; Role of asphaltene in refining; Formation evaluation of tar sands using geophysical well-logging techniques; Appendix I - Government policy statement with respect to oil-sand development – part 1; Appendix II – Government policy statement with respect to oil-sand development – part 2; Appendix III – Order-in-council No. 244/72; Appendix IV – Syncrude letter; Appendix V – Amended Syncrude letter; Appendix VI – Fracturing of reservoir rocks; References index; Subject index.

Christensen, R.J., Lindberg, W.R., and Dorrence, S.M., 1984, Viscous characteristics of a Utah tar sand bitumen:

Fuel, v. 63, no. 99, p. 1312-1317.

(Asphalt Ridge), this paper contains the following: Abstract; Introduction; Experimental procedure (sample preparation, viscosity measurement procedure); Results of extracted bitumen tests (toluene dilution, asphaltene concentration, oxidation, shear history); Summary and conclusions (temperature, solvent content, asphaltene/maltene concentration ratio, oxidation, shear history); Acknowledgments; References; List of figures (1-5); Tables 1-2a; Special summary on paper (principal new conclusions and results, methods and observations from which deduced, special limitations and assumptions).

Chu, K.S., 1995, Effect of bitumen-derived coke on deactivation of a hydrometallation catalyst: Salt Lake City, University of Utah Ph.D. Dissertation, 282 p.

(Whiterocks), This dissertation contains: Abstract; Acknowledgments; Introduction; Background (properties of heavy residue and bitumen, hydroprocessing technology for heavy residue, chemistry and reaction mechanisms of hydroprocessing, hydroprocessing catalysts, catalyst deactivation); Experimental procedures (catalyst, catalyst coking in the autoclave, BET surface area and nitrogen pore volume, catalytic activity tests for autoclave-cooked catalysts, coke extraction experiments for autoclave-coked catalysts, flow reactor aging runs, flash calculations); Results (fresh sulfided catalyst, autoclave-coked catalysts, properties of extracted coke from autoclave-coked catalysts, flow reactor-aged catalysts); Discussion (autoclave-coked catalysts, flow reactor-coked catalysts); Conclusions (autoclave-coked catalysts, flow reactor-coked catalysts); Appendices A-K; References.

Chu, K.S, Dong, D., Hanson, F.V., and Massoth, F.E., no date, Comparison of in-situ activities of bitumen-deactivated catalysts: University of Utah, Department of Chemical and Fuels Engineering, unpublished report, variously paginated.

(Whiterocks), This report contains the following: Abstract; Introduction; Experimental (catalysts and feeds); Results (properties of aged catalysts, in-situ and ex-situ activities); Discussion (nature of deposits in aged catalysts, effect of deposits on catalyst deactivation); Conclusions; Acknowledgments; Literature cited; Nomenclature; Appendix; Four tables and nine figures.

Chu, K.S., Hanson, F.V., and Massoth, F.E., 1994, Effect of bitumen-derived coke on deactivation of an HDM catalyst, *in* Anderson, L.L., editor, Fuel Processing Technology, p. 79-95.

(Whiterocks), This paper contains: Abstract; Introduction; Experimental procedures (catalysts and chemicals, coking runs, physical properties of catalysts, activity test); Results (catalyst properties, catalyst activities); Discussion (nature of coke, catalyst deactivation, temperature effect on activities); Summary; Acknowledgement; References.

Chung, H.S., and Dickert, J.J., Jr., 1985, Process for extracting bitumen from tar sands, United States Patent No. 4,512,872., 6 p.

(Patent), (No Specific Deposit), This invention provides a process for the recovery of bitumen from mined tar sands that comprises admixing mined tar sands with a hydrocarbon liquid such as light crude oil or a mixture of light crude oils from a nearby reservoir thereby obtaining a bitumen-hydrocarbon mixture mixed with ssand, separating the bulk of said bitumen-hydrocarbon mixture from the sand as a liquid, and recovering the remainder of the bitumen-hydrocarbon mixture using chemical water flooding techniques.

Clem, Keith, 1984, Economic potential of the P.R. Spring oil-impregnated deposit, Uinta Basin, Utah: Utah Geological and Mineral Survey Special Studies 65, 35 p.

(P.R. Spring), This publication covers the following: Abstract; Introduction; General geology; Economic geology; Summary and recommendation; References; Appendices, 1 - Laboratory procedure for tar sand mass fraction analysis, 2 - Mass fraction analysis from Terra Tek, and 3 – Saturation organized by township.

Clem, Keith, 1985, Economic potential of state-owned lands in the Sunnyside Special Tar Sand Area, Carbon County, Utah: Utah Geological and Mineral Survey Report of Investigation 196, 28 p.

(Sunnyside), This report includes the following: Abstract; Introduction; General geology (stratigraphy of the Wasatch and Green River Formations, as well as their structure and saturation); Resource summary; References; Appendices, 1 - Stratigraphic measurements within the Sunnyside area, 2 - Laboratory procedure for tar sand mass fraction analysis, 3 - Mass fraction analyses from Terra Tek, 4 - Tar sand evaluation of control points, and 5 - Tar sand evaluation of state-owned land; Five figures.

Clem, Keith, 1987, Bibliography of tar sand deposits in Utah, updated as of December 1987: Salt Lake City, La Plata Petro-Service Company unpublished report, 42 p.

(Numerous Utah Deposits), This bibliography provides a listing of tar sand-related references, in alphabetical order by the author's last name, and listings of references for various deposits.

Clem, K.M., Hanson, F.V., and Ritzma, H.R., 1990, Uinta Basin tar sand deposit: Salt Lake City, University of Utah, Utah Engineering Experiment Station (unpublished), 232 p.

(Numerous Utah Deposits), This book contains: Short descriptions of approximately 30 tar sand deposits in the Uinta Basin. The following is a general pattern of each of the descriptions: Name; Location; Description; Geology; Lithology; Character of reservoir; Resource estimate; Character of the oil; Development history; References.

Cohenour, R.E., no date, Salient Features of the bituminous sandstone occurrence near Sunnyside, Carbon County, Utah: Utah Geological Survey unpublished report, 4 p.

(Sunnyside), This report contains: Listing of sections containing bituminous sand outcrops; Location on Book Cliffs; Thickness, development; dip of beds; Analyses that have been done; Reserves; Wasatch-Green River transitional facies; Fracture porosity; Overburden; Continuity.

Coleman, R.D., Sparks, B.D., Majid, Abkus, and Toll, F.N., 1995, Agglomeration—flotation – recovery of hydrophobic components from oil sands fine tailings: Fuel, v. 74, no. 8, p. 1156-1161.

(Whiterocks), This article contains: Abstract; Introduction; Agglomeration theory (hot-water processing of oil sands in the presence of dispersed gas); Conclusions; Acknowledgments; Results and discussion (significance of oil sand slurry aeration, bitumen release from oil sand – the assistance of gas bubbles, hot-water processing of oil sands in the presence of dispersed gas); Conclusions; Acknowledgments; References; Four figures.

Combs, J.E., no date, Signal Oil and Gas summary test data for horizontal test wells #101-103, Sunnyside area, sec. 4, T. 14 S., R. 14 E., Carbon County, Utah: Unpublished Amoco report.

(Sunnyside), This report addresses the following: Objective; Layout; Drilling; Air injectivity test; Huff and puff steam test; Steam injectivity test; Crude analyses; Exhibits A-N, excluding D and G.

Commodor Resources Corporation, 1981, Whiterocks No. 24-1 Federal Well, Uintah County, Utah: Commodor Resources Corporation.

(Whiterocks), Information in this packet include core analyses from 482 feet to 1043 feet depth; Data summary (averages by zones), tar analysis (pp & sp gr), samples available at the Core Facility, SEM and EDAX analyses done on tar sand samples 68 and 72, petrographic analyses on samples 68 and 72.

Core Laboratories, Inc., 1973, Oil impregnated sandstone analyses for Rim Rock, P.R. Spring, and Hill Creek, done

for the Utah Geological and Mineralogical Survey: Casper, Core Laboratories, Inc., 81 p.

(Rim Rock), (P.R. Spring), (Hill Creek), This packet of information contains: Introductory letter from Kenneth R. Bowen to Howard R. Ritzma; Summary and detail pages (intervals, thickness, net thickness, bed thickness range, number of beds, and a visual classification of impregnation); Well location plats; Table 1 (depth, permeability, porosity, pore saturation, and oil in terms of gallons/ton, percent volume, and percent weight); Table 2 (retorted oil specific gravity and API gravity); Table 3 (Sulfur determination).

Cornelius, C.D., 1987, Classification of natural bitumen - a physical and chemical approach, *in* Meyer, R.F., editor, Exploration for heavy crude oil and natural bitumen: The American Association of Petroleum Geologists, Studies in Geology #25, p. 165-174.

(No Specific Deposits), This article includes the following: Introduction; Viscosity vs. gravity; Classification of bitumen after Abraham/Jacob; Chemical composition of natural bitumen; Conclusions; Acknowledgments; References cited.

Coronella, C.J., Jr., 1994, Optimizing a thermal fluidized-bed tar-sands extraction process: Salt Lake City, University of Utah Ph.D. Dissertation, 210 p.

(No Specific Deposits), This dissertation contains: Abstract; Acknowledgments; Introduction; Minimum slugging velocity in fluidized bed containing vertical rods; Pyrolysis reactor model; Erosion-corrosion of 316 stainless steel rods immersed in a bubbling fluidized bed; Modeling and temperature regulation of a thermally coupled reactor system via internal model control strategy; Appendices (reactor modifications, steady-state reactor modeling program).

Coronella, C.J., Lee, S.Y., and Seader, J.D., 1992, Minimum slugging velocity in - fluidized bed containing vertical rods, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 238-246.

(No Specific Deposits), This article contains: Abstract; Introduction; Experimental apparatus and method; Results and discussion; Conclusions; Acknowledgments; Notation; References; Twelve figures and one table.

Covington, R.E., 1957, The bituminous sandstones of the Asphalt Ridge area, northeastern Utah, *in* Seal, O.G., editor, Guidebook to the geology of the Uinta Basin: Intermountain Association of Petroleum, p. 172-175.

(Asphalt Ridge), This article contains: Introduction; Physiography and topography; General geology; Stratigraphy (Mesaverde, Wasatch, Green River, Uinta, and Duchesne River Formations); Origin of the asphalt saturation; Time of accumulation of the asphalt; Economics of the Asphalt Ridge sandstones; Nature of the bituminous sandstones; Methods of mining; Conclusions; References.

Covington, R.E., 1963, Bituminous sandstone and limestone deposits of Utah, *in* Crawford, A.L., editor, Oil and gas possibilities of Utah, re-evaluated: Utah Geological and Mineralogical Survey Bulletin 54, p. 225-247.

(Asphalt Ridge), (Whiterocks), (Sunnyside), (P.R. Spring), (Chapita Wells), (Dragon), (Asphalt Wash), (Deep Creek Nose), (Whiterocks), (John Starr Flat), (Tabiona), (Lake Fork), (Yellowstone River), (Myton Bench), (Indian Canyon), (Lake Canyon), (Raven Ridge), This article includes the following: Introduction; the geology of the Asphalt Ridge area (Rim Rock and Asphalt Ridge Members of the Mesaverde and Duchesne River Formations; Recent development of the Asphalt Ridge area; Nature of bituminous sandstone; Brief discussion of the economics of asphalt property development. It also discusses the Whiterocks area bituminous sandstones - Occurrence of the bituminous saturation; origin of the oil. Many small bituminous sandstone deposits are described in short paragraphs. Conclusion.

Covington, R.E., 1964a, Bituminous sandstones in the Uinta Basin, *in* Sabatka, E.F., editor, Guidebook to the geology and mineral resources of the Uinta Basin—Utah's hydrocarbon storehouse: Intermountain Association of Petroleum Geologists, p. 227-242.

(Sunnyside), (Asphalt Ridge), (Whiterocks), (P.R. Spring), (Chapita Wells), (Dragon), (Asphalt Wash), (Deep Creek Nose), This article contains: Introduction; Location; Geology; Geography; Reserves; Miscellaneous localities; Economics of mining and bitumen extraction; References.

Covington, R.E., 1964b, Thermal recovery may bring industry's "quiet revolution": The Oil and Gas Journal, v. 62, p. 112-118.

(Sunnyside), (Asphalt Ridge), (Whiterocks), (Green River Desert), This article contains: Present state; Thermal recovery; Legal problems; Conclusions.

Covington, R.E., 1965a, Some possible applications of thermal recovery in Utah, *in* Riley, D.L., editor, Journal of Petroleum Technology, Society of Petroleum Engineers (November issue), p. 1277-1284.

(Sunnyside), (Asphalt Ridge), (Whiterocks), (Green River Desert), (P.R. Spring), (Chapita Wells), (Dragon), (Asphalt Wash), (Others), This article contains: Abstract; Introduction; Evaluating a thermal prospect (depth to the oil sand, gross oil in place, porosity and permeability of the zone, nature of the reservoir matrix, crude oil viscosity, formation temperature, oil-water saturation ratios, bounding planes of the reservoir, areal extent of the reservoir, specific reservoir characteristics, economic factors); Conclusion; References.

Covington, R.E., 1965b, Bituminous sands with viscous crude oils, *in* Pope, B.J., Harry, J.V., and Lyon, L.B., editors, Proceedings of the First Intermountain Symposium on Fossil Hydrocarbons: Salt Lake City, Brigham Young University Salt Lake Center for Continuing Education, p. 364-373.

(Sunnyside), (Asphalt Ridge), (Whiterocks), (French Seep), (Nequoia Arch), This paper includes the following: Introduction to bituminous sandstone of the Rocky Mountain region; Thermal recovery, mechanics of thermal recovery; evaluation of a thermal recovery project; thermal recovery costs; Bituminous sandstones of Utah with thermal recovery potential; Legal problems involved in thermal recovery are discussed; Conclusions. Not a great deal of technical data is given in the article.

Covington, R.E., 1976, Oil-impregnated rocks of Utah—distribution, geology, and reserves: Brigham Young University Geology Studies, v. 22, pt. 3, p. 143-150.

(Asphalt Ridge), (NW Asphalt Ridge), (Whiterocks), (Hill Creek), (Sunnyside), This paper includes the following: Abstract; General reviews of tar sand deposits; Summary; References.

Covington, R.E., and Young, K.J., 1985, Brief history and recent developments in tar sand deposits of Uinta Basin, *in* Picard, M.D., editor, Geology and energy resources, Uinta Basin of Utah: Utah Geological Association Publication 12, p. 227-241.

(Whiterocks), (Asphalt Ridge), (Raven Ridge), (Rainbow), (Asphalt Wash), (P.R. Spring), (Hay Canyon), (Winter Ridge), (Sunnyside), This article contains: Abstract; General discussion (companies who have done development work on tar sands in Utah; Deposit-specific area geologic, and other topic discussions are given on the Asphalt Ridge, Whiterocks, Raven Ridge, South Rainbow area: Dragon-Asphalt Wash, P.R. Spring-Hay Canyon-Winter Ridge, and Sunnyside deposits.

Cowell, M.J., and Thrall, F.G., no date, The influence of processing on the planning of tar sand waste disposal facilities: Golder Associates unpublished report, 22 p.

(No Specific Deposits), This report contains: Introduction; Processing and material description (beneficiation

process, solvent extraction process, retorting-combustion process); Influence of processes on geotechnical properties (classification tests, compaction tests, shear strength tests); X-ray diffraction and electron microscopy; Operation and reclamation design considerations; Conclusions; References.

Cox, C.H., and Baughman, G.L., 1980, Oil sands - resource, recovery, and industry: Colorado School of Mines Mineral and Energy Resources, v. 23, no. 4, 12 p.

(Asphalt Ridge), (P.R. Spring), This paper contains: Introduction; Canadian deposits; United States deposits (some 24 states in the US contain occurrences of oil sand, but only six have well-defined deposits that could conceivably support commercial extractions. These are: Alabama, California, Kentucky, New Mexico, Texas, and Utah. In Utah, 51 separate deposits have been identified by UGS. Discussion and some data are presented on the Asphalt Ridge and P.R. Spring deposits in Utah); Characterization (general, saturation, physical properties, bitumen chemical composition, and viscosity); Processing (mining/surface extraction, in-situ recovery, and upgrading); Commercial projects; Research efforts; Outlook; Acknowledgments; References.

Crawford, A.L., and Pruitt, R.G., 1963, Gilsonite and other bituminous resources of central Uintah County, Utah, *in* Crawford, A.L, editor, Oil and gas possibilities of Utah, re-evaluated: Utah Geological and Mineralogical Survey Bulletin 54, p. 215-224.

(Asphalt Ridge), (Sunnyside), (Raven Ridge), This paper discusses gilsonite (Rainbow System, Willow Creek and Ouray Systems, Pariette System, and Fort Duchesne); Gilsonite mining and markets; Other bituminous resources (oil shale, bituminous sandstone, oil and gas). The bituminous sandstone discussion is very brief, and no data are given (Asphalt Ridge, Sunnyside, and Raven Ridge).

Cross, A.T., and Wood, G.D., 1976, Palynology and petrography of some solid bitumens of the Uinta Basin, Utah: Brigham Young University Geology Studies, v. 22, pt. 3, p. 157-173.

(Sunnyside), (Asphalt Ridge), This paper contains: Introduction; Nature and distribution of solid bitumens and bituminous substances in the Uinta Basin; Physical and chemical characteristics (ozocerite, argulite, tabbyite, gilsonite, glance pitch, wurtzilite, ingramite, and alberite. Bituminous sandstones from Sunnyside and Asphalt Ridge were also examined, both in thin sections and macerated preparations, abut at this time no palynomorphs have been identified); Significance of the palynomorphs recovered.

Cupps, C.Q., Land, C.S., and Marchant, L.C., 1976, Field experiment of in-situ oil recovery from a Utah tar sand by reverse combustion, *in* Smith, J.W., and Atwood, M.T., editors, Oil shale and tar sands: New York, American Institute of Chemical Engineers, v. 72, no. 155, p. 61-68.

(Asphalt Ridge), (Circle Cliffs), (Hill Creek), (NW Asphalt Ridge), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This paper includes the following: Introduction; U.S. tar sand resource; Tar sand characteristics; Comparison of reverse and forward combustion; Some results of reverse combustion experiments; Design of the field experiment; Pattern flow test and ignition procedure; Literature cited. Figures show the field experiment site, comparison of forward and reverse combustion processes, effect of air flux on peak temperature, effect of air flux on velocity of combustion front, effect of air flux on fractional oil recovery, stratigraphic column at experiment site, air-flow distribution by radio-tracer. Tables give average properties of giant tar sand deposits in Utah.

Dafter, Ray, 1980, Scraping the barrel – the worldwide potential for enhanced oil recovery: London, The Financial Times Business Information Ltd., 227 p.

(No Specific Deposit), This report includes the following: Introduction; Acknowledgments; Chapter 1 – the need for an energy bridge (supply and demand, scope for change, making the most of oil resources, prospects for enhancing production, oil resource base, the end in sight, unconventional oil, long-term viewpoint of potential oil supply and demand, changing attitudes, references); Chapter 2 – Enhanced oil recovery – the opportunities (the methods, choosing the appropriate process, technical risks, constraints, references); Chapter 3 – Geographic assessment of enhanced oil recovery potential (United States, Canada, Venezuela, western Europe, Middle East – North Africa - and Indonesia, U.S.S.R. and eastern Europe, references); Chapter 4 – Conclusion (Industries' view – results of Delphi-Type study, the real price of oil, organizational barriers, policy check list, resume, references); Appendices (A – active enhanced recovery projects, B – the world's oil producers ranked by proven reserves, C – commercial chemicals for use in enhanced oil recovery processes, D – a more optimistic oil production profile, E – selective bibliography, F – 1979 world oil production, G – glossary, H – details of enhanced oil recovery projects.); List of tables.

Dahm, J.N., 1980, Tar sand reserves - P.R. Spring deposit, Uintah and Grand Counties, Utah: Utah Geological and Mineralogical Survey, Open-File Report 27, 13 p.

(P.R. Spring), This report includes the following: Introduction and geology; Objectives; Scope; Procedure; Data discussion and interpretation; Reserves (table 1 gives reserves arranged by township and range); Summary; Conclusion, Recommendations.

Dana, G.F., Oliver, R.L., and Elliott, J.R., 1984, Geology and resources of the Tar Sand Triangle, southeastern Utah: Laramie, Western Research Institute, 50 p.

(Tar Sand Triangle), This publication contains: Introduction (previous investigations); Geology (surface features, structure, stratigraphy - Navajo Sandstone, Kayenta Formation, Wingate Sandstone, Chinle Formation, Moenkopi Formation, and Cutler Formation); Resources (reservoir characteristics, isopach map of zones of saturation, resources map and calculations, leasing of tar sand deposits); Conclusion.

Dana, G.F., and Sinks, D.J., 1984a, The P.R. Spring tar sand deposit, Uinta Basin, Utah, USA: *in* Meyer, R.F., Wynn, J.C., and Olson, J.C., editors, The Second International Conference on Heavy Crude and Tar Sands: New York, McGraw Hill, 27 p.

(P.R. Spring), This paper includes the following: Abstract; Introduction (geographic and geologic setting, cross sections, tar sand characteristics, discussion and results, bibliography); Three tables and nine figures.

Dana, G.F., and Sinks, D.J., 1984b, Chapter 26 - Characteristics of the P.R. Spring tar sand deposit, Uinta Basin, Utah, USA, *in* Myer, R.F., Wynn, J.C., and Olson, J.C., editors, The Future of Heavy Crude and Tar Sands: New York, Coal Age Mining Information Services, McGraw Hill, Inc., p. 220-236.

(P.R. Spring), (Hill Creek), (Sunnyside), (Tar Sand Triangle), (Three-Mile Canyon), (Asphalt Wash), (South Seep Ridge), This article contains: Introduction; Geographic and geologic setting; Cross sections; Tar sand characteristics; Summary; Conclusions. Table 26-1 presents core holes penetrating tar sands in the P.R. Spring deposit. Figure 26-3 shows core hole and cross section locations in the P.R. Spring deposit. Table 26-3 gives P.R. Spring tar sand characteristics. Table 26-4 gives a summary of core hole analyses. Figure 26-4 shows the areal extent of the P.R. Spring deposit with structural contours on overlying Mahogany oil shale bed. Table 26-5 gives the average analytical data for Utah tar sand deposits (P.R. Spring, Hill Creek, Sunnyside, and Tar Sand Triangle), and Table 26-6 gives the average analytical data for core holes drilled in P.R. Spring area (LETC UTS, Three-mile Canyon, Asphalt Wash, North Seep Ridge, and South Seep Ridge). Figures 26-6 through 26-9 show lithologic columns.

Daniels, J.I., Anspaugh, L.R., and Rickter, Y.E., 1981, Technology assessment – environmental, health, and safety impacts associated with oil recovery from U.S. tar-sand deposits: Livermore, Lawrence Livermore Laboratory, 118 p.

(Asphalt Ridge), (Sunnyside), (Hill Creek), (P.R. Spring), (Tar Sand Triangle), (Circle Cliffs), This report includes the following: Foreword; Acknowledgments; Glossary; Abstract; Summary; Introduction; Resource characteristics and properties; Bitumen recovery methods; Federal regulatory framework; Process descriptions; Environmental analysis and assessment; Elaboration of socioeconomic considerations; Environmental control technologies; Recommendations; References; Appendices A-C.

Davis, L.J., 1951, The characteristics, occurrences and uses of the solid bitumens of the Uinta Basin, Utah: Provo, Brigham Young University M.S. Thesis: 95 p.

(Argyle Canyon), (Sunnyside), (Dragon), (Asphalt Ridge), (Whiterocks), (Mosby Creek), This thesis contains: Acknowledgments; Introduction; Geology of the Uinta Basin; Classification and definitions of the solid bitumens; General characteristics of solid bitumens; Gilsonite (characteristics of gilsonite, occurrences of gilsonite veins - with a discussion of 34 veins, uses of gilsonite); Wurtzilite (characteristics of wurtzilite or "elaterite", occurrences of the wurtzilite or "elaterite" veins - with a discussion of 26 veins, uses of wurtzilite or elaterite); Ozokerite (characteristics of ozokerite, occurrences of ozokerite veins - with a discussion of three veins, uses of ozokerite; Asphaltic limestones (characteristics of asphaltic limestone deposits, occurrences of asphaltic limestone deposit - with a discussion of three deposits, uses of asphaltic limestone deposits); Bituminous sands (characteristics of bituminous sand deposits, occurrences of bituminous sand deposits - with a discussion of six deposits, uses of bituminous sand deposits); Occurrences of other unusual bitumens (three deposits discussed); Occurrences of bituminous seep deposits (three seeps discussed); Occurrences of oil shales; Theory of origin; Bibliography; Abstract.

Demaison, G.J., 1977, Tar sands and supergiant oil fields: American Association of Petroleum Geologists Bulletin, v. 61, no. 11, p. 1950-1961.

(Tar Sand Triangle), (Circle Cliffs), (Sunnyside), (P.R. Spring), (Hill Creek), (Asphalt Ridge), This paper includes the following: Abstract; Introduction; Nature and origin of "Tar Sands"; Factor controlling very large tar occurrences (sedimentary environment, oil generation, migration, entrapment, and degradation, age of very large tar sands); Possible settings for supergiant reserves (foreland basins, rift basins, passive Atlantic-type margins, other types of basins); Conclusions; References cited; Nine figures.

Deng, Ruping, 1993, Evaluation of Utah tar sands economics: Salt Lake City, University of Utah M.S. Thesis, 104 p.

(P.R. Spring), This paper includes the following: Abstract; Acknowledgments; Introduction (importance of Utah tar sands, purpose and scope of the study, literature review); Background of the study (definition and utilization, review of Utah tar sand resources, technology, overview of Canadian operation); Approaches for the study (introduction, discussion of barriers, the description of study cases, review of economic evaluation model, spreadsheet program); Cost estimates (production considerations, cost estimation procedures, results of preliminary cost estimation); Economic analysis (criteria for economic analysis, financial assumptions, results of discounted cash flow analysis, sensitivity analysis, benefits associated with development); Conclusions and recommendations; Appendices (A- Tar sand database information, B- Output of corehole maintenance program (P.R. Spring corehole), C- Profile of corehole interval analysis (corehole #PRS1-PRS3), D- Sample printout of tar spreadsheet program; References.

Deo, J.D., Fletcher, J.V., Shun, Dowon, Hanson, F.V., and Oblad, A.G., 1990, Modeling the pyrolysis of tar sands in fluidized bed reactors, *in* Stivers, Jack, editor, 1990 Eastern Oil Shale Symposium – oil shale – tar sands – heavy oil (November 6-8, 1990, Marriott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 105-119.

(P.R. Spring), (Sunnyside), (Tar Sand Triangle), (Whiterocks), This paper contains: Abstract; Introduction; Experimental perspective (hydrodynamic regimes); A kinetic model; A fluidized-bed model; Summary; Notation; References; Three tables and seven figures.

Deo, M.D., Fletcher, J.V., Shun, Dowon, Hanson, F.V., and Oblad, A.G., 1991, Modeling the pyrolysis of tar sands in fluidized bed reactors: Fuel, v. 70, p. 1271-1276.

(P.R. Spring), (Sunnyside), (Tar Sand Triangle), (Whiterocks), This article contains: Abstract; Introduction;

Experimental perspective; Hydrodynamic regimes; Kinetic model; Fluidized bed model; Summary; References; Nomenclature; Seven figures and three tables.

Deo, M.D., and Hanson, F.V., 1992, Asphaltene rejection from bitumens via supercritical fluid extraction, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 159-168.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedure; Results and discussion (pressure); Conclusions; Acknowledgments; References; One table and eleven figures.

Deo, M.D., Hwang, Jongsic, and Hanson, F.V., 1991, Supercritical fluid extraction of a crude oil, bitumen-derived liquid and bitumen by carbon dioxide and propane, *in* 1991 Eastern Oil Shale Symposium – oil shale – tar sands – heavy oil (November 13-15, 1991, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 209-221.

(Whiterocks), This article contains: Abstract; Introduction; Experimental methods and means (experimental apparatus, feedstock characterization); Results and discussion (extraction of the paraffinic crude oil with CO_2, extraction of the bitumen-derived liquid, extraction of the native bitumen); Modeling the extraction process; Conclusions; Acknowledgments; References.

Deo, M.D., Hwang, Jongsic, and Hanson, F.V., 1992, Supercritical fluid extraction of a crude oil, bitumen-derived liquid and bitumen by carbon dioxide and propane: Fuel, v. 71, p. 1519-1526.

(Whiterocks), This article contains: Abstract, Introduction, Experimental procedure (equipment and extraction procedure, feedstocks); Results and discussion (extraction of paraffinic crude oil with CO_2, extraction of bitumen-derived liquid, extraction of native bitumen, modeling the extraction process); Conclusions; Acknowledgments; References; Ten figures and eight tables.

Deo, M.D., Hwang, Jongsic, and Hanson, F.V., 1993, The effect of co-solubilizing lighter components on the asphaltene content of heavy oils, *in* Fuel Processing Technology: Amsterdam, Elsevier Science Publishers, v. 34, p. 217-228.

(Whiterocks), This paper includes the following: Abstract; Introduction; Experimental; Results and discussion; Conclusions; Acknowledgments; References.

Deshpande, D.A., 1992, Application of three phase ebullieted bed reactors to petroleum upgrading: Salt Lake City, University of Utah Ph.D. Dissertation, 350 p.

(Whiterocks), This dissertation contains: Abstract; Acknowledgments; Introduction; Literature survey; Similitude studies in three-phase ebullieted bed reactors (TPEB); A model for the prediction of bubble size; Correlations for effective bubble rise velocity; Determination of physical properties of bitumen and bitumen fractions; Reactor scale-down; Conclusions and recommendation; Appendices (generalized wake model computer code, computer codes for the bubble model, determining bubble rise velocity in three-phase ebullieted bed computer code, predictive correlative procedure to determine properties of Whiterocks bitumen computer code, computer code for TPEB reactor scale-down, dimensional analysis for similarity criteria, formulation of bubble model at high pressure, sample calculations for reactor design, list of symbols); Bibliography, List of tables; List of figures; Acknowledgments.

Deshpande, D.A., Deo, M.D., and Hanson, F.V., 1992, Similitude studies in three-phase ebullieted bed reactors, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 216-226.

(No Specific Deposits), This article contains: Abstract; Introduction; Calculation of phase holdups; Development of similarity criteria; Verification of the similarity criteria; A practical procedure for scale-down; Application at high pressure (effect of high pressure, methodology for adjusting $u_{br,}$ similarity criteria at high pressure, concluding remarks); Acknowledgments; Nomenclature (Greek symbols, subscripts); References; Three tables.

Deshpande, D.A., Deo, M.D., and Hanson, F.V., 1993, Scaledown of three-phase ebullieted bed reactors for bitumen hydrotreating, *in* 1993 Eastern Oil Shale Symposium: Lexington, University of Kentucky, Institute for Mining and Minerals Research, 11p.

(No Specific Deposit), This paper includes the following: Abstract; Introduction; Calculation of phase hold-ups; Development of similarity criteria; Verification of similarity criteria; A practical procedure for scale-down; Application at high pressures (effect of high pressure, methodology for adjusting ubr); Similarity criteria at high pressure; Concluding remarks; Acknowledgments; Nomenclature, Greek symbols; References.

Dix, M.W., 1974, Coring and testing wells, Asphalt Ridge, Utah: Information supplied to the Utah Geological Survey by Gulf Oil Company – U.S., 14 p.

(Asphalt Ridge), Information on Palmer lease at Asphalt Ridge, Utah. This information contains: Summary; Discussion; Attachments (details of drilling and coring, core analysis of well 2, details of injection at no. 1 and production at no. 2, graph of injection at no. 1 and production at no. 2, permeability profile at no. 1, permeability profile at no. 2).

Doelling, H.H., 1966, Reconnaissance study of bituminous sandstone deposits, Trans-Dirty Devil, Wayne and Garfield Counties, Utah: (An unpublished report of the Utah Geological and Mineralogical Survey), 16 p.

(Tar Sand Triangle), (Elaterite Basin), (Teapot Rock), This report is the result of preliminary investigations of the Elaterite Basin and Teapot Rock bituminous sandstone occurrences. Six samples were analyzed for their bitumen content and seven sections were measured in the Teapot Rock area. Up to 200 feet of varying degrees of saturation were noted in both areas.

Doelling, H.H., and Morgan, J., 1965, White Canyon Flat bituminous sandstone occurrence (Stud Horse): Unpublished Utah Geological Survey report, 9 p.

(White Canyon), (Stud Horse Peaks), This report gives a brief description of the bituminous sandstone deposit, Garfield County, Utah. Note at bottom of core location map that cores are in the UGS core repository.

Dolcater, D.L., 1988, Sunnyside tar sand – comments on source, degradation, and maturity of the heavy oil: Unpublished report for the Amoco Production Company, 47 p.

(Sunnyside), This report contains: Conclusions; Geology; Sample information; GC-MS analytical conditions; Results and discussion (source, degradation, maturity); Acknowledgments.

Dorius, J.C., 1985, The pyrolysis of bitumen-impregnated sandstone from the P.R. Spring (Utah), deposit in a fluidized bed: Salt Lake City, University of Utah M.S. Thesis, 229 p.

(P.R. Spring), This thesis discusses the following: Abstract, Nomenclature; Acknowledgments; Introduction; Recovery of the bitumen from bituminous sands (factors in the selection of a recovery process, in-situ bitumen recovery technologies, surface bitumen recovery methods, research objectives); Experimental apparatus and procedures; Results and discussion; Conclusions and recommendations; Appendices (confirmation experiments, experimental data, material balance calculations, gradient elution chromatography, modified pour point determination, fluid catalytic cracking investigation); References; Vita. The process variables investigated included the pyrolysis reactor temperature and the feed sand retention time in the pyrolysis zone.

Dorius, J.C., Hanson, F.V., and Oblad, A.G., 1984, The pyrolysis of the bitumen-impregnated sandstone from the P.R. Spring (Utah) deposit in a fluidized bed: W.R.I. /D.O.E. tar sands meeting preprint, Vail, Colorado, 32 p.

(P.R. Spring), This preprint contains the following: Abstract; Introduction (experimental equipment and procedures, results and discussion, pyrolysis of P.R. Spring, Rainbow I tar sand pyrolysis of P.R. Spring, south tar sand, pyrolysis of P.R. Spring, Rainbow II tar sand, quality of liquid products, conclusions); Acknowledgments; References; Seven figures and three tables.

Dorrence, S.M., Thomas, K.P., Branthaver, J.F., and Barbour, R.V., 1978, Analysis of oil produced during in-situ reverse combustion of a Utah tar sand, *in* Uden, P.C., and Siggia, Sidney, editors, Analytical chemistry of liquid fuel sources: Washington, D.C., American Chemical Society, Advances in Chemistry Series 170, p. 150-158.

(NW Asphalt Ridge), This paper contains the following: Abstract; Introduction; Experimental (experimental site, collection of oil samples, preparation of oils for analysis, analytical methods); Results and discussion (comparison of light oils with bitumen, comparison of heavy oils with bitumen); Summary and conclusions; Acknowledgment; Literature cited.

Drelich, Jaroslav, 1993, The role of wetting phenomena in the hot water process for bitumen recovery: Salt Lake City, University of Utah Ph.D. Dissertation, 248 p.

(Whiterocks), This dissertation contains: Abstract; Acknowledgments; Introduction; Literature survey (Utah tar sand deposits, characterization of tar sands and bitumens, water-assisted recovery of bitumen, fundamentals of hot water separation, thermodynamic criteria for bitumen release from solids, the line tension and its effect on contact angle for tiny droplets); Research objective; Surface characterization of Whiterocks bitumen (experimental procedure and materials, results and discussion, plate technique, surface tension from contact angle measurements, interfacial tension, electrical properties of bitumen emulsions, summary); Wetting phenomena in hot-water processing of Whiterocks tar sand (experimental procedure, results and discussion, summary); The effect of drop size on contact angle and its practical significance (experimental procedure, results and discussion, summary); Experimental verification of the modified Cassie equation with a well-defined model heterogeneous surface (experimental procedure, results and discussion, summary); Final summary and conclusions (surface characterization of Whiterocks bitumen, wetting phenomena in hot-water processing of Whiterocks tar sand, the effect of drop size on contact angle and its practical significance, experimental verification of the modified Cassie equation, recommendations for future research); Appendix; References.

Drelich, Jaroslav, Bukka, Krishna, Miller, J.D., and Hanson, F.V., 1994, Surface tension of toluene-extracted bitumens from Utah oil sands as determined by Wilhelmy Plate and contact angle techniques: Energy & Fuels, v. 8, p. 700-704.

(Whiterocks), (Sunnyside), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), This article includes the following: Abstract; Introduction (equation-of-state for interfacial tensions); Experimental procedure (bitumen samples, Wilhelmy Plate technique, contact angle measurements); Results and discussion (direct measurement of surface tensions, bitumen surface tension from contact angle measurements); Summary and conclusions; Acknowledgment. (The surface tension values for toluene-extracted bitumens from Whiterocks, Sunnyside, P.R. Spring, Asphalt Ridge, and Circle Cliffs oil sands were measured with the Wilhelmy plate technique. Table one gives physical properties of extracted bitumens from Utah oil sands. Table two gives fractional composition (wt%), of the Utah oil sand bitumens. Table three gives the measured surface-tension values for the Utah oil sand bitumens. Table four gives a comparison of bitumen surface-tension values calculated from contact angle measurements with bitumen-surface tension determined by Wilhelmy Plate measurements. Figure one shows the effect of temperature on the surface tension of bitumens separated from the Utah oil sands. Figure two shows

variation of contact angle with respect to contact time for a water drop placed on the surface of the bitumen film.

Drelich, Jaroslav, Hupka, Jan, Miller, J.D., and Hanson, F.V., 1992, Water recycle in moderate-temperature bitumen recovery from Whiterocks oil sands: AOSTRA Journal of Research, v. 8, p. 139-147.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Results (bitumen recovery, physiochemical properties, bitumen disengagement mechanism); Discussion (impact of water recycle, bitumen separation, bitumen disengagement); Summary and conclusions; Acknowledgments; References; Ten figures.

Drelich, Jaroslav, Lelinski, Dariusz, Hupka, Jan, and Miller, J.D., 1993, The role of gas bubbles in bitumen recovery from tar sands in hot-water processing, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 100-109.

(Asphalt Ridge), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This article contains: Abstract; Introduction; Experimental procedures (diluent-assisted hot-water experiments, significance of aeration during digestion; flotation of residual oil with the air-sparged hydrocyclone); Results and discussion (the role of gas bubbles in bitumen release from tar sand, importance of bitumen/water interfacial tension, significance of tar sand slurry aeration, flotation of oil in the air-sparged hydrocyclone); Summary; Acknowledgments; Bibliography.

Drelich, Jaroslav, Lelinski, Dariusz, and Miller, J.D., 1996, Bitumen spreading and formation of thin bitumen films at a water surface: Colloids and Surfaces –Physiochemical and Engineering aspects, Elsevier, p. 211-223.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedure (reagents, microscopic observations of bitumen spreading at the gas bubble surface, surface tension measurements); Results and discussion (bitumen spreading at the gas bubble surface in oil sand systems, bitumen spreading at the air bubble surface in model systems, bitumen film precursor pressure, thermodynamics of bitumen spreading on the water surface); Conclusions; Acknowledgment; References; Seven figures.

Drelich, Jaroslav, and Miller, J.D., 1992, Surface/interfacial tension of the Whiterocks bitumen and its relationship to tar sand processing, *in* 1992 Eastern Oil Shale Symposium - oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 265-275.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures (reagents, surface and interfacial tension measurements, contact angle measurements, microscopic observations of bitumen release from tar sand, hot water processing); Results and discussion (surface tension, interfacial tension, bitumen release from tar sand - bitumen film rupture and bitumen roll-up [lense formation], air bubble formation and bitumen spreading at the air bubble surface, rupture of particle-bitumen-particle bridges and release of oily gas bubbles and bitumen drops, correlation of interfacial tension with bitumen recovery); Summary; Acknowledgments; Bibliography; Eight figures and two tables.

Drelich, Jaroslav, and Miller, J.D., 1994, Surface and interfacial tension of the Whiterocks bitumen and its relationship to bitumen release from tar sands during hot water processing: Fuel, v. 73, no. 9, p. 1504-1510.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures (reagents, surface and interfacial tension measurements, microscopic observation of bitumen release from tar sand, hot water processing); Results and discussion (surface tension, interfacial tension, bitumen release from tar sand, bitumen film rupture and bitumen roll-up (sense formation), air bubble formation and bitumen spreading at the air bubble surface, rupture of particle-bitumen-particle bridges and release of oily gas bubbles and bitumen drops, correlation of interfacial tension with bitumen recovery); Summary; Conclusions; Acknowledgments; References; Nomenclature; One table and six figures.

Eldridge, G.H., 1902, Origin and distribution of asphalt and bituminous rock deposits in the United States, *in* Emmons, S.V., and Hayes, C.W., geologists in charge: U.S. Geological Survey Contributions to Economic Geology, p. 296-305.

(No Specific Deposits), This article contains: Classification of hydrocarbons; General features of the hydrocarbons; Distribution of the asphalts and bituminous rocks of the United States; Origin of the deposits.

ENERCOR, no date, Feasibility studies for alternative fuels production from Utah tar sands (volume 1): Technical Proposal to the United States Department of Energy under solicitation number DE-PSOI-80RA50412), variously paginated.

(Asphalt Ridge), Summary sheet; Abstract; Background (efforts on the proposed project performed to date with description of domestic resource, specific processes and general technical viability, general economic viability of proposed process, description of applicable past and present work, footnotes); Feasibility study approach (objectives of the feasibility study, projected completion data of study, detailed statement of work, management of the study, other considerations); Commercial viability (suitability of selected site, process suitability, suitability of plant output, technical readiness, resource availability, production startup time, flexibility of process, economic competitiveness); Environmental, health, safety, and socioeconomic factors (understanding of environmental health safety and socioeconomic [EHSS] impacts of project, capability of propose to perform environmental analysis, comprehensiveness of environmental information to be developed and adequacy of environmental assessment methodology, technical approach on specific environmental assessment); Proposer's capability factors (relevance of prior business experience in process plant operation and fuel marketing, parallel activity to feasibility study, experience of proposer and key personnel including resumes, managerial financial and technical capability of proposer, time of key personnel dedicated to project.)

ENERCOR, no date, Feasibility studies for alternative fuels production from Utah tar sands (volume 2): Financial Proposal to the United States Department of Energy under solicitation number DE-PSOI-80RA50412), 27 p.

(No Specific Deposit), This report contains the various elements of a financial proposal.

ENERCOR, no date, Utah Geological Survey Sample Library tar sand samples: Enercor unpublished data, 28 p.

(P.R. Spring), This packet of information gives lithologic logs of the following Enercor core holes in the P.R. Spring area: 83-5, 84-1A, 84-2, 84-2A, 84-3A, 84-4A, 84-5A, 84-6A, 84-9A, 84-10A, 84-11A, 84-12A, 84-13A.

ENERCOR, 1982, Pilot plant research report of modified hot water process on Utah tar sands: Salt Lake City, Enercor, variously paginated.

(Sunnyside), (P.R. Spring), (Whiterocks), (Raven Ridge), (Hill Creek), (Tar Sand Triangle), (Circle Cliffs), This book contains: Background (S.B. 81, state inquiry, Enercore proposal, Enercor-State contract); Management (construction, startup and operations, organization charts for pilot plant); Construction (model photos, process flow sheet, P&I diagrams, plant photos); Operations (conclusions, startup, revamp, continuous operations, bitumen cleanup, nodules, equipment performance, other test work, material and heat balance); Mining; Budget; Environmental; Marketing (site factors, alternate processing, transportation, selected process, marketing plan); Feasibility (design basis, capital cost, operating cost, mining cost); Audit reports, SRI International; Conclusions; Future work.

Erickson, R.L., Myers, A.T., and Horr, C.A., 1954, Association of uranium and other metals with crude oil, asphalt, and petroliferous rock: Bulletin of the American Association of Petroleum Geologists, v. 38, no. 10, p. 2200-2218.

(San Rafael Swell), (Circle Cliffs), (Temple Mountain), (White Canyon), (Rainbow), This article contains: Abstract; Introduction; Previous investigations; Results of this investigation; Crude oil; Solid asphalt;

Petroliferous rock; Nature and origin of metal compounds in petroleum; Conclusions. Six data tables.

Fahy, J.L., Mones, C.G., and Merriam, N.W., 1983, Northwest Asphalt Ridge tar sand deposit well logging and coring comparison: Laramie, U.S. Deparment of Energy Laramie Energy Technology Center, 69 p.

(NW Asphalt Ridge), Quantitative well logging techniques were performed on four wells used to conduct a small-scale tar sand steam flood and four additional wells used to provide reservoir data for the design of a fourth field experiment near Vernal, Utah (northwest Asphalt Ridge). A gamma, sidewall neutron, density, SP, induction and caliper log suite was used to determine porosity and water saturations. A sonic log was used to determine the elastic rock properties, pressure velocity, shear velocity, Young's modulus, and Poisson's ratio. Carbon/oxygen logs were also run to determine hydrocarbon saturation.

Farcasiu, Malvina, and Whitehurst, D.D., 1977, Double solvent extraction of organic constituents from tar sands: United States Patent 4,046,668, 5 p.

(Patent), (Utah Tar Sands), Extraction of hydrocarbons from tar sands with a light naphtha/methanol solvent system results in rapid decrepitation of the tar-sand aggregate and separation of organic matter into three phases. Distribution of the extracted and non-extracted organic material is among the phases. The most desirable, non-polar organic materials are recovered from the light naphtha phase; more polar soluble constituents are recovered from the methanol phase; and less desirable asphaltenes separate as a precipitate. Seven claims, no drawings.

Fletcher, J.V., 1991, Economics of the production of bitumen and kerogen-derived liquids: Fuels Engineering 756, 39 p.

(Numerous Utah Deposits), List of illustrations; Introduction (historical data, cost data); Technology and site considerations (site, technology), Project economics; Investment analysis of optimal combinations of economic and technical factors; Conclusions; Appendices (A-Utah oil sand projects, B-sample economic criteria, C-consumer price index table, D-U.S. bitumen and oil shale resources, E-Utah permitting process, F-Process schematics); References.

Fletcher, J.V., 1992, The pyrolysis of oil sands in a fluidized bed at reduced pressure: Salt Lake City, University of Utah Ph.D. Dissertation, 183 p.

(Whiterocks), This dissertation contains: Abstract; Notation; Acknowledgments; Introduction (oil sand resources, bitumen recovery methods); Fluidized bed processing of fossil fuels (fluidized bed combustion of coal, fluidized bed pyrolysis of coal, fluidized bed gasification of coal, oil shale processing, oil sands processing, fluidization and pressure variable, research objectives); Experimental apparatus and procedures (oil sands feeder and controls, reactor design and construction, sand removal system, liquid product recovery system, process support systems, process monitoring, feeder calibration, spent sand withdrawal system, reactor calibration and startup, oil sand feed preparation and analysis, product recovery and analysis, material balance calculations, propane consumed); Results and discussion (variables effecting feeder calibration, controls of solids flow with a modified L valve, air fluidization with push and pull gas flows, pressure analysis, fluidization characteristics, potential advantages for a pull reactor, relationship between U_{mf} and temperature for spent sand, pyrolysis in the fluidized bed reactor, the effect of reactor temperature on product yields, simulated distillation of liquid products, liquid product distributions, liquid product yields, coke and gas products, process energy consumption); Conclusions and recommendations; Appendices A-H; References, Vita.

Fletcher, J.V., Deo, M.D., and Hanson, F.V., 1992, Fluidized bed pyrolysis of bitumen-impregnated sandstone at sub-atmospheric conditions, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 247-256.

(Whiterocks), This article contains: Abstract; Introduction; Experimental; Results and discussion (pyrolysis in

the fluidized bed reactor, reactor temperature and product yields, simulated distillation of liquid products, liquid product distributions, product yields, coke and gas products); Conclusions; Acknowledgments; References; Seven figures and nine tables.

Fletcher, J.V., Deo, M.D., and Hanson, F.V., 1995, Fluidized bed pyrolysis of a Uinta Basin oil sand: Fuel, v. 74, no. 3, p. 311-316.

(Whiterocks), In this paper the pyrolysis of the mined and crushed ore from the Whiterocks oil sand deposit was studied in a fluidized bed reactor. The reactor was designed to operate by pulling the fluidizing gas through the reactor rather than by pushing the gas through the bed. This was accomplished by reducing the pressure above the bed with a gas pump operating in the suction mode. This mode of operation resulted in smooth, stable fluidization without slugging at H/D ratios up to 8. Pyrolysis energy was supplied by a propane burner, and the hot combustion gases were used to fluidize the bed. Operating the pyrolysis reactor without slugging allowed the reactor to be operated at lower temperatures than previously reported for equivalent liquid product yields. The bitumen-derived liquid yields ranged from 80 to 90 wt% based on bitumen fed to the reactor in the temperature range 720-773 K. Less than 1 wt% of the bitumen fed to the reactor was converted into a carbonaceous residue on the spent sand.

Ford, Bacon & Davis, Utah, Inc., 1978, Economic comparison of the thermal and hot-water process for recovery of oil from tar sands: Salt Lake City, unpublished consultants report (Ford, Bacon & Davis, Utah, Inc.), 37 p.

(Sunnyside), This report contains: Introduction; Basis for comparison; Process comparison (the thermal process – seven sub sections, hot water extraction process – three sub sections); Market for the product; Price structures; Conclusions.

Ford, Bacon & Davis Utah Inc., 1978, Thermal recovery of bitumen from tar sands (draft report): Unpublished report by Ford, Bacon & Davis Utah Inc., variously paginated.

(Sunnyside), This report includes the following: List of figures and tables; Introduction; Summary; Background (the Sunnyside tar sand deposit, surface mining economics, oil extraction methods; Thermal processes); University of Utah thermal process (description of the laboratory apparatus, experimental data, heat recovery and energy balance, commercial application); Proposed one ton/hour process development unit (two-stage reactor design, auxiliary unit operations, proposed plant site, major equipment required for process, development unit); Proposed project work statement (project objectives, scope of work and preliminary schedule); Project organization and principal personnel; Estimated costs; Appendix A – process and apparatus to produce synthetic oil from tar sands.

