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SURVEY NOTES

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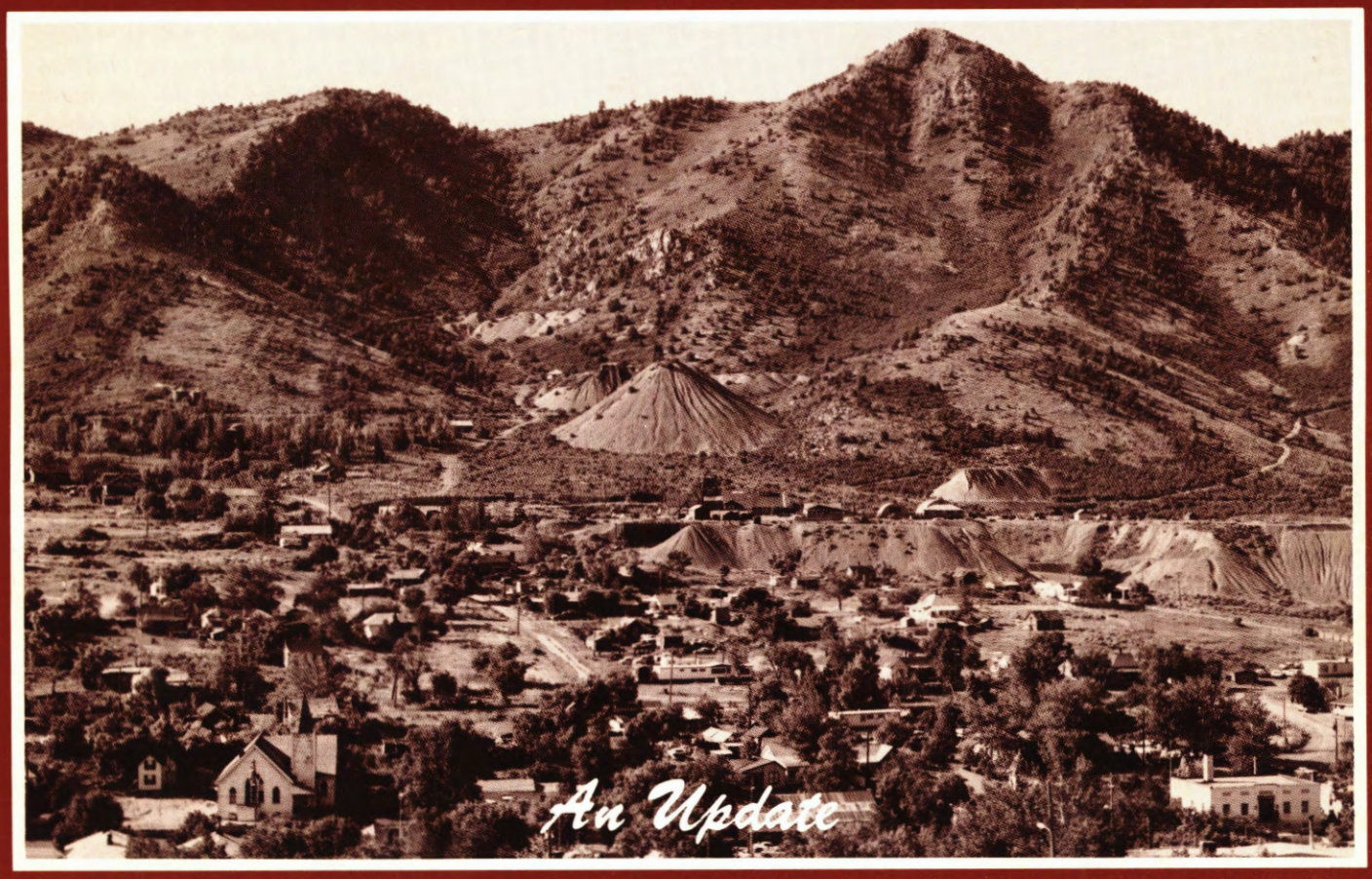
The Tintic Mining District



OVERVIEW OF EUREKA FROM THE SOUTH, JUNE 1982 (PHOTO BY G. B. PETERSON)

By LAURENCE P. JAMES

THE TINTIC mining region, located in a desert mountain range and adjacent valleys in Utah and Juab counties, is at current prices the second largest historic producer of metals in Utah. Figures 1 and 2 show two of its mines, one active and one inactive, while figure 3 shows its location, west-southwest of Provo. The high silver content of its base metal ores, commonly accompanied by unusually high gold content, has made the district famous in western history. As of 1959, it ranked 20th in the U.S. as a gold producer. Next to Bingham, whose production of gold as a by-product of copper overshadows all other districts, Tintic ranks second in Utah gold production, while Mercur, 30 miles to the northwest, has produced half as much. In silver production it holds first

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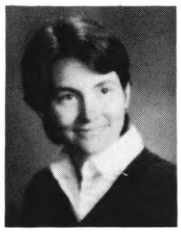

FROM THE DIRECTOR'S DESK

UGMS Needs Sound Geologic Information

THE UGMS acts as the state's advisor on the geologic resources of the state and its geologic hazards. Often we are asked our "opinion" as a technical evaluation and this can have policy consequences. We try to be as apolitical and unbiased in our evaluations as possible and take pride that we can back our advice with facts.

Earlier this year we were called upon to provide technical advice on Congressional selections of wilderness lands in Utah before Congress. Bryce Tripp has been participating as part of the state's team that is considering the BLM wilderness areas. He, Keith Clem and Ray Kerns, with the leadership of Archie Smith, responded to the Governor's request for more information on two specific proposed wilderness areas: the north flank of the Uinta Mountains, and Box-Death Hollow in the Dixie National Forest. Utah's Energy Office coordinated the input of various state agencies.

At issue in the Uinta Mountains area was a potential conflict between resource exploration and development for oil and gas versus the wilderness designation. Sohio and others projected the north flank thrust southward below the northern margin of the wilderness and argued that they believed that a significant productive area could be withdrawn from the Nation's resource base.

At issue in Box-Death Hollow was a potential conflict between the proving out and development of an identified CO_2 deposit versus the wilderness designation. Mid-Con had drilling information that showed a significant CO_2 reserve in the area and a detailed structure map based on well data that defined the CO_2 reservoir. Although most people think of CO_2 as the fizzy constituent of soda pop, recent technologic advances show that CO_2 is an excellent medium for slurry transport (such as coal) or for tertiary recovery of petroleum. For instance: were the coal of the Kaiparowits developed, it could be slurried to California in a CO_2 pipeline and then the CO_2 might be used in the California oil fields for tertiary recovery.

The UGMS briefed the Governor on the resource potential of these two areas. For the Box-Death Hollow we had industry's basic data reports, drilling information, and UGMS Report of Investigation No. 125, "Carbon dioxide resources of Utah," by Jock A. Campbell (1978).

For the northern flank of the Uinta Mountains, industry geologists had prepared an argument based on interpreted seismic data and