Fouch, T.D., 1975, Lithofacies and related hydrocarbon accumulations in Tertiary strata of the western and central Uinta Basin, Utah, *in* Bolyard, D.W., editor, Symposium on Deep drilling frontiers of the central Rocky Mountains: Rocky Mountain Association of Geologists - 1975, p. 163-173.

(Asphalt Ridge), This article contains: Abstract; Introduction; Stratigraphic framework (nomenclature, North Horn Formation, Flagstaff Member of the Green River Formation; Colton Formation, Wasatch Formation, surface and subsurface markers, major facies and depositional environments, alluvial facies, marginal lacustrine facies, open lacustrine facies); Stratigraphic control of hydrocarbon accumulations (regional facies patterns and productive areas, facies and related reservoir units); Conclusions, References cited.

Fouch, T.D., Cashion, W.B., Ryder, R.T., and Campbell, J.H., 1976, Field guide to lacustrine and related nonmarine depositional environments in Tertiary rocks, Uinta Basin, Utah, *in* Epis, R.C., and Weimer, R.J., editors, Professional contributions of Colorado School of Mines: Studies in Colorado Field Geology, No. 8 (November edition), p. 358-384.

(No Specific Deposits), This road log contains: Introduction; Road Log - Part I - Thistle to Price, Utah, via U.S.

Highway 6 and 50. Mention of tar sands noted in the introduction, pages 372, 376, 381, and 382; References.

Francis, Steve, 1979, Utah tar deposits could be major oil source: The Summer Chronicle, v. 89, no. 10, p. 1.

(Utah Deposits), This article contains the following: Introduction; Potential of tar sand development; Problems in development; Tar sand research at University of Utah.

Gabrys, Karol, 1980, High temperature-high pressure pumping of dispersed solid-hydrocarbon slurries: Unpublished report submitted to United Nations Industrial Development Organization, 34 p.

(Sunnyside), This paper includes the following: High temperature, high pressure pumping of dispersed solid-hydrocarbon slurries (introduction, description of the experimental apparatus, results, discussion); Trip to Auburn University and the SRC Pilot Plant at Wilsonville (Alabama); Acknowledgement; References.

Garvin, R.F., 1969, Stratigraphy and economic significance, Currant Creek Formation, northwest Uinta Basin, Utah: Utah Geological and Mineralogical Survey Special Studies 27, 62 p., and two plates.

(Tabiona), This report contains**:** Abstract; Introduction (previous work, location and accessibility, topography and drainage, climate and vegetation, glacial features, landslides, methods of study); Stratigraphy (general statement, Mesaverde Formation, Currant Creek Formation, Uinta (?) Formation, Bishop Conglomerate); Structure (regional structure, local structure); Tectonic history (general statement, Tabby Mountain disturbance, folding of the Uinta Mountain anticline); Economic geology (general statement, oil-impregnated sandstones, petroleum); Acknowledgments; References; Appendix A (section 1 of Currant Creek Formation along Red Creek); Appendix B (section 2 of Currant Creek Formation near Duchesne River in Little Valley); Illustrations.

Gill, Douglas, 1974, Utah & Athabasca oil sands hold huge reserves (part 1): Western Oil Reporter, October, p. 29-30.

(Numerous Utah Deposits), Introduction; Sands don't measure up; Sands more accessible; Less capital intensive; Only 60 percent recoverable; Utah not so flush.

Gill, Douglas, 1974, Oil sands operations may flourish in Alberta; they may succeed in Utah on a lesser scale (part 2): Western Oil Reporter, October, 6 p.

(Athabasca), (P.R. Spring), (Asphalt Ridge), (Tar Sand Triangle), Discusses the operations and possibilities for tar sand extraction in the Canadian and Utah areas.

Gill, Douglas, 1974, Utah oil sands could be a solid investment (part 3): Western Oil Reporter, October, p. 27-29.

(Numerous Utah Deposits), Introduction; Date with destiny; Independents lease; Anschutz block; Shenandoah block; Sohio's action; Oil development of Utah; Federal gambit; Official policy needed; Where to invest?

Gill, Douglas, 1975, Asphalt Ridge oil sand projects moving slowly: Western Oil Reporter, p. 54-55.

(Asphalt Ridge), This article discusses the progress that was made on the extraction of oil from the Asphalt Ridge deposit by Major Oil Corporation, a subsidiary of Arizona Fuels, Inc. of Salt Lake City.

Gimber, G.A., Groves, K.O., Haschke, E.M., and Vivian, T.A., 1963, Chlorinated hydrocarbons – versatile solvents for tar sand extraction: Midland, Dow Chemical U.S.A., Inorganic Chemicals Department: 17 p.

(No Specific Deposit), This report contains the following: The surface extraction of tar sands; Abstract; Some considerations in selecting a solvent (cost and availability, efficiency of extraction, safety and health, environmental release potential); Extraction of oil-bearing sands with chlorinated solvents (extraction efficiency,

solvent recovery from bitumen, solvent recovery from sand, solvent recovery from water); Summary; Seven tables and four figures; References.

Glassett, J.M., and Glassett, J.A., 1976, The production of oils from Intermountain West tar sand deposits: Provo, Eyring Research Institute, 91 p.

(Asphalt Ridge), (Circle Cliffs), (Hill Creek), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This report includes the following: Abstract; Introduction; Acknowledgment; Location of largest deposits; Surface mining; Chemical processing; Environmental aspects; Economics; Comparison of Utah and Athabasca tar sand deposits; Conclusions; Research recommendations; References; Bibliography.

Glassett, J.M., Gould, W.R., and Glassett, J.A., 1977, Utah tar sand mining methods: Provo, Eyring Research Institute, (done under contract no. J0166164 with the U.S. Bureau of Mines), variously paginated.

(Sunnyside), (Asphalt Ridge), This report contains the following: Abstract; Introduction; Acknowledgement; [Part 1] In-situ oil recovery methods (tar sands, world resources); Sunnyside tar sand deposit (history, geology, reservoir properties); In-situ exploitation (methods and limitations); Summary; Conclusions; References; Core hole data from ARCO; Glossary; Figures and list of tables. [Part II] Surface mining methods – overburden stripping (site preparation, drilling); Blasting (mining explosives); Overburden removal and mining (general, shovel-truck stripping, rippers and scrapers, bucket-wheel stripping, dragline stripping, miscellaneous methods, summary); Surface mining of Asphalt Ridge (geology and location, mining history); The evaluation of the Asphalt Ridge deposit; Proposed Asphalt Ridge mine economic study; General overview of the proposed Asphalt Ridge mine; Top soil removal and mine site reclamation; Overburden stripping; Tar sand removal and haulage; Exploration; Maintenance and miscellaneous; Summary; Part II references; Minable area maps; Key to township grids; Core holes; WABCO field application study; Bibliography; List of figures; List of tables.

Glassett, J.M., Gould, W.R., and Glassett, R.M., 1978, Study contract for comparison of Utah and Athabasca oil sands (Done under contract no. J0275016): Provo, Eyring Research Institute.

(Sunnyside), (Asphalt Ridge), (Hill Creek), (P.R. Spring), (Tar Sand Triangle), (Circle Cliffs), (Athabasca), This report contains: Abstract; Acknowledgement; Part I - Canadian overview (Introduction, history, geology and deposit characterization, the GCOS project, the Syncrude project, Imperial Oil Limited, Norcen Energy Resources Limited); Part II – Utah overview (geology and deposit characterization, in-situ recovery, history of mining); Part III – The proposed Sunnyside mining plan (evaluation of the Sunnyside project, general overview of the proposed Sunnyside mine, topsoil removal and mine site reclamation, overburden stripping, oil sand removal and haulage, exploration, maintenance and miscellaneous, summary).

Globus, A.R., 1978, Process for recovery of bituminous material from tar sands, United States Patent No. 4,120,777, 6 p.

(Patent), (No Specific Deposit), A process for the recovery of bituminous tar like materials from tar sands containing the same; the process includes mixing the tar sands with water, mildly heating the sami in the presence of an alkali metal bicarbonate, gently mixing the mixture and while the mixture is warm, removing the recovered bituminous materials therefrom.

Gloyn, R.W., Tabet, D.E., Tripp, B.T., Bishop, C.E., Morgan, C.D., Gwynn, J.W., and Blackett, R.E., 2003, Energy, mineral, and ground-water resources of Carbon and Emery Counties, Utah: Utah Geological Survey Bulletin 132, 161 p.

(Sunnyside), (Minnie Maud Creek), (Cottonwood-Jacks Canyon), (Red Canyon), (Black Dragon), (Wickiup), (Cottonwood Draw), (Nequoia Arch), (Sweetwater Dome), (Justensen Flat), (Family Butte), (Flat Top), (Chute Canyon), (Temple Mountain), (San Rafael Swell), Pages 64-73 of this book deal with oil-impregnated rock and oil shale resources. Table 56 presents a summary of oil-impregnated rock deposits of Carbon and Emery

Counties, Utah; Figure 31 is a generalized stratigraphic section showing oil-impregnated rock units in Carbon and Emery Counties, Utah; Table 57 gives reservoir and bitumen properties for the Sunnyside deposit; Figure 32 shows outcrop distribution of oil-impregnated sandstones of the Sunnyside-Jacks Canyon deposit; Table 58 gives in-place reserve estimates for Sunnyside-Cottonwood/Jacks Canyon deposit; Figure 33 shows area underlain by oil shale-bearing upper Member (Parachute Creek Member), of Green River Formation; Table 59 gives drill-hole oil shale intercepts and average yield in T. 12 S., R. 18 E., Carbon and Uintah Counties, Utah.

Godec, M.L., 2005, Hearing on the vast North American resource potential of oil shale, oil sands, and heavy oils: Testimony before the House Committee on Resources, Subcommittee on Energy & Mineral Resources, 6 p.

(No Specific Deposit), This testimony includes the following: Introduction; Undeveloped resources; Heavy oils and tar sands; Thermal-enhanced recovery; Advanced recovery methods; Zero-emission recovery methods; Overcoming barriers 1) reducing current geological, technical, and economic risks could be accomplished through an aggressive program of research and field tests, 2) investments in new technology development would lead to higher oil recovery efficiencies, 3) providing risk-mitigation incentives, and 4) update the data and information base on domestic heavy oil and oil sands); Conclusions.

Gorbaty, M.L., and Harney, B.M., editors, 1979, Refining of synthetic crudes: American Chemical Society, Advances in Chemistry series 179: 218 p.

(Asphalt Ridge), (Athabasca), This book contains the following: Preface; Advisory board; Characterization data for syncrudes and their implication for refining; Mass spectrometric analysis of heterocompounds in coal extracts and coal-liquefaction products; Catalytic hydroprocessing of shale oil to produce distillate fuels; Evaluation of a two-stage thermal and catalytic hydrocracking process for Athabasca bitumen; Catalytic cracking of Asphalt Ridge bitumen; Development of a process for the conversion of coal to catalytic-cracking charge stock; Upgrading primary coal liquids by hydrotreatment; Catalytic hydroprocessing of solvent-refined coal; Chemicals from coal-derived synthetic crude oils; Hydrorefining of flash pyrolysis coal tar; An investigation of the activity of cobalt-molybdenum-alumina catalysts for hydrodenitrogenation of coal-derived oils; The catalytic effect of active metals upon hydrodenitrogenation of heavy coal liquids; Index.

Graham, W.R.M., 1987, Analysis of metal species in petroleum and tar sands using the electron paramagnetic resonance and Fourier transform infrared techniques, *in* Filby, R.H., and Branthaver, J.F., editors, Metal complexes in fossil fuels – geochemistry, characterization, and processing: American Chemical Society, p. 358-367.

(Circle Cliffs), (P.R. Spring), This reference includes the following: Abstract, Introduction; Principles of EPR spectroscopy; Procedure; Results and discussion (vanadium, manganese, and iron); Conclusion; Acknowledgments; Literature cited.

Graham, R.J., Helstrom, J.J., and Mehlberg, R.L., 1987, A solvent extraction process for tar sand, *in* Pettit, Rhonda, 1987 eastern oil shale symposium proceedings, November 18-20, 1987 at the Hyatt Regency, Lexington, Kentucky: Kentucky Energy Cabinet Laboratory, p. 93-99.

(Sunnyside), This paper includes the following: Abstract; Introduction; The Sunnyside tar sand deposit; Bitumen recovery processes; The solvent extraction process (crushing, fines removal, tailings stripping, fines tailing drying, solvent evaporation, upgrading, syncrude quality, bitumen recovery and product yields); Summary; References.

Groves, K.O., and Hastings, L., 1983, The Tarco Process-for the surface extraction of tar sands: Midland, Dow Chemical U.S.A., 23 p. (Presented at the Synthetic Fuels from oil shale and tar sands symposium, May 17-19, at the University of Kentucky).

(No Specific Deposits), This paper contains: Abstract; The surface extraction of tar sands; Solvent extraction of tar sands; The TARCO process (solvent conversion, extraction procedure, solvent recovery from sand, solvent

recovery from bitumen, characterization of bitumen product, process economics); Summary; References; Twelve figures.

Gulf Mineral Resources, no date, Oil Sand Triangle (T. 30-32 S., R. 14-17 E.), Wayne and Garfield Counties, Utah: Unpublished report by Gulf Mineral Resources, 8 p.

(Tar Sand Triangle), This report includes the following: Location; Structure; Reservoir trap; Development history; Potential reserves; Possible recovery techniques; Summary; One figure.

Gulf Mineral Resources, no date, Plan of operations, P.R. Spring tar sands prospect, Gulf Leases, unpublished report by Gulf Mineral Resources, variously paginated.

(P.R. Spring), This report contains the following: Introduction; Lease description; Area description (topographic features, drainage features, cultural resources, vegetation, wildlife); Geology of the P.R. Spring prospect area (introduction, previous studies, stratigraphy, environments of deposition, structural history, structural setting of the P.R. Spring prospect area); Exploration plan (phased exploration program, exploration drilling and field reconnaissance methods, environmental controls for exploration); Pilot mine plan (pilot mine development method, pilot mine equipment, manpower and administration, drilling and blasting, pilot mine facilities, pilot mine design, pilot mine development schedule, pilot mine drainage system, environmental controls for mining, socioeconomic impact mitigation); Conceptual commercial mine plan (commercial mine development method, drilling and blasting, commercial mine equipment, manpower and administration, commercial mine facilities, commercial mine development schedule, commercial mine drainage system, water supply source, environmental controls for commercial operations, commercial development, socioeconomic mitigation).

Gwynn, J.W., 1971, Instrumental analysis of tars and their correlations in oil-impregnated sandstone beds, Uintah and Grand Counties, Utah: Utah Geological and Mineralogical Survey Special Studies 37, 64 p.

(P.R. Spring), This publication includes the following: Abstract; Introduction; Geography; Stratigraphy; Structure; Economic geology of tar sands in vicinity of P.R. Spring; Physical properties (pour points, flash and fire points, index of refraction); Chemical properties and analyses (ash content of tar and distillate, carbon residue of residuum and distillate, x-ray diffraction analyses of tar and tar ash, infrared analyses of tar and distillate ash, sulfur content of the tar, nitrogen content, oxygen content, carbon/hydrogen ratios of distillates, gas chromatography of tar distillates, IR analyses of tars and distillates, trace elements found in tars, sulfur isotope analyses of tar); Analytical data correlations; Origin of the tar; Summary and Conclusions, References. A companion study by Byrd gives includes 38 measured sections within the P.R. Spring area. Appendix 1- Table 1A gives core analyses (sample depth, permeability, porosity, percent oil and water of total porosity for 49 samples from five holes cored by Skyline Oil. Table 2A gives depth, permeability before and after extraction, porosity, percent volume, pore, and weight of residual liquid saturation, total water as percent of pore, and oil yield for 33 outcrop sample analyses. Appendix 2 includes crude petroleum analyses of five samples of tar from the P.R. Spring area, run by the U.S. Bureau of Mines Laramie laboratory. Appendix 3 gives infrared peak-height ratios between surface and subsurface samples (x-y plots). Appendix 4 gives the abundance of trace elements from tar ash. Appendix 5 gives the analytical results of hydrogenation of the Main Canyon tar-seep sample.

Gwynn, J.W., 1985, The Hill Creek oil-impregnated sandstone deposit: Utah Geological and Mineral Survey Report of Investigation 201, variously paginated.

(Hill Creek), This report includes the following: Introduction; Purpose; Stratigraphic setting; Structural setting; Sources of geologic data; Economic geology (areal distribution, lenticular nature and thickness, overburden, engineering properties, land status); References; Appendix A (data from various sources); Appendix B (engineering property data from core holes HC-1, 2, and 3 are given); Tables give physical and chemical properties of the Hill Creek bitumens; Topographic map of the Hill Creek area; Cross Section 4 - Hill Creek; overburden map; Land status map).

Gwynn, J.W., 1986, Overburden map and thickness determinations, Sunnyside oil-impregnated sandstone deposit, Carbon and Duchesne Counties, Utah, Utah Geological and Mineral Survey Report of Investigation 210, 9 p.

(Sunnyside), This report presents an overburden map for the Sunnyside oil-impregnated sandstone deposit, and discusses the thickness of the oil-impregnated sands within the deposit.

Gwynn, J.W., and Dalness, Bill, 1967, Capitol Reef - Miners Mountain oil-impregnated rock occurrences: Unpublished information for Utah Geological and Mineralogical Survey, 8 p.

(Capitol Reef), (Miners Mountain), This report includes the following: Setting; Stratigraphy; Structure; Description of the occurrences; Formation of occurrences; Economics; Statistics; Bibliography.

Gwynn, J.W., and Dalton, Ed, 1976, Notes on localities examined in survey for oil-impregnated sandstones, Hill Creek deposit, Uintah County: Utah Geological Survey unpublished notes, 7 p.

(Hill Creek), These notes describe 38 locations in the Hill Creek area.

Gwynn, J.W., 2007, Taking another look at Utah's tar sand resources: Utah Geological Survey, Survey Notes, v. 39, no. 1, p. 8-9.

(Asphalt Ridge), (NW Asphalt Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), This article provides a general summary of Utah's tar sand resources and a history of their exploration and development. It also announces the upcoming publication of the UGS Annotated Bibliography and Databases of Utah Tar Sands.

Hack, A.G., 1982, Flotation method and apparatus for recovering crude oil from tar-sand, United States Patent No. 4,324,652, 7 p.

(Patent), (No Specific Deposit), This invention relates to an improved method and apparatus for scrubbing crude oil (bitumen) from tar-sands, the apparatus being characterized by a heated vessel for maintaining the tar-sand/water slurry at between approximately 180.degree.-200.degree. F., a pair of counterrotating screw conveyors in the bottom of the vessel for agitating the sand and moving it to the discharge end, means for simultaneously diluting and aerating the incoming slurry that produces small bubbles effective to float the crude oil freed from the sand to the surface, an overflow wier running alongside the vessel for catching the oil skimmed off the surface of the water, transversely-extending endless chain-and-flight skimmers for skimming the oil into the wier, a bottom-opening discharge for the clean sand, and valves controlling the discharge of sand effective to remove the latter without lowering the fluid level in the vessel to a point where the oil previously released can reattach itself to the sand. The method encompasses the steps of submerging the tar-sand in a hot water bath agitating the sand while thus immersed while continuously bubbling air up through the slurry to float the oil particles freed from the sand grains to the surface, continuously skimming off the oil floating on the water bath from the surface thereof, and withdrawing the clean sand from the bottom of the vessel intermittently and quickly enough to prevent the level of the water bath from falling below the top of the screws.

Hack and Associates, 1967, Report of investigations—separation and cost analysis of recovering crude oils from bituminous sandstones near Roosevelt, Utah: (Two unpublished reports in Utah Geological Survey files).

(Whiterocks), Two reports are included: (1), The processing and recovery of crude oil from bituminous sandstones of the Whiterocks oil sand deposits, and (2), Operating cost estimate for proposed oil sand recovery plant with a capacity of 300 tons per hour.

Hanks, K.C., 1979, Chemistry of oil production from tar sands: Salt Lake City, University of Utah M.S. Thesis, 83 p.

(Sunnyside), (Tar Sand Triangle), This thesis includes the following: Abstract; Acknowledgments; Introduction;

Background (nature of tar sands studied, previous thermal processing studies); Experimental procedures (apparatus, feed preparation, operation procedure and problems, oil and coke collection); Analytical data (gas analysis, liquid analysis); Results (heat transfer, product quality); Discussion (chemical nature of bitumen, nature of thermal cracking, application to Utah tar sands); Conclusions and recommendations; Appendix (thermodynamics of thermal cracking, gas chromatography and nuclear magnetic resonance spectroscopy); References; VITA.

Hansley, P.L., 1995, Diagenetic and burial history of theLower Permian White Rim Sandstone in the Tar Sand Triangle, Paradox Basin, southeastern Utah: U.S. Geological Survey Bulletin 2000-I, 41 p.

(Tar Sand Triangle), This article contains: Abstract; Introduction; Tectonic setting; Stratigraphy; Depositional environment; Methodology; Core descriptions; Detrital mineralogy; Authigenic phases and alterations; Interpretation of authigenesis; Stable isotopes; Bleached sandstone; Fluid inclusions; Provenance; Burial history of the Tar Sand Triangle deposit; Potential source rocks; Oil migration; Conclusions; References cited; Appendix – description of core.

Hanson, F.V., Cha, S.M., Deo, M.D., and Oblad, A.G., 1991, Pyrolysis of oil shale from the Whiterocks tar sand deposit in a rotary kiln, *in* 1991 Eastern Oil Shale Symposium Proceedings (November 13-15, 1991, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 116-128.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion; Reproducibility of rotary kiln pyrolysis experiments; Rotary kiln process variable study, Effect of reactor temperature on product yields; Effect of solids retention time on product yields; Effect of sweep gas flow rate on product yields; Effect of reactor temperature on the quality of the liquid products; Effect of retention time on quality liquid product; Extent of upgrading of liquid products; Kinetics of rotary kiln pyrolysis of tar sands; Conclusions; Acknowledgments; References; Nomenclature; Fifteen tables and five figures.

Hanson, F.V., Cha, S.M., Deo, M.D., and Oblad, A.G., 1992, Pyrolysis of oil sand from the Whiterocks deposit in a rotary kiln: Fuel, v. 71, p. 1455-1463.

(Whiterocks), This paper contains the following: Abstract; Introduction; Experimental; Results and discussion (rotary kiln process variable study, effect of reactor temperature on product yields, effect of solids retention time on product yields, effect of sweep gas flow rate on product yields, effect of temperature on quality of liquid products, effect of retention time on quality of liquid products, preliminary process kinetics model); Conclusions, Acknowledgments, References; Nomenclature; Six figures and eight tables.

Hanson, F.V., Cha, Soonman, Longstaff, D.C., and Oblad, A.G., 1990, Pyrolysis of bitumen impregnated sandstones – a comparison of fluidized-bed and rotary-kiln reactors, *in* Stivers, Jack, editor, 1990 Eastern Oil Shale Symposium – oil shale – tar sands – heavy oil (November 6-8, 1990, Mariott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 136-145.

(Whiterocks), This paper includes the following: Abstract; Introduction (nature of the feed bitumen); Experimental apparatus and procedures (rotary kiln reactor system, feed preparation; Experimental results (effect of solids retention time on product yield, effect of solids retention time on properties of liquid products, effect of solids retention time on the chemical composition of produced liquids); Discussion; Summary; Acknowledgment; References; Eight tables and seven figures.

Hanson, F.V., Cha, S.M., Deo, M.D., and Oblad, A.G., 1992, Pyrolysis of oil sand from the Whiterocks deposit in a rotary kiln: Fuel, v. 71, p. 1455-1463.

(Whiterocks), This paper contains: Abstract; Introduction; Experimental procedure; Results and discussion (rotary kiln process variable study [effect of reactor temperature on product yields, effect of solids retention

time on product yields, effect of sweep gas flow rate on product yields, effect of temperature on quality of liquid products, effect of retention time on quality of liquid products, extent of upgrading of liquid products], preliminary process kinetics model); Conclusions; Acknowledgments; References; Nomenclature; Eight tables and six figures.

Hanson, F.V., Dorius, J.C., Utley, J.K., and van Nguyen, Thanh, 1991, The application of compound-type analysis to the correlation of product distribution and yields from the fluidized-bed pyrolysis of oil sands, *in* 1991 Eastern Oil Shale Symposium Proceedings (November 13-15, 1991, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 34-46.

(Sunnyside), (Tar Sand Triangle), (Whiterocks), (P.R. Spring), (Circle Cliffs), This article contains: Abstract; Introduction; Experimental apparatus and procedures; Results and discussion (analysis of the native bitumens, prediction of pyrolysis product distribution based on native bitumen properties, correlation for total liquid product yield, compound type distribution in BDSs; Conclusions; Acknowledgments; References; Fifteen figures and thirteen tables.

Hanson, F.V., Dorius, J.C., Utley, J.K., and van Nguyen, Thanh, 1992, The application of compound-type analyses to the correlation of product distributions and yields from the fluidized-bed pyrolysis of oil sands: Fuel, v. 71, p. 1365-1372.

(Sunnyside), (Tar Sand Triangle), (Whiterocks), (P.R. Spring), (Circle Cliffs), This paper includes the following: Abstract; Introduction; Experimental; Results and discussion (prediction of pyrolysis product distribution based on bitumen properties, correlation for bitumen-derived liquid yield, compound-type distribution in bitumen-derived liquids, Sunnyside tar sand, Whiterocks tar sand, P.R. Spring tar sand); Conclusions; Acknowledgments; References; Nine tables and nine figures.

Hanson, F.V., Drelich, Jaroslav, Hupka, Jan, and Miller, J.D., 1992, Water recycle in moderate-temperature bitumen recovery from Whiterocks oil sands: AOSTRA Journal of Research, v. 8, no. 2, p. 1-9.

(Whiterocks), This paper contains: Abstract; Introduction; Experimental procedures; Results (bitumen recovery, physiochemical properties, bitumen disengagement mechanism); Discussion (impact of water recycle, bitumen separation, bitumen disengagement); Summary and conclusions; Acknowledgments; References.

Hanson, F.V., Fletcher, J.V., and Zeng, H., 1995, Performance of auger-type dry materials feeders when feeding oil sands: New York, Elsevier, Fuel Processing Technology: v. 41, p. 289-304.

(Whiterocks), (P.R. Spring), This paper includes the following; Abstract; Introduction; Experimental (feed materials, feed apparatus); Methodology (preparation of feed mixtures, feeder calibration procedure); Results and discussion (feeding performance with small augers, feeding performance with large augers); Conclusions; References.

Hanson, F.V., Miller, J.D., and Oblad, A.G., 1982, Process for obtaining products from tar sand, United States Patent No. 4,337,143, 12 p.

(Patent), (Sunnyside), A novel thermal process for recovering hydrocarbon and other products from tar sand. The process includes blending tar sand with a bitumen-rich concentrate while heating the same with a hot, burnt sand. The products are recovered by passing the combined feed through a fluidized bed and selectively controlling the temperature and residence times to obtain predetermined ratios of products. Coked sand residue from the fluidized bed is burned to produce the hot, burnt sand, a portion of which may be recycled to provide heat to the fluidized bed. Coked sand may also be recycled into a known, hot-water, caustic separation process where it synergistically improves the separation efficiency of the hot-water, caustic separation process.

Hanson, F.V., Miller, J.D., and Oblad, A.G., 1983, Process for recovering products from tar sand, United States

Patent No. 4,409,090, 16 p.

(Patent), (Sunnyside), (Asphalt Ridge), (P.R. Spring), A combination physical separation process and thermal fluidized bed process for recovering products from tar sands. The process includes initially separating a portion of the sand from the tar sand through a physical separation process, yielding a bitumen-rich concentrate. The bitumen-rich concentrate is introduced into a heated fluidized bed and products are recovered and distilled into their respective fractions. A coked sand is removed from the fluidized bed and placed into a combustor where the carbonaceous residue on the sand is burned to produce a hot burnt sand, a portion of which may be recycled to provide heat to the bitumen-rich concentrate in the fluidized bed. The coked sand and a certain fraction of the distilled products may be recycled to the physical separation process to improve the separation efficiency thereof.

Hanson, F.V., and Oblad, A.G., 1989, The fluidized bed pyrolysis of bitumen-impregnated sandstone from the tar sand deposits of Utah, *in* Myer, R.F., and Wiggins, E.J., editors, The fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands proceedings, volume 5, extraction, upgrading, and transportation: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 421-438.

(Sunnyside), (Whiterocks), (Tar Sand Triangle), (Circle Cliffs), (P.R. Spring), This article contains: Abstract; Introduction; Experimental; Results and discussion (analysis and characterization of the native bitumens, product distribution and yields, characterization of produced hydrocarbon liquids; Conclusions; Acknowledgments; References; Eight tables and sixteen figures.

Harrison, W.E., III, 1986a, Production of aviation turbine fuels from Utah and Kentucky bitumens, *in* Pettit, Rhonda, editor, 1986 Eastern Oil Shale Symposium (November 19-21, 1986, Hyatt Regency, Lexington, Kentucky): Kentucky Energy Cabinet Laboratory, p. 99-103.

(Sunnyside), This paper contains: Abstract; Introduction; Approach; Results; Conclusions; References; Table 1 gives bitumen properties, Figure 1 – Ashland Petroleum's approach to processing Kentucky bitumen; Figure 2 – Ashland Petroleum's approach to processing Utah bitumen; Figure 3 – Sun Oil's approach to processing Kentucky and Utah bitumen; Table 2 – JP-4 fuel sample properties; Table 3 – JP-8 fuel sample properties; Table 4 – Normal paraffins in JP-8 samples derived from Utah bitumen.

Harrison, W.E., III, 1986b, Production of aviation turbine fuels from Utah and Kentucky bitumens, *in* DOE Tar Sand Symposium: Sponsored by U.S. Department of Energy, Hosted by the Western Research Institute, July 7-10, 1986 in Jackson, Wyoming, Paper no. 10-3.

(Sunnyside), This paper contains: Abstract; Introduction; Approach; Results; Conclusions; References. Table 1 gives bitumen properties; Table 2 gives JJP-4 fuel sample properties, Table 3 gives JP-8 fuel sample properties; Table 4 gives normal paraffins in JP-8 samples derived from Utah bitumen. Figure 1 gives Ashland Petroleum's approach to processing Kentucky bitumen; Figure 2 gives Ashland Petroleum's approach to processing Utah bitumen, Figure 3 gives Sun Oil's approach to processing Kentucky and Utah bitumens.

Hasiba, H.H., Trump, R.P., and David, A., 1973, In-situ process options for the recovery of energy and synthetic fuels from coal, oil shale, and tar sands: Dallas, Society of Petroleum Engineers of AIME paper number SPE 4710, 17 p.

(Tar Sand Triangle), (Circle Cliffs), (P.R. Spring), (Sunnyside), (Hill Creek), (Asphalt Ridge), This paper includes the following: Abstract; Introduction; Coal (surface mining and conversion, past work on in-situ recovery methods, in-situ methods - the present and the future); Oil shale (present surface mining/conversion projects, underground conversion methods, in-situ conversion methods); Tar sand deposit evaluations, in-situ recovery methods; Cyclic steam injection; Wet combustion; Discussion and conclusions; References.

Hatcher, H.J., Meuzelaar, H.L.C., and Urban, D.T., 1992, A comparison of biomarkers in gilsonite, oil shale, tar sand, and petroleum from Threemile Canyon and adjacent areas in the Uinta Basin, Utah, *in* Fouch, T.D.,

Nuccio, V.F., and Chidsey, T.C., Jr., editors, Hydrocarbon and mineral resources of the Uinta Basin, Utah and Colorado: Utah Geological Association Guidebook 20, p. 271-288.

(Asphalt Ridge), (Three-Mile Canyon), (Gilsonite), (Oil Shale), This article includes the following: Abstract; Introduction; Geologic setting; Results and discussion; Conclusions; Acknowledgments; References. Information is presented on tar sands from Asphalt Ridge, on oil shales from Southman Canyon, Uintah County, and Three-Mile Canyon, Uintah County. Hopane and sterane biomarker patterns of Uinta Basin fossil hydrocarbon sources; Numerous chromatograms are shown.

Hatfield, K.E., and Oblad, A.G., 1984, Chapter 123, Pilot plant program for upgrading heavy oils by hydropyrolysis, *in* Myer, R.F., Wynn, J.C., and Olson, J.C., editors, The future of heavy crude and tar sands: New York, Coal Age Mining Information Services, McGraw Hill, Inc., p. 1175-1179.

(Asphalt Ridge), The primary separation technique for the production of synthetic fuels from such sources as oil shale, tar sand, and black oils, produces a hydrocarbon liquid that is similar in properties to the heavier fractions of crude oil or heavy crudes. Extensive processing of these materials is required to bring them to a stage suitable for further processing in a normal oil refinery. Technical data are given in five tables (results of some delayed coking test runs, hydropyrolysis of synthetic oil intermediates, hydropyrolysis results of heavy oils - including Asphalt Ridge, pilot plant major hydropyrolysis equipment list, pilot plant operating costs).

Hatfield, K.E., Oblad, A.G., and Miller, Jan, 1982, Chapter 114, Pilot plant recovery of bitumen from oil-wet tar sands, *in* Meyer, R.F., Wynn, J.C., and Olson, J.C., editors, The future of heavy crude and tar sands: New York, Coal Age Mining Information Services, McGraw-Hill, Inc, p. 1104-1108.

(P.R. Spring), (Whiterocks), (Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), This article contains: World tar sands; Oil-wet and oil-dry sands; Processing strategy, University of Utah research team, University of Utah process licensed by Enercor (four steps); University of Utah's pilot plant; Ore mined on campaign basis; Conditioning steps; Bitumen and sand slurry; Soda ash and caustic soda; Crude bitumen concentrate; Characteristics of processed ores (sand and bitumen); Upgrading processes; Pilot plant and coking results; References; Two figures and five tables.

Hawley, C.C., Wyant, D.G., and Brooks, D.B., 1965, Geology and uranium deposits of the Temple Mountain district, Emery County, Utah: U.S. Geological Survey Bulletin 1192, 154 p.

(Temple Mountain), This bulletin contains: Abstract, Introduction, Analyses, Geology (stratigraphy, structure, geologic history); Uranium deposits distribution and general character of the deposits, localization and controls of ore in the Moss Back Member of the Chinle Formation, localization and controls of other ores, chemical composition of the ores and their enrichment relative to barren rocks, mineralogy, paragenesis, metal zoning, rock alteration, origins, suggestions for prospecting); Literature cited; Index.

Hein, F.J., 2006, Heavy oil and oil (tar) sands in North America – an overview & summary of contributions: Natural Resources Research, 18 p.

(Numerous Utah Deposits), (Rozel), This article contains the following: Abstract, Introduction (definition and origin of bitumen/heavy oil, bitumen/heavy oil resources); Bitumin/heavy oil occurrences in North America (large basin-margin/unconformity-related heavy-oil and bitumen resources, medium-small fault-unconformaity-related heavy-oil and bitumen resources, bitumen/heavy oil and MVT-type mineralization); Challenges in the development of North American heavy-oil/bitumen resources; Summary of contributions; Appendix 1 (listing of deposits by state); Acknowledgments; References.

Hernandez, R.I.A., 1982, The importance of bitumen viscosity control in the hot water processing of Utah tar sands: Salt Lake City, University of Utah M.S. Thesis, 137 p.

(Athabasca), (Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Hill Creek), (Asphalt Ridge), (Whiterocks), (Chapita Wells), (Cow Wash), (Lake Fork), (Littlewater Hills), (Raven Ridge), (Rim Rock), (Split Mountain), (Spring Branch), (Tabiona), (Upper Cane Hollow), (Others), (Numerous Utah Deposits), This thesis contains: Abstract; Acknowledgments; Introduction (Utah tar sand deposits, characteristics of Utah tar sands, separation technology); Fundamentals of the hot-water process (phase disengagement, phase separation); Experimental procedure (tar sand characterization, hot water separation test); Experimental results and discussion (characterization of tar sand samples, bitumen properties, sand properties, hot water separation tests, effect of bitumen viscosity, effect of high diluent addition, effect of diluent penetration time, effect of feed size, effect of carbonate concentration, effect of flotation cell temperature, water entrainment in the concentrate, overall discussion of experimental results, bitumen displacement from sand, sand composition, bitumen viscosity, nature of flotation response and flotation rate); Potential for by-product recovery from Utah tar sand; Conclusions, Appendices A-C; References; Vita.

Holbert, Charles, Drelich, Jaroslav, Zmierczak, Wlodzimierz, and Miller, J.D., 1997, Viscosity of bitumen-crumb rubber blend (new paving material): Petroleum Science and Technology, v. 15 (5 & 6), p. 523-543.

(Asphalt Ridge), (Circle Cliffs), This article contains: Abstract; Introduction; Experimental procedures (bitumen samples, crumb rubber, viscosity measurements, bitumen-rubber co-processing); Results and discussion (effect of processing temperature, effect of processing time); Conclusions; Acknowledgments; References; Ten figures.

Holmes, C.N., and Page, B.M., 1956, Geology of the bituminous sandstone deposits near Sunnyside, Carbon County, Utah, *in* Peterson, J.A., editor, Geology and economic deposits of East Central Utah: Intermountain Association of Petroleum Geologists, p. 171-177.

(Sunnyside), This article includes the following: Introduction; Stratigraphy (Wasatch and Green River Formations, surficial deposits); Structure; Bituminous sandstone deposits (grade and nature, reserves); Methods of quarrying and extraction; References. Some technical data is presented in two short tables.

Holmes, C.N., Page, B.M., and Averitt, Paul, 1948, Geology of the bituminous sandstone deposits near Sunnyside, Carbon County, Utah: U.S. Geological Survey Preliminary Oil and Gas Map 86, various scales.

(Sunnyside), This map shows the bituminous sandstone outcrops near Sunnyside, an enlarged view near the quarries of the Rock Asphalt Company of Utah, and one columnar section.

Holmes, S.A., Romanowski, L.J., and Thomas, K.P., 1986, Saturated hydrocarbon distributions in bitumens and oils recovered by thermal processes, *in* DOE Tar Sand Symposium: Sponsored by the U.S. Department of Energy, Hosted by the Western Research Institute, July 7-10, 1986, Jackson, Wyoming, Article 4-5.

(Asphalt Ridge), (Tar Sand Triangle), This article contains: Abstract; Introduction; Experimental procedures (isolation of tar sand bitumen, thermal processing of tar sand, material balances and physiochemical analyses, compound-type fractionation using liquid chromatography, characterization techniques applied to compound-type fractions); Results and discussion (product yields from thermal processing of tar sand, physiochemical properties of tar sand bitumens and oils, amounts of compound-types in bitumens and product oils, saturated hydrocarbon distributions in bitumens and oils, high resolution gas chromatographic analysis of saturates, field ionization mass spectrometric analysis of saturates, carbon number distributions for saturated hydrocarbons, z-series analysis for saturate class distribution, effects of thermal processes on product oil quality and saturated hydrocarbon distribution); Conclusions; Acknowledgement; Disclaimer; References.

Hooper, W.G., 1972, Geologic report Rio Vista Oil Ltd property, Circle Cliffs uplift, Garfield County, Utah: Unpublished report, 16 p.

(Circle Cliffs), This report includes the following: Introduction; Summary; Recommendations; References

(miscellaneous data); Eight figures.

Hosterman, J.W., and Meyer, R.F., 1989, Chemistry and resources of heavy oil and natural bitumen deposits, *in* Meyer, R.J., and Wiggins, E.J., editors, The Fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands proceedings, v. 2, geology and chemistry: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 251-255., and, *in* Fourth UNITAR/UNDP Conference on Heavy Crude and Tar Sands, preprints: UNITAR, v. 5, p. 148-1 to 148-5.

(Sunnyside), (Asphalt Ridge), This article contains: Abstract; Introduction; Mineralogy; Bitumen deposits (Wyoming, California, Utah, New Mexico, Oklahoma, Texas, Kentucky, Canada, Venezuela, Trinidad); Discussion; References.

Hosterman, J.W., Meyer, R.F., Palmer, C.A., Doughten, M.W., and Anders, D.E., 1989, Chemistry and mineralogy of natural bitumens and heavy oils and their reservoir rocks from the United States, Canada, Trinidad and Tobago, and Venezuela: U.S. Geological Survey Circular 1047, 19 p.

(Sunnyside), (NW Asphalt Ridge), (Rozel Point), (Gilsonite), This paper contains: Abstract; Introduction; Acknowledgments; Analytical techniques (dividing reservoir rock samples into available hydrocarbon and sediment residue, determining the composition of the available hydrocarbon, determining the mineral content of the sediment residue, determining the trace-element distribution; Bitumen and heavy oil deposits (California, Kentucky, New Mexico, Oklahoma, Texas, Utah, Wyoming, Canada, Trinidad and Tobago, Venezuela); Discussion; References; Appendix (description of sample localities); Eight tables.

Hu, Jin, 1994, Two-stage process for conversion of petroleum residual oils distillable fuels: Salt Lake City, University of Utah M.S. Thesis, 102 p.

(No Specific Deposits), This thesis contains: Abstract; Acknowledgments; Introduction (some general needs of refinery industry, residual oil conversion process, approaches to conversion of heavy oils – background, framework and objective of the thesis); Experimental procedures (apparatus, materials, catalyses, experimental procedure, analytical procedures); Conversion of residual oils into distillable fuels by sequential hydrotreatment-hydrocracking treatment (general considerations, yield and distribution of products from acid-catalyzed hydrotreatment of residual oil feed, composition of products from hydrotreatment of the residual oil feed, sequential hydrotreatment – hydrocracking of residual oil comparison with direct hydrocracking); Studies of residual oil-simulating model compounds (general considerations, reactions of sulfur-containing model compounds, hydrogenolysis reactions of residual oil-simulating hydrocarbons, conclusions); Appendix (simulated distillation method), References.

Humphries, Mark, 2008, North American oil sands – history of development, prospects for the future: Congressional Research Service, 30 p.

(No Specific Deposit), This report contains the following: Summary; Introduction; World oil sands reserves and resources (what are oil sands?, U.S. oil sand resources, Canadian oil sand resources); History of development (role of industry and government, oil sands production processes, U.S. markets); Issues for Congress; Appendix A; Appendix B; Acronyms and abbreviations; Lists of figures and tables.

Hunt, J.M., Stewart, Francis, and Dickey, P.A., 1954, Origin of hydrocarbons of Uinta Basin, Utah: Bulletin of the American Association of Petroleum Geologists, v. 38, no. 8, p. 1671-1698.

(No Specific Deposits), This paper includes the following: Abstract; Introduction; Stratigraphy (Wasatch, Green River, and Uinta Formations); Petrography of sediments; Chemical identification of source rocks; Identification of source beds of hydrocarbons; Comparison of vein hydrocarbons (ozocerite, albertite and ingramite, gilsonite, wurtzilite) with organic matter extracted from lacustrine source beds; Possible sources of hydrocarbons in asphaltic sandstones; Summary of chemical identification of source rocks, Change in hydrocarbon type with

depositional environment; General environmental conditions (Wasatch time, Early Green River time, Middle and Late Green River time, Uinta time); Effect of other geologic factors on hydrocarbon composition; Conclusions; References.

Huntsman, J.M., and Fletcher, Ernie, 2006, Development of America's strategic unconventional fuels resources (Initial report to the President and the Congress of the United States): Task Force on Strategic Unconventional Fuels, 31 p.

(No Specific Deposit), This article includes the following: Transmittal letter; Task force members and their official representatives; Introduction (directives from Congress, task force activities, scope of effort); Task force findings (analyses and assessments, initial findings and conclusions, potential domestic fuels production under various policy and fiscal scenarios, uncertainties constraining development investment); Initial task force recommendations and options for consideration (options for accelerating commercial development of unconventional fuels, options for addressing major development impediments, recommendations regarding international collaboration and partnerships); Next steps for task force; Appendix A – Net energy balance, the energy cost of producing energy; Appendix B – Major assumptions for estimating production under various policy and fiscal scenarios.

Huntoon, J.E., Hansley, P.L., and Naeser, N.D., 1999, The search for a source rock for the giant Tar Sand Triangle accumulation, southeastern, Utah: American Association of Petroleum Geologists Bulletin, v. 83, no. 3, p. 467-495.

(Tar Sand Triangle), This paper presents the following: Introduction; The Tar Sand Triangle accumulation; Stratigraphy and depositional environment; Diagenesis and oil migration; Fluid inclusions; Fission-track analysis (methods, results); Thermal modeling (method, White Rim Sandstone); Potential source rocks; Burial history of potential source rocks (Chuar Group, Delle Phosphatic Member of the Desert Limestone, Paradox Formation, Meade Peak Member of the Park City (Phosphoria), Formation, Kaibab Limestone, Sinbad Limestone Member of the Moenkopi Formation, Twin Creek Limestone, Carmel Formation, and Arapien Shale); Paleohydrology; Tectonic history; Discussion; Conclusions. Figures show the location of the deposit, a generalized cross section, apatite track-length distributions in White Rim Sandstone, temperature curves, depth versus time and temperature, thermal modeling results for the Grand Canyon area, thermal modeling results for the Pavant Range area, thermal modeling results for the Paradox basin, Moab area, and the Salt Lake City area. Tables give apatite fission-track ages, White Rim Sandstone burial history, Potential source rocks for the Tar Sand Triangle, Chuar Group burial history, Grand Canyon Area, Burial history for the Pavant Range area, Paradox Formation burial history, Burial history for the Park City Formation (including the Mead Peak Member).

Hupka, Jan, Biernat, J.F., Hupka, M., Dworzanski, J.P., and Miller, J.D., 1993, Isolation and characterization of surfactants from tar sand process water, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 110-116.

(Asphalt Ridge), (Whiterocks), This paper includes the following: Abstract; Introduction; Experimental procedures (procurement of process water, isolation of surfactants, analytical techniques); Results and discussion (sublated materials, precipitate, oily residue, composition of the oily residue); Summary and conclusions; References; Eleven figures and four tables.

Hupka, Jan, Budzich, M., and Miller, J.D., 1991, Preliminary examination of oil bonding and sand surfaces and its influence on hot water separation, *in* 1991 Eastern Oil Shale Symposium Proceedings – oil shale – tar sands – heavy oil (November 13-15, 1991, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 202-207.

(Asphalt Ridge), This article contains: Abstract; Introduction; Fundamental considerations; Experimental procedures; Results and discussion (optimization of the oil-sand separation process, impact of silica dehydration,

separation efficiency); Summary and conclusions; Acknowledgments; References.

Hupka, Jan, Bukka, Krishna, and Miller, J.D., 1995, Crumb rubber dispersion in tar sand bitumen: International Polymer Seminar Gliwice 95, p. 243-246.

(Asphalt Ridge), This article contains: Abstract; Introduction; Asphalt potential of tar sand bitumen; Production of crumb rubber; Experimental procedures; Rubber accommodation by bitumen; Acknowledgments; References; Final comments; One figure and two tables.

Hupka, Jan, Drelich, Jaroslav, and Miller, J.D., 1990, Impact of water recycle on water-based processing of Whiterocks tar sands, *in* Stivers, Jack, editor, 1990 Eastern Oil Shale Symposium – oil shale – tar sands – heavy oil (November 6-8, 1990, Mariott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 39-44.

(Whiterocks), This paper includes the following: Abstract; Introduction; Processing method; Results and discussion (bitumen recovery, water recycle and sedimentation of tailings, thickening of sediment); Conclusion, Acknowledgments; Literature; Two tables and three figures.

Hupka, Jan, Drelich, Jaroslav, Miller, J.D., White, R.R., Hanson, F.V., and Oblad, A.G., 1991, Impact of water recycle on water-based processing of Whiterocks tar sand: Fuel, v. 70, p. 1313-1316.

(Whiterocks), This article contains: Abstract; Introduction; Processing method; Experimental procedures; Results and discussion (bitumen recovery, water recycle, sedimentation of tailings, thickening of sediment); Conclusions; Acknowledgement; References.

Hupka, Jan, and Miller, J.D., 1990, Moderate-temperature water-based bitumen recovery from tar sand, *in* Stivers, Jack, editor, 1990 Eastern Oil Shale Symposium – oil shale – tar sands – heavy oil (November 6-8, 1990, Marriott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 130-145.

(Asphalt Ridge), (Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion (microscopic observations, processing strategy, pretreatment with diluent, digestion, gravity separation, flotation, water recycle, bitumen concentrate clean-up); Summary; References; Five figures

Hupka, Jan, and Miller, J.D., 1991a, Moderate-temperature water-based bitumen recovery from tar sand: Fuel, v. 70, p. 1308-1312.

(Asphalt Ridge), (Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Microscopic observations; Processing strategy (pretreatment and diluent, digestion, gravity separation, flotation, water recycle, bitumen concentrate clean-up); Conclusions; Acknowledgments; References; Five figures.

Hupka, Jan, and Miller, J.D., 1991b, Electrophoretic characterization and processing of Asphalt Ridge and Sunnyside tar sands: Amsterdam, Elsevier, International Journal of Mineral Processing, v. 31, p. 217-231.

(Asphalt Ridge), (Sunnyside), This article includes the following: Abstract; Introduction; Processing strategy for Utah tar sands; Experimental procedures (hot water separation experiments, analytical methods); Results and discussion (mobility of bitumen droplets, mobility of fine mineral particles); Hot water processing technology; Summary and conclusions; Acknowledgments; References.

Hupka, Jan, and Miller, J.D., 1993, Tar sand pretreatment with diluent: Minerals and Metallurgical Processing, p. 139-144.

(Asphalt Ridge), (Whiterocks), This article contains: Abstract; Introduction; Fundamental considerations;

Natural porosity of tar sand (porosity measurements, porosity results and discussion); Tar sand pretreatment with diluent (experimental procedure, pretreatment results and discussion); Conclusions and comments; Acknowledgments; References; Three tables and six figures.

Hupka, Jan, Miller, J.D., and Cortez, A., 1983, Importance of bitumen viscosity in the hot water processing of domestic tar sands: Mining Engineering, v. 35, no. 12, p. 1635-1641.

(Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Whiterocks), This paper includes the following: Abstract; Introduction; Experimental procedures; Results and discussion (penetration time, coefficient of separation, concentrate grade, bitumen losses in the tailing); Processing strategy recommendations; Summary and conclusions; References. Tables 2 and 3 list the following Utah deposits from which samples were obtained: Asphalt Ridge, Sunnyside, Tar Sand Triangle, P.R. Spring, Rainbow, P.R. Spring South, P.R. Spring North, Whiterocks (possibly others whose states are not identified).

Hupka, Jan, Miller, J.D., and Drelich, Jaroslav, 2004, Water-based bitumen recovery for diluent-conditioned oil sands: The Canadian Journal of Chemical Engineering, v. 82, p. 978-985.

(Asphalt Ridge), (P.R. Spring), (Rainbow), (Sunnyside), (Whiterocks), (Others), This article contains: Abstract; Development of bitumen separation/recovery (process for Utah oil sands, impact of bitumen viscosity, diluent containment within oil sand, oil sand pretreatment with solvent, tripolyphosphate-enhanced processing); Conclusions; Appendix (diluent-to-bitumen ratio); Acknowledgments; References; Two tables and seven figures.

Hupka, Jan, Oblad, A.G., and Miller, J.D., 1984, Hot water processing of U.S. tar sands - water recycle and tailings disposal, *in* Pawlowski, L., Verdier, A.J., and Lacy, W.J., editors, Chemistry for Protection of the Environment: New York, Elsevier, 17 p.

(Asphalt Ridge), (Sunnyside), This paper includes the following: Abstract; Introduction; Strategy and environmental considerations in hot water processing of tar sands; Tailings treatment (water loss and mass balance, sand sedimentation, dissolved organic compounds, water recycling); Final comments and conclusions; Acknowledgement; References.

Hupka, Jan, Oblad, A.G., and Miller, J.D., 1987, Diluent-assisted hot-water processing of tar sands: AOSTRA Journal of Research, v. 3, p. 95-102.

(Asphalt Ridge), (P.R. Spring), (Rainbow), (Sunnyside), (Whiterocks), This article includes the following: Abstract; Introduction; The role of diluent in the process; Bitumen recovery experiments; Results and discussion; Conclusions; References. Tables 1-3 give experimental data.

Hutchinson, H.L., Spivak, Allan, and Johnson, L.A., 1979, Simulation study of the LETC-2C in-situ combustion test in Utah tar sands: Society of Petroleum Engineers Annual Technical Conference and Exhibition, September 23-26, Las Vegas, NV, 11 p.

(Asphalt Ridge), This paper contains: Abstract; Introduction; Review of the field test; Model descriptions; Procedure (data selection and preparation, simulation of laboratory tube runs, simulation of the field experiment); Results (areal simulation of the TS-2C experiment, vertical cross-sectional results, final match, prediction runs); Conclusion and recommendations; Acknowledgement; References; Four tables and 13 figures.

Hwang, Jongsic, 1993, Application of dynamic supercritical fluid extraction to the recovery and upgrading of complex hydrocarbon mixtures: Salt Lake City, University of Utah M.S. Thesis, 267 p.

(Whiterocks), This thesis includes the following: Abstract; Acknowledgments; Introduction (recovery of oil sand bitumen, research objectives); Literature survey (solvent extraction of oil sands, upgrading bitumen by solvent deasphalting, SFE process of petroleum fractions); Experimental apparatus and procedures (general

system specification, experimental procedures, analysis methods); Modeling the extraction process; Results and discussion (feedstock characterization, preliminary process test, extraction of paraffinic crude oil by CO_2, extraction of bitumen-derived liquid by propane, extraction of native bitumen by CO_2, extraction of native bitumen by propane, reproducibility of extraction experiments, modeling results and comparisons); Conclusions and figure work; Appendices (supercritical fluid extraction reproducibility data, supercritical fluid extraction data, material balance calculations, computer program for GC-MS analysis, Whitson's lumping procedure, computer program for the estimation of thermodynamic properties, detailed calculation for modeling study); References; Vita. A supercritical fluid extraction system was used to study the extraction of hexadecane, a paraffinic crude oil, a bitumen-derived liquid, and the native Whiterocks bitumen with solvents such as CO_2 and propane.

Hwang, Jongsic, Park, S.J., Deo, M.D., and Hanson, F.F., 1995, Phase behavior of CO_2/crude oil mixtures in supercritical fluid extraction system – Experimental data and modeling: I&EC Research, p. 1280-1286.

(No Specific Deposits), This paper includes the following: Abstract; Introduction; Theoretical section; Experimental section; Results and discussion (effect of pressure, effect of temperature, effect of time, EOS modeling); Conclusions; Nomenclature; Literature cited.

Interstate Oil Compact Commission, 1984, Major tar sand and heavy oil deposits of the United States (Utah portion): Oklahoma City, Interstate Oil Compact Commission, 272 p.

(Numerous Utah Deposits), Chapter 9, Utah deposits. This chapter includes the following: Summary; Major deposits; Regional geology (northeastern Utah, southeastern Utah); Individual deposit descriptions; Minor deposits; References.

Jayakar, K.M., 1979, The thermal recovery of oil from tar sands: Salt Lake City, University of Utah Ph.D. Dissertation, 223 p.

(Tar Sand Triangle), (Asphalt Ridge), This dissertation presents the following: Abstract; Acknowledgments; Introduction (appearance and nature of tar sands, mineral matter in tar sands, nature of bitumen in tar sands, uses of tar sand bitumen, occurrence and reserves of tar sands, commercial interest in development of tar sands, factors affecting economic recovery of bitumen); Objectives; Review of previous work on tar sand processing (recovery of bitumen from tar sand, upgrading of bitumen, laboratory studies on thermal processing of tar sands and recovered bitumen); Selection of a process (theoretical feasibility of thermal recovery methods, choice of operating modes for thermal recovery, outline of a new process and its characteristics, the heat pipe, operating parameters, design variables, and constraints, effect of composition of tar sand on thermal processing); Design and construction of equipment (description of the laboratory apparatus, principles of design and construction of primary processing unit, feeding system, fines separation system, product-recovery system, heat-recovery system); Experimental procedure (fluidization studies, processing of tar sands); Results and discussion (fluidization studies, processing of tar sands); Conclusions and recommendations; Notation; References; Appendices (estimation of enthalpy changes, sample calculations for a lean tar sand, operating equations for heat pipes, mercury and potassium as heat-pipe working fluids, thermal processing of a lean tar sand, principles of fluidization, suggestions for pilot plant studies, fluidization studies, operating conditions for Tar-Sand Triangle feed, operating conditions for Asphalt Ridge feed); Vita.

Jensen, G.F., and Zenger, J.J., 1975, Potential for a petrochemical industry in Utah (feasibility study): Salt Lake City, Utah Engineering Experiment Station, University of Utah, variously paginated.

(No Specific Deposits), This report contains: Introduction (Utah resources, study objective and scope, method of approach); Summary and conclusions (petrochemical industry, petrochemical markets, Utah raw materials plant site factors, non-raw material plant site factors, alternative products for a Utah plant, Utah petrochemical plant possibilities, summary); Profile of the U.S. petrochemical industry (industry characteristics, history of petrochemicals, performance of the petrochemical industry, impact of the petrochemical industry, petrochemical production concentration, western markets); Utah raw materials as plant site factors (major plant location factors,

Utah natural resources, crude oil, development of Utah oil fields, oil refineries and pipelines, plant location, crude oil characteristics, tar sands, oil shale, coal, gilsonite, raw material resource summary); Non-raw material plant site factors (labor and general statistics, railroad transportation, motor transportation, air transportation, land availability, water availability, taxes and laws, utilities, cost of living, education, environment, recreation, climate); Alternative products for a Utah plant (ethylene, benzene, propylene, butadiene, zylenes, toluene, finished products, plastics and resins, synthetic fibers, synthetic elastomers, surface coatings, organic dyes and pigments, surfactants, pharmaceuticals, pesticides); Utah petrochemical plant possibilities (petrochemical plant demand, plant size and cost, plant outputs, plant location, petrochemical plant impact on Utah); Appendices (A - Petrochemical industry performance data, B - Trends for selected petrochemicals, C - Hypothetical industrial chemical complex).

John Short & Associates, 1981, Utah energy developments - a summary of existing and proposed activity, 1981-1990: Report done for the Utah Energy Office, 131 p.

(Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), (Raven Ridge), This publication contains: Acknowledgments; Introduction; Oil Shale; Tar sands (Asphalt Ridge, Sunnyside, undetermined area north of Green River, Five miles west of Vernal, unknown area, Tar Sands Triangle, five miles southeast of Vernal, Raven Ridge); Coal gasification/liquefaction; Coal; Uranium; Power plants; County summations.

Johnson, L.A., Jr., 1989, Development of an inclined liquid fluidized bed for tar sand processing (Work performed under cooperative agreement no. DE-FC21-86MC11076): Laramie, Western Research Institute, 11p.

(Asphalt Ridge), This report includes the following; List of figures and tables; Summary; Background; Description of reactor system; discussion of tests; Conclusions and recommendations; Acknowledgements; References.

Johnson, L.A., Jr., Fahy, L.J., Romanowske, L.J., Jr., Barbour, R.V., and Thomas, K.P., 1982, An echoing in-situ combustion oil recovery project in a Utah tar sand, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC monograph Series—Tar Sands: Interstate Oil Compact Commission, p. 151-162. Also, Journal of Petroleum Technology, February, 1980 issue.

(NW Asphalt Ridge), This chapter includes the following: Introduction; Experimental plan; Site description and reservoir properties; Injection and production equipment (well complexities, well pumping, air injection, steam, products separation); Data acquisition and instrumentation; Preliminary testing; Conduct of experiment; Product analysis; Results; Summary and conclusion.

Johnson, L.A., Jr., Fahy, L.J., Romanowski, L.J., and Hutchinson, H.L., 1984, Chapter 74 - A steam flood in a Utah tar sand, U.S.A., *in* Myer, R.F., Wynn, J.C., and Olson, J.C., editors, The future of heavy crude and tar sands, New York, Coal Age Mining Information Services, McGraw Hill, Inc., p. 727-736.

(NW Asphalt Ridge), This paper contains: Abstract; Introduction; Experimental plan; Test zone description; Well completion; Steam injection system; Product handling system; Instrumentation and data acquisition; Preliminary testing; Conduct of experiment; Product analysis; Model study; Results; Summary and conclusions). Figures show (LETC TS-1S pattern, layout, steam injection, temperature profile during test, hot water and steam zone locations at end of test, cumulative production). Tables give (average reservoir and oil properties, experimental results).

Johnson, L.A., Fahy, L.J., Thorton, M.W., Romanowski, L.J., Marchant, L.C., 1978, Oil recovery from a Utah tar sand deposit by in-situ combustion: The Interstate Oil Compact Commission Committee Bulletin, v. XX, no. 1, p. 63-76.

(NW Asphalt Ridge), This report contains: Abstract; Introduction; Experimental plan; Site description; Reservoir properties; Injection and production equipment (well completions, well pumping, air injection, steam,

products separation); Data acquisition and instrumentation; Preliminary testing; Conduct of experiment; Results; Summary and conclusion; References.

Johnson, L.A., Marchant, L.C., and Cupps, C.Q., 1975a, Properties of Utah tar sands - Asphalt Wash area, P.R. Spring deposit; U.S. Bureau of Mines Report of Investigation 8030, 11 p.

(P.R. Spring), (Asphalt Wash), This report includes the following: Introduction; Acknowledgment; Description of areas; Analytical procedures (core sample preparation, porosity and permeability tests, compressive strength testing, oil and water saturation determinations); Tar sand characteristics; Discussion of results; References. Illustrations include map of P.R. Spring deposit, cross section of Asphalt Wash area, porosity, oil saturation and permeability versus elevation for core holes PR-1, PR-4, and PR-4, columnar sections of Asphalt Wash. Tables include Utah Geological and Mineralogical Survey core hole locations in P.R. Spring deposit, Summary of core analyses for Asphalt Wash, and properties of tar sand by well and zone.

Johnson, L.A., Marchant, L.C., and Cupps, C.Q., 1975b, Properties of Utah tar sands - North Seep Ridge area, P.R. Spring deposit: Laramie, U.S. Department of Energy, Laramie Energy Research Center Report of Investigation 75/6, 17 p.

(P.R. Spring), (North Seep Ridge), This report includes the following: Introduction, Acknowledgment, Description of area; Analytical procedures (core sample preparation, porosity and permeability tests, compressive strength testing, oil and water saturation determinations); Tar sand characteristics; Discussion of results; References. Illustrations include map of P.R. Spring deposit, cross section of the north Seep Ridge area (two), Porosity, oil saturation, and permeability versus elevation for core holes PR-2,6 and 7; Columnar sections of north Seep Ridge area. Tables include Utah Geological and Mineralogical Survey core hole location and elevations in the P.R. Spring deposit, summary of core analysis and core hole data, north Seep Ridge area, and properties of tar sand by well and zone.

Johnson, L.A., Marchant, L.C., and Cupps, C.Q., 1975c, Properties of Utah tar sands - South Seep Ridge Area, P.R. Spring Deposits: U.S. Bureau of Mines Report of Investigations 8003, 14 p.

(P.R. Spring), (South Seep Ridge), This publication includes the following: Introduction; Acknowledgment; Description of areas; Analytical procedures (core sample preparation, porosity and permeability tests, compressive strength testing, and water and oil saturation determinations); Tar sand characteristics; Discussion of results; Summary; References. Figures include: map of P.R. Spring deposit, cross section of the south Seep Ridge area, and porosity, soil saturation, and permeability versus elevation for core holes PRS-1 through PRS-3, columnar sections of south Seep Ridge area. Tables include: Utah Geological and Mineralogical Survey core hole location in P.R. Spring deposit, summary of core analysis and core hole data for South Seep Ridge area, and average properties of oil zones by core hole.

Johnson, L.A., Marchant, L.C., and Cupps, C.Q., 1976, Properties of Utah tar sands - Flat Rock Mesa area, Hill Creek deposit: Laramie, U.S. Department of Energy, Laramie Energy Research Center Report of Investigation 76/5, 18 p.

(Hill Creek), (Flat Rock Mesa), This report includes the following: Introduction, Acknowledgments, Description of area; Analytical procedures (core sample preparation, porosity and permeability tests, compressive strength testing, oil and water saturation determinations); Tar sand characteristics; Discussion of results; References. Illustrations include map of Hill Creek deposit, cross section of Flat Rock Mesa area, Tertiary formations of the southern Uinta Basin, columnar sections of Flat Rock Mesa area, porosity, oil saturation, and permeability versus elevation for core holes HC1-3). Tables include (UGMS core hole locations and elevations, summary of core hole data and core analysis for Flatrock Mesa area, and properties of tar sands by well and zone).

Johnson, L.A., Jr., and Thomas, K.P., 1986, Comparison of laboratory and field steamfloods in tar sands, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie,

Western Research Institute, p. 296-304.

(Asphalt Ridge), This paper includes the following: Abstract; Introduction; Experimental procedure (experimental apparatus, sample and sample preparation, test operation); Results and discussion (product analysis); Conclusions; References. Table 1 gives average initial properties, Table 2 gives test parameters, Table 3 gives results, and Table 4 gives chemical and physical properties of original bitumen and oils produced by steam flood. Figure 1 shows the block reactor schematic, Figure 2 shows the cumulative recovery curves for steam flood tests, and Figure 3 shows produced oil viscosities.

Johnson, L.A., and Thomas, K.P., 1986, Comparison of laboratory and field steam floods in tar sand, *in* DOE Tar Sand Symposium: U.S. Department of Energy, Western Research Institute, Paper No. 6-3.

(Asphalt Ridge), This paper includes the following: Abstract; Introduction; Experimental procedure (experimental apparatus, sample and sample preparation, test operation); Results and discussion (product analysis); Conclusions; References. Table 1 gives average initial properties, Table 2 gives test parameters, Table 3 gives results, and Table 4 gives chemical and physical properties of original bitumen and oils produced by steam flood. Figure 1 shows the block reactor schematic, Figure 2 shows the cumulative recovery curves for steam flood tests, and Figure 3 shows produced oil viscosities.

Johnson, L.A., Jr., and Thomas, K.P., 1988, Comparison of laboratory and field steamfloods in tar sand, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 805-811.

(Asphalt Ridge), This article contains: Abstract; Introduction; Experimental procedure (experimental apparatus, sample and sample preparation, test operation); Results and discussion (product analysis); Conclusions; References; Four tables and three figures.

Kasevich, R.S., 1991, Electromagnetic apparatus and method for in situ heating and recovery of organic and inorganic materials, United States Patent No. 5,065,819, 16 p.

(Patent), (No Specific Deposit), The disclosure describes an electromagnetic apparatus, and a method of use thereof, for simultaneously generating near-uniform heating in a subsurface formation and simultaneously recovering organic and inorganic materials through the apparatus itself. The apparatus may be constructed from flexible or semi-rigid materials for use in horizontal borehole applications. The disclosure also describes a phase-modulated multiple borehole system, and a method of use thereof, for heating larger subsurface volumes and for creating steerable and variable heating patterns. The apparatus and system described herein may be used for recovering oil trapped in rock formations and for decontaminating a region of the earth contaminated with hazardous materials.

Kasparek, R.B., 1984, Draft environmental impact statement on conversion of oil and gas leases to combined hydrocarbon leases, Tar Sand Triangle, Utah: U.S. National Park Service and U.S. Bureau of Land Management Draft Environmental Impact Statement, variously paginated.

(Tar Sand Triangle), This book includes the following: Purpose of and need for action (introduction, background, NPS finding of no resulting significant adverse impact, scope of the analysis, interrelationship with other proposals); Alternatives including the proposed action (overview of the alternatives, alternatives considered but eliminated, description of the alternatives, evaluation and comparison of the alternatives, agency preferred alternative); Affected environment (natural environment, cultural resources, socioeconomic environment, land use, recreation and wilderness values); Environmental consequences (alternative 1; convert all leases (proposed action), alternative 2A: convert leases with additional protective restrictions, alternative 2B: deny conversion on BLM WSA lands, alternative 2C: deny conversion on NPS NRA Lands, alternatives 2A, 2B, and 2C: unavoidable adverse impacts, alternative 3: deny conversion of all leases); Consultation and coordination (Introduction, scoping process and issues, agencies and organizations consulted, list of agencies, organizations, and persons to

whom copies of the statement are sent, preparers and consultants, references, appendixes A-G; List of tables and illustrations.

Kayser, R.B., 1966, Bituminous sandstone deposits Asphalt Ridge: Utah Geological and Mineralogical Survey Special Studies 19, 62 p.

(Asphalt Ridge), This report contains: Abstract; Introduction; Economic features (terms, exploration and development, reserves, production methods), Geologic setting; Stratigraphy (Mancos Shale, Mesaverde Group, Wasatch and Green River, Uinta, and Duchesne River Formations); Structure; Distribution of bitumen (stratigraphy and structure); Physical and chemical properties of bitumen; Origin of bitumens; Physical properties of reservoir rocks; Field evaluation of bituminous saturation; References; Appendix; Four plates and six figures.

Keefer, T.N., and McQuivey, R.S., 1979, Water availability for development of major tar sand areas in Utah: Arlington, The Sutron Corporation (Work performed under contract EW-78-S-20-0013), 228 p.

(Asphalt Ridge), (Whiterocks), (Hill Creek), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This report covers the following: Introduction (purpose, background); Tar sands deposit (nature and distribution, physical setting, geologic setting); Water requirements for development (in-situ processes, approximate water requirements); Water resources near Asphalt Ridge and Whiterocks (surface water, groundwater); Water resources near Hill Creek P.R. Spring, Sunnyside, Tar Sand Triangle deposits (surface water, ground water); Legal, social and other factors (introduction, laws, impact, planned water development, usage and population trends; Summary of water availability; Recommendations for each of the five deposits mentioned; References.

Keighin, C.W., and Hibpshman, M.H., 1975, Preliminary mineral resource study of the Uintah and Ouray Reservation, Utah: U.S. Bureau of Indian Affairs Report 4, 41 p.

(Whiterocks), (Deep Creek Nose), (Tabiona), (Myton Bench), (Pariette), (Hill Creek), (P.R. Spring), (Willow Creek), (Littlewater Hills), (Lake Fork), (Chapita Wells), (Spring Branch), This report includes the following: Summary and conclusions; Introduction; Geologic setting; Mineral resources (energy resources, metallic mineral resources, nonmetallic mineral resources); Mineral leasing; Markets; Recommendation for further work; References.

Kelley, D.R., and Kerr, P.F., 1958, Urano-organic ore at Temple Mountain, Utah: Bulletin of the Geological Society of America, v. 69, no. 6, p. 700-755.

(Temple Mountain), This bulletin contains: Introduction; Acknowledgments; Techniques of investigation; Organic materials (general statement, relics of vegetation, organic material of petroliferous origin, dry oil impregnating sandstone, asphalt, urano-organic materials); Metallic minerals of the ore; Ore aggregates; Alteration associated with mineralization; Conclusion; References.

Kerns, Ray, 1984, Utah tar sands: Utah Geological Survey Survey Notes, v. 17, no. 4, p. 1, 4-9.

(Numerous Utah deposits), This article contains: Introduction; Composition of petroleum; Origin of petroleum and tar; Distribution of Utah tar sands; Recent developments at the Utah Geological and Mineralogical Survey; References; Two tables and six figures.

Kim, Jai-Woh, 1995, Catalytic and thermal effects in the upgrading of bitumen-derived heavy oils: Salt Lake City, University of Utah Ph.D. Dissertation, 347 p.

(P.R. Spring), This dissertation contains: Abstract; Abbreviations and nomenclature; Acknowledgments; Introduction (research objectives); Literature survey (definition of oil sand, oil sand reserves, origin and geology of oil sands, nature of oil sands and bitumen, oil sand recovery, constituents of bitumen, hydroprocessing

catalysts, deactivation of hydrotreating catalysts, hydroprocessing technology, bench scale hydrotreating reactors); Experimental apparatus and procedures (feedstock preparation, hydrotreater reactor system, impregnation of sodium on the HDN catalyst support, vapor-liquid equilibrium calculation); Results and discussion (variables, kinetic study, catalyst evaluation, comparison of catalyst performance, product yield from residuum conversion); Conclusions; References.

Kim, Jai-Woh, Longstaff, D.C., and Hanson, F.V., 1997, Thermal conversion of P.R. Spring bitumen-derived heavy oil in the presence of Na/alumina: Fuel Processing Technology, v. 55, p. 71-82.

(P.R. Spring), This paper contains: Abstract; Introduction; Experimental; Results and discussion (effect of WHSV, effect of temperature); Conclusions; Acknowledgments; References.

Klubov, B.A., 1993, A new scheme for the formation and classification of bitumens: Journal of Petroleum Geology, v. 16, no. 3, p. 335-344.

(No Specific Deposits), This article includes the following: Introduction (previous work, oil and bitumen formation, new scheme of bitumen formation); Progressive naphthide formation; Regressive naphthide formation; Pyrodestructive bitumogenesis; Dynamic-hydrothermal bitumogenesis; Phase-migration bitumogenesis; Conclusions; Acknowledgments; References.

Koch, C.A., 1982, The oil resources in tar sand deposits in the United States, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, Tar Sands: Interstate Oil Compact Commission Monograph Series, p. 19-25.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Asphalt Ridge), (Hill Creek), (San Rafael Swell), (NW Asphalt Ridge), (Raven Ridge), (Whiterocks), (Wickiup), (Argyle Canyon), This paper has the following sections: Summary (overview, world oil resources, general geology, major U.S. deposits, oil characteristics, reservoir characteristics, available maps, and recovery methods); Table 1- Comparison of world resources and reserves for tar sands, oil, and oil shale. Table 2 - Geological age of deposits; Table 3 - Tar sand resources of U.S.; Table 4 - Oil Characteristics; Table 5 - Reservoir characteristics; Table 6 - Available maps; Table 7 - Research projects.

Kotlyar, L.S., Montgomery, D.S., Woods, J.R., Sparks, B.D., and Ripmeester, J.A., 1989, Properties of GPC separated maltene fractions derived from Utah and Athabasca bitumen, in Lazar, D.J., editor, 1989 Eastern Oil Shale Symposium (November 15-17, Marriott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky Institute for Mining and Minerals Research, p. 68-78.

(No Specific Deposits), This article contains: Abstract; Introduction; Experimental procedures, Results (yields and molecular weights, elemental analysis, absorption spectroscopy, proton NMR, carbon-13 NMR, discussion); Conclusion; Acknowledgement; References.

Kotlyar, L.S., Ripmeester, J.A., and Sparks, B.D., 1989, ^{13}C NMR characterization of humic matter present in different oil sands, *in* Speight, J.G., and Schlosberg, R.H., editors, Fuel Science & Technology International: New York, Marcel Dekker, Inc., v. 7, nos. 5 and 6, p. 477-505.

(Athabasca), (Sunnyside), This paper includes the following: Abstract; Introduction; Experimental (cold water agitation test [CWAT], float-sink density fractionation, humic and fulvic acids extraction, acid treatment, solid state CP/MS 13C NMR, solution 13C NMR, analysis); Results and discussion (humic acids, humins); Conclusions; Acknowledgments; References.

Kotlyar, L.S., Ripmeester, J.A., and Sparks, B.D., 1989, Comparative study of organic rich solids present in Utah and Athabasca oil sands, *in* Meyer, R.F., and Wiggins, editors, The fourth UNITAR/UNDP International conference on heavy crude and tar sands proceedings, volume 5, extraction, upgrading, and transportation: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 59-69.

(Sunnyside), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion (separation); ^{13}Cp/MAS NMR; Conclusions; Acknowledgment; References.

Kraemer, Phillip, Meresz, Otto, and Mills, Don, 1978, Rotary separating and extracting devices, United States Patent 4,098,648, 12 p.

(Patent), (No Specific Deposit), This patent describes: a rotary separator, specially adapted for extraction of bituminous materials from tar sands or shale, comprises an inclined vessel having a helical conveyor attached to it, provided with apertures at the radically outer portion of the helical flights. Material introduced at the bottom is conveyed upwardly, and solvent washes downward to dissolve the bituminous material. The apertures in the helix permit downward passage of liquid but prevent substantial downward passage of solids. A solvent recovery vessel is provided for recovering residual solvent from the separated solids. Included are 13 claims and eight drawing figures.

Kumar, Rajinder, 1995, Pilot plant studies of a new hot water process for extraction of bitumen from Utah tar sands: Salt Lake City, University of Utah Ph.D. Dissertation, 253 p.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Whiterocks), (Asphalt Ridge), This dissertation contains: Abstract; Acknowledgment; Introduction (the U.S. scenario, the current project); Literature survey (definition of tar sands, geographical distribution of tar sand deposits, bitumen properties – general physical and chemical, selection of the technology); Research objectives and method to achieve them; Solid-liquid separation theory and T-PLOT hydrocyclone (settling of solids, free and forced vortex, definition of D_{50}, pressure drop in a pipe, viscosity of the slurry, density of the slurry, T-PLOT hydrocyclone); Study of the T-PLOT hydrocyclone (flow pattern in the T-PLOT hydrocyclone, variables studied for the T-PLOT hydrocyclone, data collection and analysis, results and discussions); Bench scale thickening tests on tailings (flocculent and flocculent screening, bench scale thickening tests, unit area calculations); Design of spiral classifier (sizing of spiral classifier, concentration of $^{+}65$ solids obtained in a beaker test of tailings); Final results and discussions (product quality from T-PLOT hydrocyclone, water loss in the process, comparison of water loss in new process with the water loss in the process shown in figure 2.7, explanation of increased underflow flow rate above critical underflow split, bitumen loss to underflow in T-PLOT hydrocyclone, final recovery of bitumen); Scale up of the T-PLOT hydrocyclone (determination of diameter of T-PLOT hydrocyclone, determine of height of overflow above the middling pipe, diameter of middling pipe, determination of diameter of overflow pipe); Summary and conclusions (recommendations); Appendices (nomenclature, experimental data for T-PLOT hydrocyclone, data from bench scale thickening tests, figures for fabrication or construct 30-inch T-POT hydrocyclone, PI diagram of boiler and circuit diagram for flame controller, pictures of the T-PLOT hydrocyclone and bench scale equipment used for thickening tests); References.

Kuuskraa, V.A., 1984, Major tar sand and heavy oil deposits of the United states, *in* Eastern oil shale symposium (November 26-28, 1984, Hyatt Regency, Lexington, Kentucky: University of Kentucky, Institute for Mining and Minerals Research, p. 117-123. Also, *in* Exploration for heavy crude oil and bitumen, v. 2, American Association of Petroleum Geologists Research Conference, October 28-November 2, 1984, Santa Maria, California, 22 p.

(Numerous Utah Deposits), This article includes the following: Abstract; Introduction; Definitions; Review by state (Alabama, Alaska, California, Kentucky, New Mexico, Oklahoma, Texas, Tri-state, Utah, Wyoming); Heavy oil deposits; Acknowledgement.

Kuuskraa, V.A., 1988, Major tar sand and heavy oil deposits of the United States, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy Crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 191-207.

(Numerous Utah Deposits), This article contains: Abstract; Introduction; Definitions; Review of the tar sand

resource by state (Alabama, Alaska, California, Kentucky, Texas, Utah); Heavy oil deposits in the United States (size of the heavy oil resource base, current domestic heavy oil production, nature of the heavy oil resource, categorization of the domestic heavy oil resource for analytical purposes – shallow reservoirs, Alaska, other states – in-situ combustion, other states steam, California deep steam, California in-situ combustion, environmentally restricted areas); Study methodology (geological inputs, steam drive recovery models, engineering costing and economics); Major findings; Eight tables and seventeen figures.

Kuuskraa, V.A., Chalton, Sandra, and Doscher, T.M., 1978, The economic potential of domestic tar sands: Prepared for the U.S. Department of Energy under contract no. 9014-018-021-22004, variously paginated.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Asphalt Ridge), (Hill Creek), This publication includes the following: Summary Report (background, purpose for the analysis, review of the major findings, summary); Appendix A: Technical methodology (steam drive recovery, in-situ combustion recovery, surface mining); Summary report (exhibits 1-6); Appendix A (steam drive recovery and surface mining); Appendix B (Tar Sand Triangle, P.R. Spring, Sunnyside, Asphalt Ridge, Hill Creek). For each of the deposits, topics such as the following are addressed (isopach map, core holes locations, formations, cross-sections, diagrammatic cross section, core hole analyses, quantities of recoverable oil required to cover energy input and economic costs of steam drive tar sands development, quantities of recoverable oil per acre foot to cover economic and energy costs, and selected properties of the tar sand by best and worst section, and average),

Kuuskraa, V.A., Chalton, Sandra, and Doscher, T.J., 1982, The economic potential of domestic tar sands, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC Monograph Series - Tar Sands: Oklahoma City, The Interstate Oil Compact Commission, p. 181-189.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Asphalt Ridge), (Hill Creek), This chapter includes the following: Summary report (background, purpose for the analysis, review of the major findings, summary). Tables indicate size, nature of mining potential, technically feasible segment for in-situ thermal recovery, and other information.

Kuuskraa, V.A., Godec, M.L., McFall, K.D., and Hochhesier, H.W., 1986, Appraisal of the technical and economic potential of U.S. tar sands: 1986 Eastern Oil Shale symposium, p. 73-81.

(No Specific Deposit), This paper includes the following: Abstract; Introduction; Tar sand resources in-place; Study methodology (overview, geologic analysis, technical screening of prospects, tar sand recovery models, engineering costing and economics models); Conclusions; References.

Kuuskraa, V.A., and Hammershaimb, E.C., 1984, Major tar sand and heavy oil deposits of the United States (Utah Chapter): Oklahoma City, The Interstate Oil Compact Commission, p. 175-230.

(P.R. Spring), (Hill Creek), (Sunnyside), (Whiterocks), (Asphalt Ridge), (NW Asphalt Ridge), (Tar Sand Triangle), (Nequoia Arch), (Circle Cliffs), (San Rafael Swell), (Argyle Canyon), (Raven Ridge), (Rim Rock), (Cottonwood-Jacks Canyon), (Littlewater Hills), (Minnie Maude Creek), (Pariette), (Willow Creek), (Black Dragon), (Chute Canyon), (Cottonwood Draw), (Red Canyon), (Wickiup), This section of the book contains: Summary; Major deposits; Regional geology; (northeastern Utah, southeastern Utah - White Rim Sandstone and Moenkopi Sandstone); Individual deposit descriptions, including reservoir properties and development history. Data tables and maps are provided for each of the major deposits.

Kuuskraa, V.A., Hammershaimb, E.C., and Paque, M., 1987, Major tar sand and heavy-oil deposits of the United States: Tulsa, The American Association of Petroleum Geologists Studies in Geology 25, p. 123-135.

(Numerous Utah Deposits), This paper includes the following: Abstract; Introduction; Definitions; Review by state (Alabama, Alaska, California, Texas, Utah); Heavy-oil deposits.

Kwak, Seokhwan, 1994, Hydrotreating heavy oils over a commercial hydrometallation catalyst: Salt Lake City, University of Utah M.S. Thesis, 254 p.

(Whiterocks), This thesis includes the following: Abstract; Acknowledgments; Introduction; Literature survey (origin of bitumen, bitumen separation technologies, chemical composition of bitumen and petroleum resides, heavy oil upgrading technology, hydroprocessing catalysts, bench scale hydrotreating reactor, chemistry and reaction mechanisms of hydroprocessing); Experimental apparatus and procedure (feedstock preparation, experimental equipment, experimental procedure, product gas and liquid analysis); Results and discussion (properties of bitumen, bitumen-derived liquid and hydrotreated products over HDM and HDN, upflow mode operation, plug-flow equations, process variable studies); Conclusions. Appendices (basic programs for simulated distillation of liquid products, Fortran program for calculating hydrotreated product distribution, Fortran program for calculating hydrogen consumption, Fortran program for kinetics of two parallel first-order reactions using non-linear regression, input file for process simulation, output file for process simulation, non-linear numerical integration Fortran program for molecular weight reduction model); References, Vita. A Uinta Basin bitumen was hydrotreated over a sulfided Ni-Mo on alumina commercial hydrometallation catalyst. The primary process variables studied were reactor temperature (620-685 K; 656-775 °F), liquid weight hourly space velocity (0.24-1.38 h^{-1}), and total reactor pressure (11.3-16.7 Mpa; 1634-2423 psia). The hydrogen/oil ratio was fixed in all experiments at 890 m^3/m^3 (5000 scf H_2/bbl).

Kwak, Seokhwan, Longstaff, D.C., Deo, M.D., and Hanson, F.V., 1992, Hydrotreating process kinetics for bitumen and bitumen-derived liquids, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 208-215.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures (feed preparation, operating conditions); Results (hydrogen partial pressure, plug flow assumption, non-plug flow nTH order kinetics, two parameter determination methods, alternative kinetic representations, mild hydrocracking); Conclusions; Acknowledgments; Nomenclature; References; Seven tables and five figures.

Kwak, Seokhwan, Longstaff, D.C., Deo, M.D., and Hanson, F.V., 1994, Hydrotreatment process kinetics for bitumen and bitumen-derived liquids: Fuel, v. 73, no. 9, p. 1531-1536.

(Whiterocks), This paper includes the following: Abstract; Introduction; Experimental; Results and discussion (hydrodenitrogeneration and hydrodesulfurization process kinetics, non-plug flow nth-order kinetics, comparison of non-linear parameter estimation and conventional kinetic analysis, alternative kinetic representation, mild hydrocracking); Conclusions; Acknowledgments; References; Nomenclature; Five figures and six tables.

Kwak, Seokhwan, Longstaff, D.C., and Hanson, F.V., 1993, Catalytic upgrading of a Uinta Basin bitumen over a commercial HDM catalyst, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 168-176.

(Whiterocks), This article includes the following: Abstract; Introduction; Experimental procedures feedstock preparation, reactor startup, catalyst description and loading, catalyst sulfiding, initial catalyst deactivation, mass balances, operating procedures); Results and discussion (process variable studies – effect of space velocity - effect of temperature - effect of pressure, preliminary process kinetic study, sulfur and residuum conversions); Conclusions; Acknowledgments; References; Eight figures and five tables.

Kydd, P.H., 1983, Method for in situ recovery of heavy crude oils and tars by hydrocarbon vapor injection, United States Patent No. 4,407,367, 10 p.

(Patent), (Asphalt Ridge), (Athabasca), The recovery of heavy crude oils and tars from subterranean oil bearing formations is enhanced by the injection of pressurized and heated hydrocarbon vapor into a single well

drilled into the formation. Condensation of the hydrocarbon vapor heats the heavy oil and tars entrapped in the formation and dilutes the oil so as to decrease its viscosity and enhance its flow into a lower portion of the well. The oil and solvent collected are removed to the surface by pumping. The preferred hydrocarbon vapor is a low boiling fraction derived by distillation of the oil recovered from the formation, however, some stable externally-produced aromatic hydrocarbon vapors of high solvent power such as benzene or toluene or mixtures thereof may also be used and reclaimed from the oil by distillation.

Land, C.S., Carlson, F.J., and Cupps, C.Q., 1975, Laboratory investigation of reverse combustion in two Utah tar sands: Laramie, U.S. Department of Energy, Laramie Energy Research Center, 29 p.

(P.R. Spring), (Asphalt Ridge), This report contains: Abstract; Introduction; Reverse combustion; Laboratory apparatus; Laboratory procedures; Results of combustion runs; Conclusions; References; Twenty illustrations.

Land, C.S., Cupps, C.Q., Marchant, L.C., and Carlson, F.M., 1976, Field test of reverse combustion oil recovery from a Utah tar sand: Petroleum Society of Canadian Institute of Mining, Metallurgy, and Petroleum, Paper no. 7603, 8 p., and The Wyoming Geological Association Earth Science Bulletin, v. 9, no. 2, p. 7-15.

(Asphalt Ridge), This paper contains: Abstract; Introduction; Tar sand properties; Air injection tests; Instrumentation; Operation of the field test; Results; Summary and conclusions; Acknowledgment; References.

Land, C.S., Cupps, C.Q., Marchant, L.C., and Carlson, F.M., 1977, Field experiment of reverse combustion oil recovery from a Utah tar sand: The Interstate Oil Compact Commission Committee bulletin, v. XVII, no. 1, p. 53-60.

(Asphalt Ridge), This paper contains: Abstract; Introduction; Tar sand properties; Air injection tests; Instrumentation; Summary and conclusions; Acknowledgment; References.

Laramie Energy Technology Center, 1979, Environmental assessment – tar sand in-situ steam injection experiment: Laramie, U.S. Department of Energy, Laramie Energy Technology Center, 44 p.

(Asphalt Ridge), This paper contains: Executive summary; Purpose and need; Description of the proposed action (introduction, construction phase, operational phase, post-operation phase, alternatives not considered, no action alternative, mitigation measures); Description of the existing environment (baseline climatology and meteorology, air quality, geological setting and hydrology, biological, aesthetic, recreational and cultural, socioeconomic environment); Environmental consequences (air quality, water quality, waste disposal, biological, socioeconomic environment); List of preparers (LETC employees, contracted employees); List of figures and tables.

Laramie Energy Technology Center, no date, A bibliography of publications dealing with tar sands: Laramie, U.S. Department of Energy, Laramie Energy Technology Center, 179 p.

(Numerous Utah Deposits), This bibliography includes the following sections: Author index; Geology and resource evaluation; Chemical and physical properties; Mining and surface extraction.

Larsen, Annette, 1980, Survey of literature relating to energy development in Utah's Colorado Plateau: Provo, Brigham Young University, Business and Economic Research Center, 29 p.

(Numerous Utah Deposits), This publication contains the following: Introduction and scope of study; Oil shale and oil developments; Geothermal resources in Utah; Coal resources in Utah; Uranium resources in Utah; Oil and natural gas resources in Utah; Advantages of mine-mouth power plants in comparison to combined cycle or hybrid power plants; Appendices (federal and State of Utah requirements, oil shale and the environment, oil shale bibliography, oil sands bibliography, geothermal bibliography, coal and coal gasification bibliography, nuclear bibliography, natural gas bibliography, dual power plant, power plant bibliography).

Lasaki, G.O., Martel, Richard, and Fahy, L.J., 1985, Numerical simulation of combined reverse combustion and steamflooding for oil recovery in a Utah tar sand: Society of Petroleum Engineers Journal (April edition), p. 227-234.

(NW Asphalt Ridge), This articles contains: Abstract; Introduction; Geology; Procedure (laboratory tube experiments, history match, preliminary combustion runs, three-dimensional model); Processes (reverse combustion, steamflooding, optimization); Data preparation; Results; Conclusion; Nomenclature/; Acknowledgment; References; Appendix A.

Lechner, C.A., Liapis, A.I., and Findley, M.E., 1989, A pyrolysis process for tar sands: The Canadian Journal of Chemical Engineering, v. 67, p. 85-95.

(Tar Sand Triangle), (Asphalt Ridge), This paper includes the following: Abstract; Introduction; Proposed pyrolysis system; Reactor volumes and their variation with system parameters; Effects of temperature distributions in particles; Conclusions; Acknowledgement; Nomenclature; References.

Lelinski, Dariusz, Drelich, Jaroslav, Miller, J.D., and Hupka, Jan, 2004, Rate of bitumen film transfer from a quartz surface to an air bubble as observed by optical microscopy: The Canadian Journal of Chemical Engineering, v. 83, p. 794-800.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedure; Results and discussion (general observations, rate of bitumen spreading, temperature effect); Summary; Nomenclature; References; Eleven figures and two tables.

Lewin Energy Corporation, 1980, Report of Utah Tar Sand Triangle, Circle Cliffs, Utah and Burnt Hollow, Wyoming accumulations: Unpublished report by the Lewin Energy Corporation, p. G1-G16.

(Tar Sand Triangle), This report includes the following: Summary of findings; Discussion (purpose, background, extent of geological control, required reservoir properties and recovery technology, delineation of the identified parcel, preparation of report); Resume of Vello A. Kuuskraa.

Lin, L.C., 1988, The kinetics of the pyrolysis of tar sands and the combustion of coked sands: Salt Lake City, University of Utah M.S. Thesis, 256 p.

(P.R. Spring), (Whiterocks), (Sunnyside), This thesis contains: Abstract; Acknowledgments; Introduction (tar sand resources and distribution, recovery of tar sand bitumen, origin and geology of tar sands, research objectives); Literature survey (definition of bitumen-impregnated sandstone, characteristics of tar sands, pyrolysis of oil shale and tar sand, combustion of the carbonaceous residue), Experimental apparatus and procedure (introduction, thermogravimetric analysis apparatus, operating procedures); Experimental results and discussion (kinetics of the thermal pyrolysis of tar sand bitumen, discussion, intrinsic kinetics of the combustion of coked sand, discussion); Conclusions (conclusions related to the pyrolysis of tar sand particles, conclusions related to the combustion of coked sands); Appendices (conversion of bitumen versus reaction time at various temperatures - isothermal thermogravimetric analysis, conversion of bitumen versus temperature at various heating rates - non-isothermal TGA, Arrhenius plots for the evaporation region of isothermal pyrolysis of tar sand bitumen, analytical solutions of the coupled second-order partial differential equations); References; Vita. The kinetic parameters for the pyrolysis of bitumen-impregnated sandstone, particles have been determined by TGA. The intrinsic kinetics of the combustion of the carbonaceous residue or coke deposited on the sand during pyrolysis was studied by TGA.

Lin, L.C., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1990, Kinetics of tar sand pyrolysis using a distribution of activation energy model, *in* AIChE Journal, Chemical engineering research and development: New York, American Institute of Chemical Engineers Journal, v. 36, no. 10, p. 1585-1588.

(Whiterocks), Introduction; Experimental details; Theoretical considerations; Results and discussion; Acknowledgment; Notation; Literature; One table and five illustrations.

Lin, L.C., Hanson, F.V., and Oblad, A.G., 1986, A preliminary mathematical model of the pyrolysis of bitumen-impregnated sandstone in a fluidized bed, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 410-418.

(No Specific Deposit), This paper contains the following: Abstract; Introduction; Solutions to the differential equations; Production rates; Discussion; Acknowledgments; Nomenclature; References.

Lin, L.C., Hanson, F.V., and Oblad, A.G., 1987, The pyrolysis of bitumen-impregnated sandstone in short contact time reactors: Fuel Processing Technology, v. 16, p. 173-190.

(Whiterocks), (P.R. Spring), This article contains the following: Abstract; Introduction; Theory; Transfer of heat to the sand particles; Conversion of bitumen to hydrocarbon products as a function of time; Particle entrainment and cyclone residence time; Experimental; Results and discussion; Conclusions; Nomenclature; Acknowledgments; References.

Lindberg, W.R., 1980, Tar sand extraction by steam stimulation and steam drive – measurement of physical properties (task order 028 for the period 10/1/78 to 11/1/79): Laramie, University of Wyoming, 109 p.

(Asphalt Ridge), This report includes the following: List of figures; Abstract; Introduction and progress summary; Technical discussions (standard core analysis and zone identification, viscosity, specific heat, relative permeability, thermal conductivity); Goals for FY 79-80; Personnel for FY 1978-79; References, Appendixes (1-computer program of routine data analysis, 2-specific heat measurement, 3-thermal conductivity measurement, 4-relative permeability measurement).

Lindskov, K.L., and others, 1983, Potential hydrologic impacts of a tar-sand industry in 11 special tar sand areas in eastern Utah: U.S. Geological Survey Water-Resources Investigation Report 83-4109, 130 p.

(Asphalt Ridge), (Whiterocks), (Raven Ridge), (Rim Rock), (Pariette), (Argyle Canyon), (Willow Creek), (Sunnyside), (Hill Creek), (P.R. Spring), (San Rafael Swell), (Tar Sand Triangle), (White Canyon), (Circle Cliffs), This publication includes the following: Introduction; Data-site numbering system; Discussions including location, climate, surface and groundwater resources, existing water use, and hydrologic impacts unique to the area; Hydrologic impacts of a tar-sand industry; Summary.

Longstaff, D.C., 1992, Hydrotreating the Whiterocks oil sand bitumen and bitumen-derived liquid: Salt Lake City, University of Utah Ph.D. Dissertation, 317 p.

(Whiterocks), This dissertation contains: Abstract; Acknowledgments; Introduction (bitumen availability and origin, research objectives); Literature survey (separation procedures, chemical constituents of bitumen, bitumen upgrading, catalysts, mechanisms, hydroprocessing of Uinta Basin bitumen); Experimental apparatus and procedures, Postscript; Vita.

Longstaff, D.C., Balaji, G.V., Kim, J.W., Kwak, Seokhwan, Tsai, C.H., and Hanson, F.V., 1995, Hydrotreating Uinta Basin bitumen-derived heavy oils, *in* Meyer, R.F., editor, Heavy crude and tar sands – fueling for a clean and safe environment, 6th UNITAR International Conference on Heavy Crude and Tar Sands: U.S. Department of Energy, p. 427-439.

(Whiterocks), (P.R. Spring), This article includes the following: Abstract; Introduction; Experimental (feedstock preparation, hydrocracking process unit, reaction conditions, catalyst and catalyst activation); Results and discussion (process-variable study methodology, effect of feed molecular weight, effect of catalyst selection, effect of feed properties, residuum conversion pathways); Conclusions; Acknowledgments; References; Eight tables and eleven figures.

Longstaff, D.C., Deo, M.D., and Hanson, F.V., 1992, Hydrotreating the bitumen from the Whiterocks oil sand deposit, *in* 1992 Eastern Oil Shale Symposium – oil shale – tar sands/heavy oil (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 199-207.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion (process variable study, preliminary process kinetics, effect of WHSV, effect of reaction temperature, effect of pressure); Conclusions; Acknowledgments; References; Thirteen figures and seven tables.

Longstaff, D.C., Deo, M.D., and Hanson, F.V., 1994, Hydrotreatment of bitumen from the Whiterocks oil sand deposit: Fuel, v. 73, p. 1523-1530.

(Whiterocks), This paper contains: Abstract; Introduction; Experimental procedures (feedstock preparation, hydrotreater process unit, catalyst and activation); Results and discussion (process-variable study, preliminary process kinetics, effect of WHSV, effect of reaction temperature, effect of pressure, molecular weight reduction); Conclusions; Acknowledgments; References; Twelve figures and seven tables.

Longstaff, D.C., Deo, M.D., Hanson, F.V., Oblad, A.G., and Tsai, C.H., 1991, Hydrotreating the bitumen-derived hydrocarbon liquid produced in a fluidized-bed pyrolysis reactor (Presented at "Eastern Oil Shale symposium", 13-15 November, Lexington, KY): Fuel, v. 71, p. 1407-1419.

(Whiterocks), This paper includes the following: Abstract; Introduction; Experimental (fluidized-bed pyrolysis system, hydrotreater process unit, catalyst and catalyst activation); Results and discussion (process-variable study, effect of reaction temperature, effect of LHSV, effect of reactor pressure, statistical analysis, pyrolysis-hydrotreating process sequence, preliminary process kinetics); Conclusions; Acknowledgments; References; Appendix; Sixteen figures, Seven tables.

Longstaff, D.C., Deo, M.D., Hanson, F.V., Oblad, A.G., and Tsai, C.H., 1992, Hydrotreating the bitumen-derived hydrocarbon liquid produced in a fluidized-bed pyrolysis reactor: Fuel, v. 71, p. 1407-1419.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures (fluidized-bed pyrolysis system, hydrotreater process unit, catalyst and catalyst activation); Results and discussion (process-variable study, effect of reaction temperature, effect of LHSV, effect of reactor pressure, statistical analysis, pyrolysis-hydrotreating process sequence, preliminary process kinetics); Conclusions; Acknowledgments; References; Six tables and 16 figures.

Longstaff, D.C., Hanson, F.V., and Kwak, Seokhwan, 1993, Uinta Basin bitumen hydrotreating – a comparison of HDN and HDM catalyst performance, *in* 1993 Eastern Oil Shale Symposium Proceedings (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA: University of Kentucky, Institute for Mining and Minerals Research, p. 177-185.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion (effect of catalyst and feed on conversion, effect of catalyst and feed on selectivity, pathways for residuum conversion); Conclusions; Acknowledgments; References; Three tables and seven figures.

Lowe, R.M., 1975, Status of tar sand exploitation in the U.S.: Presented at American Institute of Chemical Engineers (AIChE), November 20.

(Asphalt Ridge), (Sunnyside), (Whiterocks), This paper includes the following: Introduction; Athabasca; Basic methods of recovery (thermal, water, solvent-assisted water); Additional work being done.

Lowe, R.M., 1976, The Asphalt Ridge tar-sand deposits, *in* Smith, J.W., and Atwood, M.T., editors, Oil Shale and Tar Sands: New York, American Institute of Chemical Engineers, v. 72, no. 155, p. 55-60.

(Asphalt Ridge), This article includes the following: Introduction; Recovery methods; Tar sand development tests; Other extraction experiments; Other factors affecting tar sands development; Literature cited. Figures include: Recovery processes for bitumen from mined ore (extraction and thermal methods); A few headlines by date; Significant U.S. field tests on extraction from mined tar sand ore; U.S. Bureau of Mines hot water-solvent oil-recovery process; Simplified flow diagram; Arizona Fuels recovery unit - schematic diagram; Current research and development U.S. tar sands extraction methods.

Malhotra, V.M., and Graham, W.R.M., 1983, Characterization of P.R. Spring (Utah) tar sand bitumen by the EPR technique – free radicals: Fuel, v. 62, November, p. 1255-1264.

(P.R. Spring), This article includes the following: Abstract; Introduction; Experimental (sample preparation, EPR measurements); Results and discussion (free radicals in vacuum, g-Values, effect of oxygen [air] on asphaltene spectra, effect of heat treatment); Conclusions; Acknowledgments; References.

Mann, D.C., Berninni, Dave, Blakey, R.C., Peterson, P.R., Quigley, Sam, and Ritzma, H.R., (no date given), Oil impregnated rocks in the Green River Formation, southwestern Uinta Basin: Utah Geological Survey unpublished report, 15 p.

(Reservation Ridge), (Argyle Canyon), (Minnie Maud Creek), (Nine-Mile Canyon), (Cottonwood-Jacks Canyon), (Sunnyside), This report contains: Location and access; Regional geologic and structural setting; Tertiary stratigraphic developments; Stratigraphy (North Horn Formation, Flagstaff Limestone, Colton, Wasatch, and Green River Formations); Source migration and entrapment; Oil impregnation; Development and history.

Mann, D.C., and Mann, J.B., 1972, Tar sandstone—investigation in southwestern Uinta Basin: Utah Geological Survey unpublished report, 14 p.

(Sunnyside), This report contains: Introduction; Range Creek (general description, ownership and access, geology and oil-impregnated sandstone); Road Plateau (general description and access roads, geology and oil-impregnated sandstone, Flat Canyon, Jack Creek, Cottonwood Canyon, Dry Canyon, Stone Cabin Canyon, Whitmore Canyon and Sheep Canyon); Reservation Ridge and the Headwaters of Avintaquin Canyon (general description, geology and oil-impregnated sandstone); Ridges west of Flat Ridge T. 6 S., R. 9 W. (USM); Conclusion; Notes.

Mann, D.C., and Quigley, Sam, 1972, Oil impregnated sandstone study near Bruin Point and Range Creek—Sunnyside quadrangle: Utah Geological Survey unpublished report, 11 p.

(Sunnyside), This report contains: Introduction; Accessibility and general description; Geology; Range Creek; Dry Creek; Conclusion; References; Two maps and two cross sections; One oil analysis.

Marchant, L.C., 1976a, Oil-impregnated rocks of Utah - USERDA field experiment to recover oil from tar sand: Provo, Brigham Young University Geology Studies, v. 22, pt. 3, p. 151-155.

(Asphalt Ridge), This paper includes the following: Abstract; General location and geology of field experiment site; Field plan for testing the reverse combustion process; References cited. The Laramie Energy Research Center conducted a reverse combustion process, in preference to the alternative forward process. The site of the field experiment is in the Northwest Asphalt Ridge tar sand deposit, about 5 miles west of Vernal, Utah. The experimental process and expected results are explained.

Marchant, L.C., 1976b, U.S. Energy Research and Development Administration field experiment: The Wyoming

Geological Association Earth Science Bulletin, v. 9, no. 2 (June edition), p. 1-5.

(NW Asphalt Ridge), This article contains: Introduction; Site location; Geology; Tar sand description; Production and injection wells; Ignition of tar sand; Volume of air/air flux; Recovery of product; References.

Marchant, L.C., 1984, U.S. tar sand oil recovery projects – 1984, *in* 1984 Eastern Oil Shale Symposium (November 26-28, 1984, Hyatt Regency, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 125-135.

(Sunnyside), (NW Asphalt Ridge), (Tar Sand Triangle), This article includes the following: Abstract; Introduction; Tar sand definition; U.S. tar sand resources; Projects (in-situ processes, mining and plant extraction processes, modified in-situ processes); Costs; Summary; Tables (1a – U.S. tar sand field projects, 1b – U.S. tar sand field projects mining and plant extraction, 2a – U.S. tar sand field projects in-situ, 2b – U.S. tar sand field projects mining and plant extraction, 2c – U.S. tar sand field projects modified in-situ, 3 – Status of reported projects); References cited; Other references.

Marchant, L.C., 1985, U.S. tar sand projects – 1985: Presented at the UNITAR/UNDP Third International Conference on Heavy Crude and Tar Sands, Long Beach, California, July 22-31, 14 p.

(Sunnyside), (NW Asphalt Ridge), (P.R. Spring), (Whiterocks), This paper includes the following: Abstract; Introduction; Tar sand definition; U.S. tar sand resource; In situ processes (steam, in situ combustion, RF heating); Mining and plant extraction processes (solvent and water); Upgrading processes; Costs; Summary; References; Table 1a – U.S. tar sand field projects in-situ; Table 1b – U.S. tar sand field projects mining and plant extraction; Table 2a.

Marchant, L.C., 1986, Final report, volume II, publications and presentations, April 1983-September 1986: U.S. Department of Energy, Western Research Institute, 45 p. (Research performed under cooperative agreement no. DE-FC21-83FE60177.

(Asphalt Ridge), (NW Asphalt Ridge), (Tar Sand Triangle), (P.R. Spring), This report contains: Oil shale; Tar sand; Underground coal gasification; Advanced process technology; Asphalt; Annual and quarterly reports.

Marchant, L.C., 1987, Tar sand research and development 1970-1986: Laramie, Western Research Institute, variously paginated.

(Sunnyside), (Asphalt Ridge), (Tar Sand Triangle), (P.R. Spring), (Whiterocks), (NW Asphalt Ridge), (Numerous Utah Deposits), This report contains the following: Introduction (definition of tar sand, history of U.S. government RD&D on tar sand); Task 1 – In situ tar sand processes (Rational for emphasis on in situ research, U.S. government support for in situ and surface processes, technical objectives of in situ processes, economic variables of in situ processes); Task 2 – U.S. Government tar sand programs and expected development (U.S. Department of Energy research programs, expectations regarding development of U.S. tar sands); Task 3 – Expectations and plans of other entities (Canadian activities, state government initiatives, U.S. Synfuels Corporation, U.S. industry); Bibliography; Appendices (A – DOE tar sand document lists, B – Marchant papers, C – Factors that influence the selection of tar sand resources for in situ thermal recovery).

Marchant, L.C., 1987, Tar sand research and development 1972-1981: Laramie, Western Research Institute, variously paginated.

(Sunnyside), (Asphalt Ridge), (Tar Sand Triangle), (Athabasca), This report contains the following: Executive summary; Introduction (definition of tar sand); In-situ tar sand processes (rationale for emphasis on in-situ research, U.S. government support for in-situ and surface processes, technical objectives of in-situ processes, economic variables of in-situ processes); U.S. Government tar sand programs and expected development (U.S. Department of Energy research programs, expectations regarding development of U.S. tar sands; Expectations and plans of other entities (Canadian Federal and Alberta activities, state government initiatives, U.S. Synfuels Corporation, U.S. industry); Conclusions; Bibliography; Appendices (A-DOE tar sand document list, B-University of Utah tar sands bibliography, C-Marchant papers, D-factors that influence the selection of tar sand resources for in-situ thermal recovery).

Marchant, L.C., 1988, U.S. tar sand oil recovery projects – 1985, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 933-940.

(NW Asphalt Ridge), (Sunnyside), This article contains: Abstract; Introduction; Tar sand definition; U.S. tar sand resource; Projects (in-situ processes – steam, in-situ combustion, RF heating, mining and plant extraction processes – solvent, water, upgrading processes); Costs; Summary; Abbreviations; References; Two figures and five tables.

Marchant, L.C., Cupps, C.Q., and Stosur, G., 1979, Current activity in oil production from U.S. tar sands, *in* Mayer, R.F., and Steele, C.T., editors, The Future of Heavy crude Oils and Tar Sands, First international UNITAR conference): New York, McGraw Hill, p. 477-488.

(Numerous Utah Deposits), This paper contains: Introduction; Tar sand resources in the United States (California, Kentucky, New Mexico, Texas, Utah); Utah tar sand deposits; Field activity to recover oil from U.S. tar sands and some heavy oils (followed by descriptions of several fields in California, Utah, Louisiana); Activity toward development of field tests of proposed recovery technologies; Current research relating to tar sand; Tar sand research program at Laramie Energy Technology Center; Activity in tar sand resource evaluation; Summary appraisal of significance of current activity.

Marchant, L.C., Johnson, L.A., and Cupps, C.Q., 1974, Properties of Utah tar sands - Three-Mile Canyon area, P.R. Spring deposit: U.S. Bureau of Mines Report of Investigation 7923, 14 p.

(P.R. Spring), (Three-Mile Canyon), This publication includes the following: Introduction; Analytical procedures (core sample preparation, porosity and permeability tests, compressive strength testing, oil and water saturation determinations); Analytical results; Discussion of results, and references; Illustrations include (map of P.R. Spring deposit, cross section of the Threemile Canyon area, and porosity, oil saturation, and permeability versus elevation for core holes PR-3A, 3B, 3C, and 3D. Tables include Utah Geological and Mineralogical Survey core hole locations, cored intervals, and elevation; Tertiary formation of the southeastern Uinta Basin, and summary of core analysis and core hole data for Three-Mile Canyon area.

Marchant, L.C., and Koch, C.A., 1981, Small U.S. tar sand projects: Laramie, U.S. Department of Energy, Laramie Energy Technology Center, 27 p.

(Asphalt Ridge), (P.R. Spring), (Raven Ridge), (Sunnyside), (Whiterocks), This report contains: Abstract; Introduction; Tar sand definition; U.S. tar sand resource; Oil recovery projects (in-situ processes, mining and plant extraction processes, upgrading); Costs; Summary; References; Figures and tables.

Marchant, L.C., and Koch, C.A., 1982, U.S. tar sand oil recovery projects, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC Monograph Series, tar sands: Oklahoma City, Interstate Oil Compact Commission, p. 191-200.

(NW Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), This article contains the following: Abstract; Introduction; Tar sand definition; U.S. tar sand resources; Oil recovery projects (in-situ processes, mining and plant extraction processes, upgrading); Costs; Summary; Appendix; Abbreviations ; References.

Marchant, L.C., and Koch, C.A., 1984, U.S. tar sand oil-recovery projects (Chapter 107), *in* Meyer, R.F., Wynn, J.C., and Olson, J.C., editors, The Future of Heavy Crude and Tar Sands, (Second International Conference,

7-17 February, Caracas, Venezuela): The United Nations Institute for Training and Research, p. 1029-1040.

(NW Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Raven Ridge), (Whiterocks), This article includes the following: Introduction; Tar sand definition; U.S. tar sand resource; Oil-recovery projects (a -in-situ processes - steam, combustion and other, b -mining and plant extraction processes - solvent, water, and thermal retort, and c- upgrading - diluent, upgrading plant, upgrading by oil recovery process); Costs; Summary; References; Table 107 -1a (U.S. tar sand field projects - in-situ includes NW Asphalt Ridge D, Sunnyside D, Tar Sand Triangle D), Table 107-1b. (U.S. tar sand field projects - in-situ. Includes NW Asphalt Ridge, Sunnyside, and Tar Sand Triangle D.) Table 107-2a (U.S. tar sand field projects - mining and plant extraction. Includes Asphalt Ridge, P.R. Spring, Raven Ridge, Sunnyside, and Whiterocks.). Table 107-2b (U.S. tar sand field projects - mining and plant extraction. includes Asphalt Ridge, P.R. Spring, Raven Ridge, Sunnyside, and Whiterocks.). Table 107-5a (cost data - selected in-situ projects). Includes NW Asphalt Ridge and the Tar Sand Triangle). Table 107-5b (cost data - selected mining and plant extraction projects. Includes Asphalt Ridge, P.R. Spring, and Sunnyside).

Marchant, L.C., and Terry, R.E., 1982, U.S. tar sand oil recovery projects: Paper presented to Pan-Pacific Synfuels Conference, Tokyo, Japan, November 17-19, 36 p.

(Sunnyside), (Tar Sand Triangle), (Raven Ridge), (NW Asphalt Ridge), (Asphalt Ridge), (P.R. Spring), (Whiterocks), (Other), This report includes the following: Abstract; Introduction; Tar sand definition; U.S. tar sand resource; Projects (in situ processes, mining and plant extraction processes, modified in situ processes, upgrading processes); Costs; Summary; References; Table 1a – U.S. tar sand field projects – in situ; Table1b – U.S. tar sand field projects; Table 1c – U.S. tar sand field projects – modified in situ; Table 2a – U.S. tar sand field projects – in situ; Table 2b – U.S. tar sand field projects – mining and plant extraction; Table 2c – U.S. tar sand field projects - modified in situ; Table 3a – Cost data – selected in situ projects; Table 3b – Cost data – selected mining and plant extraction projects; Table 3c – Cost data – selected modified in situ projects; Table 4 – U.S. tar sand field operations – upgrading; Appendix; Abbreviations; Two figures; Appendix C – Factors that influence the selection of tar sand resources for in situ thermal recovery (no information given).

Marchant, L.C., and Westhoff, J.D., 1985, In-situ recovery of oil from Utah tar sand—a summary of tar sand research at the Laramie Energy Technology Center: Laramie, U.S. Department of Energy, Morgantown Energy Technology Center, 200+ p.

(NW Asphalt Ridge), This report contains: Executive summary; Introduction; Characterization of Utah tar sand; Laboratory extraction studies relative to Utah tar sand in-situ methods; Geological site evaluation; Environmental assessments and water availability; Reverse combustion field experiment TS-1C; A reverse combustion followed by forward combustion field experiment TS-2C; Tar sand permeability enhancement studies; Two-well steam injection experiment; An in-situ steam-flood experiment TS-1S; Design of a tar sand field experiment for air-steam co-injection TS-4; Wastewater treatment and oil analyses; An economic evaluation of an in-situ tar sand recovery process; Acknowledgment; Appendix I – Extraction studies involving Utah tar sands surface methods.

Mason, G.M., and Daley, R.L., 1986, Mineralogy of the P.R. Spring tar sand deposit, Uinta Basin, Utah, *in* 1986 Eastern Oil Shale Symposium (November 19-21, 1986, Hyatt Regency, Lexington, Kentucky): Kentucky Energy Cabinet Laboratory, p. 83-92.

(P.R. Spring), This article contains: Abstract; Introduction; Geologic setting; Experimental procedure; Results; Discussion; Summary and conclusions; References.

Mason, G.M., and Kirchner, Gretchen, 1992, Authigenic pyrite – evidence for a microbial origin of tar sand: Fuel, v. 71, p. 1403-1403.

(P.R. Spring), This article contains the following: Abstract; Introduction; Experimental; Results; Discussion; Conclusions; Acknowledgments; References.

Mason, G.M., Owen, T.E., Daley, R.L., and Donovan, R.C., 1986, Clay minerals in a Utah tar sand and their potential effects on processing: Laramie, U.S. Department of Energy, Western Research Institute, 36 p.

(P.R. Spring), This report contains: Summary; Introduction; Geologic setting; Experimental procedures (bitumen-mineral separation, quantitative optical microscopy, x-ray diffraction, iron analysis); Results (quantitative optical microscopy, x-ray diffraction, iron analyses); Processing implications; Discussion; Conclusions; Acknowledgment; Disclaimer; References.

Mason, G.M., Yin, Peigui, and Daley, R.L., 1988, Porosity modification related to tar sand process water, *in* Meyer, R.F., and Wiggins, E.J., editors, Fourth UNITAR/UNDP Conference on Heavy Crude and Tar Sandsproceedings, volume 5, extraction, upgrading, transportation: Alberta, Alberta Oil Sands Technology and Research Authority, v. 3, p. 107-1 to 107-16.

(NW Asphalt Ridge), (P.R. Spring), This article contains: Abstract; Introduction; Experimental procedures (sample sources, analytical methods); Results; Discussion; Conclusions; Acknowledgement; References; One table and fifteen figures.

Mauger, R.L., Kayser, R.B., and Gwynn, J.W., 1973, A sulfur isotopic study of Uinta Basin hydrocarbons: Utah Geological and Mineralogical Survey Special Studies 41, 17 p.

(P.R. Spring), (Sunnyside), (Asphalt Ridge), (Raven Ridge), (Rim Rock), (Littlewater Hills), (Whiterocks), (Spring Branch), (Lake Fork), (Tabiona), (Spring Hollow), This publication includes the following: Abstract; Acknowledgments; Introduction; Experimental procedures; Sulfur isotopes in petroleums and hydrocarbons of the Uinta Basin; Sulfur isotope data; Crude oils; Bituminous sands; Sulfur isotopes in bituminous sandstones of the north rim of Uinta Basin (includes nine deposits from Tabiona on the west to Raven Ridge on the east); Migration and accumulation of hydrocarbons in Uinta Basin bituminous sands; Conclusions; References.

McLendon, T.R., and Bartke, T.C., 1990, Tar sand – technology status report: U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, 36 p.

(Tar Sand Triangle), (P.R. Spring), (Whiterocks), (Sunnyside), This report contains: Executive summary; Introduction (background, U.S. Department of Energy mission); Technology (chemistry and physics, surface extraction, in-situ recovery); Current research (University of Utah – fluidized bed, fluidized-bed pyrolyzer/heat pipe coupled combustor, rotary kiln pyrolysis, solvent extraction, water-assisted extraction, upgrading and product utilization, University of Arkansas, Western Research Institute); Conclusions; References; Terminology.

Meadus, F.W., Sparks, B.D., and Puddington, I.E., 1976, Apparatus for separating organic material from particulate tar sands and coal and agglomeration of the particulate residue: United States Patent 3,984,287, 6 p.

(Patent), A rotatable drum having an interior which tapers in a horizontal direction has a first port at the smaller end for receiving particulate tar sands or coal, and an agglomerating liquid, for example water, and a second port at the larger end for receiving an organic material separating liquid, for example Varsol, with which the agglomerating liquid is immiscible. The first port is larger than the second port so that the separating liquid will drain from the drum through the first port. A conveying means delivers the particulate material and agglomerating liquid into the drum interior, and the separating liquid forms a slurry therewith so that inorganic residue from the particulate material is formed into ball agglomerates as it tumbles along the drum and the ball agglomerates overflow through the second port while the separating liquid fed into the second port separates organic material from the particulate material (tar sands), in the drum and overflows therewith through the first port; Seven claims, two drawing figures.

Meadus, F.W., Sparks, B.D., Puddington, I.E., and Farnand, J.R., 1977, Separating organic material from tar sands or oil shale: United States Patent 4,057,486

(Patent), (No Specific Deposit), Tar sands and like mineral solids-plus petroleum deposits are separated into a petroleum fraction and a solids fraction by contacting with an organic solvent or diluent (in one or more stages), to give a liquid slurry, providing in the system a small amount of an aqueous agglomerating liquid, mixing and agitating until discrete compact agglomerates of hydrophilic solids form, separating the solid easily-handled agglomerates and recovering the petroleum fraction and solvent or diluent. This process avoids the large volumes of aqueous effluent inherent in the "hot water" and other processes using large amounts of water. The solid agglomerates may be used as clean fill, sintered to aggregate, or modified to serve as soil amendments. Eighteen claims, no drawings.

Merriam, N.W., and Fahy, L.J., 1985, LETC tar sand research - North Asphalt Ridge, *in* Picard, M.D., editor, Geology and energy resources, Uinta Basin of Utah: Utah Geological Association Publication 12, p. 253-257.

(NW Asphalt Ridge), (Asphalt Ridge), This paper contains: Introduction; Discussion of field experiments. Figures include LETC tar sand well locations, Rimrock Sandstone Member cross section, and LETC TS-IS site layout.

Merrill, R.C., 1972, Geology of the Mill Fork area, Utah: Brigham Young University Geology Studies, v. 19, pt. 1, p. 65-88.

(Mill Fork), (Oil Hollow), This article contains: Introduction; Stratigraphy – general, Cretaceous (?), and Tertiary rocks (North Horn, Flagstaff, Colton, Green River Formations); Tertiary (?) and Quaternary rocks; Structural geology; Faults; Geomorphology; Economic geology (short paragraph on tar sands); Geologic history; Appendix; References; Illustrations.

Meyer, R.F., editor, 1987, Exploration for heavy crude oil and natural bitumen: American Association of Petroleum Geologists Studies in Geology 25, 731 p.

(Numerous Utah Deposits), This book contains individual articles that fall under the following general headings: Section I – Regional Resources; Section II – Characterization, maturation, and degradation; Section III – Geological environments and migration; Section IV – Exploration methods; Section V – Exploration histories; Section VI – Recovery; and an Appendix.

Meyer, R.F., editor, 1995, Fueling for a clean and safe environment - tables of contents (6th UNITAR international conference on heavy crude and tar sands, February 12-17, Houston Texas): United States Department of Energy, v. 1 (811 p.) and v. 2 (733 p).

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), Volume 1 contains no references to Utah tar sands. Volume 2 contains three references to Utah tar sands as follows: Supercritical fluid extraction of Uinta Basin bitumens by Subramanian and others, pyrolysis of Uinta Basin oil sands in fluidized bed and rotary kiln reactors by Nagpal and others, and hydrotreating Uinta Basin bitumen-derived heavy oils by Longstaff and others.

Meyer, R.F., and Attanasi, E.D., 2003, Heavy oil and natural bitumen - strategic petroleum resources: U.S. Geological Survey Fact Sheet 700-03: Online Version 1.0, 6 p. <http://pubs.usgs.gov/fs/fs070-03.html>.

(No Specific Deposits), This fact sheet contains: Introduction; Definitions; Geographic distribution; Current production technology; Production projections.

Meyer, R.F., and Attanasi, E.D., 2004, Natural bitumen and extra-heavy oil (chapter 4), *in* 2004 survey of energy resources: ©World Energy Council, published by Elsevier Ltd., p. 93-116.

(No Specific Deposits), This chapter contains: Commentary (introduction, chemistry, resources, production methods, upgrading and refining, conclusions, references); Definitions; Tables; Country notes.

Meyer, R.F., Attanasi, E.D., and Freeman, P.A., 2007, Heavy oil and natural bitumen resources in geological basins of the world: U.S. Geological Survey Open File-Report 1084, 36 p.

(No Specific Deposit), This report contains the following: Abstract; Introduction; Terms defined for this report; Chemical and physical properties; Origins of heavy oil and natural bitumen; Data sources; Resource estimates; Recovery methods; Maps; Klemme basin classification (Type I – interior craton basins, Type II – continental multicyclic basins, Type III – continental rifted basins, Type IV – delta [Tertiary to recent], Type V – fore-arc basins); Regional distribution of heavy oil and natural bitumen; Summary; Acknowledgments; References cited; Tables; Appendix 1 – Map basin name conventions; Appendix 2 – Basins, basin type and location of basins having heavy oil and natural bitumen deposits; Appendix 3 – Klemme basin classification figure from plate 1; Appendix 4 – Tables from the plates.

Meyer, R.F., Fulton, P.A., and Dietzman, W.D., 1984, A preliminary estimate of world heavy crude oil and bitumen resources, *in* Meyer, R.F., Wynn, J.C., and Olson, J.C., editors, The Future of Heavy Crude and Tar Sands, Second International Conference: New York, Coal Age Mining Information Services, McGraw-Hill, Inc., p. 97-158.

(Asphalt Ridge), (NW Asphalt Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), This article contains: Introduction; Purpose; Results; Definitions; Data sources; Methodology; Resource consideration; Recovery; Oil mining; Heavy oil offshore; Undiscovered resources; Production and reserves; Area considerations (China, Gabon, Italy, Middle East, Nigeria, and adjoining countries, North Sea, Peru, Senegal, U.S.S.R., U.S.A., Venezuela); World summary; References; Twenty-three tables.

Meyer, R.F., and De Witt, Wallace, Jr., 1990, Definition and world resources of natural bitumens: U.S. Geological Survey Bulletin 1944, 14 p.

(No Specific Deposits), This Bulletin includes the following: Abstract, Introduction; Definitions of natural bitumens and related substances (natural bitumens, crude oil, coal); Classification systems of natural bitumens; Differentiating natural bitumens and crude oil; Usage of natural bitumens; Natural asphalt resources (natural asphalt deposits, resource evaluation); References.

Meyer, R.F., and Schenk, C.J., 1988, An estimate of world resources of heavy crude oil and natural bitumen, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy Crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 73-83.

(Asphalt Ridge), (Circle Cliffs), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This article contains: Abstract; Introduction; Definitions; Generalization concerning occurrences; Resources of natural bitumen; Resources of heavy crude oil; Heavy oil and bitumen production; Conclusions; References; Seven tables.

Mikula, R.J., Munoz, V.A., and Omotoso, O., 2006, Laboratory and pilot experience in the development of a conventional water based extraction process for the Utah Asphalt Ridge tar sands: Paper presented in the Petroleum Society's International Petroleum Conference 2006, Calgary, Alberta, Canada (June 13-15, 2006).

(Asphalt Ridge), This paper contains: Abstract; Introduction; Laboratory assessments; Pilot scale results (tailings handling); Summary; Acknowledgments; References; Eight tables and five figures.

Miller, J.D., and Hupka, Jan, 1984, Bitumen recovery from tar sands, United States Patent No. 4,470,899, 17 p.

(Patent), (Whiterocks), (P.R. Spring), A process for recovering bitumen from tar sands wherein the tar sands are pretreated with a diluent, such as kerosene in the preferred embodiment, to lower the viscosity of the bitumen such that it is in the range of about 5 to about 20 poise at the digestion temperature. The tar sands are then digested at a temperature in the range of about 45.degree. C. to about 60.degree. C. and at a pH of about 7.8 to about 8.6. The tar sands are then transferred to a flotation cell where the bitumen-rich concentrate is separated from the sand.

Miller, J.D., and Misra, Manoranjan, no date, Concentration of Utah tar sands by an ambient temperature flotation process: Salt Lake City, University of Utah, Department of Metallurgy and Metallurgical Engineering, 38 p.

(Sunnyside), (Tar Sand Triangle), This article contains: Abstract; Introduction; Experimental procedures (ambient temperature separation experiments, hot water processing of ambient temperature concentrate, compositional analysis, titrations, contact angle measurement, particle size analysis); Results and discussion (criterion for phase disengagement by grinding, sand size distribution, bitumen-tar sand surface chemistry, bench scale flotation – promoter addition, effect of pH, dispersant addition, effect of oxidation, hot water processing of ambient temperature concentrate); Summary and conclusions; References; Five tables; Eleven figures.

Miller, J.D., and Misra, Manoranjan, 1981, Hot water process development for Utah tar sands: For presentation at the 1981 Spring National Meeting of the American Institute of Chemical Engineers Journal, Houston, TX, April 5-9, 50 p.

(Asphalt Ridge), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), (Hill Creek), (Whiterocks), This paper includes the following: Abstract; Introduction (Utah tar sand reserves, processing strategies for tar sand deposits, properties of Utah tar sands, hot water process for Utah tar sands); Phase disengagement - digestion (tar sands containing moderate viscosity bitumen [Asphalt Ridge and P.R. Spring], Tar sands containing high viscosity bitumen [Sunnyside and Tar Sand Triangle]; Analysis of experimental results; Phase separation – modified froth flotation (operating variables, fundamental features of flotation separation); Upgrading of the primary concentrate; Summary and conclusions (phase disengagement – digestion, phase separation - modified froth flotation, concentrate upgrading); Acknowledgments; References; twenty-one figures, eight tables.

Miller, J.D., and Misra, Manoranjan, 1982a, Concentration of Utah tar sands by an ambient temperature flotation process: International Journal of Mineral Processing, v. 9, p. 269-287.

(Sunnyside), (Tar Sand Triangle), (Asphalt Ridge), This article includes the following: Abstract; Introduction; Experimental procedure (ambient temperature separation experiments, hot water processing of ambient temperature concentrate, compositional analysis, points-of-zero-charge, contact angle measurement, particle size analysis); Results and discussion (criterion for phase disengagement by grinding, sand size distribution, bitumen-tar sand surface chemistry, bench scale flotation, effect of pH, effect of oxidation, hot water processing of ambient temperature concentrate); Summary and conclusions; References.

Miller, J.D., and Misra, Manoranjan, 1982b, Hot water process development for Utah tar sands, *in* Fuel Processing Technology: Amsterdam, Elsevier Scientific Publishing Company, p. 27-59.

(Asphalt Ridge), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), (Circle Cliffs), (Hill Creek), (Whiterocks), This paper contains: Abstract; Introduction (Utah tar sand reserves, processing strategies for tar sand deposits, properties of Utah tar sands, hot water process for Utah tar sands); Phase disengagement – digestion (tar sands containing moderate viscosity bitumen, tar sands containing high-viscosity bitumen, analysis of experimental results); Phase separation – modified froth flotation (operating variables, fundamental features of flotation separation); Upgrading of the primary concentrate; Summary and conclusions (phase disengagement – digestion, phase separation – modified froth flotation, concentrate upgrading); Acknowledgments; References; Eight tables, twenty-two figures.

Miller, J.D., and Misra, Manoranjan, 1983, Process for separating high viscosity bitumen from tar sands, United States Patent No. 4,410,417, 8 p.

(Patent), (Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Hill Creek), A novel process for separating high viscosity bitumen from tar sand. The process includes grinding the tar sand to obtain phase disengagement of the bitumen phase from the sand phase and thereafter using flotation techniques to obtain phase separation of the bitumen phase from the sand phase. Phase disengagement is assisted by using a suitable wetting agent during the crushing step while the phase separation step is assisted by the inclusion of a promoter oil for the flotation step.

Miller, J.D., and Misra, Manoranjan, 1984, Process for separating high viscosity bitumen from tar sands, United States Patent No. 4,486,294, 11 p.

(Patent), (Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Hill Creek), (Asphalt Ridge), A novel process for separating high viscosity bitumen from tar sand. The process includes grinding the tar sand to obtain phase disengagement of the bitumen phase from the sand phase and thereafter using flotation techniques to obtain phase separation of the bitumen phase from the sand phase. Phase disengagement is assisted by using a suitable wetting agent such as sodium carbonate or sodium silicate during the grinding step, while the phase separation step is assisted by the inclusion of a promoter oil for the flotation step.

Miller, J.D., and Sepulveda, J.E., 1978, Separation of bitumen from dry tar sands, United States Patent No. 4,120,776, 12 p.

(Patent), (Asphalt Ridge), (P.R. Spring), A process for the separation and recovery of bitumen from dry tar sands or sands with negligible quantities of connate water. The process includes comminuting the tar sands to an average particle size of approximately one centimeter in diameter and digesting the comminuted tar sand in a hot, aqueous solution having a pH within the range of pH 10 to pH 14. Optimal digestion is obtained by assuring that the tar sand in the digester is within the range of 50 to 80% solids so as to provide the necessary high shear environment. The digested tar sand is thereafter subjected to a flotation process wherein additional water is introduced to lower the temperature and the solids concentration. Preferably, the pH of the separation cell is maintained above about pH 10. Air is bubbled into the mixture to carry the separated bitumen particles to the top of the separation cell for subsequent recovery.

Minerals Management Service, 1982, Tract summary report, Gordon Corral combined hydrocarbon tract, Wayne County, Utah: U.S. Geological Survey, Minerals Management Service, Central Region, District Resource Evaluation Office, 39 p.

(Gordon Corral), (Tar Sand Triangle), This EIS includes the following: Description of area; Issues and concerns; Description of alternatives; Affected environment; Environmental consequences of alternatives; Irretrievable and irreversible commitment of resources; Adverse environmental impact; Relationship of short-term use to long-term productivity; References.

Mintiloglitis, Vasilios, no date, Drilling core samples of tar sands in Sunnyside area of Utah: Unpublished company report, 25 p.

(Sunnyside), This report contains the following: Tar sands; Sunnyside-geology; Conclusions; References; Memorandum from Robert S. Bacon to Jock A. Campbell (reduction of data for Signal Sunnyside core hole and three Texaco core holes); Drilling reports; Core analyses; Twelve figures and two tables.

Miskell, J.T., 1980, Tar sands – economically feasible?: Energy, Fall issue, p. 29.

(Sunnyside), (Asphalt Ridge), (Tar Sand Triangle), This article contains the following: Abstract; Introduction; Lessons from Canadian tar sands; Tar sand processing.

Misra, Manoranjan, 1981, Physical separation of bitumen from Utah tar sands: Salt Lake City, University of Utah Ph.D. Dissertation, 190 p.

(Sunnyside), This dissertation contains: Abstract; Acknowledgments; Introduction (nature and origin of tar sand; major tar sand deposits in the world, characteristics of Utah tar sand deposits, mining methods); Review of recovery and extraction technology (in-situ processing, processing of mined tar sands); Commercial tar sand operations (hot water separation, upgrading process); Hot water processing of Utah tar sands (processing strategy, limitations); Research objective; Experimental procedure (physical separation experiments, characterization, upgrading of primary bitumen concentrate, surface chemistry experiments); Results and discussion (tar sand characterization, hot water separation experiments, analysis of experimental results, upgrading of the primary concentrate, surface chemical analysis, ambient temperature separation); Summary and conclusions (hot water process, ambient temperature process, upgrading); References; Four Appendices.

Misra, Manoranjan, and Miller, J.D., 1979, The effect of feed source in the hot-water processing of Utah tar sand: Presentated at the 1979 AIME annual meeting, New Orleans, Louisiana, February 18-22, 11 p.

(Sunnyside), (Asphalt Ridge), (P.R. Spring), (Tar Sand Triangle), This article includes the following: Abstract; Introduction (low temperature separation technology, hot water processing of Utah tar sand); Experimental procedure (hot water separation test, analytical technique, bitumen viscosity measurements, molecular weight determination, particle size analysis); Results and discussion (tar sand properties [bitumen viscosity, molecular weight, sand analysis], hot water process [effect of soda ash, effect of diluent], product characterization [particle size analysis]); Summary and conclusions; Acknowledgments; References. The majority of the experiments focused on the behavior of the Sunnyside sample.

Misra, Manoranjan, and Miller, J.D., 1980, The effect of feed source in the hot-water processing of Utah tar sand: Mining Engineering, March, p. 302-311.

(Sunnyside), (Asphalt Ridge), (P.R. Spring), (Tar Sand Triangle), This article has the following sections: Introduction; Low-temperature separation technology (solvent only, solvent-assisted water, and water only); Hot water processing of Utah tar sand; Experimental procedure most experiments focused on the behavior of the Sunnyside sample); Results and discussion (tar sand properties, hot water process); Summary and conclusions.

Misra, Manoranjan, and Miller, J.D., 1991, Comparison of water-based physical separation processes for U.S. tar sands: Fuel Processing Technology, v. 27, p. 3-20.

(**Asphalt Ridge), (P.R. Spring), (Sunnyside), (White Rocks),** This article covers the following topics: Introduction (tar sand properties, bitumen properties, sand size distribution); Water-based physical separation process (hot-water process, phase disengagement-digestion, effect of soda ash, effect of trona solution, phase separation-modified froth flotation, the diluent-assisted hot-water process, digestion, flotation, criterion for phase disengagement by grinding, sand size distribution, and flotation); Summary and conclusions.

Mitchell, G.C., Rug, F.E., and Byers, J.C., 1989, The Moenkopi – horizontal drilling objective in east central Utah: Oil & Gas Journal, September 25 edition, p. 120-123.

(Numerous Utah Deposits), This paper discusses the tar sand reserves of several of the Central Utah deposits, and then the oil potential of the Last Chance and Grassy Trail Creek fields.

Mitchell, T.O., 1984, Processing of tar sands, United States Patent No. 4,424,113, 7 p.

(Patent), (So Specific Deposit), The present invention relates to an improved process for the recovery of bitumen from tar sands comprising first heating the raw tar sands with steam at a temperature sufficient to visbreak a portion of the bitumen without significant thermal cracking thereby producing a vaporous distillate product mixed with steam and lowering the viscosity and specific gravity of the residual bitumen on the heat treated tar sands. The distillate product and steam are cooled and condensed and mixed with the heat treated tar sands containing residual beneficiated bitumen to form a slurry. Bitumen is then recovered from the slurry by a hot-water separation process.

Mono Power Company, 1984, P.R. Spring coring information.

(P.R. Spring), This packet of information shows the locations of core holes drilled in the P.R. Spring area, an inventory of the drill holes and what information is available. The logs for these holes are filed in the tar sands file in the Economic Program of the Utah Geological Survey.

Moore, H.F., Johnson, C.A., Sutton, W.A., Henton, L.M., and Chaffin, M.H., 1984, Aviation turbine fuels from tar sands, bitumen, and heavy oils: Ashland, Ashland Petroleum Company, 144 p.

(Uinta Basin), (Asphalt Ridge), (Tar Sand Triangle), (Sunnyside), (P.R. Spring), (Hill Creek), This report contains: Introduction; Resources and material properties (Utah, California-tar sands and heavy oils, Wyoming, Kentucky, New Mexico, Alabama, Oklahoma, Louisiana, Kansas, Missouri); Refining of tar sands bitumen and heavy oil; Process description; Bases, assumptions, and case definitions; Results; Conclusions; Recommendations; References; Bibliography; Two Appendices.

Morrison Knudsen, 1984, Mono Power Company, Sunnyside tar sands project – 1983 geologic evaluation: Morrison Knudsen, 133 p.

(Sunnyside), (P.R. Spring), This report contains: Summary; Introduction (purpose of the investigation, previous work, present investigation, project organization); Program of investigation (general scope of work, P.R. Spring drilling, Sunnyside drilling, logging and sampling, assaying and testing, surveying, aerial photography and mapping, geologic mapping, geologic evaluation, resource/reserve estimation); Geologic evaluation (regional geologic setting, general stratigraphy, Range Creek/Bruin Point stratigraphy, Whitmore Canyon stratigraphy, geologic structures, structural analysis, summary of geotechnical evaluation, groundwater hydrology); Laboratory testing (tar sand assay procedures development, tar sand assay results, bulk density testing results, tar sand degradation testing results); Economic geology (resource/reserve estimation, geologic considerations for mining, oil and gas possibilities); Recommendations (general recommendation, resource/reserve drilling program, characterization of Whitmore Canyon tract bitumen, definition of Whitmore Canyon's anomaly); References; Four Appendices.

Murray, R.G., and Gikis, B.J., 1978, Process and apparatus for separating coarse sand particles and recovering bitumen from tar sands: United States Patent 4,120,775, 7 p.

(Patent), (Utah Tar Sands), A system for effecting a sharp separation from tar sands of the large weight fraction of coarse materials present therein and for recovering bitumen, or tar, from the remaining product, wherein, as a first step, finely divided particles of tar sand are added to a liquid hydrocarbon solvent in an agitation zone to form a dilute solution of the bitumen component which is agitated to maintain both the coarse as well as the fine solid particles present in a well dispersed condition. This dispersion flows downwardly from the agitation zone and through a shallow conduit, generally rectangular in cross section and having an opening extending across its bottom portion over which the dispersion passes. During the short residence time of the dispersion over the opening, the coarse sand particles, which under the influence of gravity fall faster than the fines, selectively drop out of the suspension and pass through the conduit opening into an underlying sand-receiving chamber. The latter is continuously provided with solvent which wells up into the bitumen solution passing overhead which still contains the fines portion of the dispersion. Seven claims, three figures.

Nagpal, Samir, 1995, Pyrolysis of oil sands in a large diameter fluidized bed reactor: Salt Lake City, University of Utah M.S. Thesis, 179 p.

(P.R. Spring), This thesis contains: Abstract; Notation; Acknowledgments; Introduction (oil sand resources, economics of oil sands processing, methods of bitumen recovery from oil sands, fluidized beds, fluidized bed pyrolysis of oil sands, research objectives); Fluidized bed pyrolysis of oil sands (pyrolysis of oil sands, general trends in product yields and quality, rotary kiln process); Process description and experimental procedures (process description, modification in burner system, process variable studies, mass balance calculations, liquid sample preparation, liquid product analysis); Results and discussion (determination of minimum fluidization velocity, feeder calibration, effect of process parameters on product distribution, discussion, characterization of liquid products, comparison of fluidized bed and rotary kiln pyrolysis processes, preferred process conditions); Conclusions; Six Appendices; References; Vita.

Nagpal, Samir, Fletcher, J.V., and Hanson, F.V., 1995, Pyrolysis of Uinta Basin oil sands in fluidized bed and rotary kiln reactors, *in* Meyer, R.F., editor, Heavy crude and tar sands – fueling for a clean and safe environment (6th UNITAR International Conference on Heavy Crude and Tar Sands): U.S. Department of Energy, p. 205-212.

(P.R. Spring), (Whiterocks), This paper contains: Abstract; Introduction (Review of results of previous investigations); Experimental apparatus and process description; Results and discussion (comparison with rotary kiln process); Conclusions; Acknowledgments; References; Seven figures, five tables.

National Research Council, 1990, U.S. production of liquid transportation fuels – costs, issues, and research and development directions: Washington, National Academy Press, variously paginated.

(No Specific Deposit), This report includes the following: Executive summary; Introduction (objective of the study, U.S. R7D for liquid fuels production from domestic resources, current concerns about energy and the U.S. transportation system, increasing the use of domestic resources, planning scenarios, organization of the study and report); Conventional petroleum, enhanced oil recovery, and natural gas (remaining domestic oil and gas resources, production technologies and processes, upstream oil and gas environmental impacts, time and investment required for increased oil and gas production, loss of reserve growth and EOR potential, technological opportunities, DOE research program, summary); Production costs for alternate liquid fuels sources (structure of the analysis, cost estimates for the various technologies, issues of fuel distribution and use, conclusions); Conversion technologies and R&D opportunities (production of hydrogen and synthesis gas, heavy oil conversion, tar sands recovery and processing, oil shale, syngas-based fuels, direct coal liquefaction, coal oil co-processing, coal pyrolysis, direct conversion of natural gas); Environmental impacts of alternative fuels (air quality, health and safety effects, greenhouse gas emissions); Major conclusions and recommendations for R&D on liquid transportation fuels (overview, resources, environmental considerations, major conclusions and recommendations); Appendix A – Statement of task; Appendix B – Committee meetings and activities; Appendix C – U.S. and world resources of hydrocarbon fuels; Appendix D – Cost analysis methods; Appendix E – Technologies for converting heavy oil; Appendix F – Retorting technologies for oil shale; Appendix G – Research, development, and demonstration definitions; Appendix H – Co-processing technologies; Appendix I – Technical data for coal pyrolysis; Appendix J – Description of technologies for direct conversion of natural gas; Appendix K – Temperature characteristics of high-temperature gas reactors; References; Glossary.

NEVTAH, 2007, The Utah tar sands: Online, http://www.nevtahoilsands.com/the-utah-tar-sands.htm, accessed August 2007.

(Whiterocks), (Asphalt Ridge), This article contains the following; The Whiterocks deposit, Utah Oil Sands (location and access, physiography and land use, geologic setting, bitumen analyses, development history); Source – U.S. Department of Geology; Asphalt Ridge (photographs, reservoir properties, oil saturation, distribution of richness and net pay, summary of resource-in place.

New Energy Resources Company (NESCO), 1976, A demonstration of economic oil recovery from P.R. Spring tar sands – Volume I – Technical Proposal: New Energy Sources Company (NESCO), 98 p.

(P.R. Spring), Volume I includes the following: Summary; Photographs of NESCO's engineering prototype for oil extraction; Introduction and background summary; Technical approach (background of NESCO process, tasks accomplished by NESCO, tasks to be accomplished, identification of technical problems, exceptions to the ERDA statement of work); Project plan (introduction, division of project into tasks and sub-tasks, detailed estimates for each task and sub-task, project task monthly summaries, the annual report); Project schedule (introduction, project schedule prior to contract award, project schedule after July 1, 1976, contribution to

alleviation of energy crisis); Project organization and qualifications of offeror; Personnel qualifications (resumes); Supporting data and other information (identification of contract end-point, concurrence with reporting requirements, listing of current government contracts, data resulting from other government tar sands contracts); Exhibit – Ford, Bacon and Davis brochure.

New Energy Resources Company (NESCO), 1976, A demonstration of economic oil recovery from P.R. Spring tar sands – Volume II– Technical Proposal: New Energy Sources Company (NESCO), 51 p.

(P.R. Spring), Volume II includes the following: Introduction (acceptance of provisions of the RFP, representations and certification, cost firm for ninety days, the effect on contract price by availability of GFE); Cost forms; Cost summary (summary of cost element, summary by major tasks, cost summary by months); Detailed cost information (salaries and wages, rates, subcontractors' rates, materials, travel and subsistence, computer use, special test equipment, other costs); Cost sharing; Representations and certifications, NESCO financial capability; Type of contract; NESCO's authorized representatives; Exhibit A.

Nielson, J.P., 1989, Recovery of oil from oil-bearing formation by continually flowing pressurized heated gas through channel alongside matrix: United States Patent 4,856,587, 11 p.

(Patent), (Sunnyside), The invention comprises a method and apparatus for recovering oil from so-called depleted oil fields and also from tar sands. A pressurized, heated, non-aqueous gas, such as carbon dioxide, is continuously flowed through a channel, which is in heat exchange relationship with an oil-bearing matrix, thus reducing the viscosity and mobilizing the oil in the sensible boundary region. Mobilized oil flows to a collection reservoir from which it is then produced. Twelve Claims, Four drawings.

Nielson, J.P., 1992, Separation of oil and precious metals from mined oil-bearing rock material: United States Patent 5,122,259, 16 p.

(Patent), (Asphalt Ridge), (P.R. Spring), A method and apparatus for producing oil, bitumen, precious metals, and hydrocarbon gases from mined oil-bearing rock material, such as tar sands and oil shale. The rock is ground preconditioned in a heated and pressurized atmosphere devoid of oxygen, and subsequently centrifuged in the presence of an oil-replacement gas to produce oil, and also any precious metals particles that are present in the oil-bearing rock material. The produced oil and precious metals are subsequently separated from each other by centrifuging. Sixteen claims, Eight drawing sheets.

North, W.B., Thomas, C.P., Becker, A.B., Faulder, D.D., and Brashear, J.P., 2000, Petroleum technology through applied research by independent oil producers: Tulsa, The Brashear Group, LLC, 134 p.

(P.R. Spring), (Asphalt Ridge), This book contains: Contractor disclaimer and acknowledgments; Summary; Background; Overview of project results; Project-by-project summary of results; Project economic assessments; Program level benefit-cost analysis; Conclusions and recommendations; Project fact sheets (drilling, exploration, formation evaluation, improved oil recovery, operations, production problems, simulation, water productions, well bore problems); Appendices. (Note, article on tar sands – Closed loop extraction of hydrocarbons and bitumen from oil-bearing soils – by X-Trac Energy, Inc. - on page 47).

Oaks, K.M., Sale, J.J., Vaughan, N.D., Switek, J., and Etnier, E.L., 1982, Tar Sand, *in* Reed, R.M., editor, Preparation of environmental analyses for synfuel and unconventional gas technologies: Oak Ridge, Oak Ridge National Laboratory, p. 35-58.

(No Specific Deposits), This section of the publication includes the following: Resource description; Technology overview (surface mining, separation processes, upgrading processes, in-situ extraction); Potentially significant issues (land use, air quality, water use, water quality, impacts on biota, noise, solid waste disposal, reclamation, socioeconomics, health and safety); References.

Oblad, A.G., Bunger, J.W., Dahlstrom, D.A., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., and Seader, J.D., 1993, University of Utah oil sand research and development program, report for July 7, 1992 to July 6, 1993, work performed under contract no. DE-FC21-89kMC26268: Salt Lake City, University of Utah Department of Chemical and Fuels Engineering, 8 p.

(Asphalt Ridge), (P.R. Spring), (Circle Cliffs), (Sunnyside), This report contains: Abstract, Results and discussion (characterization of bitumen, aqueous separation/recovery of Uinta Basin bitumens, extraction of bitumen by an energy-efficient thermal method, fluidized bed pyrolysis of oil sands in a large diameter reactor, rotary kiln pyrolysis of oil sands, combustion of carbonaceous residues on spent oil sands in a dense phase transport reactor, supercritical fluid extraction of oil sand bitumen, catalytic upgrading of Uinta Basin bitumens over an HDM catalyst, catalytic upgrading of Uinta Basin bitumens: HDM versus HDN catalysts); Conclusions; References.

Oblad, A.G., Bunger, J.W., Dahlstrom, D.A., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., and Seader, J.D., 1993, The extraction of bitumen from western oil sands, quarterly report July 1993 – September 1993, work performed under contract no. DE-FC21-89MC26268 for the U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, Laramie, Wyoming: Salt Lake City, University of Utah, Department of Chemical and Fuels Engineering and Department of Metallurgical Engineering, 13 p.

(Whiterocks), (Sunnyside), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), This report gives the project tasks for the given period of time and the actions that were taken.

Oblad, A.G., Bunger, J.W., Dahlstrom, D.A., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., and Seader, J.D., 1994, The extraction of bitumen from western oil sands quarterly report July 1989 to September 1993: Salt Lake City, University of Utah, Department of Fuels Engineering, Department of Metallurgical Engineering, University unpublished report, 600 p. Work performed under contract no. DE-FC21-89MC26268 for the U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, Laramie, Wyoming.

(P.R. Spring), (Circle Cliffs), (Whiterocks), (Sunnyside), (Asphalt Ridge), This report contains: Executive summary; Information required for the National Environmental Policy Act; Characterization of Uinta Basin oil sand deposits and acquisition of mined ore samples; Aqueous separation/recovery of Uinta Basin bitumens; Bitumen release from oil sand during stagnant digestion; Enhanced bitumen recovery from Whiterocks oil sands by control of the bitumen/water interfacial tension; Bubble size distributions generated during operation of an air-sparged hydrocyclone; A dimensional analysis of cleanup of a bitumen concentrate derived from Utah oil sand; Water-based separation process design and development for Utah oil sands; Extraction of bitumen from Western oil sands by an energy-efficient thermal method; Fluidized bed pyrolysis of oil sands in a large diameter reactor; Rotary kiln pyrolysis of oil sands; Performance and calibration of dry materials feeders when feeding oil sands; Combustion of carbonaceous residues on spent oil sands in a laboratory-scale dense-phase transport reactor; Supercritical fluid extraction of oil sand bitumen; Upgrading Uinta Basin oil sands - catalytic upgrading of a Uinta Basin bitumen over a commercial HDM catalyst; Uinta Basin bitumen hydrotreating - a comparison of HDN and HDM catalyst performance; Effects of coke on HDM catalyst deactivation; Similitude studies in three-phase ebullieted bed reactors; Development studies of equipment for three-product gravity-separation of bitumen, sand, and water; Technical and economic comparison of bitumen upgrading options; References; Appendix A - Whiterocks oil sand deposit bibliography; Appendix B - Asphalt Ridge oil sand deposit bibliography; Appendix C - P.R. Spring oil sand deposit bibliography; Appendix D - Sunnyside oil sand deposit bibliography; Appendix E - Circle Cliffs oil sand deposit bibliography; Appendix F - University of Utah oil sands bibliography (theses, dissertations, final reports, patents and publications).

Oblad, A.G., Bunger, J.W., Dahlstrom, D.A., Deo, M.D., Hanson, F.V., Miller, J.D., and Seader, J.D., 1992, The extraction of bitumen from Western oil sands, annual report July 1991 to July 1992, Work performed under contract ho. DE-FC21-89MC26268: Salt Lake City, University of Utah, Departments of Fuels, Metallurgical, and Chemical Engineering, unpublished report, 447+ p.

(Asphalt Ridge), (Sunnyside), (P.R. Spring), (Whiterocks), This report contains: Executive summary; Information required for NEPA; Introduction; Projects and principal investigators; Project descriptions; Characterization and potential utilization of the Asphalt Ridge oil sand bitumen (introduction, experimental procedures, results and discussion, summary and conclusions, future activities); Effect of solvent and intrinsic volatile fraction of bitumen on the precipitation of asphaltenes (introduction, experimental procedures, results and discussion, summary and conclusions, future activities); Water-based tar sand separation technology (introduction, results and discussion, conclusions, future activities; FTIR analysis in processing of tar sands (introduction, FTIR microscope examination of thin bitumen films, adsorption/desorption of bitumen-derived surfactants using internal reflection FTIR spectroscopy, conclusions, future activities); New separation cell for bitumen recovery from tar sand slurry (introduction, final comments, future activities); Water recycle in moderate-temperature bitumen recovery from Whiterocks tar sands (introduction, experimental procedures, results, discussion, summary and conclusions, future activities); Air-sparged hydrocyclone flotation of oil from oil-in-water emulsions; (introduction, the principles of air-sparged hydrocyclone flotation, experimental procedure, results and discussion, conclusions, future activities); Underground hot water processing of tar sands (introduction, borehole mining of tar sands, concept development for underground processing, experimental procedure, results and discussion, future activities); Extraction of bitumen from western oil sands by an energy-efficient thermal method (introduction, experimental procedures, results and discussion, future activities, notation); Development of a fluidized bed reactor system for reduced pressure pyrolysis studies (introduction, experimental procedures, results and discussion, summary and conclusions, future activities, notation); Pyrolysis of oil sands in a rotary kiln reactor (introduction, summary and conclusions, future activities); Hydrotreating the bitumen from the Whiterocks oil sand deposit (introduction, experimental methods and means, results and discussion, summary and conclusions, future activities); Reaction pathways in the oil sand pyrolysis-hydrotreating sequence as revealed by high resolution GC-MS analyzers (introduction, experimental procedures, results and discussion, summary and conclusions, future activities); Supercritical extraction of Whiterocks bitumen asphaltene rejection (introduction, experimental procedures, results and discussion, summary and conclusions, future activities); Bitumen recovery during tailings dewatering (introduction, experimental, results and discussion, summary and conclusions, future activities).

Oblad, A.G., Bunger, J.W., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., and Seader, J.D., 1993, The extraction of bitumen from western oil sands, quarterly report April 1993 – June 1993, work performed under contract no. DE-FC21-89MC26268: Salt Lake City, University of Utah Department of Chemical and Fuels Engineering and Department of Metallurgical Engineering, 12 p.

(Whiterocks), (Sunnyside), (P.R. Spring), (Asphalt Ridge), (Hill Creek), (Circle Cliffs), This report gives the project tasks for the given period of time and the actions that were taken.

Oblad, A.G., Bunger, J.W., Deo, M.D., Hanson, F.V., Miller, J.D., and Seader, J.D., 1990, The extraction of bitumen from Western tar sands: Salt Lake City, Department of Fuels Engineering, Department of Metallurgical Engineering, University unpublished report, 431 p. (Work performed under contract no. DE-FC21-89MC26268 for the U.S. Department of Energy, Morgantown Energy Technology Center, Morgantown, West Virginia.)

(Whiterocks), (Asphalt Ridge), (Sunnyside), This report contains: Executive summary; Acquisition and characterization of the bitumen impregnated sandstone from the Whiterocks tar sand deposit; Characterization of the native bitumen from the Whiterocks tar sand deposit; Physical and chemical properties of the Whiterocks bitumen samples; Water-based tar sand separation technology; Characterization of Whiterocks tar sand bitumen and mineral matter; Electrophoretic characterization of bitumen and fine mineral particles from Asphalt Ridge and Sunnyside tar sands; Residual solvent effect on the viscosity of bitumen from Whiterocks tar sand; The influence of tar sand slurry viscosity on the hot water digestion-flotation process; Development of a moderate temperature separation process for tar sands; The effect of electric field pulsation frequency on breaking water-in-oil emulsions; Extraction of bitumen from Western tar sands by an energy-efficient thermal method; Process concepts for the recovery and upgrading of bitumen and bitumen-derived liquids; Solvent extraction of tar sand; Catalytic upgrading of bitumen and bitumen-derived liquids; Bitumen upgrading; Design of the tandem hydropyrolysis-hydrotreating unit; References; Appendices.

Oblad, A.G., Bunger, J.W., Deo, M.D., Hanson, F.V., Miller, J.D., and Seader, J.D., 1992, The extraction of bitumen from Western tar sands, annual report for the period July 1990 - July 1991: Salt Lake City, Department of Fuels Engineering, Department of Metallurgical Engineering, University unpublished report, 451 p. (Work performed under contract no. FC21-89MC26268 for the U.S. Department of Energy, Morgantown Energy Technology Center, Morgantown, West Virginia).

(Whiterocks), (Asphalt Ridge), This report contains: Executive summary; Characterization of the native bitumen from the Whiterocks oil sand deposit; Acquisition of the bitumen-impregnated sandstone from the Asphalt Ridge oil sand deposit; The influence of carboxylic acid content on bitumen viscosity; Water-based oil sand separation technology; Air bubble filming by bitumen; Preliminary examination of oil bonding at sand surfaces and its influence on hot water separation; Oil sand pretreatment with diluent; Bitumen separation from digested oil sand slurry; Sand and water separation from bitumen concentrate; Extraction of bitumen from Western oil sands by an energy-efficient thermal method; Large-diameter fluidized bed reactor studies; Rotary kiln pyrolysis of oil sand; Catalytic upgrading of bitumen and bitumen derived liquids; Ebullieted bed hydrotreating and hydrocracking; Supercritical fluid extraction; Bitumen upgrading; Future activities; References; Three Appendices.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., Ritzma, H.R., and Seader, J.D., 1987, Tar sand research and development at the University of Utah, *in* Hollander, J.M., editor, Palo Alto, Annual Reviews Inc., Annual Review of Energy, v. 12, p. 256-283.

(Asphalt Ridge), (NW Asphalt Ridge), (Hill Creek), (P.R. Spring), (Sunnyside), (Whiterocks), This paper covers the following topics: Historical overview of tar sand, development in the U.S. and Canada; Tar sand research and development at the University of Utah; Utah tar sand resources; Characterization of native tar sand bitumens; Bitumen upgrading, refining, and utilization; Pyrolysis of bitumen-impregnated sandstone in a fluidized-bed reactor; Coupled fluidized-bed pyrolysis of bitumen-impregnated sandstone; Water-assisted recovery of bitumen; Economic analysis of synthetic crude production; Summary.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1979, Recovery of oil from Utah's tar sands (Final report for contract #ET77-S-03-1762, for the period July 1, 1979 to November 30, 1979): Salt Lake City, University of Utah, Departments of Mining and Fuels Engineering, Metallurgical Engineering, and Chemical Engineering, 140 p.

(Numerous Utah Deposits), This report includes the following: Title page; Abstract; Table of contents; List of tables and figures; Introduction; Hot water recovery (low temperature separation technology, hot water processing of Utah tar sand, experimental procedure, results and discussion); Energy recovery in thermal processing (energy-efficient thermal processing concept, experimental apparatus, experimental results, conclusions and recommendations, references); Effect of variables on thermal processing (experimental, results and discussion, conclusions, references); Bitumen processing and utilization (conclusions, references); Bibliography

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1979, Recovery of oil from Utah's tar sands (A progress report submitted to the U.S. Department of Energy under contract EY-77-S-03-1762 for the period July 1, 1977 to June 30, 1979),): Salt Lake City, University of Utah, Departments of Mining and Fuels Engineering, Metallurgical Engineering, and Chemical Engineering, 134 p.

(Sunnyside), (Tar Sand Triangle), (Asphalt Ridge), (P.R. Spring), This report includes the following: Title page; Abstract; Tables of contents; List of tables and figures; Introduction; Hot water recovery (low temperature separation technology, hot water processing of Utah tar sand, experimental procedure, results and discussion); Energy recovery in thermal processing (energy-efficient thermal processing concept, experimental apparatus, experimental results, conclusions and recommendations, references); Effect of variables on thermal processing

(experimental, results and discussion, conclusions, references); Bitumen processing and utilization (conclusions, references).

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1983, Recovery of oil from Utah's tar sands (for the period December 1, 1979 - March 31, 1983: Salt Lake City, University of Utah Departments of Fuels Engineering , Metallurgical Engineering, and Chemical Engineering, 256 p. (Work done under contract no. DE-AT20-81LC-10332).

(P.R. Spring), (Tar Sand Triangle), (Whiterocks), This report covers the following: Summary; Table of contents; Introduction; Section A - Hot water processing of Utah tar sands (dewatering, dilution - centrifugation); Section B - Fluidized bed pyrolysis of tar sand; Section C - Upgrading and utilization of bitumen (introduction, coking, hydrotreating, steam cracking, other activities); Section D - Energy recovery in a thermal system utilizing heat pipes (introduction, objectives, background and process development in thermal processing, thermodynamic analysis of thermal recovery of tar sands, development of a dynamic model, equipment and experimental procedure, results and discussion, conclusions and recommendations); Patents issued or applied for; Theses completed; References.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1983, Recovery of oil from Utah's tar sands (Work for the period of April 1, 1983 through June 30, 1983, and April 1 through June 30, under contracts DE-AT2080LC10332 and DE-AS20-82LC10942): Salt Lake City, University of Utah, Department of Fuels Engineering, 43 p.

(No Specific Deposit), Quarterly Progress report for period of May 1 through July 31. This report contains the following: Summary; Computer simulation (introduction, problem statement, development of the mathematical model, details of specific case, thermal conductivity, diffusivity); Results (critical boiling point of feed, critical drop size at nozzle, chemical reactions in hydropyrolysis, economics of hydropyrolysis, equipment upgrade).

Continued - **(P.R. Spring), Tar sand quarterly report, work through April 1 through June 30:** This report contains the following: Introduction; Project status; Future work; References.

Continued - **(Asphalt Ridge), Air-sparged hydrocyclone, quarterly report for April 1 through June 30:** This report includes the following: Summary and status of work; Future work.

Continued **- (Sunnyside), Energy recovery in thermal processing of Utah tar sands, Quarterly progress report for the period April 1 through June 30:** This report includes the following: Introductory statement and discussion of work completed.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1984, Recovery and hydropyrolysis of oil from Utah's tar sands (for the period of December 1982 - December 1984): Salt Lake City, University of Utah, variously paginated. (Work done under contract no. DE-AS20-82LC10942 for the U.S. Department of Energy, Laramie Energy Technology Center.)

(Asphalt Ridge), (Sunnyside), (P.R. Spring), This book contains: Summary; Table of contents; Section A: Hot water processing of Utah tar sands (air sparged hydrocyclone, type III tar sand/bitumen concentrate grade, data processing, references); Section B: Upgrade of tar sand bitumen by hydropyrolysis process (Introduction, objectives and statement of work, process design, fabrication of unit, operation of unit and results, process simulation economics and thermodynamics, summary, references); Section C: The fluidized bed pyrolysis of bituminous sands (Exploratory process variable studies - P.R. Spring deposit [introduction, experimental equipment and procedures, results and discussion, pyrolysis of P.R. Spring tar sand, quality of liquid products, conclusions, references] - Large diameter bed pyrolysis unit [introduction, reactor design, references]; Section D: Energy recovery in thermal processing of Utah tar sands (introduction, objectives, control theory and strategy, experimental, results and discussion, conclusions and recommendations, appendices, references cited).

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1985a, Recovery and upgrading of oil from Utah tar sands (First annual report, October 1, 1984 - September 30, 1985): Salt Lake City, University of Utah, 267 p. (Work done under contract no. DE-FG20-84LC11057 for the U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, Laramie Project office, Laramie, Wyoming).

(P.R. Spring), This book contains: Executive summary; Bitumen upgrading (experimental description, results and discussion, summary); Fluidized bed pyrolysis of bitumen-impregnated sandstone (synopsis, introduction, recovery of the bitumen from bituminous sands, experimental apparatus and procedures, material balance calculations, results and discussion, conclusions, nomenclatures); Modified hot water separation technology (introduction, motion analysis of bitumen in shear flow, concluding remarks); Two-stage thermal recovery using heat pipes (summary, introduction, literature review, discussion, appendices, nomenclature); References.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1985b, Studies of Utah's and other domestic tar sands, *in* Extraction Projects Management Division, Proceedings of the First Annual Oil Shale/Tar Sand Contractors Meeting: U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, p. 73-88.

(Whiterocks), (Sunnyside), (Asphalt Ridge), (Tar Sand Triangle), (Circle Cliffs), (P.R. Spring), This article contains: Introduction; Upgrading of bitumen to synthetic crude oil; Thermal recovery of bitumen-derived liquids; Hot water separation process; Recovery of bitumens from tar sands by energy efficient fluidized bed process (process description, experimental results); References.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1986, Recovery and upgrading of oil from Utah tar sands (second annual report, October 1, 1985 - September 30, 1986): Salt Lake City, University of Utah, 252 p. (Work done under contract no. DE-FG20-84LC11057 for the U.S. Department of Energy, Office of Fossil Energy, Laramie Project office, Laramie, Wyoming).

(Sunnyside), (Tar Sand Triangle), (Whiterocks), (P.R. Spring), (Circle Cliffs), This report contains: Executive summary; Section A - Bitumen upgrading (introduction, summary of previous studies, experimental methods, procedures, results and discussion, conclusions); Section B - Fluidized bed pyrolysis of bitumen-impregnated sandstone (fluidized bed pyrolysis of bitumen-impregnated sandstone in a small diameter (1.5-inch), reactor [introduction], fluidized bed pyrolysis of bitumen-impregnated sandstone from the Circle Cliffs tar sand deposit [introduction], fluidized bed pyrolysis of bitumen-impregnated sandstone in a large diameter (4.5-inch), reactor [summary, introduction], fluidized bed pyrolysis of bitumen-impregnated sandstone in a cyclone reactor [summary, introduction, theory, transfer of heat to the sand particles, conversion of bitumen to hydrocarbon products as a function of time, particle entrainment and cyclone residence time, experimental procedures, results and discussion, conclusions, nomenclature], a mathematical model of bitumen-impregnated sandstone in a fluidized-bed reactor [summary, introduction, nomenclature]); Section C - Modified hot-water separation technology (introduction); Section D - Two-stage thermal recovery using heat pipes (summary, introduction, process designs, economic evaluations, conclusions, references, appendices).

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1987, Recovery and upgrading of oil from Utah tar sands (Monthly highlight report, contract # DE-FG20-84LC11057): Laramie, U.S. Department of Energy, 28 p.

(Circle Cliffs), This report contains the following: Bitumen upgrading; Fluidized bed pyrolysis of bitumen-impregnated sandstone (thermogravimetric determination of the kinetic parameters for the pyrolysis of bitumen-impregnated sandstone and for the combustion of the carbonaceous residue on the spent sand, fluidized bed pyrolysis of bitumen-impregnated sandstone in the small diameter reactor [D=1.5 inch], characterization/analysis of the native Circle Cliffs bitumen, fluidized bed pyrolysis of bitumen-impregnated sandstone in the large diameter reactor [D=4 inch]); Modified hot water separation technology; Two-stage thermal recovery of bitumen using heat pipes.

Oblad, A.G., Bunger, M.D., Hanson, F.V., Miller, J.D., and Seader, J.D., 1987, Recovery and upgrading of oil from Utah tar sands: Salt Lake City, University of Utah, 371 p. (Work performed under contract no. DE-FG20-84LC11057 for the period October 1, 1984 - December 31, 1987, for the U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, Morgantown, West Virginia.)

(Circle Cliffs), (P.R. Spring), (Asphalt Ridge), This book contains: Executive summary; Section A - Bitumen upgrading (introduction, summary of previous studies, experimental description, results and discussion, conclusions); Section B - Fluidized bed pyrolysis of bitumen-impregnated sandstone (tribute to Dr. Jay C. Dorius); Introduction; Fluidized-bed pyrolysis of bitumen-impregnated sandstone from the P.R. Spring tar sand deposit (synopsis, experimental apparatus and procedures, material balance calculations, results and discussion, conclusions and recommendations, nomenclature); Fluidized bed pyrolysis of bitumen-impregnated sandstone from the Circle Cliffs tar sand deposit (introduction); Pyrolysis of bitumen-impregnated sandstone in a large diameter (4.5 inch), reactor (summary, introduction); Mathematical model of the pyrolysis of bitumen-impregnated sandstone particles (abstract, introduction, problem formation, solutions to the partial differential equations, production rate, discussion, nomenclature); Pyrolysis of bitumen-impregnated sandstone in a cyclone reactor (summary, introduction, theory, transfer of heat to the sand particles, conversion of bitumen to hydrocarbon products as a function of time, particle entrainment and cyclone residence time, experimental procedures, results and discussion, conclusions, nomenclature); Section C - Modified hot water separation technology (fundamentals of bitumen displacement, low shear digestion, selection and evaluation of diluent, conclusions and recommendations); Section D - Two-stage thermal recovery of bitumen using heat pipes (summary, introduction, upgrading of oil, preliminary process designs and economic evaluations, process designs and economic evaluations for a range of tar sand bitumen contents, second-law analyses for competing thermal processes, development of a correlation for minimum fluidization velocity for sand at elevated temperatures); References.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1988, The extraction of bitumen from western tar sands, Work covering May-September, done under contract DE-FG21-88MC25046: Salt Lake City, University of Utah, Departments of Fuels, Metallurgy, and Chemical Engineering, 48 p.

(Circle Cliffs), (Whiterocks), (Asphalt Ridge), (Sunnyside), (P.R. Spring), (Athabasca), This multi-section report contains the following: Bitumen upgrading (hydropyrolysis, hydropyrolysis/hydrotreating, hydrotreating, specialty products); Fluidized-bed pyrolysis of bitumen-impregnated sandstone (small diameter fluidized-bed reactor studies, rotary kiln reactor studies, large diameter fluidized-bed reactor, professional activities); Modified hot-water separation technology (effect of diluent nature, contact angle measurements, fractional and broad identification of bitumen components); Selection and evaluation of diluents in the modified hot-water process (abstract, introduction, experimental); Selection and evaluation of diluents in the modified hot-water process (abstract, introduction, results and discussion, conclusions, references); Continuing studies of an energy-efficient thermal method for processing tar sands; Nomenclature; References.

Oblad, A.G., Bunger, M.D., Hanson, F.V., Miller, J.D., and Seader, J.D., 1989, The Extraction of bitumen from Western tar sands - final report for the period May 9, 1988 - May 8, 1989: Salt Lake City, Department of Fuels Engineering, Department of Metallurgical Engineering, University unpublished report, 258 p. (Work performed under contract no. DE-FG21-88MC25046 for the U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology Center, Laramie Project office, Laramie, Wyoming.)

(Circle Cliffs), (Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This report contains: Executive summary; Bitumen upgrading (introduction, model description, data fitting and interpretation); Fluidized-bed pyrolysis of bitumen-impregnated sandstone (small diameter fluidized-bed reactor studies, kaolinite effect on product yield and possible cracking activity of tar sand matrix, rotary kiln reactor studies [introduction, experimental apparatus and procedures, experimental results and characterization, discussion, conclusions]); Modified hot-water separation technology (introduction, experimental procedures, results and discussion, conclusions, fractionation and characterization of Asphalt Ridge and Sunnyside tar sand bitumens [experimental

procedures, FTIR spectra, comparison of Hiawatha coal and bitumen-derived resins, conclusions]); Extraction of bitumen from western tar sands; Energy efficient thermal method (experimental work, results, future work, nomenclature); Appendices; References.

Oblad, A.G., Bunger, J.W., Hanson, F.V., Miller, J.D., and Seader, J.D., 1979, Recovery of oil from Utah's tar sands (for the period July 1, 1979 - November 30, 1979): Salt Lake City, University of Utah, Departments of Mining and Fuels Engineering, Metallurgical Engineering, and Chemical Engineering , 140 p. (Work done under contract no. ET77-S-03-1979).

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), This report contains: Abstract; Table of contents; Lists of tables and figures; Introduction; Hot water recovery (low temperature separation technology, hot water processing of Utah tar sand, experimental procedure, results and discussion); Energy recovery in thermal processing (energy-efficient thermal processing concept; experimental apparatus; experimental results, conclusions and recommendations, references); Effect of variables on thermal processing (experimental, results and discussion, conclusions, references); Bitumen processing and utilization (visbreaking, coking, catalytic cracking, hydropyrolysis); Conclusions; References; Bibliography.

Oblad, A.G., Dahlstrom, D.A., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., Seader, J.D., 1997, The extraction of bitumen from western oil sands, Volume I, Final Report, (Work performed under contract no: DE-FC21-93MC30256): Salt Lake City, University of Utah, Departments of Chemical and Fuels Engineering and Metallurgical Engineering, 583 p.

(Whiterocks), (Sunnyside), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), This report (Volumes I) contains: Executive summary; Information required for the national environmental policy act (NEPA); Water based recovery of bitumen; Supercritical fluid extraction of oil sand bitumens from the Uinta Basin, Utah; Compositional analysis of bitumens and bitumen-derived products; Fluidized bed pyrolysis of oil sands in a three-inch-diameter fluidized bed; Fluidized bed pyrolysis of oil sands in a large diameter reactor. (The remaining sections are in volume II).

Oblad, A.G., Dahlstrom, D.A., Deo, M.D., Fletcher, J.V., Hanson, F.V., Miller, J.D., Seader, J.D., 1997, The extraction of bitumen from western oil sands, Volume II, Final Report, (Work performed under contract DE-FC21-93MC30256): Salt Lake City, University of Utah, Departments of Chemical and Fuels Engineering and Metallurgical Engineering, 614 p.

(Whiterocks), (Sunnyside), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), This report (Volumes II) contains: Two-stage thermal recovery of bitumen using heat pipes; In-situ technologies – steam assisted gravity drainage (SAGE); Uinta Basin hydrotreating – catalytic upgrading of the P.R. Spring bitumen over a commercial HDM catalyst; Uinta Basin bitumen hydrotreating – catalytic upgrading of the P.R. Spring bitumen over a commercial HDN catalyst; Uinta Basin bitumen hydrotreating – thermal conversion of the P.R. Spring bitumen-derived heavy oil in the presence of Na/alumina; Uinta Basin bitumen hydrotreating – a comparison of catalytic and thermal effects during hydrotreating of bitumen-derived heavy oils; Hydrotreating kinetic study for P.R. Spring bitumen-derived heavy oils over HDN and HDM catalysts; Uinta Basin bitumen hydrotreating – catalytic upgrading of the Asphalt Ridge bitumen; Bitumen upgrading by hydropyrolysis; References; Tar sand bibliography. (Preceding sections are found in Volume I).

Oblad, A.G., and Hanson, F.V., 1988, Production of bitumen-derived hydrocarbon liquids from Utah's tar sands - final technical report for the period September 30, 1987 to July 31, 1988: Salt Lake City, Laboratory of Coal Science, Synthetic Fuels and Catalysis, Department of Fuels Engineering, unpublished report, 164 p. (Work performed under contract no. DE-FG21-87MC11090 for the Laramie Projects office, Morgantown Energy Technology Center, U.S. Department of Energy, Laramie, Wyoming 82070).

(Circle Cliffs), (Whiterocks), This report contains: Executive summary; Introduction; Acquisition of tar sand ores (Circle Cliffs and Whiterocks); Characterization of the native Circle Cliffs and Whiterocks bitumen; Feed

sand preparation; Design of fluidized-bed pyrolysis pilot unit; Experimental operating procedures; Preliminary fluidization tests; Preliminary pyrolysis experiments; Pyrolysis reactor production run with Whiterocks tar sand; Design modifications suggested by preliminary pyrolysis experiments and implemented during production run; Material balance for production run; Analysis of bitumen-derived hydrocarbon liquid produced in production run; Design modifications suggested by production pyrolysis experiment; Conclusions; Acknowledgments; References; Two appendices.

Oblad, A.G., Seader, J.D., and Miller, J.D., 1977, Recovery of oil from Utah's tar sands (final report for 1975-1977, through grant AER 74-21867): Salt Lake, University of Utah, College of Mines and Mineral Industries and College of Engineering, 146 p.

(Athabasca), (Asphalt Ridge), (Tar Sand Triangle), (P.R. Spring), (Sunnyside), This report includes the following: Table of contents; List of figures and tables; Abstract; Introduction; Extent and nature of Utah tar sands; Bitumen recovery methods; Extraction of bitumen by a hot-water digestion and flotation technique (experimental approach, results and discussion, conclusions); Thermal recovery of bitumen by a fluidized-bed technique (thermogravimetric studies, particle movement studies, studies with a bench-scale fluidized-bed reactor); Energy recovery in thermal process (experimental two-stage fluidized-bed system); Upgrading of bitumen (destructive distillation, thermal cracking and visbreaking, catalytic cracking); References; Publications.

Oblad, A.G., Seader, J.D., Miller, J.D., and Bunger, J.W., 1975, Recovery of bitumen from oil-impregnated sandstone deposits of Utah: Paper presented at 68th Annual Meeting of AIChE, Los Angeles, California on November 16-20, 1975, 31 p.

(Asphalt Ridge), This paper includes the following: Introduction; Extent and nature of Utah tar sands; Recovery of bitumen; Thermal recovery; Acknowledgments; References. Tables include (Utah tar sands in perspective (billions of barrels), Extent of Utah tar sand deposits (in-place bitumen and approximate weight percent), Typical tar sand composition, analysis of bitumen, other properties of Utah bitumens, analysis of Utah nine bitumens, gross compositions of bitumens, typical mass balance for hot water extraction process, bitumen recovery - hot water extraction process for Asphalt Ridge tar sands). Figure captions (yield of bitumen from tar sands, comparison of sieve analyses, comparison of bitumen viscosities, simulated distillation curves for several bitumens, laboratory hot water extraction procedure, isothermal TGA for Asphalt Ridge tar sand, combustion of coked sand, and fluidized-bed process for thermal recovery of bitumen.

Oblad, A.G., Seader, J.D., Miller, J.D., and Bunger, J.W., 1976, Recovery of bitumen from oil-impregnated sandstone deposits of Utah, *in* Smith, J.W., and Atwood, M.T. editors, Oil Shale and Tar Sands: New York, American Institute of Chemical Engineers, v. 72, no. 155, p. 69-78.

(Asphalt Ridge), (P.R. Spring), (Tar Sand Triangle), (Athabasca) This paper includes the following: Introduction; Extent and nature of Utah tar sands; Recovery of bitumen, (hot water extraction, thermal recovery); Acknowledgments; Literature cited. Tables include (Utah tar sands in perspective, extent of Utah tar sand deposits, typical tar sand composition, analysis of Utah bitumens, other properties of Utah bitumens); Analysis of Utah bitumens gross compositions of bitumens, typical mass balance for hot water extraction process; Bitumen recovery – (hot water extraction process Asphalt Ridge tar sands, thermal recovery); Acknowledgments; Literature cited. Figure captions (yield of bitumen from tar sands, comparison of sieve analyses, comparison of bitumen viscosities, simulated distillation curves for several bitumens, laboratory hot water extraction procedure, isothermal TGA for Asphalt Ridge tar sand, direct flash distillation, cracking, and coking of tar sands, combustion of coked sand, two-vessel thermal process).

Oblad, A.G., and Shabtai, Joseph, 1981, Hydropyrolysis process for upgrading heavy oils and solids into light liquid products, United States Patent No. 4,298,457, 9 p.

(Patent), (Asphalt Ridge), A hydropyrolysis process for upgrading heavy, high molecular weight feedstocks such as coal-derived liquids, petroleum crudes, tar sand bitumens, shale oils, bottom residues from process streams,

and the like, to lighter, lower molecular weight liquid products. The process includes subjecting the feedstocks to pyrolysis in the presence of hydrogen under carefully controlled conditions of temperature and pressure. The process can be defined as hydrogen-modified, thermal cracking in the specific temperature range of 450. degree. C. to 650.degree. C. and in the hydrogen pressure range of about 120 psi to 2250 psi. The amount of hydrogen present can be varied according to the type of feedstock and the liquid product desired. Although the hydrogen is not consumed in large amounts, it does participate in and modifies the process, and thereby provides a means of controlling the process as to the molecular weight range and structural type distribution of the liquid products. The presence of hydrogen also inhibits coke formation. The process also eliminates the requirement for a catalyst so that the reaction will proceed in the presence of heavy metal contaminants in the feedstock which contaminants would otherwise poison any catalyst.

Oil and Gas Journal, 1967, Interest quickening in Utah tar sands: Oil and Gas Journal, December 18, p. 49-50.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), (Hatch Canyon), (Elaterite Basin), (Teapot Rock), (Cove), (Circle Cliffs), (Wagon Box Mesa), This article contains: Introductory comments; Suite pending; The deposits; U.S. Bureau of Mines.

Oil Shale & Tar Sands Leasing Programmatic EIS Information Center, 2006, About tar sands: Oil Shale & Tar Sands Leasing Programmatic EIS Information Center, 5 p.

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), (Others), This article contains: What are tar sands; Tar sand resources; The tar sand industry; Tar sands extraction and processing; References to more information.

Oliver, R.L., and Sinks, D.J., 1986, Major tar sand deposits of Utah, United States-recent field investigations article 2-6, *in* U.S. Department of Energy Tar Sand Symposium: Sponsored by the U.S. Department of Energy, Hosted by the Western Research Institute, July 7-10, Jackson, Wyoming,

(P.R. Spring), (Asphalt Ridge), (Tar Sand Triangle), This article contains: Abstract; Introduction; P.R. Spring deposit (geographic and geologic setting, resource evaluation, resource development); NW Asphalt Ridge deposit (geographic and geologic setting, resource characterization, in-situ recovery field experiments, conclusions); Tar Sand Triangle deposit (geology, resources, conclusion); References.

Owen, T.E., and Humenick, J.J., 1986, The effect of water treatment alternatives on water demands for in situ production of biumen, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 363-374.

(Asphalt Ridge), This article contains the following; Abstract; Introduction (in situ steam-drive recovery, in situ combustion recovery, water balance); Conclusions; Acknowledgment; References.

Park, J.H., 1976, Method of separating bitumen from tar sand with cold solvent: United States Patent 3,993,555, 5 p.

(Patent), (Athabasca), This patent describes: a method for separating bitumen from tar sand by solvent extraction with efficient separation of water from the recovered bitumen. Tar sand may often be recovered by surface mining techniques. The tar sand is comprised of bitumen, water, and sand including clays. The tar sand is contacted with bitumen solvent having a freezing point below that of the water, and the temperature of the mixture is lowered below the freezing point of the water in the tar sand. The solid ice crystals may then be easily removed along with the sand leaving a water-free liquid bitumen solvent mixture.

Pearson, M., 1979, Oil sands - reservoir or orebody?, *in* Meyer, R.F., and Steele, C.T., editors, The Future of Heavy Crude Oils and Tar Sands (First International UNITAR Conference): New York, McGraw Hill, p. 295-300.

(No Specific Deposits), This paper contains: Abstract; Introduction; The mining approach; The petroleum

approach; Which approach is correct?; When is oil sand ore?; When is oil sand a reservoir?; Other approaches; Conclusions; Acknowledgments; References.

Peck, L.B., 1981, Mineralogy of Sunnyside, Utah tar sand deposits: Unpublished Amoco report, 46 p.

(Sunnyside), This report is a collation of data on particle sizes and mineralogy of the Amoco Sunnyside tar sands deposit as revealed by the 1978 coring program. A run-of-mine feed has an extremely fine particle size distribution, with thirty weight-percent of the mineral smaller than 400 mesh (37 μm), particles. The variation of size within the deposit is extreme, with some sections composed entirely of < 325 mesh (44μm), particles. Size appears independent of bitumen content. The mineral consists primarily of quartz and feldspar, with local high concentrations of carbonates. Of the clays, illite and chlorite predominate, but total clay content is generally below ten weight-percent. Mineralogy appears nearly independent of particle size.

Penner, S.S., 1982, Assessment of research needs for oil recovery from heavy-oil sources and tar sands (Work done under U.S. Department of Energy contract number DE-AC01-79ER10007): La Jolla, University of California, San Diego, Energy Center and Department of Applied Mechanics and Engineering Sciences, 529 p.

(Numerous Utah Deposits), This report contains: List of illustrations and tables; Executive summary; Nomenclature; Chapter 1 – Overview of oil recovery from heavy oil resources and tar sands (oil recovery from heavy oil sources, oil recovery from the tar sands of Alberta, oil recovery from the tar sands of Utah, research recommendation on oil recovery from tar sands derived from site visits and discussions, selected examples of current studies relating to oil recovery from heavy-oil sources and tar sands); Chapter 2 – Resource assessments (introduction and definitions, available physical property data on tar sands, resources and reserves of heavy oils, recommendations); Chapter 3 – Process research relating to oil recovery from tar sands and heavy oil sources (surface mining and aboveground processing of tar sands, in-situ processing of tar sands and heavy oil sources); Chapter 4 – Environmental aspects (air and water quality, land); Chapter 5 – Fundamental research on oil recovery from heavy oil sources and tar sands (basic research policy, examples of basic research relating to oil recovery from heavy oil sources and tar sands, resource characterization, thermal recovery methods, chemical additives, environmental problems); Chapter 6 – Upgrading and refining (introduction, residuum conversion alternatives, research needs); Chapter 7 – Costing of oils from EOR and Utah tar sands; Appendix 7-1, Appendix A.

Penner, S.S., 1982, Assessment of research needs for oil recovery from heavy-oil sources and tar sands: La Jolla, University of California, Energy Center and Department of Applied Mechanics and Engineering Sciences, 127 p.

(Numerous Utah Deposits), (Athabasca), This report includes the following: List of illustrations and tables; Executive Summary; Nomenclature; Overview of oil recovery from heavy oil sources and tar sands (oil recovery from heavy oil sources, oil recovery from the tar sands of Alberta, oil recovery from the tar sands of Utah, research recommendations on oil recovery from tar sands derived from site visits and discussions, selected examples of current studies relating to oil recovery from heavy-oil sources and tar sands); Resource assessments (introduction and definitions, available physical property data on tar sands, resources and reserves of heavy oils, recommendations); Process research relating to oil recovery from tar sands and heavy oil sources, surface mining and aboveground processing of tar sands, in situ processing of tar sands and heavy oil sources); Environmental aspects (air quality, water quality, land); Fundamental research on oil recovery from heavy oil sources and tar sands (basic research policy, examples of basic research relating to oil recovery from heavy oil sources and tar sands, resource characterization, thermal recovery methods, chemical additives, environmental problems); Upgrading and refining (introduction, residuum conversion alternatives, research needs); Costing of oils from EOR and Utah tar sands (appendix 7-1 costing of oil from heavy oil sources and tar sands); Appendix A – FERWG-IIIA statement of work draft letter to reviewers.

Penner, S.S., Benson, S.W., Camp, F.W., Clardy, J., Deutch, J., Kelley, A.E., Lewis, A.E., Mayer, F.X., Oblad, A.G., Sieg, R.P., Skinner, W.C., and Whitehurst, D.D., 1982, Assessment of research needs for oil recovery

from heavy-oil sources and tar sands, *in* New sources of oil & gas (gases from coal, liquid fuels from coal, shale, tar sands, and heavy oil sources): New York, Pergamon Press, 104 p.

(Numerous Utah Deposits), This chapter contains the following: Abstract; Notation; Introduction (resource assessments, process research relating to oil recovery from tar sands and heavy-oil sources, environmental studies, fundamental research, upgrading and refining); Overview of oil recovery from heavy oil sources and tar sands (oil recovery from heavy oil sources, oil recovery from the tar sands of Alberta, oil recovery from the tar sands of Utah); Resource assessments (introduction and definitions, available physical property data on tar sands and heavy oils, resources and reserves of heavy oils, ultimate recovery of heavy oils – proved reserves, conclusions); Process research relating to oil recovery from tar sands and heavy oil sources (surface mining and above-ground processing of tar sands, in situ processing of tar sands and heavy oil sources); Environmental aspects (air quality, water quality, land); Fundamental research on oil recovery from heavy oil sources and tar sand technology (basic research policy, examples of basic research, resource characterization, thermal recovery methods, chemical additives, environmental problems); Upgrading and refining (introduction, residuum conversion alternatives, research needs); Costing of oils from EOR and Utah tar sands; References.

Penney, W.R., 1989, Solvent extraction of southern U.S. tar sands (quarterly progress report done under contract DOE/MC/26267—2930): Fayetteville, University of Arkansas, Department of Chemical Engineering, , 57 p.

(Sunnyside), This report contains the following: Executive summary; Introduction; Program summaries; Future plans; Personnel; University of Nevada-Reno (executive summary, progress, beneficiation work, work plans for the next quarter); Diversified Petroleum Recovery, Inc (introduction, oil industry, oil process, the asphalt market, changes in the oil industry, the international market, site selection, work in progress); Endnotes. Several comparisons are given between Spring Creek (Arkansas) and Sunnyside (Utah) bitumen. Core analyses are given for Shell core hole no. 1.

Perrini, E.M., editor, 1975, Oil from shale and tar sands *in* Chemical Technology Review No. 51: New Jersey, Noyes Data Corporation, 307 p.

(Patents), This book contains the following information generally related to patents: Introduction; Oil shale retorting (gas combustion, solid heat transfer media, in-ground processes, other processes); Oil shale refining processes (hydrogenation, other processes); Tar sands separation processes (hot water processes, hot water-clarification processes, cold water processes, other processes); Tar sands retorting and refining processes (retorting and coking, hydrogenation); Recovery of metal values (aluminum, vanadium, zirconium); Company index; Inventor index; U.S. patent number index.

Peterson, G.R., Hicks, M.C., and Schwartz, P.W., 1978, Process and apparatus for extracting bituminous oil from tar sands: United States Patent 4,110,194, 8 p.

(Patent), (No Specific Deposit), Tar sands are put into finely divided form, preferably by pressing them into sheets and flaking the sheets. The flakes are mixed with a solvent for the contained oils for a time sufficient to extract the oils. The resulting slurry is introduced beneath the surface of a body of water and the solids allowed to settle, while the solvent containing the oil rises to the top to form a liquid phase above the surface of the body of water. The wet solids and the oil-containing solvent are separately removed. After the oil is recovered from the solvent, as by fractional distillation, the solvent is recycled in the process, which is preferably carried on as a continuous operation. Fifteen claims, Three drawing figures.

Peterson, J.C., 1987, The potential use of tar sand bitumen as paving asphalt: Interstate Oil Compact Commission, p. 94-101.

(Sunnyside), (Asphalt Ridge), This article contain the following: Introduction; Materials evaluated; Comparison of the tar sand and petroleum asphalts based on properties often used for specifying paving asphalts; Tar sand asphalts from hot water process; Tar sand asphalts from in-situ steamflood; Tar sand asphalts from in-situ combustion; Temperature susceptibility of tar sand asphalts; Composition-related property comparisons; Aging characteristics of tar sand asphalts; Properties of asphalt-aggregate mixtures prepared using tar sand asphalts; Summary and conclusions; Acknowledgment; References.

Peterson, P.R., no date, Oil-impregnated sandstones in Utah and Wayne Counties, Utah: Utah Geological Survey unpublished report, 8 p.

(Thistle), (Thousand Lake Mountain), This report contains: Abstract; The Thistle asphalt area (Site 1 - the Asphaltum mine, Site 2 - Oil Hollow, Site 3 - Ledges east of Thistle); The Thousand Lake Mountain site.

Peterson, P.R., 1971, Oil-impregnated sandstone mapping project – Nine-Mile Canyon Area, Carbon and Duchesne Counties, Utah: Utah Geological Survey unpublished report, 15 p.

(Nine-Mile Canyon), This report contains: Abstract; Introduction; Badland Cliffs area; Roan Plateau area; Geology; Conclusions; Recommendations; References.

Peterson, P.R., 1975, Lithologic logs and correlation of core holes, P.R. Spring and Hill Creek oil-impregnated sandstone deposits, Uintah County, Utah: Utah Geological and Mineral Survey Report of Investigation 100, 30 p.

(P.R. Spring), (Hill Creek), This report includes the following: Introduction; Lithologic logs (thirteen in P.R. Springs area, and five in the Hill Creek area.); three cross section in the P.R. Springs area and one in the Hill Creek area. Also included are another set of lithologic logs labeled 1974 which are apparently the originals used in the report.

Peterson, P.R., 1982, An analysis of the tar sand deposit on the Rocky Mountain Exploration company Whiterocks Federal lease, Uintah County, Utah: Unpublished report in UGS files.

(Whiterocks), This report contains: Introduction; Geology; Reservoir (lean zone); Base map with overlays; Tables and cross section of rocky core holes; Discussion of core holes - 16 holes; Core description - two holes; Tar sand classification; Contractor; Drilling chronology; Recommendation; Selected references; Accompanying tables; Base map; Overlays; Core analyses.

Peterson, P.R., 1985, The Whiterocks tar sand deposit, *in* Picard, M.D., Geology and Energy Resources, Uinta Basin of Utah: Utah Geological Association Publication 12, p. 243-252.

(Whiterocks), This article contains: Abstract; Introduction (location, history); Geology (areal extent, origin of the tar); The reservoir (reservoir zones, - shallow, lean, and deep); The cross section; The holes (Whiterocks oil, rocky, older conventional wells, core hole synopses; Conclusions; References; Appendix (easy, john, doc and others). The paper is derived largely from a study of the Whiterocks tar sand deposit done by the author for Rocky Mountain Exploration Company of Salt Lake City; Table 1 - Summary of reservoir data; Table 2 - Basic core hole data; Appendix - contains description of 14 core holes.

Peterson, P.R., 1987, Oil-impregnated sandstones in Utah and Wayne Counties, Utah: Unpublished Utah Geological Survey report, 8 p.

(Thistle), (Oil Hollow), (Thousand Lake Mountain), This report contains: Abstract; The Thistle asphalt area (Site 1 – The Asphaltum mine, Site 2 – Oil Hollow, Site 3 – Ledges east of Thistle); The Thousand Lake Mountain site.

Peterson, P.R., and Ritzma, H.R., 1972, Oil-impregnated sandstone, Thistle area, Utah County, Utah, *in* Baer, J.L., and Callaghan, Eugene, editor, Plateau-Basin and Range transition zone, central Utah: Utah Geological Association Publication 2, p. 93-95.

(Thistle), This paper contains: Introduction; Asphaltum mine (locality A); Ledges east of Thistle (locality B); Oil Hollow (locality C); Economic aspects; Analysis; Location map.

Peterson, P.R., and Ritzma, H.R., 1974, Informational core drilling in Utah's oil-impregnated sandstone deposits, southeast Uinta Basin, Uintah County, Utah: Utah Geological and Mineral Survey Report of Investigation 88, 10 p.

(Rim Rock), (P.R. Spring), (Hill Creek), This report includes the following: Introduction; Plan of operation and actual performance; Timing of program; Field operation and supervision; Summary of operations (core holes - Rim Rock deposit - 1 core hole; core holes - P.R. Spring deposit - 13 core holes; core holes - Hill Creek deposit - 3 core holes; Summary of drilling and coring; Locations of core holes on topographic maps; Results of coring - areal extent of deposits - Rim Rock, P.R. Spring, Hill Creek; Low dip area experiment; high dip area experiment; Results of analyses (core analyses, gravity, percent sulfur, and sulfur isotope ratio (S^{34}/S^{32}); Figures within the report (index map, OISS deposits in the Uinta Basin, index map of the P.R. Spring deposit, thickness of OISS sandstone in core holes, and average gravity and percent sulfur in oils).

Petty Geophysical Engineering Company, 1967, Reflection seismograph survey, Asphalt Ridge area, Uintah County, Utah: Utah Geological and Mineralogical Survey Open-File Report No. 8, 17 p., and nine folded maps.

(Asphalt Ridge), Reflection seismograph report and maps.

Petzet, G.A., 1986, Tar sand extraction method due tests: Oil and Gas Journal, April 28, p. 42-43.

(Athabasca), This articles has the following sections: Introduction; Shell project; Demonstration project; Solv-Ex process; and pilot plant (The pilot plant ran 170 tons of ore from P.R. Spring, Uintah County, Utah, in 1983-1984, and 100 tons of high and low grade Athabasca ore in 1984-1985).

Phillips, S.T., 1987, Transmittal of geochemical results for Tar Sand Triangle, Circle Cliffs, and San Rafael Swell outcrop samples: La Habra, California, Chevron Oil Field Research Company, 34 p. (See Chevron Oil 1987 also)

(Tar Sand Triangle), (Circle Cliffs), (San Rafael Swell), This report discusses a geochemical evaluation of heavy oil from twelve selected outcrop samples collected by Utah Geological and Mineralogical Survey geologists. Four samples each from the Tar Sand Triangle, Circle Cliffs, and San Rafael Swell were included in this study. Extracts from the White Rim Sandstone host rock (Permian), and Moenkopi Formation (Triassic), were analyzed for weight percent extract, sulfur concentration, stable carbon isotope ratio, and capillary chromatography. One sample extract from each of these three areas was separated into saturate, aromatic, NSO, and asphaltine compounds. These same three samples were also analyzed for porphyrin content. These three samples were further studied to determine the programmed-pyrolysis gas-chromatography, fingerprint of the asphaltine fraction and the gas-chromatography mass-selective-detection, fingerprint of the saturate fraction. These data are summarized in Tables 1 and 2 and on the attached plots.

Picard, M.D., 1966, Oriented linear-shrinkage cracks in Green River Formation (Eocene), Raven Ridge area, Uinta Basin, Utah: Journal of Sedimentary Petrology, v. 36, p. 1050-1057.

(Raven Ridge), This article contains: Abstract; Introduction; General stratigraphy; Description of cracks; Angles between cracks; Orientation of cracks; Origin; Addendum; Acknowledgments; References.

Picard, M.D., 1971, Petrographic criteria for recognition of lacustrine and fluvial sandstone, P.R. Spring oil-impregnated sandstone area, southeast Uinta Basin, Utah: Utah Geological and Mineralogical Survey Special Studies 36, 24 p.

(P.R. Spring), This report contains: Abstract; Introduction; General Stratigraphy; Methods of study; General petrographic relationships; Sandstone types; Major constituents of sandstone; Minor constituents of sandstone; Allochems and analcime in lacustrine sandstone; Provenance; Interpretation of results (general, authigenic carbonate and matrix, coarse mica, quartz and feldspar, allochems and analcime); Diagenetic features (physical diagenesis, red pigment, cement, diagenetic sequence); Maturity of sandstone; Oil and gas; Conclusions; Acknowledgments; References.

Picard, M.D., and High, L.R., Jr., 1970, Sedimentology of oil-impregnated, lacustrine and fluvial sandstone, P.R. Spring area, southeast Uinta Basin, Utah: Utah Geological and Mineralogical Survey Special Studies 33, 32 p.

(P.R. Spring), This report contains: Abstract; Introduction; General stratigraphy; Fluvial sandstone bodies; Lacustrine sandstone bodies; Paleocurrents (general, field procedure, analysis of measurements, paleocurrent maps, provenance); Paleocurrents as environmental criteria; Paleocurrent patterns in Wasatch and Green River Formations; Conclusions; Acknowledgments; References.

Pinnell, M.L., 1972, Geology of the Thistle quadrangle, Utah: Provo, Brigham Young University Geology Studies, v. 19, pt. 1, p. 89-130.

(Thistle), This thesis contains: Introduction; Acknowledgments; Stratigraphy (general statement, Jurassic, Cretaceous, Cretaceous-Tertiary, Tertiary systems); Structural geology (general statement, Cedar Hills orogeny, Laramide deformations, Cenozoic folds, Cenozoic normal faults, minor faults, joints, age of faulting, cause of faulting); Economic geology (metals, non metals, water, petroleum products; Twp appendices; References; Illustrations and plates.

Pisio, Peter, and Kirkvold, C.F., 1977, Arrangement for recovering viscous petroleum from thick tar sand, United States Patent No. 4,020,901, 9 p.

(Patent), (Athabasca), An arrangement is provided for recovering viscous oil from a tar sand formation having a large vertical dimension including a substantially vertical lined shaft extending through the tar sand formation. A first opening is formed in the lower portion of the shaft lining and at least one lateral hole extends into the formation through the first lateral hole. A plurality of tubular members are positioned in the lateral hole to provide both a closed loop flow path for fluid flow from the shaft into and out of the hole out of contact with the formation and a separate flow path for production fluids from the hole into the shaft. A steam source is connected to the tubular members forming the closed loop flow path. A second opening is formed in the shaft lining and a steam injection conduit extends through the second opening into the formation. The steam injection conduit is connected to the steam source for injecting steam into the formation.

Pittman, T.A., and Woods, J.L., 1977, Method of recovery of oil and bitumen from oil-sands and oil shale: United State Patent 4,029,568, 5 p.

(Patent), (Asphalt Ridge), This patent describes a method of recovering oil from oil sands, wherein the system is operated without the need of water or in general even of heat, at least in appreciable quantities. The subject method includes providing crushed ore, crushed preferably to particulate size, on a perforate bed or support and then spraying the crushed oil sands ore with a selected solvent at from 1-100 psi gauge pressure such that an oil-containing solution can be collected beneath such support. Thereafter, the oil is recovered by vaporizing the solvent and thereafter condensing the solvent for re-use. Upon vaporization of the solvent, the oil and lighter fractions remain and can be introduced into a refinery or distillation column for recovering desired fractions from the recovered oil or bitumen and also for producing a separate fraction so that the same can be used as an energy source to supply the necessary heat required as well as power for the mechanical equipment used. In the process of selecting and utilizing solvents, it is preferred that methylchloroform, trichloroethylene, or perchloroethylene be used. Six claims; One drawing figure.

Polumbus, E.A., and Associates, no date, Core hole and well data summary, White Rocks Oil, Uintah County, Utah, variously paginated.

(White rocks), This packet of information contains core hole data for the following holes (Able, Baker, Charlie, Dog, Easy, Fox, George, Harry, Item, John, King). It also contains sample and core descriptions; Hydrocarbon content measurements; core summaries.

Pope, J.B., Harry, J.V., and Lyon, L.B., editors, 1965, Fossil hydrocarbons: Salt Lake City, Brigham Young University Salt Lake Center for Continuing Education, 421 p.

(Numerous Utah Deposits), This publication is a compilation of 28 papers as follows: A look at the fossil hydrocarbons of the Intermountain area; The economics, use and energy demand of the southwest coastal area for fossil hydrocarbons; Fossil fuel utilization and world energy resources; Coal deposits of the Intermountain West; Economic potential of petroleum and natural gas industries; Gilsonite; Hydraulic mining, tunnel boring and shaft drilling operations; Primary extraction, conversion, and upgrading hydrogen-deficient fossil hydrocarbons; Petrochemicals from fossil hydrocarbons; The pipeline movement of solids as capsules and paste slugs; New developments in hydrocarbon processing; Coal refining for fuels and petrochemicals; H-oil for liquid fuels production from hydrogen-deficient hydrocarbons; Energy from coal mine to market; Power generation from by-product fossil hydrocarbons; Fossil hydrocarbons for synthetic fuels to operate gas turbines and diesel engines; Petrochemicals from hydrogen-deficient hydrocarbons; Fossil hydrocarbons of the tri-state basins; A survey of extraction, retorting, and processing methods for oil shale; Current mining practices; Western U.S. coal mines; Bituminous sands and some legal aspects of leasing; Coal; The natural gas industry in the Intermountain area, with emphasis on Utah; Gilsonite; Petroleum. Is the climate right for a major development of the hydrocarbon resources of the Intermountain area?; Bituminous sands and viscous crude oils; Oil-shale deposits; Steam-drive - a process for in-situ recovery of oil from the Athabasca oil sands; Recommendation for developing the major resources of fossil hydrocarbons in the three corners area and in Utah; General information.

Porritt, B.T., Johanson, L.A., and Noall, K.L., 1978, Apparatus and method for recovery of bituminous products from tar sands: United States Patent 4,096,057.

(Patent), An apparatus and method for (1), reducing agglomerated masses of tar sand and (2), recovering as a bituminous product the bituminous matrix material there from. The apparatus includes a vessel which is divided into an attrition zone enclosed by a screen member, a sand separation zone, and a product recovery zone. The vessel accommodates liquid which is, advantageously, a solvent into which the agglomerated masses of tar sands are introduced. The liquid is impelled vigorously upwardly into the attrition zone to create a high shear environment by which the tar sand masses are reduced by attrition into sand particles coated with the bituminous matrix material of the tar sand. The separated grains of sand are also stripped of the bituminous product by the high shear environment. The cleansed sand passes through the screen member surrounding the attrition zone into the sand separation zone. The liquid and the bituminous product removed from the sand passes into the product recovery zone. Eight claims, One drawing figure.

Pruitt, R.G., Jr., 1961, The mineral resources of Uintah County: Utah Geological and Mineralogical Survey Bulletin 71, 101 p.

(Gilsonite), (Asphalt Ridge), (Whiterocks), (Raven Ridge), (Others), This bulletin contains: Forward; Abstract; Introduction; Bituminous sandstone deposits; Gilsonite; Oil shale; Oil and gas; Coal; Phosphate; Metallic and minor non-metallic minerals; Index.

Pruitt, R.G., Jr., 1965, Bituminous sands and some legal aspects of leasing, *in* The Intermountain Symposium on Fossil Hydrocarbons proceedings: Salt Lake City, Brigham Young University Salt Lake Center for Continuing Education, p. 327-337.

(Asphalt Ridge), (Sunnyside), (Whiterocks), (P.R. Spring), (Evacuation Creek), (Rozel Point), (San Rafael

Swell), (Green River Desert), This article contains the following: Introduction; Occurrence and description of bituminous deposits; Bituminous sandstone leasing; Brief history of petroleum leasing (leases with private land owners, leases of state lands, leases of federal lands – federal leasing policies, The 1960 amendment to the Mineral Leasing Act, State of Utah leases); Conclusions and some proposed solutions; References.

Pu, Jiazhi, 1995, Technical and economic evaluation and comparison of bitumen upgrading alternatives: Salt Lake City, University of Utah Ph.D. Dissertation, 252 p.

(No Specific Deposits), This dissertation contains: Abstract; Abbreviations; Acknowledgments; Introduction; Literature survey (introduction to heavy oil upgrading, non-hydroprocesses, catalytic hydroprocesses, economic evaluation); Reactor models (general description of models, delayed coking, visbreaking, catalytic cracking, hydrotreating, hydropyrolysis); Flowsheet simulation (introduction, delayed coking, visbreaking – conventional, visbreaking – Washimi, catalytic cracking, hydrotreating, hydropyrolysis); Economic evaluation (methodology, parameters common to all processes, delayed coking, visbreaking, catalytic cracking, hydropyrolysis, sensitivity analysis, summary); Process combinations (solvent deasphalting + hydrotreating, SDA visbreaking – Washimi + HT, VRDS + RFCC, VRDS + delayed coking, VRDS + hydrocracking, Lc-fining + delayed coking, delayed coking + hydrotreating and visbreaking + hydrotreating, hydropyrolysis + hydrotreating, summary); Pilot plant recommendations (introduction, process description and major parameters, analysis and determination of major parameters, pilot plant recommendations – alternatives 1-3, risk analysis, summary and recommendation); Conclusions; Five appendices; References.

Purington, P.R., 1984, Inventory of P.R. Spring tar sand drill holes: Mono Power Company unpublished letter and attachments (listing of holes and location map).

(P.R. Spring), This letter and attachments contain: Listing of 29 drill holes, giving number (on attached map segments (5), depth, date, location, and the information that is available for each hole. The well designation is also given, such as (PRS 82-12, or MP-9). This information and the cores were donated to the Utah Geological Survey via a letter to Mr. Carl Brown from Paul R. Purington with the Mono Power Company dated December 19, 1984.

Quick, Jeff, 1998, Classification, petrographic expression, and reflectance of native bitumen: Utah Geological Survey unpublished report, 59 p.

(No Specific Deposits), This paper includes the following: Introduction; Classification of bitumens; Petrographic expression of bitumens (granular, homogeneous); Optical properties of native bitumens; Discussion; References; Glossary.

Quigley, Sam, 1970, Uteland Butte deposit: Utah Geological Survey unpublished report, 2 p.

(Uteland Butte), (Pleasant Valley), This short report contains: Uteland Butte (extent, description); Ideas (Pariette Draw, Myton SE); Pleasant Valley (extent, description).

Quigley, Sam, 1972, Oil-impregnated sandstones of Raven Ridge, Vernal, Utah: Utah Geological Survey unpublished Report.

(Raven Ridge), This report includes the following: Introduction; Stratigraphy (Tertiary and Quaternary systems); Structure; Oil impregnation (definition, location and reservoir, description, economics); Conclusions; References.

Rall, C.G., Hamontre, H.C., and Taliaferro, D.B., 1954, Determination of porosity by a Bureau of Mines method – a list of porosities of oil sands (Revision of Report of Investigation 4548): U.S. Bureau of Mines Report of Investigations 5025, 24 p.

(No Specific Deposits), This publication contains: Introduction; Acknowledgments; Definitions; Description

of method (general scheme, apparatus, procedure, calculations); Reproducibility and accuracy; Advantages of method; Porosities of oil sands; Bibliography, Nine tables and five figures.

Ranney, M.W., editor, 1979, Oil shale and tar sands technology – recent developments: Noyes Data Corporation, 427 p.

(Utah Tar Sands), This book includes the following: Introduction and overview (oil shale, Canadian tar sands, U.S. tar sands); Oil shale retorting (gas combustion, external heat pyrolysis, external heat pyrolysis and particulate heat source, solid heat transfer processes, other recovery processes); In-situ processing of oil shale (formation of retort cavities, retorting processes, treatment of off-gases from retort, other in-situ recovery processes); Shale oil refining and purification processes (combined retorting and refining processes, shale oil refining); In-situ processing of tar sands (hot aqueous fluid drive, solvent leaching and fluid flow, solvent extraction, oxidation and combustion, electrode wells); Tar sands separation processes (hot water processes, cold water processes, solvent extraction processes, coking and refining processes, other separation processes); Company index; Inventor index; U.S. Patent number index.

Reed, R.L., Reed, D.W., and Tracht, J.H., 1960, Experimental aspects of reverse combustion in tar sands: AIME Petroleum Transactions, v. 219, p. 99-107.

(Asphalt Ridge), (Athabasca), This paper contains: Abstract; Introduction; Description of the process; Combustion experiments (equipment, procedure); Results (temperature distribution, velocity of combustion, approach to steady state, oil recovery, air-oil ratio, initial temperature, initial oxygen concentration, coke residual oil and fuel, permeability, material and heat balance); Conclusions; Final remarks; Acknowledgments; References.

Reed, R.M. editor, 1982, Preparation of environmental analyses for synfuel and unconventional gas technologies (tar sand section only): Oakridge, Oak Ridge National Laboratory, Environmental Saciences Division Publication no. 1843, p. 35-58.

(No Specific Deposit), This section includes the following: Resource description; Technology overview (surface mining, separation processes, upgrading processes, in situ extraction); Potentially significant issues (land use, air quality, water use, water quality, impacts on biota, noise, solid waste disposal, reclamation, sosioeconomics, health and safety); References.

Remy, R.R., 1984, Report on the composition, texture, diagenesis, and provenance of the Sunnyside tar sands, Carbon County, Utah: Unpublished report written for AMOCO Minerals Company, Englewood, Colorado, 63 p.

(Sunnyside), This report contains: Summary and conclusions; Introduction; Method of investigation; Previous work on petrology of Green River Formation sandstones (texture, composition and classification, detrital components and carbonate grains); Diagenesis (introduction, burial and compaction, precipitation of carbonate cements, formation of quartz and albite overgrowths, dissolution of feldspars, precipitation of pyrite cement, emplacement of tar and solid bitumen, precipitation of hematite cement); Grain size distribution; Source of detrital sediments; Petrology of ostracod coquina limestones; References; Appendix (glossary, 19 photos, Seven figures, 13 Tables).

Remy, R.R., 1991, Analysis of lacustrine deltaic sedimentation in Green River Formation, southern Uinta Basin, Utah: Baton Rouge, Louisiana State University and Agricultural and Mechanical College Ph.D. Dissertation, 394 p.

(Sunnyside), This dissertation contains: Introduction; Stratigraphy of the Eocene part of the Green River Formation; Depositional processes of a fluvially-dominated lacustrine delta and of transgressive deposits in the Green River Formation; Lacustrine hummocky cross-stratification produced by combined flows, Green River

Formation; Distribution and origin of analcime in marginal lacustrine mudstones of the Green River Formation (field guide to deltaic and lacustrine facies of the Green River Formation); Conclusions; Combined references; Appendices (Appendix 1 – Thickness, location, and stratigraphic markers of measured stratigraphic sections, Appendix 2 – Maps showing locations of measured sections, Appendix 3 – Explanation for symbols used in measured stratigraphic sections, Appendix 4 – Measured sections); Vita; Three charts.

Remy, R.R., and Ferrell, R.E., 1989, Distribution and origin of analcime in marginal lacustrine mudstones of the Green River Formation, south-central Uinta Basin, Utah: Clay and Clay Minerals, v. 37, no. 5, p. 419-432.

(Nine Mile Canyon), This paper includes the following: Abstract; Introduction; Materials and methods; Results (field observations, thin section petrography, mineralogy of mudstones sandstones siltstones and carbonates, composition of analcime); Discussion (origin of analcime, evidence for saline alkaline conditions, origin of mineralogical difference between red and green mudstones); Summary and conclusions, acknowledgments; References.

Rendall, J.S., 1988, Council on alternate fuels conference '88, the U.S.A. perspective, in Alternate Energy '88: Council on Alternate Fuels, p. 235-250.

(No Specific Deposit), This article contains the following: Introduction; The SOLV-EX approach to synfuels (SOLV_EX, our approach, the benefits of this approach, the economic evaluation, case study); Twelve overhead slides.

Resnick, B.S., Dike, D.H., English, L.M., III, and Lewis, A.G., 1981, Evaluation of tar sand mining, Volume 1 - an assessment of resources amenable to mine production - final report: Wayne, Pennsylvania, Ketron, Inc., Prepared for the U.S. Department of Energy, Carbondale Mining Technology Center, under Contract No. DE-AC22-80PC30201, (Utah-related sections only).

(Asphalt Ridge), (Circle Cliffs), (Hill Creek), (P.R. Spring), (Sunnyside), (Tar Sand Triangle), This portion of the paper includes the following: Utah tar sand resources; Summary of tar sand resource base; Assessment of mineable tar sand resources (Alabama, Kentucky, Midwestern tri-state region, New Mexico, Utah; Summary; Conclusions; Bibliography. Numerous tables and figures.

Reynolds, Bruce, 2007, Utah oil sands – production status and challenges: Idaho National Laboratory (presented to the Utah Energy Summit on April 17, 2007), 11 p.

(Numerous Utah Deposits), This presentation includes the following: Selected regional fossil energy resources (Canadian oil sands, U.S. oil sands, Utah oil sands); What are oil sands (oil sands are, Alberta oil sands are, U.S. oil sands differ in, impact); In-situ oil sands recovery (common issues, Alberta issues, Utah issues); Ex-situ oil sands recovery (common issues, Alberta unique issues, Utah issues); Alberta oil sands history; Economics (hurdles, actions); Regulatory and environmental (hurdles and actions); Technical and infrastructure (hurdles and actions); A guess about what a U.S. oil sands industry might look like; Sources of information.

Reynolds, J.G., 1990, Trace metals in heavy crude oils and tar sand bitumens, *in* Stivers, Jack, editor, 1990 Eastern Oil Shale Symposium (November 6-8, 1990, Marriott Griffin Gate Resort, Lexington, Kentucky): University of Kentucky, Institute for Mining and Minerals Research, p. 9-23.

(Asphalt Ridge), (Sunnyside), This article contains: Abstract; Introduction; Metals concentrations; Separation and characterization (distillation, SARA separation (ASTM D 2007 with asphaltine precipitation), size exclusion chromatography with element specific detection); Conclusions; Acknowledgments; References; Five tables and thirteen figures.

Reynolds, J.G., and Crawford, R.W., 1988, Pyrolysis of Sunnyside (Utah), tar sand - characterization of volatile compound evolution: Livermore, Lawrence Livermore National Laboratory, 27 p.

(Sunnyside), This report contains: Abstract; Introduction; Experimental procedures; Results (hydrocarbon evolution, methane, aromatic hydrocarbons, hydrogen, carbon monoxide, carbon dioxide, water); Discussion (hydrocarbon evolution, CO_2, CO, H_2O, and H_2); Conclusions; Acknowledgments; References; Six figures.

Reynolds, J.G., and Crawford, R.W., 1989, Pyrolysis of Sunnyside (Utah) tar sand – characterization of volatile compound evolution: Fuel Science & Technology International, v. 7, nos. 5 and 6, p. 823-849.

(Sunnyside), This article includes the following: Abstract; Introduction; Experimental; Results (hydrocarbon evolution, methane, aromatic hydrocarbons, hydrogen, carbon monoxide, carbon dioxide, water, nitrogen-, sulfur-, oxygen-containing compounds, gas yields, hydrocarbon evolution, CO_2, CO, H_2O, and H_2); Conclusions, Acknowledgments; References.

Reynolds, J.G., Jones, E.L., Bennett, J.A., and Biggs, W.R., 1989, Characterization of nickel and vanadium compounds in tar sand bitumen by UV-VIS spectroscopy and size exclusion chromatography coupled with element specific detection: Fuel Science & Technology International, v. 7, nos. 5 and 6, p. 625-642.

(Athabasca), (Asphalt Ridge), This paper includes the following: Abstract; Introduction; Experimental (tar sand samples); Results (petroporphyrin contents, size behavior profiles); Conclusions; Acknowledgments; References.

Ritzma, H.R., 1968, Preliminary location map of oil-impregnated rock deposits of Utah: Utah Geological and Mineralogical Survey Map 25, scale 1:1,000,000.

(Numerous Utah Deposits), This map includes most of the oil-impregnated rock deposits. The accompanying text includes the following: Geographic distribution; Geologic distribution; Lithology of deposits; Origin, migration, and entrapment; Reserves; Exploration; References; and table showing deposit name, location, county(s), formation(s), in which deposit occurs (geologic age), and size of deposit.

Ritzma, H.R., 1972, Exploration and development of oil shale and oil-impregnated rock, 1970-1975: American Association of Petroleum Geologists Bulletin, v. 56, no. 3, p. 649-650.

(No Specific Deposits), This abstract contains: Discussions of oil shale and tar sand exploration and development in Utah and other states.

Ritzma, H.R., 1973a, Commercial aspects of Utah's oil-impregnated sandstone deposits: Paper presented to joint session of Interstate Oil Compact Commission, New Orleans, Louisiana, December 03, 11 p.

(Tar Sand Triangle), (Circle Cliffs), (San Rafael Swell), (Whiterocks), (Asphalt Ridge), (Raven Ridge), (P.R. Spring), (Hill Creek), (Sunnyside), This paper contains: Introduction; Central southeast Utah; Uinta Basin deposits; Land problems; Sulfur content; Diversity within deposits; Outlook.

Ritzma, H.R., 1973b, Utah's oil-impregnated sandstone deposits – a giant undeveloped resource: American Association of Petroleum Geologists Bulletin, v. 57, no. 5, p. 961-962.

(Asphalt Ridge), (Hill Creek), (P.R. Spring), (Sunnyside), This abstract presents the estimated volume of oil in place for the deposits in Utah, information on the oil characteristics, the types of deposits (in-situ and migrated), and probable mining methods.

Ritzma, H.R., 1973c, Location map oil-impregnated rock deposits of Utah: Utah Geological and Mineralogical Survey Map 33, scale 1:1,000,000 (supersedes Map 25, 1968).

(Numerous Utah Deposits), This map includes most of the oil-impregnated rock deposits in Utah. The accompanying text includes the following: Geologic distribution; Lithology of deposits; Origin, migration and

entrapment; Reserves; Exploration and exploitation; Analyses of extracted oil; References.

Ritzma, H.R., 1974, Towanta Lineament, Northern Utah, *in* Hodgson, R.A., Gay, S.P., Jr., Banjamins, J.Y., editors, Proceedings of the first International Conference on The New Basement Tectonics (June 3-7, 1974 in Salt Lake City, Utah): Utah Geological Association Publication no. 5, p. 118-125.

(Asphalt Ridge), (Spring Branch), (Lake Fork), (Daniels Canyon), This paper contains: Abstract; Definitions; Location; Trace of lineament; Geophysical implications; Characteristics; Specific areas (Towanta Flat, Whiterocks River area, north of Vernal); Relationship to petroleum; Relationship to mineralization; Relationship to ground water; Conclusions; References.

Ritzma, H.R., 1975, The Chinese wax mine – a unique oil-impregnated rock deposit; Utah Geology, v. 2, no. 1, p. 79-82.

(Daniels Canyon), This article contains: Abstract; Location and topographic setting; History; Geologic setting; Description of deposit and mine; Structural implications; Acknowledgments; References.

Ritzma, H.R., 1976, Utah's tar sand resource - Geology, politics, and economics, *in* Smith, J.W., and Atwood, M.T., editors, Oil Shale and Tar Sands: New York, American Institute of Chemical Engineers, p. 47-54. Also in American Institute of Chemical Engineers Symposium, December 1975.

(Tabiona), (Asphalt Ridge), (P.R. Spring), (Sunnyside), (Whiterocks), (Raven Ridge), (Hill Creek), (San Rafael Swell), (Teasdale), (Circle Cliffs), (Tar Sand Triangle), (Mexican Hat), (Rozel Point), This article includes the following: Introduction; Definitions (size of deposits, parameters, terminology); The resource (world and nation-wide); The resource in Utah; References. Five figures include oil-impregnated sandstone deposits in the Uinta Basin, Central Southeast, and other areas; Age of rocks in which deposits occur; Percent sulfur in oil; Age of rocks in which deposits occur.

Ritzma, H.R., 1976-78, Reports to the tar sands sub-committee of the Interstate Oil Compact Commission, State of Utah: Utah Geological Survey, 6 p.

(Numerous Utah Deposits), These reports describe the tar sand activity in the State of Utah; reports are dated December 1, 1976, June 24, 1977, and June 9, 1978.

Ritzma, H.R., 1977, United States and Utah oil-impregnated rock (tar sand), resources: American Association of Petroleum Geologists Bulletin, v. 61, no. 5, p. 822-823.

(Asphalt Ridge), (NW Asphalt Ridge), This abstract contains: Distribution of tar sands; Utah's share of deposits; Origin of Uinta Basin tar sands; Present activity; Problems of the industry; Estimate of Utah's oil in place.

Ritzma, H.R., 1979, Oil-impregnated rock deposits of Utah: Utah Geological and Mineral Survey Map 47, 2 sheets, scale 1:1,000,000.

(Numerous Utah Deposits), This map shows all the oil-impregnated sandstone deposits in Utah. Geographic distribution; Geologic distribution; Lithology of deposits; Origin migration and entrapment; Reserves; Exploration and exploitation; Analyses of extracted oil; References. On sheet two, the following information is given: Deposit, location, county, formation(s) in which deposit occurs, dominant lithologies, size of deposit, gross oil in place, and source of data.

Ritzma, H.R., 1980, Oil-impregnated sandstone deposits, Circle Cliffs uplift, Utah, *in* Picard, M.D., editor, Henry Mountains Symposium: Utah Geological Association Publication 8, p. 244-251.

(Circle Cliffs), This paper contains: Introduction (location, geologic setting, description of study); Moenkopi Formation (general, depositional environments, upper ledge-forming unit); Source of oil; Emplacement of oil (Muley Twist, other occurrences); Figure 2 is a diagrammatic cross section of the Circle Cliffs uplift; Figure 3 is a section of Moenkopi Formation showing degree of oil-impregnation in three localities.

Ritzma, H.R., 1984, Evaluation of tar sand resource, Batchelder property, sections 3 and 10, T. 14 S., R. 14 E., Carbon County, Utah – Sunnyside tar sand deposit: Unpublished report prepared for Sabine Production Company, 13 p.

(Sunnyside), This report contains the following: Summary; Introduction; Figures and tables; Geology – stratigraphy; Geology – Structure; Observation of coreholes; Resource estimate (table 1).

Ritzma, H.R., 1984, Geology and tar sand resource, Nine-Mile Ranch and vicinity, Carbon County, Utah (Sunnyside and Cottonwood - Jack Canyon tar sand deposits): Prepared for Sabine Production Company, variously paginated.

(Sunnyside), (Cottonwood-Jacks Canyon), This report includes the following: Regional setting (general, elevations and terrain); Stratigraphy (general, tar sand distribution, thickness, overburden, and sedimentary patterns); Structure (general, faulting, patterns of oil impregnation); Tar sand resource evaluation (background, method employed, tabulation by township, estimate of resource controlled by Sabine, tar analyses, and subsurface data compilation); Oil shale resource evaluation; Mineral occurrence assays; Reconnaissance soil surveys.

Ritzma, H.R., 1984b, Stratigraphy (Sunnyside and Cottonwood - Jack Canyon tar sand deposits), a supplement to report "Geology and tar sand resource Nine-Mile Ranch and vicinity, Carbon County, Utah:" Prepared for Sabine Production Company, variously paginated.

(Sunnyside), (Cottonwood-Jacks Canyon), This report discusses the Green River Formation, depositional pattern, nature of the reservoir, and bases of correlation. These sections are followed by stratigraphic sections (localities examined in study area, and localities examined outside of study area, and cross sections (southwest to northeast and northwest to south).

Ritzma, H.R., 1986, Structural and stratigraphic controls Uinta Basin tar sand deposits, northeast Utah, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 46-50.

(Numerous Utah Deposits), This paper includes the following: Abstract; Three figures.

Ritzma, H.R., and Campbell, J.A., 1979, Bibliography of oil-impregnated rock deposits of Utah: Utah Geological and Mineral Survey Circular 64, 18 p.

(Numerous Utah Deposits), This Circular contains: Author Index; Deposit index; Map.

Robeck, R.C., 1954, Uranium deposits of Temple Mountain, *in* Brier, Bill (editor), Geology of portions of the High Plateaus and adjacent canyon lands, Central and South-Central Utah: Intermountain Association of Petroleum Geologists, p. 110-111.

(Temple Mountain), This article contains: Introduction; Stratigraphy; Fault zones; Uranium and vanadium minerals; References.

Rocky Mountain Oil & Gas Association, 1981, Production of synthetic fuel from tar sands: Rocky Mountain Oil & Gas Association, 15 p.

(No Specific Deposit), This paper contains the following: Preface; Production of synthetic fuel from tar sands

(recovery by in-situ processes and above-ground processes, upgrading, physical and chemical changes).

Rold, J.W., 1983, Research and information needs for management of tar sands development: Washington D.C., National Academy Press, 30 p.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), (Circle Cliffs), (Hill Creek), (Asphalt Ridge), (San Rafael Swell), (Argyle Canyon), (Raven Ridge), (Whiterocks), (Pariette), The purpose of this report is to review the research needed to support the regulatory and managerial role of the agencies in the development of tar sands resources. Included are the distributions, geology, and characterization of Utah tar sands, technologies for oil recovery, environmental aspects of tar sands mining and processing, and references. Approximately 11 tar sand areas in Utah are shown on figure 1.

Romanowski, L.J., and Thomas, K.P., 1986, Laboratory studies of forward combustion in tar sand (Tar Sand Triangle), *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 284-295.

(Tar Sand Triangle), This paper includes the following: Abstract; Introduction; Experimental apparatus and procedure; Results and discussion (tar sand ignition and combustion oil yields and properties, bitumen distillation and pyrolysis, oil yield losses); Conclusions; References.

Rose, P.E., Bukka, Krishna, Deo, M.D., Hanson, F.V., and Oblad, A.G., 1992, Characterization of Uinta Basin oil sand bitumens, *in* 1992 Eastern Oil Shale Symposium (November 17-20, 1992, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 277-282.

(Whiterocks), (Asphalt Ridge), (Sunnyside), This article contains: Abstract, Introduction; Experimental approach; Structural analysis; Carbon-number distributions/ Z-number distributions; Biodegradation; Conclusions; Acknowledgments; References; One table.

Rose, P.E., and Deo, M.D., 1993, New algorithms for steam assisted gravity drainage using combinations of vertical and horizontal wells, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 232-240.

(No Specific Deposits), This article includes the following: Abstract; Introduction; Horizontal well-pair; Vertical wells; Configuration comparison; Conclusions; Acknowledgments; References; One table and six figures.

Routson, W.G., 1977, In situ solvent fractionation of bitumens contained in tar sands, United States Patent No. 4,022,277, 9 p.

(Patent), (Asphalt Ridge), (P.R. Spring), (Athabasca), Bituminous hydrocarbons are recovered from unconsolidated tar sands by in-place, selective leaching with a hot condensate formed upon contact with hot solvent vapors injected in the formation. The composition and temperature of the vapors are regulated so that a less soluble fraction of the tar is left behind as a residue. This residue does not dissolve in the vapors passing through the already leached portion of the formation and continues to act as a sand-supporting and immobilizing agent. Thus, subsidence of the leached formation and release of sand grains (which tend to interfere with removal of the leachate from the formation) are avoided. Solvent for the process is obtainable by distillation or cracking of the produced bitumens.

Rozelle Consulting Services, 1989, Final Report on 1989 update of the computerized geologic model to include the 1988 drill hole data, Sunnyside tar sands project, Sunnyside, Utah: Golden, Rozelle Consulting Services, variously paginated.

(Sunnyside), This report contains: Introduction; Summary; Recommendations; Update of the computerized database (data coding and format, processing of the database, current status of the computerized database); Resource interpretation (modeling methodology, tar zone interpretation, generation of tar zone structure contour

maps); Computerized geologic modeling (general, surface modeling, grade modeling, density results from the 1983 study, internal dilution of the model); Geologic resource estimations (general, resource classification); Bibliography; Appendix A – 1983 geostatistical studies.

Rozelle, J.W., Stinnett, L.A., Wehinger, J.A., and Zeindler, R.W., 1990, Sunnyside tar sands project, 1990 mining studies, alternate case I, comparison of Wirtgen and Krupp continuous miners: Lakewood, Pincock, Allen and Holt, Inc., variously paginated.

(Sunnyside), This volume contains the following: Introduction and approach; Executive summary; Detailed cost analysis.

Rozelle, J.W., Stinnett, L.A., Sandefur, R.L., Wehinger, J.A., and Zeindler, R.W., 1990, Sunnyside tar sands project, 1990 mining studies, alternate case II, comparison of direction of advance, 50,000 BPD production rate Krupp continuous miners: Lakewood, Pincock, Allen and Holt, Inc., variously paginated.

(Sunnyside), This volume contains the following: Introduction; Summary and recommendations; Mineable reserves; Mine design and layout (mining approach and scheduling, equipment selection; facilities location and sizing, production analysis and year end plans); Capital and operating cost estimate; Appendix A – MARA equipment data as input; Appendix B – Detailed costing backup.

Rozelle, J.W., Stinnett, L.A., Wehinger, J.A., and Zeindler, R.W., 1990, Sunnyside tar sands project 1990 mining studies, 25,000 and 50,000 BPD scenarios using Wirtgen Miners-mining south to north: Lakewood, Pincock, Allen and Holt, Inc., v. I, variously paginated.

(Sunnyside), This volume contains the following: Introduction; Summary; Mineable reserves; Mine design and layout (mining approach, mine scheduling, equipment selection, facilities location and sizing, production schedules, year end plan – 25,000 BPD, year end plan – 50,000 BPD, reclamation); Capital and operating cost estimate; Appendix I – Mineable reserves by panel within the limits of the ultimate pit; Appendix II – Conveyor costing and operating cost determination; Appendix III – 25,000 barrel-per-day detailed backup; Appendix IV – 50,000 barrel-per-day detailed backup.

Rozelle, J.W., Stinnett, L.A., Wehinger, J.A., and Zeindler, R.W., 1990, Sunnyside tar sands project 1990 mining studies, 25,000 and 50,000 BPD scenarios using Wirtgen mines-mining south to north: Lakewood, Pincock, Allen and Holt, Inc., v. II, variously paginated.

(Sunnyside), This volume contains mining-plan maps only.

Rozelle, J.W., Stinnett, L.A., Wehinger, J.A., and Zeindler, R.W., 1990, Sunnyside tar sands project 1990 mining studies, 25,000 and 50,000 BPD scenarios mining south to north, comparison of Wirtgen and Krupp surface miners: Lakewood, Pincock, Allen and Holt, Inc., v. III, variously paginated.

(Sunnyside), This volume contains appendices. Appendix I – Mineable reserves by panel within the limits of the ultimate pit; Appendix II – Conveyor costing and operating cost determination; Appendix III – 25,000 barrel-per-day detailed backup; Appendix IV – 50,000 BPD detailed backup.

Ryu, Hoil, 1989, Kinetic modeling applied to hydrocarbon process design and engineering: I. Hydropyrolysis of heavy oils; II. Acetylene from calcium carbide: Salt Lake City, University of Utah Ph.D. Dissertation, 244 p.

(No Specific Deposits), This dissertation contains: Abstract; Nomenclature; Acknowledgments; Part I. Kinetic modeling and simulation of hydropyrolysis - Introduction; Literature survey on heavy oil upgrading technology (introduction, outline of heavy oil upgrading technology, hydroprocesses, nonhydroprocesses, other processes, summary); Kinetic modeling (introduction, model description, data fitting and interpretation, the hydropyrolysis

process, simulation, optimization); Conclusions; Part II. Kinetics and design for coproduction of acetylene and calcium chloride - Introduction; Literature survey (history, calcium carbide manufacturing, acetylene manufacturing); Theoretical treatment of reaction kinetics; Experimental methods (apparatus and experimental procedure, analytical method, composition and properties of materials); Results and discussion (kinetic experiments, kinetic expressions); Process development unit (PDU) design (design procedure, experimental design for the PDU operation); Conclusions; Appendices (listing of non-linear numerical integration programs, listing of program file and run-time command file for simusolv, listing of user-added subroutine for kinetic reactor model, listing of an input file of process simulation, listing of typical stream report of simulation result, listing of an input file for process optimization, listing of typical results of optimization, data and results, details of process design calculations); Literature cited; Vita.

Sanborn, A.F., and Goodwin, J.C., 1965, Green River Formation at Raven Ridge, Uintah County, Utah: The Mountain Geologist, v. 2, no. 3, p. 109-114.

(Raven Ridge), This article contains: Abstract; Introduction; Stratigraphy (Wasatch-Green River transition facies, ostracodal facies, lower sandstone facies, middle shale facies, laminated sandstone and algal pellet facies, massive sandstone facies, Parachute Creek zone, upper green shale facies); Conclusions; Acknowledgments; References.

Sanford, R.F., 1995, Ground-water flow and migration of hydrocarbons to the Lower Permian White Rim Sandstone, Tar Sand Triangle, southeastern Utah: U.S. Geological Survey Bulletin 2000-J, 24 p.

(Tar Sand Triangle), This article contains: Abstract; Introduction; Paleotopographic history; Ground-water flow history; Pennsylvanian-Permian aquifers; Hydrocarbon source rocks; Diagenetic evidence for hydrocarbon migration; Evaluation of hydrocarbon sources; Summary and conclusions; References cited.

Schenk, C.J., 1989, Petrography and diagenesis of the bitumen- and heavy-oil-bearing White Rim Sandstone member of the Cutler Formation (Permian), Tar-Sand Triangle area, southeastern Utah, *in* Myer, R.F., and Wiggins, E.J., editors, The Fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands Proceedings, volume 2, Geology and Chemistry: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 155-172.

(Tar Sand Triangle), This article contains: Abstract; Introduction; Geologic setting; Mineralogy and diagenesis of the White Rim Sandstone (detrital mineralogy, diagenesis, dust rims, quartz overgrowths, dolomite rhombohedra, cementation by calcite, dissolution of calcite cement, authigenic feldspar, dissolution of detrital feldspars, kaolinite cement, illitic clay, quartz overgrowths, Fe-bearing carbonate cement, migration of hydrocarbons); Discussion; Conclusions; Acknowledgments; References.

Schenk, C.J., and Pollastro, R.M., no date, Petrologic aspects of some bitumen-bearing sandstones from Sunnyside, Utah: Unpublished report in UGS files, 21 p.

(Sunnyside), This report contains: Abstract; Introduction; Location, sampling, and analytical techniques; Mineralogy and diagenesis of sandstones (bitumen saturation, mineralogy of sandstones, diagenesis of sandstones); Summary; References; Nine figures.

Schenk, C.J., and Pollastro, R.M., 1987, Preliminary geologic analysis of the tar sands near Sunnyside, Utah, *in* Meyer, R.F., editor, Exploration for Heavy Crude Oil and Natural Bitumen: Tulsa, American Association of Petroleum Geologists Studies in Geology 25, p. 589-599.

(Sunnyside), This paper contains: Introduction; Geologic setting; Methods of study; Preliminary results (sedimentology); Mineralogy; Diagenesis; Summary.

Schick, R.B., 1966, Drillers probing Utah's French Seep area: The Oil and Gas Journal, February 7 issue, p. 134-136.

(French Seep), This article contains: Introduction (play origins, area); Surface geology; History; Economic considerations (potential reserves); Estimated development costs; Estimated operating costs; Bibliography.

Schumacher, M.M., editor, 1980, Enhanced recovery of residual and heavy oils, second edition: Noyes Data Corporation, 378 p.

(Sunnyside), This book includes the following: Introduction; Augmenting petroleum production; Secondary recovery of crude oil; Tertiary recovery of crude oil-miscible techniques; Tertiary recovery of crude oil-thermal techniques; Mining of petroleum; Conceptual mining systems for selected fields; Another method – oil recovery by nuclear explosion; Application of EOR techniques to achieve production potential; Chemical and research requirements of EOR; Environmental aspects; Status of EOR technology – summary of field tests and projects; Recovery of heavy oil; Use of solvents and explosives to recover heavy oil; Chemical flooding – some projects and research; Thermal recovery – some projects and research; CO_2 flooding – studies on temperature effect and CO_2 reserves; The future of enhanced oil recovery; Glossary; Sources utilized. Some information on the Sunnyside deposit is given on pages 148-150.

Schumacher, M.M., editor, 1982, Heavy oil and tar sands recovery and upgrading – International Technology: New Jersey, Noyes Data Corporation, 552 p.

(No Specific Deposit), This book contains the following: Part I Heavy Oil. Introduction and executive summary (introduction, executive summary); Basic recovery processes for heavy crude oils (definition and problem statement, thermal recovery methods, other viscosity reduction methods, viscous displacement methods, chemical flooding methods, summary of methods); Modified and innovative heavy oil processes (thermal recovery methods, miscellaneous other methods); Surface and down hole equipment (thermal insulation, Otis heavy-crude lift system, steam generation equipment); National efforts in heavy oil recovery (Brazil, Canada, China, France, Germany, Indonesia, Italy, Japan, Malagasy Republic, Mexico, Peru, Romania, Trinidad, Turkey, U.S.S.R., Venezuela, miscellaneous countries): Appendix A – Literature survey summaries; Appendix B – List of personal communications; References and bibliography. Part II – Tar sands. Introduction; Executive summary; Tar sand resources (bitumen properties are not rigidly defined, bitumen and very heavy oil resources are distributed worldwide, references); Tar sand production methods (process selection overview, surface recovery processes, in-situ tar sands recovery processes, factors affecting tar sands development, commercial tar sands projects, pilot projects for bitumen recovery, references); Bitumen and very heavy oil upgrading (upgrading processes selection overview, factors affecting upgrading process selection, conventional upgrading methods and commercial facilities, recent developments in foreign heavy oil upgrading technologies, references); Appendix I – upgrading process descriptions – U.S. technology (solvent deasphalting, fluid coking, flexicoking, Texaco partial oxidation, heavy oil cracking, Shell residue hydrodesulfurization, hydrodemetallization, H-oil/LC-fining; Appendix II – Abbreviations and conversion factors; Appendix III – Bibliography.

Seader, J.D., Bezama, R.J., and Chakravarty, Tamnoy, 1986, Design and economic evaluation of an energy-integrated thermal process for recovery of oil from tar sands, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 388-400.

(No Specific Deposit), This paper includes the following: Abstract; Introduction; Second-law analysis; Process designs; Economic evaluation; Conclusions and recommendations; References; Seven tables and three figures.

Seader, J.D., and Coronella, C.J., 1990, An advanced energy-efficient coupled fluidized-bed system for recovering bitumen from tar sand, *in* 1990 Eastern Oil Shale Symposium – oil shale, tar sands, heavy oil (November 6-8, 1990, Marriott Griffin Gate Resort, Lexington, Kentucky): Lexington, University of Kentucky, Institute for Mining and Minerals Research, p. 120-129.

(No Specific Deposits), This article contains: Abstract; Introduction; Hydrodynamics; Mathematical model; First-stage combustion bed; Second-stage combustion bed; Pyrolysis bed; Computer simulation; Results; Future work; Nomenclature; References; Six figures.

Seader, J.D., and Jayakar, K.M., 1979, Process and apparatus to produce synthetic crude oil from tar sands, United States Patent No. 4,160,720, 12 p.

(Patent), (Utah Tar Sands), A process and apparatus for producing synthetic crude oil from bitumen-bearing sands. The apparatus includes a vessel segregated into a pyrolysis zone and a combustion zone, each zone being in the form of a fluidized bed reactor. At least one heat pipe is provided for transferring thermal energy from the combustion zone to the pyrolysis zone where the thermal energy is used to pyrolyze the bitumen. The apparatus may also include additional heat exchange equipment for heating the incoming combustion air for the combustion zone. The combustion air serves as the fluidizing medium for the fluidized bed reactor of the combustion zone while flue gases from the combustion zone serve as the fluidizing medium for the fluidized bed reactor of the pyrolysis zone.

Seader, J.D., and Smart, L.M., 1988, Recovery of bitumen from tar sands by a thermally coupled fluidized-bed process, *in* Meyer, R.F., editor, The Third UNITAR/UNDP International Conference on Heavy Crude and Tar Sands: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 721-730.

(P.R. Spring), This article contains: Introduction; Process description (data acquisition system, process control); Results; Conclusions; Acknowledgments; References; Six figures.

Sepúlveda, J.E., 1977, Hot-water separation of bitumen from Utah tar sands: Salt Lake City, University of Utah M.S. Thesis, 178 p.

(Asphalt Ridge), This thesis contains: Abstract; Acknowledgments; Introduction (major tar sand deposits of the world, separation technology, research objectives); Fundamentals of hot-water process; Experimental optimization techniques (operation variables controlling the performance of the hot-water process, specification of an objective function for optimization, identification of main variables and process optimization); Experimental procedures (tar sand characterization, hot water separation tests); Experimental results and discussion (characterization of tar sand samples, preliminary experimental results, identification of main variables; Process optimization – the Box and Wilson algorithm, effect of digestion temperature on the quality of the separation, effect of the feed source on the quality of the separation, particle size classification during hot-water processing); Summary and conclusions; References, Appendices A-C; Vita.

Sepúlveda, J.E., and Miller, J.D., 1978, Separation of bitumen from Utah tar sands by hot water digestion-flotation technique: Mining Engineering, v. 30, no. 9, p. 1311.

(Asphalt Ridge), (P.R. Spring), This paper contains: Introduction; Separation technology; Definition of the research problem; Experimental procedures; Experimental results and discussion; Summary and conclusions; Acknowledgments; References.

Sepúlveda, J.E., Miller, J.D., and Oblad, A.G., 1976, Hot water extraction of bitumen from Utah Tar Sands, *in* Radding, S.B., director of publication, 172nd National Meeting of American Chemical Society, Division of Fuel Chemistry (August 29-September 3, 1976): American Chemical Society, p. 110-122.

(Asphalt Ridge), (P.R. Spring), (Sunnyside), This article contains: Introduction; Fundamentals of the hot water process (hot water extraction tests, analytical techniques, bitumen characterization); Results and discussion (hot water extraction, bitumen characterization); Summary and conclusions; Acknowledgments; References; Two tables and seven figures.

Shea, G.D., and Higgins, R.V., 1952, Separation and utilization studies of bitumens from bituminous sandstones of the Vernal and Sunnyside, Utah, deposits (Part 1 - laboratory hot-water separation tests): U.S. Bureau of Mines Report of Investigation 4871, p. 1-10. (See also Wenger, W.J., Hubbard, R.L., and Whisman, M.L.,

1952).

(Asphalt Ridge), (Sunnyside), This chapter contains: Foreword; Acknowledgments; General characteristics (reserves); Elements of hot-water separation process; Laboratory separation-plant procedure; Discussion of Vernal separation tests (recovery of bitumen); Discussion of Sunnyside separation tests (recovery of bitumen).

Shepherd, R.A., and Graham, W.R.M., 1984, EPR and FTIR study of metals in bitumen and mineral components of Circle Cliffs, Utah tar sand: American Chemical Society, St. Louis Meeting, April 8-13, 16 p.

(Circle Cliffs), This paper includes the following: Introduction; Procedure; Results and discussion; Conclusion; Acknowledgments; Literature cited; Two tables and five figures.

Shepherd, R.A., and Graham, W.R.M., 1986, Characterization of Circle Cliffs tar sands. 2. Application of the e.p.r. technique to paramagnetic metal ions: Fuel, v. 65, November, p. 1612-1615.

(Circle Cliffs), This paper includes the following: Abstract; Introduction; Experimental; Results and discussion (vanadium, manganese, iron); Conclusions; Acknowledgments; References.

Shepherd, R.A., Kiefer, W.S., and Graham, W.R.M., 1986, Characterization of Circle Cliffs tar sands. 1. Application of the FT-i.r. technique to mineral matter: Fuel, v. 65, September, p. 1261-1264.

(Circle Cliffs), This paper includes the following: Abstract; Introduction; Experimental; Results and discussion; Conclusions; References.

Shirley, H.B., 1961, Estimate of total oil in place, White Rocks oil properties, Uintah County, Utah: Unpublished report prepared for Western Industries, Inc., 25 p., 14 illustrations.

(Whiterocks), This report includes the following: Introduction and purpose; Location and access; Description of properties; Regional geology; Local geology (topography, Navajo sandstone); Evaluation of wells and sampling program; Estimation of reserves (interpretation of saturated intervals, interpretation of core analysis results, determination of net oil sand, classification of reserves, calculation of reservoir volume and oil in place); General comments. Seven figures, three tables, and an appendix.

Shun, Dowon, 1990, The pyrolysis of bitumen-impregnated sandstone from the Circle Cliffs (Utah), deposit in a fluidized-bed reactor: Salt Lake City, University of Utah Ph.D. Dissertation, 160 p.

(Circle Cliffs), This dissertation includes the following: Abstract; Acknowledgments; Introduction (geology, estimation of mineability, estimate of hydrocarbon resource, analysis of native bitumen, environmental assessment, research objectives); Literature survey (estimation of Utah tar sand resource, Circle Cliffs tar sand deposit data, tar sand processing, effect of mineral matter on the pyrolysis of coal, oil shale, and tar sand); Experimental apparatus and procedures (reactor design and reconstruction, reactor calibration and start-up activities, analysis method, fluidized-bed material balance calculation); Results and discussion (properties of native bitumen, the nature of the tar sand matrix, pyrolysis reaction, catalytic cracking activity, kinetic study); Conclusions and suggestions; Appendices A-D, References; Vita.

Silliman, B.J., 1975, The San Rafael oil fields; where the oil runs out of the rocks, *in* Fassett, J.E., and Wengerd, S.A., editors, Canyonlands country: Four Corners Geological Society Guidebook, 8th Field Conference, Canyonlands, p. 59-61.

(San Rafael Swell), This paper contains: Introduction; Location; Topography; Accessibility; Geological structure; Geological formations; Indications of oil; The oil; Saturated sands; Operating conditions; Field development.

Sinks, D.J., 1985a, Geologic evaluation and reservoir properties of the P.R. Spring tar sand deposit, Uintah and Grand Counties, Utah (draft copy): Laramie, U.S. Deparment of Energy, Western Research Institute, 190 p.

(P.R. Spring), This report includes the following: Acknowledgments; Abstract; Introduction; Previous investigations; Geographic and geologic setting; Coring program; Resource evaluation; Discussion; Summary; References; Appendices. The report discusses previous investigation, geographic and geologic setting, the coring program conducted by the Laramie Energy Technology Center, and a resource evaluation (bitumen-bearing zones, computerized mapping program, lateral and vertical extent, reservoir properties including porosity, permeability, oil saturation, water saturation, bulk density, grain density, and bitumen characteristics. Appendices include A) Detailed lithologic description of cores UTS-1 through UTS-7, B) Detailed tar sand analyses of cores UTS-1 through UTS-6, C) Cored intervals with detailed analyses for selected sample locations, D) Average reservoir property values for selected sample location, and E) Isopleth maps of reservoir properties for zones E, D, C, B, and A.

Sinks, D.J., 1985b, Geologic influences on the in-situ processing of tar sand at the northwest Asphalt Ridge deposit, Utah: Laramie, U.S. Deparment of Energy, Western Research Institute, 81 p.

(NW Asphalt Ridge), This book includes the following: Abstract; Introduction; Geographic and geologic setting; Northwest Asphalt Ridge deposit (areal extent, outcrop characterization, subsurface field site characterization, local structure); Summary; In-situ recovery field experiments (pretest site characterization, processing techniques, operation and results); influence of geologic parameters on results of field experiments; Discussion; Summary.

Skinner, Quentin, 1980, Environmental survey – tar sands in situ processing research program (Vernal, Uintah County, Utah), (Work performed under contract no. EY-77-C-04-3913; to 005): Laramie, Rocky Mountain Institute for Energy and Environment, 162 p.

(Asphalt Ridge), This report includes the following: Forward; Description of proposed action (introduction, construction phase, operational phase, post-operational phase); Description of the existing environment (air quality, water quality, biological, aesthetic, recreational, and cultural, socioeconomic, and environment); Potential impacts and mitigations (air quality, water quality, biological, aesthetic, recreational, and cultural, socioeconomic environment, and occupational health and safety); Coordination with federal, state, and local plans; Alternatives (selected references); Appendix A – birds of sagebrush-type habitat; Appendix B – Mammals found in sagebrush-type habitats); List of figures and tables.

Smart, L.M., 1984, Thermal processing of Utah tar sands: Salt Lake City, University of Utah M.S. Thesis, 139 p.

(Sunnyside), (P.R. Spring), (Whiterocks), This thesis contains: Abstract; Acknowledgments; Objectives; Background (tar sand resources, tar sand properties, methods for tar sand processing); Processes and apparatus (process description, primary reactor design, heat recovery system, solids separation system, product recovery system, feeding system, measurement and control processor); Experimental procedure (equipment calibration, operating procedure, processing of tar sands, trials with Sunnyside tar sands, trials with Whiterocks tar sands, trials with P.R. Spring tar sands); Results and discussion (process control, studies of variables, product properties, energy usage); Conclusions and recommendations; Appendices (experimental data, experimental enthalpy balance, histories of tar sand trials); References.

Smith, J.W., and Atwood, M.T., editors, 1976, Oil shale and tar sands: New York, American Institute of Chemical Engineers Symposium Series, v. 72, no. 155, 78 p.

(Numerous Utah Deposits), This symposium series contains: Six articles dealing with oil shales; Five articles dealing with tar sands (Introduction, Utah's tar sand resources – geology, politics and economics by Ritzma, the Asphalt Ridge tar sand deposits by Lowe, Field experiments of in-situ recovery from a Utah tar sand by reverse combustion by Cupps and others, and recovery of bitumen from oil-impregnated sandstone deposit of Utah by Cupps and others.

Smith, R.J., 1980, Asphalt Ridge tar sands-flotation behavior and process design: Salt Lake City, University of Utah M.S. Thesis, 186 p.

(Asphalt Ridge), This thesis contains: Abstract; Introduction (historical perspective, major tar sand deposits of the world, separation technology); Review of the hot water processes (tar sand properties, hot water process fundamentals, hot water process for Athabasca tar sands, hot water process for Utah tar sands); Experimental procedures (contact angle measurements, compositional analysis, particle size analysis, hot water process tests, liquid-solid separation tests, water recycling test); Experimental design and analysis of flotation experiments (flotation variables, definition of the objective function, experimental designs, hypothesis testing, summary); Experimental results and discussion (contact angle measurements, hot water processing experiments, liquid-solid separation of flotation tailings, water recycling, summary); Process design and cost estimate (proposed flowsheet, process problems, cost estimate, recommendations for future research); References; Appendices A-E; Vita.

Smith, R.J., and Miller J.D., 1981, The flotation behavior of digested Asphalt Ridge tar sands: Littleton, Society of Mining Engineers of AIME, Preprint 80-100, 26 p.

(Asphalt Ridge), (Athabasca), This article contains: Abstract; Introduction (processing Athabasca tar sands; processing Utah tar sands); Experimental methods (contact angle measurements, hot water processing experiments, analytical techniques); Results and discussion (contact angle measurements, hot water processing experiments, temperature study, carbonate addition, concentrate particle size, continuing work); Summary; Acknowledgments; References. Includes 6 tables and 12 figures, plus 12 figures credited to F.V. Hanson (LCSSFC, 3/81).

Smith, S.L, 1984, Ambient froth flotation process for the recovery of bitumen from tar sand, United States Patent No. 4,425,227, 13 p.

(Patent), (Sunnyside), A method for upgrading the bitumen content of tar sands, wherein a raw tar sand slurry admixture of tar sands, water, collectors, and dispersing/wetting agents is milled; conditioned and then separated by a series of froth flotations at ambient temperatures from about 2.degree. C. to about 25.degree. C. to recover a concentrated bitumen tar sand product which may be processed by conventional means to recover oil from the bitumen. Enhanced recovery of bitumen may be accomplished by moderate heating in one or more of the flotation zones to about 50.degree. C. The method permits recovery and recycle of various components used in processing of the tar sand.

Smith, V.E., 1994a, Research investigations in oil shale, tar sand, coal research, advanced exploratory process technology, and advanced fuels research, Volume 1 – base program (final report for period from October 1986 to September 1993 under contract no. DE-FC21-86MC11076): Laramie, University of Wyoming Research Corporation, 150 p.

(Asphalt Ridge), This report includes the following: Foreword; Acknowledgments; Disclaimer; Executive summary; **Oil shale** (kerogen decomposition, characterization of reference oil shales, shale oil residua for paving applications, inorganic geochemical characterization of retorted oil shale, organic characterization of retorted oil shale and product water, ion speciation of process waters and fossil fuel leachates, studies on development of western oil shale, oil shale references); **Tar Sand** (in-situ combustion simulation testing of tar sand, validation of steady-state operating conditions for recycle oil pyrolysis and extraction (ROPEä), development of an inclined liquid fluid-bed reactor system for processing tar sand, an evaluation of oil produced from Asphalt Ridge (Utah) tar sand as a feedstock for production of asphalt and turbine fuels, evaluation of the potential end use of oils produced by the (Ropeä), process from California tar sand, tar sand references); Coal research (groundwater remediation activities at the Rocky Mountain 1 underground coal gasification test site, groundwater monitoring at the Rocky Mountain 1 underground coal gasification test site, initial study of coal pretreatment and coprocessing, evaluation of coal pretreatment prior to coprocessing, investigations into coal coprocessing and coal liquefaction, value-added coal products, coal references); Advanced exploration process technology (the use of oil shale as a sulfur sorbent in a circulating fluidized-bed combustor, treatment of well-block pressures in reservoir simulation, thermal reservoir modeling, development of the CROWä process, steamflood enhancement in naturally fractured reservoirs, preliminary evaluation of a concept using microwave energy to improve an adsorption-based natural gas clean-up process, advanced exploration process technology references); Advanced fuels research (evaluation of western shale oil as a feedstock for high-density aviation turbine fuel, evaluation of processes for the utilization of eastern shale oil as a feedstock for high-density aviation turbine fuel, evaluation of coal-derived liquid as a feedstock for high-density aviation turbine fuel, advanced fuels research references).

Smith, V.E., 1994b, Research investigation in oil shale, tar sand, coal research, advanced exploration process technology, and advanced fuels research, volume II – jointly sponsored research program, final report October 1986 to September 1993 (Work performed under Contract DE-FC21-86MC11076, 82 p.

(Sunnyside), This report contains: Foreword; Acknowledgments; Disclaimer; Executive summary; Pilot test of the CROWä process at the Bell Lumber and Pole site; In-situ treatment of manufactured gas plant contaminated soils demonstration program; Operation and evaluation of the CO_2 Huf-n-Puff process; Oil field waste cleanup using the tank bottom recovery and remediation process; Enhanced gravity drainage of oil in the North Teasdale reservoir; Assessment, design, and testing of oil recovery and processing technologies for near-surface reserves; Shallow oil production using horizontal wells with enhanced oil recovery techniques; Model development and testing of steam injection tubulars; Evaluation of a molecular sieve carbon as a pressure swing adsorbent for the separation of nitrogen from natural gas; Characterization of petroleum residua; Mild gasification of Usibelli coal; Series B pilot-plant tests; Feasibility of using wood-derived fuel for cogeneration; Bench-scale simulation of quenching and stabilization of modified in-situ oil shale retorts; Investigation of the Recycle Oil Pyrolysis and Extraction (ROPEä) process performance on Sunnyside tar sand; Evaluation of products recovered from scrap tires; Remote chemical sensor development; A standard test method for sequential batch extraction; NMR analysis of organic matter in sedimentary rocks; Testing and demonstration of utilization of Wyoming fly ash; Hazardous waste stabilization utilizing clean coal combustion waste materials; Development of a hydrologic data management system; Charfuelâ process.

Snell, G.J., and Long, R.H., 1978, Separation of solids from tar sands extract: United States Patent 4,094,781, 10 p.

(Patent), (No Specific Deposit), This patent contains the following: Abstract; Separation of solids from tar sands extract. Patent contains one table, Analysis of a typical moisture-free tar sands extract or bitumen.

Sohio Petroleum Company, 1957, Northwest Asphalt Ridge (Information on Sohio Corehole D-4, drilled in 1957): Sohio information sheet.

(NW Asphalt Ridge), This information sheet contains: Location; Footages and formations; Sample numbers with depth, resource data; Quality factor (visual).

Sohio Petroleum Company, 1959, Engineering prospectus of a field test thermal recovery of oil from tar sands, Asphalt Ridge, Uintah County, Utah: Oklahoma City, Sohio Petroleum Company, 40 p.

(Asphalt Ridge), This prospectus contains: Introduction; Summary; Description of test area (geology, coring program and core analysis, tar properties, air injection tests, oxygen take-up tests); Laboratory combustion tests; Possible field approaches to thermal recovery in tar sands (creation of permeability, heating rich tar sand by thermal conduction); Proposed field combustion test (general procedure, air injection facilities, well completion materials, surface equipment, schedule of operation, personnel office and laboratory facilities, estimated costs, outline of accounting, reporting engineering committee).

Sohio Petroleum Company, 1974, Proposed plan for mining and processing operations, bituminous sands deposits, Asphalt Ridge area, Uintah County, Utah: Presentation before the Utah Department of Natural Resources Board of Oil & Gas Conservation, Vernal, Utah, 14 p.

(Asphalt Ridge), This report contains: Introduction; Description of the proposed operations (site selection, mining plans, extraction processes - Arizona Fuels Process, Fairbrim Process); Description of the environment (general regional description, description of the proposed site); Environmental impacts (land, vegetation, water, air, animal life, archeology, socio-economic); Agencies and individuals contacted for assistance in preparation of this report.

South, D.W., Nagle, J.C., Nagle, J.W., Rose, K.J., and Winter, R.C., 1984, Areawide and local effects of tar sands development at the Sunnyside site in Utah – a socioeconomic analysis: Argonne, Illinois, Argonne National Laboratory, Report number ANL/EES-TM-249, Work sponsored by the U.S. Department of the Interior, Bureau of Land Management.

(Sunnyside), This report includes the following: Acknowledgments, Summary (introduction, description of existing conditions and baseline projections, description of the development scenarios for the Sunnyside STSA, socioeconomic impact analysis of three tar sands, socioeconomic impacts associated with development of the other energy projects in Carbon and Emery Counties, summary and comparison of cumulative impacts); Appendix A – Analytical methods, assumptions and models used in the analysis; Appendix B – Baseline employment and income data by county; Appendix C – Housing demand by county and community; Appendix D – Fiscal profiles of counties and communities.

South, D.W., Nagle, J.C., Nagle, J.W., and Winter, R.C., 1983, Socioeconomic technical report; Sunnyside Special Tar Sands Area development analysis: Argonne, Argonne National Laboratory, variously paginated.

(Sunnyside), This report includes the following: Acknowledgments; Executive summary; Introduction; Description of existing conditions and baseline projections; Description of the development scenarios for the Sunnyside STSA; Socioeconomic impact analysis of three tar sands development scenarios; Socioeconomic impacts associated with development of the other energy projects in east-central Utah; Cumulative impacts; Appendix A – Analytical methods, assumptions and models used in the analysis; Appendix B – 1980 population and household characteristics by county, CCD, and county; Appendix C – Baseline employment and income data by county; Appendix D – Housing demand by county and community; Appendix E – Fiscal profiles of counties and communities.

South, D.W., Nagle, J.C., Nagle, J.W., Rose, K.J., and Winter, R.C., 1984, Sunnyside combined hydrocarbon lease conversion socioeconomic technical report: Argonne, Argonne National Laboratory, 247 p.

(Sunnyside), This report contains the following: Preface; Acknowledgments; Summary; Introduction; Description of existing conditions and baseline projections; Description of the development scenarios for the Sunnyside STSA; Socioeconomic impact analysis of three tar sands development scenarios; Socioeconomic impacts associated with development of the other energy projects in Carbon and Emery Counties; Summary and comparison of cumulative impacts; Appendix A – Analytical methods, assumptions, and models used in the analysis; Appendix B – Baseline employment and income data by county; Appendix C – Housing demand by county and community; Appendix D – Fiscal profiles of counties and communities.

Spencer, G.B., Eckard, W.E., and Johnson, F.S., 1969, Domestic tar sands and potential recovery methods – a review: Presented at the Second Recovery and Pressure Maintenance Committee meeting at the Interstate Oil Compact Commission Meeting, December 8-10, 14 p.

(Numerous Utah Deposits), This paper contains: Abstract; Introduction; Definition and physical properties of tar sands (occurrence and reserves); Recovery methods (in-situ methods, cyclic steam injection, steam drive, in-situ combustion, solvent extraction, hot water and hot gas injection, nuclear applications); Mining methods (Great Canadian Oil Sands Method, Syncrude Canada, Lte. Method); Processing (hot water method, other proposed methods); Discussion; Conclusions; References.

Spieker, E.M., 1930, Bituminous sandstone near Vernal, Utah, *in* Miser, H.D., geologist in charge, Contributions to

Economic Geology, Part II, Mineral Fuels: United States Geological Survey Bulletin 822, p. 77-100.

(Asphalt Ridge), This paper includes the following: Abstract; Introduction; Physical features of the area; Geology (stratigraphy, structure); Bituminous sandstone (general character, localities and detailed sections, collection and examination of samples, mechanical analysis and microscopic examination, rock density and pore space; bituminous content of sand, chemical nature of the bitumen, wells drilled to the bituminous sand, amount of bitumen, mining, uses); Index.

Sprinkel, D.A., compiler, 1999, A summary of the geologic resource atlas of Utah: Utah Geological Survey Open-File Report 364, 154 p.

(No Specific Deposits), All of the oil shale and tar sand locations displayed in the atlas are from database files at the Utah Geological Survey. Some of the oil shale and tar sand location were extracted from the UMOS database. No discussion or technical information is given in the reference other than locations marked on 1-degree x 30-minute maps.

Sresty, G.C., Dev, Harsh, Snow, R.H., and Bridges, J.E., 1981, Recovery of bitumen from tar sand deposits using the IITRI RF process (presented at the 56th annual fall technical conference and exhibition of the Society of Petroleum Engineers of AIME in San Antonio, Texas, October 5-7): Society of Petroleum Engineers of AIME, 12 p.

(Asphalt Ridge), This paper contains the following: Abstract; Introduction; Concept of the RF process; RF properties of Utah tar sands; Recovery of bitumen; Viscosity-temperature relationship; Gravity drainage; Autogenous drive; Fluid replacement; Tar sand field experiment; Conclusions; References.

Sresty, G.C., Harsh, Dev, Snow, R.J., and Bridges, J.E., 1984, Method for recovery of viscous hydrocarbons by electromagnetic heating in situ, United States Patent No. 4,485,868, 15 p.

(Patent), (Asphalt Ridge), A method of electromagnetic heating in situ recovers liquid hydrocarbons from an earth formation containing viscous hydrocarbonaceous liquid and water in an inorganic matrix where the formation is substantially impermeable to fluids under native conditions. A block of the earth formation is substantially uniformly heated with electromagnetic power to a temperature at which the viscous hydrocarbonaceous liquid is relatively fluid and a portion of the water vaporizes to water vapor at a pressure sufficient to overcome the capillary pressure of the liquid in the matrix. Water vapor thereupon escaping from the block under such pressure is recovered with hydrocarbonaceous liquid driven thereby. The magnitude of the electromagnetic power is controlled to limit the current recovery ratio of water vapor to hydrocarbonaceous liquid below a predetermined limit assuring substantial recovery of the hydrocarbonaceous liquid prior to the driving off of substantially all the water.

Sresty, G.C., Harsh, Dev, Snow, R.H., and Bridges, J.E., 1986, Recovery of bitumen from tar sand deposits with the radio frequency process: SPE Reservoir Engineering, Society of Petroleum Engineers, p. 85-94.

(Asphalt Ridge), This report discusses the following: Introduction; Concept of the RF process; RF properties of Utah tar sands (triplate line geometry); Recovery of bitumen (viscosity/temperature relationship, gravity drainage, autogenous drive, fluid replacement); Tar sand field experiments; Process economics; Conclusions; Acknowledgments ; References.

Sresty, G.C., Snow, R.H., and Bridges, J.E., 1982, The IITRI RF process to recover bitumen from tar sand deposits – a progress report: Chicago, IIT Research Institute, 23 p.

(Asphalt Ridge), This report contains the following: Abstract; Introduction; Description of the RF process; RF properties of Utah tar sands; Recovery of bitumen; Field experiments – description; Field experiments – results; References; Eight figures, two tables.

Steed, R.H., 1954, Geology of Circle Cliffs anticline, *in* Brier, Bill, editor, Geology of portion of the high plateaus and adjacent canyon lands, central and south-central Utah: Intermountain Association of Petroleum Geologists, p. 99-102.

(Circle Cliffs), This article includes the following: Location; Physiography; Surface stratigraphy (Jurassic, Triassic, Permian); Subsurface stratigraphy (Pennsylvanian, Mississippian, Devonian, Cambrian); Structure (regional structure, local structure); Development; Acknowledgment.

Stern, Konrad, 1960, Native bitumens, pyrobitumens, and asphaltic type petroleum bitumens, *in* Gillson, J.L., editor-in-chief, Industrial minerals and rocks (nonmetallics other than fuels): New York, The American Institute of Mining, Metallurgical, and Petroleum Engineers, p. 631-637.

(No Specific Deposits), This article contains: Introduction; Native lake asphalt; Selenitza, Iraq, and Boeton asphalts; Rock asphalt; Native asphaltites (gilsonite, grahamite, glance pitch); Petroleum bitumen; Wurtzilite, elaterite, albertite, impsonite, ozokerite; Bibliography.

Subramanian, Murugesan, 1994, Application of supercritical fluid extraction to upgrading oil sand bitumens: Salt Lake City, University of Utah M.S. Thesis, 239 p.

(Whiterocks), (P.R. Spring), This thesis contains: Abstract; Nomenclature; Acknowledgement; Introduction (world and U.S. reserves and origin of oil sand, nature of oil sands, oil sand recovery methods, supercritical extraction, research objectives); Literature survey (solvent extraction of oil sands, upgrading bitumen by solvent deasphalting, supercritical fluid extraction, modeling bitumen extraction); Experimental apparatus and procedures (supercritical fluid supply system, supercritical fluid extractor assembly, densitometer assembly, SPE separator assembly, calibration of the densitometer, oil sand bitumen preparation, experimental procedure, product analysis); Modeling the supercritical fluid extraction process (component lumping procedure, calculation of pseudo component properties, procedure, and phase behavior calculation); Results and discussion (feedstock characterization, preliminary process test, extraction of Whiterocks bitumen by propane, extraction of P.R. Spring bitumen, modeling supercritical fluid extraction); Conclusions and future work; Appendices A-E; References; Vita.

Subramanian, Murugesan, 1996, Compositional analysis of bitumen and bitumen-derived products: Journal of Chromatographic Science, v. 34, p. 20-26.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This paper includes the following: Abstract; Introduction; Experimental (gas chromatography, samples); Results and discussion; Conclusion; Acknowledgments; References.

Subramanian, Murugesan, 1996, Supercritical fluid extraction of oil sand bitumens from the Uinta Basin, Utah: Salt Lake City, University of Utah Ph.D. Dissertation, 502 p.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This dissertation contains: Abstract; Acknowledgments; Introduction (worldwide and USA oil sands resources, nature of bitumen, recovery processes, research objectives); Literature review (supercritical fluid extraction (SFE) fundamentals, applications of SFE, phase behavior studies at supercritical conditions, SFE of oil sands, commercial SFE processes, modeling the bitumen extraction process, phase behavior studies on bitumen systems, modeling approach); Experimental apparatus and procedures (supercritical fluid supply system, supercritical fluid extractor and densitometer assembly, data acquisition system, SFE separator assembly, calibration of the densitometer, oil sands bitumen preparation, experimental procedures, product analysis); Results and discussion (feedstock characterization, simulated distillation, preliminary process experiments, SFE of oil sands bitumens, SFE of Asphalt Ridge bitumen, SFE of Sunnyside bitumen, comparison of SFE of bitumens from Uinta Basin, compositional analyses of residual fraction, elemental analyses, modeling SFE using continuous thermodynamics principle, modeling

SFE process); Conclusions; Appendices (SFE data, simulated distillation data, analytical test procedure for sara analysis, figures pertaining to modeling, simulated distillation software code); References; Vita. The SFE of bitumens from the Whiterocks, Asphalt Ridge, P.R. Spring, and Sunnyside oil sand deposits has been investigated in a semicontinuous system. The results indicated that the cumulative extraction yields increased with an increase in pressure at constant temperature and decreased with increase in temperature at constant pressure. The extraction yields increased with an increase in solvent density.

Subramanian, Murugesan, Deo, M.D., Fletcher, J.V., and Hanson, F.V., 1993, Supercritical fluid extraction of oil sand bitumen, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radison Plaza Hotel, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 241-252.

(P.R. Spring), This article contains; Abstract; Introduction; Experimental methods (experimental apparatus and procedure, solvent and feed stocks); Results and discussion (extraction of hexadecane, extraction of P.R. Spring bitumen – pressure effect – temperature effect – extraction product analysis, modeling the extraction process); Conclusions; Acknowledgments; References; Four tables.

Subramanian, Murugesan, Deo, M.D., and Hanson, F.V., 1995, Supercritical fluid extraction of Uinta Basin bitumen, *in* Meyer, R.F., editor, Heavy crude and tar sands – fueling for a clean and safe environment (6th UNITAR International Conference on Heavy Crude and Tar Sands): U.S. Department of Energy, p. 193-203.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This paper contains: Abstract; Introduction; Experimental methods (experimental apparatus and procedure, solvent and feedstocks); Results and discussion (supercritical fluid extraction of hexadecane, supercritical fluid extraction of bitumens, effect of pressure temperature and solvent density, simulated distillation analyses of extract and residues, modified SARA analyses of extract and residue, elemental analysis, modeling of extraction process); Conclusions; Acknowledgments; References; Six tables and twelve figures.

Subramanian, Murugesan., Deo, M.D., and Hanson, F.V., 1996, Compositional analysis of bitumen and bitumen-derived products: Journal of Chromatographic Science, v. 34, p. 20-26.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This paper includes the following: Abstract; Introduction; Experimental (gas chromatography, samples); Results and discussion; Conclusion; Acknowledgments; References; Nine figures and four tables.

Subramanian, Murugesan, and Hanson, F.V., 1998, Supercritical fluid extraction of bitumens from Utah Oil Sands: Fuel Processing Technology, v. 55, p. 35-53.

(Whiterocks), (Asphalt Ridge), (P.R. Spring), (Sunnyside), This paper contains: Abstract; Introduction; Experimental methods (experimental apparatus and procedure, solvent and feedstocks); Results and discussion (supercritical fluid extraction of hexadecane, SFE of bitumens, effect of pressure, temperature and solvent density, simulated distillation analyses of extract and residues, modified SARA analyses of extract and residue, experimental analyses, modeling the extraction process); Conclusions; Acknowledgments; References

Sung, Seung Hyun, 1988, The fluidized bed pyrolysis of bitumen-impregnated sandstone in a large diameter reactor: Salt Lake City, University of Utah M.S. Thesis, 319 p.

(Circle Cliffs), (Whiterocks), This thesis contains: Abstract; Acknowledgments; Introduction (tar sand resources, origin and nature of tar sands); Review of bitumen recovery techniques and scale up concepts (in-situ recovery methods, mining-surface recovery methods, high temperature surface recovery processes, scale-up concepts for fluidized beds); Experimental procedures (experimental apparatus, calibration equipment, operational procedure); Results and discussion (preliminary fluidization test, material balance from Circle Cliff tar sand, production run with Whiterocks tar sand); Conclusions and recommendations (recommendations for apparatus modifications);

Appendix (computer program for pilot plant control and data logging); References; Vita. A fluidized bed reactor has been used for the thermal processing of tar sands to produce a bitumen-derived hydrocarbon liquid, which could be used as a refinery feedstock. The influence of process operating variables on the product distribution and the yields has been investigated in a small scale (1.38 inch diameter fluidized bed reactor.

Synthetic Fuels, 1974, Fairbrim & Arizona Fuels to begin oil sands recovery on Sohio property in Utah: Synthetic Fuels (September), p. 3-26 to 3-30.

(Asphalt Ridge), This article contains: Introduction; Water rights, Data indicate low grade reserves; Arizona Fuels and Fairbrim historically related; Comment.

Tabor, P.R., 1982, Method of in situ oil extraction using hot solvent vapor injection, United States Patent No. 4,362,213, 12 p.

(Patent), (Asphalt Ridge), (Athabasca), Heavy oil or bitumen is extracted and removed from underground oil bearing formations having low permeability such as tar sands by injection of hot hydrocarbon solvent vapor into a single well hole at a pressure not substantially exceeding the pressure in the formation to effectively heat and extract the bitumen. The hot solvent vapor is passed downwardly through an annular passage of concentric piping place in the well bore and is injected out through upper performations in the casing and into the formation. The hot solvent vapor condenses in the formation and drains along with recovered oil through lower perforations back into the bottom end of the inner pipe, from which the product oil and solvent mixture is pumped to above ground. The solvent is partially reclaimed from the oil product by distillation means and the solvent friction is reheated and reinjected into the well bore for further use. The solvent used should be matched to the characteristics of the bitumen in the tar sands formation for most effective recovery of bitumen, and contains substantially aromatic compounds. As more bitumen is dissolved and removed from the formation, the injection and drainage perforations in the casing are spread further apart vertically so as to cause the solvent to penetrate the formation more effectively and dissolve bitumen further away from the bore hole.

Talbot, A.F., Hook, Marcus, and Harrison, W.E., III, 1989, Conversion of tar sand bitumen and heavy crude to high yields of aviation turbine fuel, *in* Meyer, R.F., and Wiggins, E.J., editors, The Fourth UNITAR/UNDP International Conference on Heavy Crude and Tar Sands proceedings, volume 5, extraction, upgrading, and transportation: Edmonton, Alberta Oil Sands Technology and Research Authority, p. 309-319.

(Sunnyside), This article contains: Abstract; Introduction; Preliminary studies; Experimental results (feedstocks, hydrovisbreaking, hydrotreating, hydrocracking); Refinery material balance; Refinery capital; Turbine fuel cost; Conclusions; Acknowledgment; References; Eight tables and four figures.

Tang, H.Q., 1995a, Combustion of carbonaceous residues on spent oil sands in a transport reactor: Salt Lake City, University of Utah Ph.D. Dissertation, 227 p.

(No Specific Deposits), This dissertation contains: Abstract; Nomenclature; Acknowledgments; Introduction (research objectives); Literature survey (oil sand research, oil sand recovery methods, fluidized bed combustion, fluidized bed incineration, combustion kinetics of coke/char on spent shale/sand); Experimental apparatus and procedures (coked sand feeder design, construction and calibration, reactor design and construction, air supply and preheating, gas-solid separation, process monitoring and control, combustion experiment operating procedures, product sampling and analysis, material balance calculations); Results and discussion (solid feed material preparation, hydrodynamic studies, combustion studies, carbon balances in the laboratory-scale fluidized bed combustion reactor); Conclusions; Appendices (A-transport fluidized bed reactor design calculations, B – Thermal conductivity detector response factor determination, C- evaluation of coke analysis data, D – Experimental data for coked sand combustion runs); References; Vita.

Tang, H.Q., 1995b, Fluidization of coked sands and pyrolysis of oil sands in a fluidized bed reactor: Salt Lake City, University of Utah M.S. Thesis, 160 p.

(P.R. Spring), This thesis contains: Abstract; Notation; Acknowledgments; Introduction (definition of oil sands, world and U.S. oil sands resources, oil sands recovery technologies, research objectives); Literature review of oil sand recovery technologies (in-situ oil sands recovery technologies, mining surface oil sands recovery technologies); Experimental methods (fluidized bed experimental apparatus, bed height determination, stepwise oil sands feeding during pyrolysis, experimental procedures, product analysis methods, bitumen mass balance calculation); Results and discussion (coked sands and oil sands feeding studies, pneumatic L-valve as a solids withdrawal device, coked sands fluidization studies, effect of pyrolysis variables on product distributions and yields, characteristics of total liquid products); Conclusions; Appendices A-B, Summary of experimental data produced during fluidized bed pyrolysis data; References.

Task Force on Strategic Unconventional Fuels, 2006, Development of America's unconventional fuels resources – initial report to the President and the Congress of the United States: Task Force on Strategic Unconventional Fuels, 38 p.

(No Specific Deposit), This report includes the following: Transmittal letter; Task force members and their official representatives; Introduction (directives from Congress, task force activities, scope of effort); Task force findings (analyses and assessments, initial findings and conclusions, potential domestic fuels production under various policy and fiscal scenarios, uncertainties constraining development investment); Initial task force recommendation and options for consideration (options for accelerating commercial development of unconventional fuels, options for addressing major development impediments, recommendations regarding international collaboration and partnerships); Next steps for task force; Appendix A (net energy balance – the energy cost of producing energy); Appendix B (Major assumptions for estimating production under various policy and fiscal scenarios).

Task Force on Strategic Unconventional Fuels, 2007, America's strategic unconventional fuels – oil shale, tar sands, coal derived liquids, heavy oil, CO_2 enhanced recovery and storage, Volume 1 - Preparation strategy, plan, and recommendations: Task Force on Strategic Unconventional Fuels, 104 p.

(No Specific Deposit), This report includes the following: Transmittal letter; Preface; Members of the task force; Task force charter and activities; Executive summary; Introduction; Part A (situation analysis and program rationale (national energy and security concerns, U.S. domestic liquid fuels resources, potential to augment domestic oil supply, national economic costs and benefits, program rationale); Part B (strategic unconventional fuels strategy (major program goals, program vision, factors constraining investment, strategies); Part C (program structure and management plan); Part D (conclusions and task force recommendation; Appendix statements governors of Colorado and Wyoming; References.

Task Force on Strategic Unconventional Fuels, 2007, America's strategic unconventional fuels – oil shale, tar sands, coal derived liquids, heavy oil, CO_2 enhanced recovery and storage, Volume II – Resource-specific and cross-cut plans: Task Force on Strategic Unconventional Fuels, 187 p.

(No Specific Deposit), This report includes the following: Oil shale subprogram plan; Tar sands subprogram plan; Coal to liquids subprogram plan; Heavy oil subprogram plan; CO_2 enhanced oil recovery subprogram plan; socio-economic cross-cut plan; Carbon management cross-cut plan; Water resources cross-cut plan; Environmental outreach cross-cut plan; Markets cross-cut plan; Infrastructure cross-cut plan; References.

Task Force on Strategic Unconventional Fuels, 2007, America's strategic unconventional fuels – oil shale, tar sands, coal derived liquids, heavy oil, CO_2 enhanced recovery and storage, Volume III – Resource and Technology Profiles: Task Force on Strategic Unconventional Fuels, 159 p.

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), (Other), This report includes the following: Oil shale profile; Tar sands profile, Coal to liquids profile; Heavy oil profile; CO_2 enhanced oil recovery profile; Resources.

Taylor, J.E., 2001, Rock asphalt quarry/tramway operations, Sunnyside area, Carbon County: Unpublished

manuscript, 21 p.

(Sunnyside), This manuscript contains: Comments and observations related to the history of the mining and tramway operations at the Sunnyside tar sand deposit. Several photographs.

Texaco Geochemical Research Section, 1988, Geochemical analysis of various oil-impregnated rocks, Uinta Basin, Utah: Unpublished data provided to Utah Geological and Mineral Survey by Texaco Geochemical Research Section.

(Asphalt Ridge), (Raven Ridge), (Gilsonite), (Elaterite Basin), (Minnie Maud Creek), (Argyle Canyon), This report (incomplete), contains: Sample index (Asphalt Ridge, Raven Ridge, fresh gilsonite, elaterite, Minni Maud, Argyle Canyon); Tables (organic carbon and Rock-Eval pyrolysis data, API & SARA group type analysis, normalized paraffin abundance).

The Pace Consultants, Inc., 1989, Pace synthetic fuels report – oil shale, coal, oil sands: The Pace Consultants, Inc., p. 3-1, 3-36.

(Sunnyside), (P.R. Spring), (Circle Cliffs), (Tar Sand Triangle), This report contains the following: Project activities; Corporations; Government; Energy policy and forecasts; Economics; (two pages missing); Resource; Status of oil sands projects; Completed and suspended projects; Status of oil sands projects.

Thode, H.G., Monster, Jan, and Dunford, H.B., 1958, Sulphur isotope abundances in petroleum and associated materials: Reprinted from the Bulletin of the American Association of Petroleum Geologists, v. 42, no. 11, p. 2619-2641.

(Asphalt Ridge), This publication contains: Abstract; Introduction; Experimental procedures (treatment of oil samples, sulphate in rock samples, pyrite in rock samples, sulphate water samples, hydrogen sulphide); Mass spectrometry; Leduc oil field; Upper Devonian oil pools - western Canada; Upper Cretaceous oils; Oils in United States; Mississippian oils; Hydrocarbons from Uinta Basin, Utah (data for Asphalt Ridge given); Discussion and conclusions; Oil migration; General discussion; Isotope fractionation; Isotope level of source sulphur; References.

Thomas, K.P., and Dorrence, S.M., 1984, Chapter 86 - Chemical evaluation of product oils from two in-situ tar sand oil recovery projects, *in* Myer, R.F., Wynn, J.C., and Olson, J.C., editors, The Future of Heavy Crude and Tar Sands, New York, Coal Age Mining Information Services, McGraw Hill, Inc., p. 836-843.

(NW Asphalt Ridge), This article contains: Introduction; Experimental methods (collection and treatment of oil samples and bitumen, analytical methods); Results (conduct of the TS-2C field project, properties of TS-2C produced oils and comparison with the original, comparison of the product oil from TS-2C with a visbroken bitumen, comparison of the product oil from TS-2C with some fuel oils, conduct of the TS-1S field project, properties of the TS-1S produced oil and comparison with the original bitumen); Discussion; Conclusions. All tests were conducted in the Rimrock Member of the Mesa Verde Formation on the NW Asphalt Ridge (Utah), tar sand deposit.

Thomas, K.P., and Witt, M.A., 1985, The determination of the major elements and trace metals present in bitumen from several tar sand deposits: U.S. Department of Energy Technical Information Center, Office of Scientific and Technical Information, 15 p.

(P.R. Spring), (Hill Creek), (Whiterocks), (Raven Ridge), (Circle Cliffs), (Tar Sand Triangle), This article contains: Abstract; Introduction; Experimental procedures; Results and discussion; Conclusion; Acknowledgement; References. The results of the analyses of 14 tar sand samples for the concentration of major elements and trace metals are presented. Ten samples were obtained from the Uinta Basin of Utah, three from the southeastern part of Utah, and one from New Mexico. In general, the major element composition of the bitumens is comparable to what has been determined previously. The trace metals content of the bitumen samples

is similar to what would be expected for a heavy crude oil. However, there are three samples that contain higher than usual concentrations of some metals. These samples are Whiterocks-West side (uranium and molybdenum), P.R. Spring-Three Mile Canyon (manganese), and Circle Cliffs (zinc). These particular metals are believed to come from a distinct but unknown source.

Thurber, J.L., and Welbourn, M.E., 1977, How Shell attempted to unlock Utah tar sands: Petroleum Engineer, November issue, p. 31-42.

(Sunnyside), This article contains: Introduction; Drive pilot theory (create an initial fracture by cold water injection, close vertical fractures formed during the cold water fracture treatment or that existed naturally, create a thin water layer and close the horizontal fracture, inject low-quality steam and gradually increase to high quality steam); Procedures followed and results.

Tom Brown, Inc, (no date given), Heavy oil prospect NW Asphalt Ridge, Uintah County, Utah: Unpublished consultant's , Midland, Texas.

(NW Asphalt Ridge), This report contains: Summary; Introduction; Geological setting; Stratigraphy (Cretaceous, Tertiary); Corehole program; Oil in place - Mesaverde Formation (Average oil in place, volume of oil-saturated sandstone); Oil in place - Tertiary strata; Physical and chemical properties of the oil; U.S. Bureau of Mines field thermal project; References; Two Appendices.

Tripp, B.T., 1985, Reconnaissance study of the Black Dragon tar sand deposit, T. 20-22 S., R. 12-13 E., San Rafael Swell, Emery County, Utah: Utah Geological and Mineral Survey Report of Investigation 194, 48 p.

(Black Dragon), (Cottonwood Draw), (Red Canyon), (Wickiup), (Justensen Flat), (Temple Mountain), (Flat Top), (Family Butte), (Chute Canyon), This report includes the following: Abstract; Introduction (study area boundaries, geography and geologic structure, ecologic setting, economic factors, previous work, scope and methods of study); Stratigraphy; Depositional and tectonic history of the Black Dragon deposit; Cottonwood Draw facies tar sand deposits (Cottonwood Draw, Red Canyon, Wickiup, Black Dragon); Other San Rafael Swell tar sand deposits (Justensen Flat, Temple Mountain, Flat Top, minor Chinle deposits, Family Butte, Chute Canyon and other Torrey Member deposits, Permian tar sand deposits); Summary and conclusions; Selected references; One appendix.

Tripp, B.T., 1986, Report of oil-impregnated sandstones of the Green River Formation, Argyle and Willow Creeks: Utah Geological Survey unpublished report, 4 p.

(Argyle Canyon), (Willow Creek), This report includes the following: Introduction; Willow Creek deposit (location, stratigraphy, significance); Argyle Creek deposit (location, stratigraphy, significance).

Tripp, B.T., 1986a, Argyle Canyon – Willow Creek tar sand deposit – isopach map: Utah Geological and Mineral Survey Open-File Report 100, scale 1:50,000.

(Argyle Canyon), (Willow Creek), This publication is an isopach map of the tar sand.

Tripp, B.T., 1986b, Argyle Canyon – Willow Creek tar sand deposit – overburden map: Utah Geological and Mineral Survey Open-File Report 101, scale 1:50,000.

(Argyle Canyon), (Willow Creek), This publication is an overburden map of the tar sand.

Tsai, C.H., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1991, Characterization and potential utilization of Whiterocks (Utah) tar sand bitumen, *in* Speight, J.G., editor, Fuel Science & Technology International: New York, Marcel Dekker, Inc., v. 9, no. 10, p. 1259-1286.

(Whiterocks), This article contains the following: Abstract; Introduction; Experimental (material, vacuum distillation, asphalt specification tests, elemental analysis and physical properties determination, simulated distillation, FTIR analysis, gas chromatography and mass spectrometry); Results and discussion (aviation turbine fuel potential, asphalt potential); FTIR analysis; GC_MS analysis (saturated cyclic hydrocarbons, aromatic hydrocarbons, oxygenated compounds); Conclusions; Acknowledgments; References.

Tsai, C.H., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1992, Characterization and potential utilization of Whiterocks (Utah) tar sand bitumen: Petroleum Science and Technology, v. 9, issue 10, p. 1259-1286.

(Whiterocks), This paper contains the following: Abstract; Introduction; Experimental (material, vacuum distillation, asphalt specification tests, elemental analysis and physical properties determination, simulated distillation, FTIR analysis, gas chromatography, and mass spectrometry); Results and discussion (aviation turbine fuel potential, asphalt potential, FTIR analysis, saturated cyclic hydrocarbons, aromatic hydrocarbons, oxygenated compounds); Conclusions; Acknowledgments; References; Eight figures and five tables.

Tsai, C.H., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1993, Characterization and potential utilization of the Asphalt Ridge tar sand bitumen - I. Gas chromatography – mass spectrometry and pyrolysis-mass spectrometry analyses: Fuel Science and Technology International, v. 11, nos 3 and 4, p. 475-506.

(Asphalt Ridge), This paper contains the following: Abstract; Introduction; Experimental (materials, vacuum distillation, Fourier transform infrared spectroscopic analysis, gas chromatography and mass spectrometry, asphalt specification tests, simulated distillation, Curie-point low voltage mass spectroscopic analysis); Results and discussions (gas chromatography-mass spectroscopic analyses, FTIR analysis, pyrolysis-mass spectroscopic analysis); Conclusions; Acknowledgments; References.

Tsai, C.H., Longstaff, D.C., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1991, Characterization and utilization of hydrotreated products produced from the Whiterocks (Utah), tar sand bitumen-derived liquid, *in* 1991 Eastern Oil Shale Symposium Proceedings - oil shale – tar sands – heavy oil (November 13-13, 1991, Hyatt Regency Lexington, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 79-90.

(Whiterocks), This article contains: Abstract; Introduction (experimental methods - fluidized bed pyrolysis unit, hydrotreater process unit, analysis of hydrotreated products, simulated distillation, FTIR analysis, gas chromatography-mass spectrometry analysis); Results and discussion (FTIR analysis, gas chromatography-mass spectrometry, alkanes and alkenes, monocyclic compounds, bicyclic compounds, tricyclic compounds, tetracyclic compounds, pentacyclic compounds, tetraterpenoids, hetroatom species, pyrolysis-hydrotreating reaction pathways); Conclusions; Acknowledgments; References; Five tables.

Tsai, C.H., Longstaff, D.C., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1992, Characterization and utilization of hydrotreated products produced from the Whiterocks (Utah), tar sand bitumen-derived liquid: Fuel, v. 71, p. 1473-1482.

(Whiterocks), This article contains: Abstract; Introduction; Experimental procedures (fluidized-bed pyrolysis unit, hydrotreater process unit, simulated distillation, FTIR analysis, GC-MS analysis); Results and discussion (FTIR analysis, GC-MS spectrometry [alkanes and alkenes, bicyclic compounds, tricyclic compounds, tetracyclic compounds, pentacyclic compounds, tetraterpenoids, heteroatom species], pyrolysis-hydrotreating reaction pathways); Conclusions, Acknowledgments; References.

Tsai, C.H., Longstaff, D.C., Deo, M.D., Hanson, F.V., and Oblad, A.G., 1992, Potential of jet fuels from Utah tar sand bitumens and bitumen-derived liquids: Presented before the Division of Petroleum Chemistry, Inc., American Chemistry Society, San Francisco Meeting, April 5-10, pagination not visible.

(Whiterocks), (Asphalt Ridge), This paper contains the following: Introduction; Experimental (materials, hydrotreating); Results; Jet fuel potential of the IBP-650^{o} F fractions of the native bitumens; Jet fuel potential of

bitumen-derived liquids; Conclusions; Acknowledgments; Literature cited; Four tables.

Turner, T.F., and Nickerson, L.G., 1986, Pyrolysis of Asphalt Ridge tar sand: Laramie, U.S. Department of Energy, Western Research Institute, 27 p. (Work performed under cooperative agreement DE-FC21-83FE60177).

(Asphalt Ridge), This report contains: Summary; Introduction; Experimental procedures (isothermal, non-isothermal); Results and discussion; Conclusions; Acknowledgments; References.

Uden, P.C., and Siggia, Sidney, editors, 1978, Analytical chemistry of liquid fuel sources – tar sands, oil shale, coal, and petroleum: Washington, D.C., American Chemical Society, Advances in Chemistry Series 170, 341 p.

(Numerous Utah Deposits), (NW Asphalt Ridge), (Athabasca), This book contains the following articles: Spontaneous combustion liability of subbituminous coals; Analysis of five U.S. coals; A ^{1}H and ^{13}C NMR study of the organic constituents in different solvent-refined coals as a function of the feed coal; Analysis of solvent-refined coal, recycle solvents, and coal liquefaction products; Structural characterization of solvent fractions from five major coal liquids by proton nuclear magnetic resonance; New techniques for measuring PNA in the workplace; Characterization of mixtures of polycyclic aromatic hydrocarbons by liquid chromatography and matrix isolation spectroscopy; Chromatographic studies in oil sand bitumens; Petroleum asphaltenes – chemistry and composition; Organometallic complexes in domestic tar sands; Analysis of oil produced during in situ reverse combustion of a Utah tar sand; Mass and electron paramagnetic resonance spectrometric analyses of selected organic compounds of Cretaceous shales of marine origin; A preliminary electron microprobe study of Green River and Devonian oil shales; Analysis of oil shale materials for element balance studies; Aspects of chromatographic analysis of oil shale and shale oil; Olefin analysis in shale oils; Comparative characterization and hydro-treating response of coal shale and petroleum liquids; High-precision trace element and organic constituent analysis of oil shale and solvent-refined coal materials; Chemical class fractionation of fossil-derived materials for biological testing; HPLC techniques for analysis of residual fractions; Analytical characterization of solvent-refined coals comparison with petroleum residua; Index.

Umoh, R.A., 1981, Steam cracking of Utah tar sand bitumen in a Kellogg millisecond furnace: Salt Lake City, University of Utah M.S. Thesis, 156 p.

(Asphalt Ridge), (Sunnyside), This thesis contains: Abstract; Acknowledgments; Introduction; Literature review (bitumen chemistry and characterization, recovery, extraction, and processing of Utah tar sands, mechanism of steam cracking and hydrocarbon cracking trends, technologies for gas, oil, and crude oil steam cracking, Cosmos process, Lurgi-Ruhrgas, BASF, ONIA, ACR and HOC processes); Experimental methods (sources and preparation of samples, reactor design, experimental procedure, analysis of products, material balance); Results and discussion (furnace performance, feedstock properties, hexane cracking, Redwash crude oil cracking, pyrolysis of hydropyrolyzed TS-IIC Asphalt Ridge bitumen, pyrolysis of TS-IIC Asphalt Ridge bitumen, kinetics of pyrolysis of TS-IIC bitumen, pyrolysis of virgin Asphalt Ridge bitumen, pyrolysis of virgin Sunnyside bitumen, feedstock properties and its effects on ethylene yield, mechanism of ethylene production from Utah bitumen); Conclusions; Three appendices; References, Vita.

UNITAR, 1983, First international survey of heavy crude and tar sands: UNITAR/UNDP information center for heavy crude and tar sands, 105 p.

(No Specific Deposits), This book contains: Executive summary; Table 1 (Africa, Asia Pacific, Europe, MiddleEast & Asia Minor, North America, South & Central America, Caribbeans); Tables 2 and 3; Appendices I and II, Figure I, Conversions.

UNITAR, 1984, 1988, 1989, Tables of contents for the second international conference – The future of heavy crude and tar sands, edited by Meyer, R.F., Wynn, J.C., and Olson, J.C., February 7-17, 1982 in Caracas, Venezuela; The third UNITAR/UNDP international conference on heavy crude and tar sands, edited by Meyer, R.F.,

July 22-31, 1985 in Long Beach, California, USA; The fourth UNITAR/UNDP international conference on heavy crude & tar sands (preprints with no editor listed), August 7-12, 1988, Edmonton, Alberta, Canada; and The fourth UNITAR/UNDP international conference on heavy crude and tar sands, proceedings, edited by Meyer, R.F., and Wiggins, E.J., August 7-12, 1988, Edmonton, Alberta, Canada.

(No Specific Deposits), This reference is a listing of tables of contents.

University of Kentucky, 1981-1993, Proceedings of the Eastern Oil Shale Symposia: University of Kentucky, Institute for Mining and Minerals Research, 91 p.

(Numerous Utah Deposits), This index gives the table of contents for the twelve Eastern Oil Shale Symposia held in Lexington, Kentucky from 1981 to 1993. Within the index are numerous references to investigations on Utah tar sands.

University of Kentucky, 1982-1993, Eastern Oil Shale Symposium Indexes for the years 1982-1984, and 1986 to 1993.

(Numerous Utah Deposits), This citation gives references to over 30 tar sand articles dealing with Utah tar sand deposits.

Untermann, G.E., and Untermann, B.R., 1950, Stratigraphy of the Split Mountain area: Intermountain Association of Geologists, *Guidebook* to the Geology of Utah, no. 5, p. 121-126.

(Split Mountain), This article contains: Description of area; Structure; Stratigraphy.

Urban, Dale, 1987, Bio Materials Profiling information: Salt Lake City, University of Utah, Bio Materials Profiling Center, 27 p.

(Asphalt Ridge), (Bonanza), (Gilsonite), (Oil Shale), (Hells Hole Canyon). This information consists of the following: Introduction; Experimental procedure (sample preparation, pyrolysis mass spectrometry, data analysis); Results and discussions; Spectra.

U.S. Bureau of Land Management, 1983a, San Rafael Swell special tar sands area, site specific analysis, Black Dragon tract: U.S. Bureau of Land Management, Moab District, 32 p.

(Black Dragon), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983b, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 1 tract: U.S. Bureau of Land Management, Moab District, 35 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983c, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 2 tract: U.S. Bureau of Land Management, Moab District, 38 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983d, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 3

tract: U.S. Bureau of Land Management, Moab District, 33 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983e, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 4 tract: U.S. Bureau of Land Management, Moab District, 29 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983f, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 5 tract: U.S. Bureau of Land Management, Moab District, 30 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983g, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 6 tract: U.S. Bureau of Land Management, Moab District, 33 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983h, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 7 tract: U.S. Bureau of Land Management, Moab District, 36 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983i, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 8 tract: U.S. Bureau of Land Management, Moab District, 37 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983j, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 9 tract: U.S. Bureau of Land Management, Moab District, 33 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983k, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 10 tract: U.S. Bureau of Land Management, Moab District, 27 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives;

Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983l, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 11 tract: U.S. Bureau of Land Management, Moab District, 29 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1983m, Sunnyside special tar sand area, site specific analysis, Sunnyside No. 12 tract: U.S. Bureau of Land Management, Moab District, 28 p.

(Sunnyside), This tract description includes the following: Description of the area; Issues and concerns identified with the tract; Description of alternatives; Affected environment; Environmental consequences of alternatives; Participating staff; References; Appendices.

U.S. Bureau of Land Management, 1984, Circle Cliffs combined hydrocarbon lease conversion), Draft Environmental Impact Statement): Cedar City, Utah, U.S. Bureau of Land Management, variously paginated.

(Circle Cliffs), This Draft EIS contains: Description of proposed actions and alternatives (introduction, proposed action, restricted development alternative, alternative technology, No action alternative, alternatives considered but eliminated from detailed analysis, and mitigation); Comparative analysis; Affected environment and environmental consequences (introduction, water resources, socioeconomics, soils vegetation, livestock grazing, wildlife, recreation and wilderness, visual resources, transportation systems, air quality, noise, agriculture, cultural resources, paleontology, and mineral resources, land use plans, policies, and programs); Site-specific mitigation, monitoring, irreversible/irretrievable commitments, unavoidable adverse impacts, and long-term environmental consequences; Consultation and coordination; List of preparers and contacts; Literature cited; Glossary, and Appendix A.

U.S. Bureau of Land Management, 1984, Final environmental impact statement on the Sunnyside combined hydrocarbon lease conversion: U.S. Bureau of Land Management, 453 p.

(Sunnyside), This report contains the following: Preface; List of preparers; Summary; Description of proposed actions and alternatives; Comparative analysis; Affected environment and environmental consequences; Site specific mitigation, monitoring, unavoidable, adverse, long-term environmental consequences, and irreversible and irretrievable commitment of resources; Comments and responses; References; Abbreviations; Glossary; Appendices.

U.S. Bureau of Land Management, 1985, Utah BLM statewide wilderness environmental impact statement – draft: Utah State Office, U.S. Bureau of Land Management, 402 p.

(No Specific Deposit), This report contains the following: Summary; Introduction; Description of the alternatives; Affected environment; Environmental consequences of alternatives; Coordination and consultation; List of preparers; Appendices 1-8; Glossary; Bibliography; Index.

U.S Bureau of Land Management, 2002, Final Mineral Report – Mineral potential report for the Vernal Planning Area: Vernal, United States Bureau of Land Management, 22 p.

(Argyle Canyon), (Willow Creek), (Pariette), (Asphalt Ridge), (Whiterocks), (P.R. Spring), (Sunnyside), (Hill Creek), (Raven Ridge), (Rim Rock), This report contains: Summary and conclusions (oil and gas, tar sand, gilsonite, oil shale, phosphate, mineral materials, locatable minerals, coal); Introduction (purpose, lands involved); Description of geology (regional geology, geologic formations containing mineral resources of note, geological structures); Description of mineral resources (mineral deposits, mineral exploration development, production history); Potential for occurrences and reasonable foreseeable development of mineral resources (oil and gas, tar

sand, gilsonite, oil shale, phosphate, mineral materials, locatable minerals, coal); References, Glossary.

U.S. Bureau of Land Management, 2007, Draft oil shale and tar sands resource management plan amendments to address land use allocations in Colorado, Utah, and Wyoming and programmatic environmental impact statement: U.S. Bureau of Land Management, v. 1, chapters 1-3, 420 p.

(Argyle Canyon), (Asphalt Ridge), (Hill Creek), (Pariette), (P.R. Spring), (Raven Ridge), (San Rafael Swell), (Sunnyside), (Tar Sand Triangle), (White Canyon), Volume 1 includes the following: Notation, English/metric and metric/English equivalents; Executive summary; Introduction (purpose and need, scope of the analysis, cooperating agencies, relationship of the proposed action to other BLM and cooperating agency programs policies and plans); Descriptions of alternatives (introduction, existing statutory requirements and BLM policies potentially applicable to oil shale and tar sands development, oil shale, tar sands, alternatives and issues considered but eliminated from detailed analysis, comparison of alternatives, references); Affected environment (land use, geological resources and seismic setting, paleontological resources, water resources, air quality and climate, existing acoustic environment, ecological resources, visual resources, cultural resources, socioeconomics); Figures.

U.S. Bureau of Land Management, 2007, Draft oil shale and tar sands resource management plan amendments to address land use allocations in Colorado, Utah, and Wyoming and programmatic environmental impact statement: U.S. Bureau of Land Management, v. 2, chapters 4-6, 673 p.

(No Specific Deposits), Volume 2 includes the following: Notation; English/metric and metric/English equivalents; Effects of oil shale technologies (Assumptions and impact-producing factors for individual facilities by commercial oil shale technology, land use, soil and geologic resources, paleontological resources, water resources, air quality and climate, noise resources, ecological resources, visual resources, cultural resources, socioeconomics, environmental justice, hazardous materials and waste management, health and safety, references); Effects of tar sands technologies (assumptions and impact-producing factors for individual facilities by commercial tar sands technology, land use, soil and geologic resources, paleontological resources, water resources, air equality and climate, noise resources, ecological resources, visual resources, cultural resources, socioeconomics, environmental justice, hazardous materials and waste management associated with tar sands development, health and safety, references); Impact assessment for oil shale and tar sands alternatives (oil shale alternatives, tar sands alternatives, endangered species action section 7 requirements, references); Figures.

U.S. Bureau of Land Management, 2007, Draft oil shale and tar sands resource management plan amendments to address land use allocations in Colorado, Utah, and Wyoming and programmatic environmental impact statement: U.S. Bureau of Land Management, v. 3, chapters 7-9, 371 p.

(No Specific Deposits), Volume 3 includes the following: Notation, English/metric and metric/English equivalents; Consultation and coordination (public scoping, government-to-government consultation, coordination of BSM state and field offices, agency consultation and coordination, explanation of the public protest process for the proposed land use plan amendments, references); List of preparers; Glossary; Appendix A (oil shale development background and technology overview; Appendix B (tar sands development background and technology overview); Appendix C (proposed land use plan amendments associated with alternatives a and c for oil shale and tar sands); Appendix D (federal, state, and county regulatory requirements potentially applicable to oil shale and tar sands development projects); Appendix E (threatened and endangered species within the oil shale and tar sands study area); Appendix F (proposed conservation measures for the preferred alternative); Appendix G (socioeconomic and environmental justice analysis methodologies), Appendix H (approach used for interviews of selected residents in the oil shale and tar sands study area).

U.S. Bureau of Land Management, 2008, Proposed oil shale and tar sands resource management plan amendments to address land use allocations in Colorado, Utah, and Wyoming and final programmatic environmental impact statement: U.S. Bureau of Land Management (volumes 1-4, chapters 1-8), variously paginated.

(Argyle Canyon), (Asphalt Ridge), (Hill Creek), (Pariette), (P.R. Spring), (Raven Ridge), (San Rafael Swell), (Sunnyside), (Tar Sand Triangle), (White Canyon), This four-volume publications contains the following: (Volume 1) Executive summary; chapter 1 – Introduction; Chapter 2 – descriptions of alternatives; Chapter 3 – affected environment; Chapter 4 – effects of oil shale technologies; (Volume 2) Chapter 5 – effects of tar sands technologies; Chapter 6 – impact assessment for oil shale and tar sands technologies; (Volume 3) Chapter 7 – Consultation and coordination; Chapter 8 – Lists of preparers; Chapter 9 – glossary; Appendix A – oil shale development background and technology overview; Appendix B – tar sands development background and technology overview; Appendix C – proposed land use plan amendments associated with alternatives B and C for oil shale and tar sands; Appendix D – federal, state, and county regulatory requirements potentially applicable to oil shale and tar sands development projects; Appendix E – threatened and endangered species within the oil shale and tar sands study area; Appendix F – proposed conservation measures for oil shale and tar sands leasing and development; Appendix G – socioeconomic and environmental justice analysis methodologies; Appendix H – approach used for interviews of selected residents in the oil shale and tar sands study area; Appendix I – in stream flow water rights in the Piceance Basin, Colorado; (Volume 4) Comments and responses (CD in back of volume 3).

U.S. Bureau of Mines, 1943, Whiterock River bituminous sandstone deposit, Uintah County, Utah: War Minerals Report to Secretary of the Interior, Harold L. Ickes, 16 p.

(Whiterocks), This report contains: Summary; Introduction; History; Location; Labor and living conditions; Topography and climate; Geology and stratigraphy; Description of the deposit; Samples and products; Method of extraction; Method of mining; Reserves; Plans for company operations; Proposed exploration by the U.S. Bureau of Mines; Conclusions.

U.S. Bureau of Mines, 1974, Draft environmental assessment for proposed reverse combustion oil recovery experiments in NW Asphalt Ridge tar sand deposit near Vernal, Uintah County, Utah: U.S. Bureau of Mines, 27 p.

(Asphalt Ridge), This report contains; Summary; Description of the proposed action; Description of the environment; Environmental impact; Mitigating measures included in the proposed action; Unavoidable adverse effects; Relationship between local short-term used of man's environment and the enhancement of long-term productivity; Irreversible and irretrievable commitment of resources; Alternatives to the proposed action; Agencies and individuals contacted for comment; References.

U.S. Congress, 2005, Energy policy act of 2005, Public Law 109-58: United States Congress, 551 p.

(No Specific Deposits), This act contains the following: Energy efficiency; Renewable energy; Oil and gas; Coal; Indian energy; Nuclear matters; Vehicles and fuels; Hydrogen; Research and development; Department of Energy management; Personnel and training; Electricity; Energy policy tax incentives; Miscellaneous; Ethanol and motor fuels; Climate change; Incentives for innovative technologies; Studies; Definitions.

U.S. Department of Energy, no date, Fact Sheet – U.S. tar sands Potential: U.S. Department of Energy Office of Petroleum Reserves – Strategic Unconventional Fuels, 2 p.

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), (Other), This fact sheet includes the following: Background; U.S. tar sand resources; Tar sands technology; Tar sand economics; Markets for oil from tar sands; Tar sands economic data.

U.S. Department of Energy, 1979, U.S. tar sand oil forecasts (1985-1995): U.S. Department of Energy Technical Report DOE/EIA-0183/15, 46 p.

(P.R. Spring), (Sunnyside), (Hill Creek), (Asphalt Ridge), (Tar Sand Triangle), (Circle Cliffs), This report contains: Preface; Executive summary; Introduction; Resources; Description of mining, processing, and upgrading facilities; Assumptions; Minimum acceptable price; Tar sand oil value and transportation cost; Development pattern; Forecasts; Uncertainties and alternate concepts; Summary and conclusions; References; Tables.

U.S. Department of Energy, 1980, Toward a definition of tar sands: U.S. Department of Energy, Reston, Virginia, variously paginated.

(Tar Sand Triangle), (P.R. Spring), (Sunnyside), This report includes the following: Introduction; Definitions; Resource location and characteristics; Summary of presentations; Summary of write-in definitions; Summary of discussion; Conclusions; Attachments 1-3, Exhibits (1-Major U.S. tar sands deposits, 2-Production from EOR projects by viscosity, 3-Summary of proposed definitions).

U.S. Department of Energy, 1981, A facsimile report (on tar sands): U.S. Department of Energy, (DOE/LETC/RI-81-2), 294 p.

(Numerous Utah Deposits), This report is a bibliography related to tar sands from many areas, and includes the following: Introduction; Indexes (author, subject, geology and resource evaluation, chemical and physical properties, mining and surface extraction, in situ recovery, upgrading and refining, history, environmental, miscellaneous, and patents).

U.S. Department of Energy, 1988, Third annual oil shale, tar sand, and mild gasification contractors review meeting – agenda, project synopses, list of participants: U.S. Department of Energy, Office of Fossil Energy, Morgantown Energy Technology center (July 19-21, 1988), variously paginated.

(No Specific Deposits), This book contains: Oil shale I – Session IA-Oil shale properties and behavior; Session IB-Mild gasification; Oil shale II – Session 2A-Oil shale surface processes R&D; Session 2B-Tar Sand I-; Oil shale III – Session 3A-mining, material handling and in-situ processes; Session 3B-Tar sand II; Session 4A-Oil shale IV Environmental R&D. Thirteen abstracts of talks within each session are given in the book.

U.S. Department of Energy, 2007, Fact Sheet – U.S. Tar Sands Potential: DOE Office of Petroleum Reserves – Strategic Unconventional Fuels, 2 p.

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), (Other), This fact sheet contains the following: Background; U.S. tar sand resources; Tar sand technology; Tar sands economics; Markets for oil from tar sands; Tar sands environmental data; References.

U.S. Department of Energy, 2007, Secure fuels from domestic resources – the continuing evolution of America's oil shale and tar sand industries: U.S. Department of Energy, Office of Petroleum Reserves, Office of Naval Petroleum and Oil Shale Reserves, 64 p.

(Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Asphalt Ridge), (Circle Cliffs), This publication includes the following: A word from the Office of Petroleum Reserves; An historical perspective – secure fuels from domestic resources; America's oil shale and tar sands resources (oil shale, tar sands); The evolution of oil shale and tar sands technology (tar sands, oil shale); Oil shale and tar sands company profiles – companies investing today to advance technology to provide clean secure fuels for tomorrow; Suggested reading; References; Tables and figures.

U.S. Geological Survey, 2006, Natural bitumen resources of the United States: U.S. Geological Survey Fact Sheet 2006-3133, 2 p.

(Numerous Utah Deposits), This information sheet contains: Introduction; Tar-sand resource summary; Natural bitumen characterization team; References.

U.S. National Park Service, 1980, Mineral Management Plan – Glen Canyon National Recreation Area, Arizona and Utah: U.S. National Park Service, 37 p.

(Tar Sand Triangle), This resource management plan contains: Introduction and orientation; Management zoning plan; Proposed boundary adjustments; Proposals for land exchange; Mineral Management Plan; Contiguous areas of wilderness, primitive or natural character; Mineral resources (oil-impregnated rocks, pilot fire flood project, oil and gas, coal, uranium, Shootering canyon uranium project, vanadium, copper, manganese and gold, construction materials, halite and gypsum, availability of mineral resources (summary); Land ownership, mineral interests, and access (state lands and mineral interests, federal oil and gas leases and mining claims, access to mineral interests); Consultation and coordination with others; Bibliography; The planning team and consultants; Appendices.

U.S. National Park Service and U.S. Bureau of Land Management, 1984, Draft environmental impact statement on conversion of oil and gas leases to combined hydrocarbon leases – Tar Sand Triangle, Utah: U.S. Department of the Interior, National Park Service and Bureau of Land Management, variously paginated.

(Tar Sand Triangle), This book contains: Purpose of and need for action (introduction, background, NPS finding of no resulting significant adverse impact, scope of the analysis, interrelationship with other proposals); Alternatives including the proposed action (overview of the alternatives, alternatives considered but eliminated, description of the alternatives, evaluation and comparison of the alternatives, agency preferred alternative); Affected environment (natural environment, cultural resources, socioeconomic environment, land use, recreation and wilderness values); Environmental consequences (alternative 1-convert all leases (proposed action), alternative 2A convert leases with additional protective restrictions, alternative 2B deny conversion on BLM WSA lands, alternatives 2A, 2B, and 2C unavoidable adverse impacts); Consultation and coordination (introduction, scoping process and issues, agencies and organizations consulted, list of agencies/organizations and persons to whom copies of the statement are sent, preparers and consultants; References; Seven appendices).

Utah Division of Environmental Health, 1985, ENERCOR – Site inspection Report: Utah Division of Environmental Health, variously paginated.

(No Specific Deposit), This inspection report contains the following: Executive summary; Site inspection report; EPA site inspection form 2070-13 (7-81); Attachment A – Population data; Attachment B – Warning letter to Enercor; Attachment C – Well data; Attachment D – Laboratory analysis sheets; Attachment E – photographs.

Utah Division of Oil & Gas Conservation, 1974, Preliminary environmental impact analysis – a proposed oil extraction and strip-mining project: Utah Division of Oil & Gas Conservation, 7 p.

(Asphalt Ridge), This paper includes the following: Proposed action; Geology, exploration, and exploitation; Location and natural setting; Effects on the environment by the proposed action; Alternatives to the proposed action; Conclusion and mitigating factors; References, Two figures.

Utah Energy Office, 1980, An assessment of oil shale and tar sand development in the State of Utah, Phase 1: Salt Lake City, Utah Energy Office, 79 p.

(Asphalt Ridge), (Sunnyside), (Tar Sand Triangle), (P.R. Spring), (Hill Creek), (Circle Cliffs), This document includes the following: Preface; Executive Summary; Introduction; Current status (oil shale, tar sand development, constraints and problems, production scenarios); Oil shale projects in Utah (White River Shale project, Paraho project, Tosco Sand Wash project, Geokinetics Inc. in-situ project); Tar Sand projects in Utah (Sohio Natural Resources Company, Great National Corporation project); References. Tables include the following: Utah tar sands characteristics, production scenarios, mining scenarios, White River Shale project, White River Dam, Paraho Oil Shale project, Tosco Sand Wash project, Geokinetics oil shale project, Sohio tar sand project, Great National tar sand project. This publication is a description of the potential development

scenario as revealed through individual project proposals and as considered likely to actually occur by 1990 by the U.S. Department of Energy in concurrence with the State of Utah. The Utah Energy Office compiled all the information provided by the individual company proposals and the Uintah Basin Association of Governments into this document.

Utah Energy Office, 1982, An assessment of oil shale and tar sand development in the State of Utah – Phase 2 – Policy analysis: Salt Lake City, Utah Energy Office, variously paginated. (Prepared for the U.S. Department of Energy, grant no. DE-FG48-80R807255)

(No Special Deposits), This book contains: Acknowledgments, Section I - Summary and policy analysis (introduction, summary of findings, policy analysis); Section II – Supporting analysis (introduction, overview of synthetic fuels development, leasing and permitting, aggregate production and input requirements, aggregate emissions); Appendix (time schedule of project development, map of proposed Utah projects, project descriptions); Glossary.

Utah Energy Office, 1983, Status report on Utah tar sand development: Utah Energy Office, 4 p.

(Numerous Utah Deposits), This report contains the following: Introduction; Tar sand recovery methods (in-situ, surface mining, application of recovery methods); Table giving tar sands development activity in the state.

Utah Engineering Experiment Station, 1984, Economic evaluation of oil shale and tar sands located in the state of Utah, Final report, Appendix 2 – borehole analysis and block grade estimation: Utah Engineering Experiment Station, variously paginated.

(No Specific Deposit), This appendix contains six sections as follows: Appendix 2.1 – Drill hole interval program (introduction, program operation, methodology, program structure); Appendix 2.2 – Semivariogram program (introduction, program operation, methodology, program structure, references); Appendix 2.3 – Kriging program (introduction, program operation, methodology, program structure, references); Appendix 2.4 – Section plot program (Introduction, program operation, program structure); Appendix 2.5 – Base map plot program (introduction, program operation, program structure); Appendix 2.6 – drill hole locate program (introduction, program operation, program structure).

Utah Engineering Experiment Station, 1984, Economic evaluation of oil shale and tar sands located in the State of Utah, Final report, Appendix 3 – mine costing: Utah Engineering Experiment Station, variously paginated.

(No Specific Deposit), This appendix contains three sections as follows: Appendix 3.1 – Tar sand processing costs (introduction, output report, computer coding); Appendix 3.2 – Open pit mining costs (introduction, output report, computer coding); Appendix 3.3 – Room and pillar underground mining costs (introduction, preparation of detailed cost estimates, cost curves, timing of expenditures).

Utah Engineering Experiment Station, 1984, Economic evaluation of oil shale and tar sands located in the state of Utah, Final report, Appendix 4 – The economic evaluation model: Utah Engineering Experiment Station, variously paginated.

(No Specific Deposit), This appendix contains two sections as follows: Appendix 4.1 – OSHVAL.F (introduction, description of printout options, selection of printout options, structure of the computer program, data entry worksheet, OSHVAL.F, appendix); Appendix 4.2 – Bayes.F.

Utah Geological and Mineral Survey, 1975, Energy resources map of Utah: Utah Geological and Mineral Survey Map 36, scale 1:500,000.

(Numerous Utah Deposits), This map includes the following: Power resources, Fossil fuels; Electric power distribution; Geology; Power plants; Uranium; Geothermal.

Utah Geological and Mineral Survey, 1976, A proposal to evaluate oil-impregnated sandstone in the Uinta Basin, northeast Utah: Utah Geological and Mineral Survey unpublished proposal, 22 p.

(Sunnyside), (P.R. Spring), (Asphalt Ridge), This proposal contains: Introduction; Purpose; Analyses of cores (rock properties, petroleum, water); Chemical analyses of extracted petroleum (API gravity, specific gravity, pour point, sulfur content, carbon content, hydrogen content, nitrogen content); Sulfur isotope determinations; Specifications (cores, analyses); Estimated costs (Sunnyside deposit only); UGMS contribution to proposed work; References; Three tables, and several illustrations.

Utah Geological and Mineral Survey, 1977, Energy resources map of Utah: Utah Geological and Mineral Survey Map 44, scale 1:500,000.

(Numerous Utah Deposits), This map includes the following: Power resources, Fossil fuels; Electric power distribution; Geology; Power plants; Uranium; Geothermal.

Utah Geological and Mineral Survey, 1983, Energy resources map of Utah: Utah Geological and Mineral Survey Map 68, scale 1:500,000.

(Numerous Utah Deposits), This map includes the state's energy resources, including Geology (Precambrian outcrops, normal and thrust faults, anticlines and synclines); Gas and oil fields, pipelines, refineries, gas processing plants; Oil-impregnated rock; Gilsonite; Oil shale; Coal; Uranium; Geothermal; and Electricity.

Utah Geological Survey, no date, Tar sand samples and lithologic logs from Enercor in the Survey's Utah Core Research Center.

(P.R. Spring), This packet of information gives footages of Enercor cores in the Utah Geological Survey Core Research Center, locations of holes, and available footages. It also indicates that lithologic logs are available for most of the holes (84-1A, 2, 2A, 3A, 4A, 5, 5A, 6A, 9A, 10A, 11A, 12A, 13A).

Utah Geological Survey, 2004, Listing of Utah tar sand cores and cuttings listed in the Utah Geological Survey Core Research Center catalog.

(Sunnyside), (Circle Cliffs), (Tar Sand Triangle), (Seep Ridge), (P.R. Spring), (Whiterocks), (Hill Creek), The preceding tar sand deposits are listed as having representative core in the Utah Geological Survey Core Research Center.

Utah Heavy Oil Program, 2007, A technical, economic, and legal assessment of North American heavy oil, oil sands, and oil shale resources: Utah Heavy Oil Program, University of Utah, Institute for Clean and Secure Energy, variously paginated.

(Numerous Utah Deposits), This report includes the following: List of figures, tables, acronyms, and units; Executive summary; Introduction; Utah heavy oil program ArcIMS – Map server Interface; The North American unconventional oil resource; Production/processing technologies for unconventional oil resources; Upgrading and refining; Economic and social issues related to unconventional oil production; Environmental, legal, and policy issues related to unconventional fuel resource development on the public lands.

Utah Mining Association, 1959, Utah's mining industry - an historical, operational, and economic review of Utah's mining industry, 2nd edition: Salt Lake City, Utah Mining Association, 133 p.

(No Specific Deposits), This publication includes the following: Foreword, Other available material on Utah mining; Historical development of Utah's mining industry; Operational practices and procedures in Utah's mining industry; Economic review of Utah's mining industry (Production summary by counties); Appendix.

Utah Mining Association, 1967, Utah's mining industry - an historical, operational, and economic review of Utah's mining industry, 3rd edition: Salt Lake City, Utah Mining Association, 135 p.

(No Specific Deposits), This publication includes the following: Foreword, Other available material on Utah mining; Historical development of Utah's mining industry; Operational practices and procedures in Utah's mining industry; Economic review of Utah's mining industry (Production summary by counties); Appendix.

Veatch, Franklin, and Alford, H.E., 1979, Recovery of bitumen from tar sands, United States Patent No. 4,174,263, 7 p.

(Patent), (Asphalt Ridge), Bitumen is separated from tar sands by contacting the tar sands with a small amount of liquid, heating the liquid treated tar sands to expand the liquid as a vapor thereby reducing the density of the bitumen and separating the bitumen from the remainder of the tar sands on the basis of density.

Veil, J.A., and Puder, M.G., 2006, Potential ground water and surface water impacts from oil shale and tar sands energy-production operations: Argonne, Argonne National Laboratory, 42 p.

(No Specific Deposits), This report includes the following: Chapter 1 – introduction (background, U.S. efforts relating to oil shale and tar sands, purpose of this report, contents of report); Chapter 2 – Oil shale and tar sands – resources and technologies (oil shale resources, oil shale production technology, tar sand resources, tar sands production technology); Chapter 3 – Impacts on ground and surface water (water quantity, ground water quality, surface water quality); Chapter 4 – Regulatory programs in the United States (federal, state); Chapter 5 – Regulatory requirements for oil sands production in the providence of Alberta (Oil Sands Conservation Act and Oil Sands Conservation Regulations, Mines and Minerals Act and Regulaltions, Alberta Environmental Protection and Enhancement Act and associated regulations, Water Act and associated regulations, Public Lands Act and associated regulations); Chapter 6 – What is needed to move forward? (water quantity and quality information and research needs, waste generation and management information and research needs, other environmental issues information and research needs, production technology information and research needs, infrastructure information and research needs, legal and regulatory needs, upcoming oil shale symposium); Chapter 7 – References; Appendix A – Additional reference materials; Three figures; Two tables.

Venkatesan, V.N., 1980, Fluid bed thermal recovery of synthetic crude from bituminous sands of Utah: Salt Lake City, University of Utah Ph.D. Dissertation, 319 p.

(**Sunnyside), (Tar Sand Triangle),** This dissertation contains: Abstract; Acknowledgments; Introduction (reserves and utilization of coal and oil shale, bituminous sand definition, world and U.S. reserves of bituminous sands, origin and geology, properties of bituminous sands, nature of bitumen in bituminous sands), Recovery of bitumen or production of synthetic crudes from bituminous sands (interest in commercial development of bituminous sands, factors influencing the choice of recovery methods, in-situ recovery schemes, surface-mined recovery methods, high temperature above ground recovery processes, process selection, research objectives); Experimental work (fluid bed reactor assembly, introduction and withdrawal of solids, oil product recovery system, bituminous sand feed preparation, calibration procedures, operational procedures, product analysis, material balance); Results and discussion (effect of operating variables on yield and product distribution, characterization studies on extracted bitumen and synthetic liquid); Conclusions and recommendations; Appendices (thermogravimetric analysis of the bituminous sands of Utah, design of the fluidized bed reactor, fluidized studies at high temperatures, hydrocarbon mist removal, material balance calculations); References, Vita. In this investigation an experimental program was conducted to determine the feasibility of an aboveground fluidized bed thermal process for the recovery of a synthetic crude from the mineable bituminous sand deposits of Utah.

Venkatesan, V.N., Hanson, F.V., and Oblad, A.G., 1979, The thermal recovery of a synthetic crude from the bituminous sands of the Sunnyside (Utah) deposit, *in* Meyer, R.F., and Steele, C.T., editors, The Future

of Heavy Crude Oils and Tar Sands (First International Conference, June 4-12, 1979, Edmonton, Alberta, Canada): New York, McGraw Hill, p. 556-563.

(Sunnyside), This report has the following sections: Abstract; Introduction; Experimental apparatus; Results and discussion (effect of temperature on product quality, effect of solids retention time on yield, effect of particle size and particle size distribution on yield); Conclusions. Figures 62-1 through 62-5, and Tables 61-1 through 62-4 give the experiment results.

Venkatesan, V.N., Hanson, F.V., and Oblad, A.G., 1981, A fluidized bed-thermal pyrolysis process for the recovery of a bitumen derived liquid from the bitumen impregnated sandstone deposits of Utah: Paper submitted to the 1981 Spring National Meeting, American Institute of Chemical Engineers, April 5-9, Houston, Texas, 41 p.

(Sunnyside), (Tar Sand Triangle), This paper includes the following: Abstract; Introduction; Experimental apparatus and procedures; Discussion of results (effect of temperature on product distribution and liquid product quality - Sunnyside bituminous sand, effect of solids retention time on product distribution and liquid product quality, effect of temperature on product distribution and liquid product quality – Tar Sand Triangle feed); Conclusions; Acknowledgments; References; Twelve figures and fourteen tables.

Versar Inc., no date, Site visit report, ENERCOR tar sands conversion facility, Salt Lake City, Utah: Springfield, Versar Inc., 86 p.

(No Specific Deposit), This report includes the following: Abstract; Table of contents; List of figures and tables; Introduction (objectives of the Fossil Energy Waste Project, introduction to testing site); Safety considerations; Facility description; Specific sampling criteria (sampling rationales, feedstock tar sand sampling, spent tar sand sampling); Sample processing (general considerations, feedstock tar sand processing, spent tar sand processing); Sampling documentation and sample management (sample documentation, sample management); Quality assurance/quality control; Appendix.

Wallace, D, Starr, J, Thomas, K.P., and Dorrence, S.M., 1988, Characterization of oil sand resources (Report on the activities concerning annex 1 of the U.S.-Canada cooperative agreement on tar sand and heavy oil): Edmonton, Alberta Oil Sands Technology and Research Authority, 50 p.

(Athabasca), (Asphalt Ridge), This report contains the following: List of tables and figures; Introduction (incentives, work plan); Characterization of an oil sand deposit (background, geological description, engineering description, sample description); Evaluation of existing capabilities for analyzing bitumen and heavy oil (background, results of cooperative studies); Comparison of analytical data from the Western Research Institute and the Alberta Research Council (background, cooperative studies, exchange of oil sand samples); Contribution of sample preparation to variability in analytical data (background, experimental design, design and interpretation of factorial experiments, results and discussion); Conclusions from laboratory studies; Acknowledgments; References; Appendix A; Appendix B; Appendix C.

Walters, E.J., 1982, Review of the world's major oil sand deposits, *in* Ball, Douglas, Marchant, L.C., and Goldburg, Arnold, editors, The IOCC monograph series – Tar Sands: Oklahoma City, Interstate Oil Compact Commission, p. 1-11.

(Asphalt Ridge), (Sunnyside), (Whiterocks), (Tar Sand Triangle), (P.R. Spring), (Circle Cliffs), This article contains: Introduction; Oil sands (Melville Island, Canada, Utah deposits, California (LaBrea) deposits, and deposits in Kentucky, New Mexico, Missouri, Trinidad, Guanoco deposit of eastern Venezuela, Colombia, Madagascar, Albania, Romania, Russia, and others); References.

Wang, C.J., 1984, The solubility of carbon dioxide in tar sand bitumens: Salt Lake City, University of Utah M.S. Thesis, 92 p.

(Tar Sand Triangle), (P.R. Spring), (Athabasca), This thesis contains: Abstract; Nomenclature; Acknowledgments; Introduction (primary production of petroleum, enhanced oil recovery, carbon dioxide flooding, tar sands); Literature survey (the effect of dissolved carbon dioxide in crude oil, bitumen viscosity, theoretical background for solubility prediction, mechanisms of oil displacement by carbon dioxide, laboratory and field studies); Experimental apparatus and procedure (sample preparation, characterization, solubility determination); Results and discussions (effect of temperature and pressure on solubility, effect of characteristic factors, solubility prediction, proposal for future work, summary); Conclusions; Four appendices; References; Vita.

Wang, Jueh, 1983, The production of hydrocarbon liquids from a bitumen-impregnated sandstone in a fluidized bed pyrolysis reactor: Salt Lake City, University of Utah M.S. Thesis, 160 p.

(Whiterocks), (Tar Sand Triangle), This thesis contains: Abstract; Acknowledgments; Introduction (tar sand resources, tar sand characteristics); Tar sand recovery techniques (in-situ recovery, surface recovery, research objectives); Experimental configuration and procedure (experimental apparatus, tar sand feedstock, product analysis and material balance); Experimental results and discussion (one-variable-at-a-time technique – Tar Sand Triangle deposit, properties of the native bitumen and the bitumen-derived liquids from the Tar Sand Triangle deposit, statistical design of experiments – Whiterocks tar sands sample, properties of the native bitumen and the bitumen-derived liquid from the Whiterocks tar sand deposit); Conclusions and recommendations; Two appendices; References.

Warren, J.E., Reed, R.L., and Price, H.S., 1960, Theoretical considerations of reverse combustion in tar sands: Society of Petroleum Engineers, Petroleum Transactions (AIME), v. 219, p. 135-149.

(No Specific Deposits), This paper contains: Abstract; Introduction; Formulation of the problem (the effective reaction rate, the quasi steady-state approximation); Statement of the problem; Solutions to the problem (physical approximations, mathematical approximations); Results; Conclusions and comments; Nomenclature; Acknowledgments; References; Four appendices - Appendix A – the first integral; Appendix B – constant rate.

Warriner, J.B., 1986, Acoustic emissions for the determination of production front locations in tar sand, *in* Westhoff, J.D., and Marchant, L.C., editors, Proceedings of the 1986 tar sands symposium: Laramie, Western Research Institute, p. 318-323.

(NW Asphalt Ridge), This article contains the following: Abstract; Introduction (objectives of study, status of study); Discussion (data acquisition equipment, data interpretation software, laboratory testing procedures, field testing procedures); Summary; Acknowledgments; References.

Wayland, J.R., Jr., Lee, K.O., and Cabe, T.J., 1987, CSAMT mapping of a Utah tar sand steamflood: Journal of Petroleum Technology, March 1987 edition, p. 345-352.

(NW Asphalt Ridge), This article includes the following: Summary; Introduction; CSAMT mapping technique; TS-1S CSAMT measurements; Analysis; Conclusions; Nomenclature; Acknowledgments; References.

Weeks, J.K., Jr., 1977, Fluidized-bed processing of Utah tar sands: Salt Lake City, University of Utah M.S. Thesis, 80 p.

(Sunnyside), (Asphalt Ridge), (Tar Sand Triangle), (Athabasca), This thesis contains: Abstract; Acknowledgments; Introduction; Physical characteristics of oil-impregnated rock; Fluidized-bed processing of oil-impregnated rock; Experimental configuration and design (fluidized-bed reactor design, product recovery system design, process control and instrumentation); Experimental procedure (operating conditions, operating procedure); Results; Discussion; Conclusions and recommendations; References; Vita.

Wells, H.M., Bunger, J.W., and Jensen, G.F., 1984, Economic evaluation of oil shale and tar sand resources located

in the State of Utah – final report: University of Utah, Utah Engineering Experiment Station, variously paginated.

(No Specific Deposits), This report contains: Executive summary; Conclusions and recommendations; Introduction; Data acquisition and characterization (discussion of data requirements, discussion of data quality, definition of data, data collection, information sources); Economic evaluation (the concept of value, the assessment of value, the economic evaluation model); Other economic analyses (Bayesian analysis, optimization of public benefits); Acknowledgments; Four appendices - Appendix 1 – Data storage and retrieval programs, user operation manuals (general database management, drill hole database management); Appendix 2 – Borehole analysis and block grade estimation, user operation manuals (drill hole interval program, semivariogram program, Kriging program, section plot program, basemap plot program, and drill hole locate program); Appendix 3 – Cost estimation programs, user cooperation manuals (tar sand processing costs, open pit mining costs, room and pillar underground mining costs); Appendix 4 – Economic evaluation programs, user operation manuals (OSHVAL.F, and BAYES.F).

Wenger, W.J., Hubbard, R.L., and Whisman, M.L., 1952, Separation and utilization studies of bitumens from bituminous sandstones of the Vernal and Sunnyside, Utah deposits (Part II, Analytical data on asphalt properties and cracked products of the separated bitumens): U.S. Bureau of Mines Report of Investigation 4871, p. 11-28.

(Asphalt Ridge), (Sunnyside), This report contains: Separation of bitumens from diluent; Properties of bitumens; Possible utilization of bitumens (use with minimum processing as asphalt and fuel oil); Utilization after coking distillation (as burner fuel and motor fuels). Twelve tables provide technical data.

Wenger, W.J., and Morris, J.C., 1971, Utah crude oils - characteristics of 67 samples: U.S. Bureau of Mines Report of Investigation 7532, 51 p.

(P.R. Spring), (Asphalt Ridge), (Whiterocks), (Elaterite Basin), This report has the following: Introduction; Acknowledgments; General characteristics of the oils (sulfur content, asphalt, nitrogen, and wax, color viscosity and yields of straight-run gasoline, correlation index); References. Figures include oil and gas fields of Utah, oil and gas fields in and near the Uinta and Green River basins, oil and gas fields in the Paradox and Kaiparowits basins, waxy oils from Tertiary formations, oils from Ashley Valley field, oils from Lisbon field, surface seeps and natural asphalts. Tables include crude oil production in Utah, cumulative crude oil production for areas in Utah, estimated cumulative crude oil production for formations in each of nine geological time periods, identification and properties of Utah crude oils, and estimated cumulative crude oil production for Utah by sulfur content.

Western Oil Reporter, 1974, Syn-fuels news - two oil sand semi-works plants set for Utah: Western Oil Reporter, p. 8-9.

(Asphalt Ridge), This article contains: Introduction; Production plans; Fairbrim plant; Sohio plant; Mining methods; Management changes; Regulatory approval.

Western Research Institute, 1985, Control technology research, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Morgantown, West Virginia, United States Department of Energy, Office of Fossil Energy, Technical Information Center, Office of Scientific and Technical Information, Project Contract No. DE-FC21- 83FE60177, p. 65-72.

(Asphalt Ridge), This article contains: Background statement; Project description and results (research, characterization studies, treatability studies, concentrating sludge, sludge disposal, toxicity tests, particle size, presence of clay minerals); Future work; References; Four tables and one figure.

Western Research Institute, 1985, Recovery process evaluation, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Morgantown, West Virginia, United States Department of Energy, Office of Fossil

Energy, Technical Information Center, Office of Scientific and Technical Information, Project Contract No. DE-FC21-83FE60177, p. 58-64.

(Asphalt Ridge), This article contains: Background statement; Objectives; Project description (incorporation of both one- and three-dimensional reactor systems, screening tests for the determination of optimal preheat temperature, from results of steam flood screening tests a three-dimensional block experiment was designed, one-dimensional tube studies of reverse combustion, six tube tests and one block test used to evaluate hot gas injection, block test for hot gas injection used a 261-lb block of tar sand); Results; Key accomplishments (identification of the optimum preheat and steam flux rate for steamflooding an Asphalt Ridge tar sand, successful simulation of a tar sand field steamflood, use of reverse combustion as a production and preheat mechanism for tar sand production, identification of hot gas injection as a preheat and production process in a tar sand which contains a communication path); Future work, Acknowledgments.

Western Research Institute, 1985, Reservoir and process simulation, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Morgantown, West Virginia, United States Department of Energy, Office of Fossil Energy, Technical Information Center, Office of Scientific and Technical Information, Project Contract No. DE-FC21-83FE60177, p. 52-64.

(NW Asphalt Ridge), (Asphalt Ridge), This article contains: Background statement; Objectives; Project description; Results (in-situ processing condition are simulated, tar sand samples from the Asphalt Ridge quarry were packed to resemble cores from the NW Asphalt Ridge source, controlled packing, reproducibility and uniformity demonstrated, recovery processes tested, three-dimensional recovery process is tested and conducted); Key accomplishments (demonstrated reconstitution of crushed tar sand, developed equipment to simulate recovery process, identified predictive mathematical models); Future work (implement predictive mathematical model, relate processes performance to reservoir properties, correlate one-dimensional and three-dimensional tests, predict field performance on laboratory tests).

Western Research Institute, 1985, Resource characterization and recovery technology selection, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Morgantown, West Virginia, United States Department of Energy, Office of Fossil Energy, Technical Information Center, Office of Scientific and Technical Information, Project Contract No. DE-FC21-83FE60177, p. 34-42.

(P.R. Spring), (Tar Sand Triangle), (NW Asphalt Ridge), This article contains: Background statement; Objectives; Project description (geologic characterization, guidelines developed); Results; Key accomplishments (tar sand resource database, recent field investigations, resource and site selection criteria - land status, geographic setting, water issues, local geologic setting, permitting requirements- target zone properties – overburden, under burden, target zone); Future work; Acknowledgments, References cited.

Western Research Institute, 1985, Resource characterization and recovery technology selection, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Fossil Energy (U.S. Department of Energy, Technical Information Center), p. 34-42.

(NW Asphalt Ridge), (Tar Sand Triangle), (P.R. Spring), This report includes the following: Background information; Objectives; Project description; Results; Key accomplishments (tar sand resource data base, recent field investigations [for NW Asphalt Ridge, Tar Sand Triangle, and P.R. Spring], Resource and site selection criteria guidelines); Future work; Acknowledgments; References cited.

Western Research Institute, 1985, The effect of preheat on the properties and mechanisms involved in the production of oil from tar sand, *in* Proceedings of the first annual oil shale/tar sand contractors meeting: Morgantown, West Virginia, United States Department of Energy, Office of Fossil Energy, Technical Information Center, Office of Scientific and Technical Information, Project Contract No. DE-FC21-83FE60177, p. 43-51.

(Asphalt Ridge), This article contains: Background statement; Objectives; Project description (three types of experiments were conducted – artificial preheat-steam displacement (SDA), reverse combustion (RC), and hot gas injection (HGI), Asphalt Ridge tar sand used, amount of residual bitumen/heavy oil and coke was measured); Results; Key accomplishments (the quality of oil produced by steamflood from artificially preheated tubes improves with increasing preheat temperature, the steamflood mechanisms of thermal expansion, viscosity reduction, steam distillation and solvent extraction have been verified by simulated distillation data, the oil produced by artificial preheat-steamflood is very similar to the original bitumen while the oil produced by hot gas injection exhibits about a twofold reduction in viscosity at 140 °F to the original bitumen. The oil produced by reverse combustion exhibits a 10,000-fold reduction in viscosity at 140 °F relative to the original bitumen.); Future work, Acknowledgments; References.

Western Research Institute, 1986, Factors that influence the selection of tar sand resources for in situ thermal recovery: Laramie, Western Research Institute, 47 p.

(No Specific Deposit), This report includes the following: List of figures and tables; Summary; Introduction; Background; Resource; Methodology (goal, objective, barriers, parameters, elements); Resource characteristics (engineering, geology, geochemistry); Technical constraints (steam processes, combustion processes, combination processes, related technical elements); Environmental constraints (atmosphere, biosphere, hydrosphere, lithosphere, related environmental elements); Institutional constraints (land ownership, infrastructure, finances); Conclusions; Acknowledgments; References.

Western Research Institute, 1987, Annual Technical Progress Report, October 1986 to September 1987: Western Research Institute, variously paginated.

(Asphalt Ridge), (Sunnyside), This report contains: Foreword; Disclaimer; Executive summary; Oil shale; Tar Sand; Underground coal gasification; Advanced process technology; Advanced fuels research.

Whiting, R.L., 1981, Heavy crude oil and tar sand resources and reserves of the United States – Emphasis on the state of Texas, *in* Meyer, R.F., and Steele, C.T., editors, The future of heavy crude oils and tar sands (from the first international conference, June 4-12, 1979): New York, McGraw-Hill, Inc., p 90-96.

(Numerous Utah Deposits), This paper includes the following: Introduction; Previous heavy crude oil and tar sand resource and reserve studies; Heavy crude oil resource and reserve study (12/31/77); Summary and conclusions.

Whittier, W.H., and Becker, R.C., 1962, Geologic map and sections of the bituminous sandstone deposits in the P.R. Springs area, Grand and Uintah Counties, Utah: U.S. Geological Survey Open-File Report 62-158, approximate scale 4 1:15,840.

(P.R. Spring), This open-file map shows the P.R. Spring area and 14 measured sections within T. 15-16 S., R. 22-24 E., Uintah and Grand Counties, Utah.

Wicks, Moye, III, 1975, Pipeline processing of oil-containing solids to recover hydrocarbons: United States Patent 3,925,189, 10 p.

(Patent), (Green River Desert), A process and apparatus for the extracting of hydrocarbons from oil-containing solids like tar sands and oil shale by forming an oil-containing solid-solvent slurry; injecting the slurry into a pipeline and flowing the slurry uphill in a pipeline at an angle of at least 2 degrees above the horizontal while maintaining the slurry in suspension and at a relatively high flow velocity sufficient to leach and extract the hydrocarbon from the slurry by the time the slurry reaches the terminal end of the line. Eight claims, Four drawing figures.

Wikipedia – the free encyclopedia, 2007, Tar Sands: Online, http://en.wikipedia.org/wiki/Tar_sands, accessed December 31, 2007.

(Tar Sand Triangle), (Asphalt Ridge), This reference includes the following: As oil source, by location (Canada, Venezuela, USA); Extraction process (surface mining, cold flow, cyclic steam stimulation – CSS, Steam assisted gravity drainage – SAGD, vapor extraction process (VAPEX), toe to heel air injection – THAI); Environmental effects (local direct effects, global direct effects, environmental advocacy); See also; External links; References.

Wiley, D.R., 1967, Petrology of bituminous sandstones in the Green River Formation, southeastern Uinta Basin, Utah: Salt Lake City, University of Utah M.S. Thesis, variously paginated.

(P.R. Spring), The purpose of this study was to determine the source and environments of transportation, deposition, and diagenesis of the bituminous sandstones in the Green River Formation within the southern and southeastern portions of the Uinta Basin, Utah. Bituminous sandstones in the Green River Formation were studied from outcrops in the southern part of the basin, in the area known as the Roan Cliffs, to Watson, Utah, which is in the southeastern part of the basin.

Williams, D.F., and Martin, T.G., 1978, Extraction of oil shales and tar sands: United States Patent 4,108,760, 6 p.

(Patent), (Athabasca), This invention relates to the extraction of oil shales and tar sands by using a solvent under supercritical conditions at a temperature within 200 °C. or its critical temperature in order to effect extraction of kerogen from the sand or shale. In the case of shales, considerable heat needs to be applied to the shale before effective extraction can occur and extraction in this case may be carried out at a temperature within the range of 370° to 450 °C. Seventeen claims, no drawings.

Wolff, W.F., and Patterson, J.S., 1986, Two-stage tar sands extraction process, United States Patent No. 4,596,651, 10 p.

(Patent), (Sunnyside), (Asphalt Ridge), (Athabasca), A process for extracting bitumen from tar sands comprises a two-stage extraction wherein both specific and non-specific solvents are used to obtain a bitumen product low in fines and asphaltenes.

Wood, R.E., and Ritzma, H.R., 1972, Analysis of oil extracted from oil-impregnated sandstone deposits in Utah: Utah Geological and Mineralogical Survey Special Studies 39, 19 p.

(Asphalt Ridge), (NW Asphalt Ridge), (Chapita Wells), (Cow Wash), (Hill Creek), (Lake Fork), (Littlewater Hills), (P.R. Spring), (Raven Ridge), (Rim Rock), (Split Mountain), (Spring Branch), (Spring Hollow), (Tabiona), (Upper Cane Hollow), (Whiterocks), (Circle Cliffs), (Muley Twist), (Stud Horse Peaks), (White Canyon Flat), (Cove), (Elaterite Basin), (Hatch Canyon), (Tar Cliff), (Teapot Rock), (Salt Wash), (Ten-Mile Wash), This publication contains: Preface; Abstract; Physical and chemical analysis of tar sand samples by Wood (extraction, specific gravity, elemental analysis, distillation of tar); References; Sampling procedures and evaluation by Ritzma (procedures, outcrop samples versus cores; illustrations (1A-D, Analyses of oil extracted from oil-impregnated sandstones, Uinta Basin northeast Utah, assay, distillation, index of refraction and specific gravity), (2A-D, Analyses of oil extracted from oil-impregnated sandstones, central southeast Utah, assay, distillation, index of refraction and specific gravity); Significance of analyses by Ritzma (variation of physical properties, physical properties and geologic age for Uinta Basin and central southeast Utah); References.

Worne, H.E., and Rabinovitch, Irving, 1982, Process of microbial extraction of hydrocarbons from oil sands, United States Patent No. 4,349,633.

(Patent), (Utah Oil Sands), A process is described for the separation of hydrocarbon residues from oil and tar sands by microbiological activity. Hydrocarbon residues are released from the sands by contacting with a suspension of oxidase-synthesizing, hydrocarbon-metabolizing microorganisms.

X-Trace Energy, Inc., 2000, Closed-loop extraction of hydrocarbons and bitumen from oil-bearing soils, *in* North, W.B., Thomas, C.P., Becker, A.B., Faulder, D.D., and Brashear, J.P., editors, Petroleum technology advances through applied research by independent oil producers: Tulsa, The Brashear Group, p. 47-48.

(P.R. Spring), (Asphalt Ridge), This article contains: Background; Project description; Results; Economics; Project funding.

Yang, Y.J., Bukka, Krishna, and Miller, J.D., 1989, Selection and evaluation of diluents in the modified hot water process: Energy Processing/Canada, p. 14-21. (Also in the fourth International Conference on Heavy Crude &Tar Sands, August 7-12, 1988, Edmonton, Alberta, Canada, published by Alberta Oil Sands Technology and Research Authority, paper 15, p. 1-10).

(Sunnyside), (P.R. Spring), (Asphalt Ridge), (Athabasca), This article contains: Abstract; Introduction; Experimental procedure (diluent evaluation in the batch processing of Sunnyside tar sands); Results and discussion (evaluation of diluent in the modified hot water processing of Sunnyside tar sands); Conclusions; References; Three figures and eight tables.

Yeh, Tsao-Fa, 1997, Catalytic upgrading of Asphalt Ridge bitumen over hydrodenitrogeneration catalysts: Salt Lake City, University of Utah Ph.D. Dissertation, 260 p.

(Asphalt Ridge), This dissertation includes the following: Abstract; Acknowledgments; Introduction; Literature survey (definition of oil sands, oil sands resources, origin of oil sands, nature of oil sands and bitumens, bitumen recovery methods, properties of bitumen, bitumen upgrading, hydroprocessing catalysts, deactivation of hydroprocessing catalysts, hydroprocessing reactions); Experimental apparatus and procedures (feedstock preparation, catalyst characterization, hydrotreating system, liquid products analysis); Results and discussion (properties of Asphalt Ridge bitumen, properties of HDN catalysts, reaction conditions, presentation of results, process kinetic models for bitumen hydrotreating, investigation of process variables, evaluation of catalyst performance, secondary hydrotreating); Conclusions; Eight appendices; References.

Yen, T.F., editor, 1976, Shale oil, tar sands, and related fuel sources: American Chemical Society, Advances in Chemistry Series 151, 184 p.

(Utah Tar Sands), This book includes the following: Preface; Characteristics of synthetic crude from crude shale oil produced by in situ combustion retorting; Sulfur compounds in oils from the Western Canada tar belt; Characterization of synthetic liquid fuels; Rate of dissolution of carbonate mineral matrix in oil shale by dilute acids; hydrogasification of oil shale; production of synthetic crude from crude shale oil produced by in-situ combustion retorting; solution of silica in Green River oil shale; fracturing oil shale with explosives for in situ recovery; Development of communication paths within a tar sand bed; Characterization of Utah tar sand bitumen; Feasibility studies of a biochemical desulfurization method; Chemical modification of bitumen heavy ends and their non-fuel uses; direct zinc chloride hydrocracking of sub-bituminous coal and regeneration of spent melt; differences among ozokerites; Index.

Zajic, J., Seffens, W., and Rogen, N., 1984, Surface energy study of Utah tar sand and spreading tension – a new technique, *in* Meyer, R.F., Wynn, J.C., and Olson, J.C., editors, The Future of Heavy Crude and Tar Sands, second international conference: New York, Coal Age Mining Information Services, McGraw-Hill, Inc., p. 397-403.

(No Specific Deposits), This article contains; Introduction; Contact angles and surface free energy of minerals; Particle spreading at fluid interfaces; Materials and methods; Results; Summary; Acknowledgement; Note; References; One table and ten figures.

Zheng, H., Tang, H.Q., Fletcher, J.V., and Hanson, F.V., 1993, Performance and calibration of dry materials feeders when feeding oil sands, *in* 1993 Eastern Oil Shale Symposium – oil shale – oil sands/heavy oil (November 16-19, 1993, Radisson Plaza Hotel, Lexington, Kentucky, USA): University of Kentucky, Institute for Mining and Minerals Research, p. 144-150.

(Whiterocks), (P.R. Spring), This article contains: Abstract; Introduction; Experimental procedures (feed materials, experimental apparatus, methodology – preparation of feed mixtures, feeder calibration procedures); Results and discussion (feeding performance with small augers, feeding performance with large augers); Conclusions; Nomenclature; References; Eight figures and seven table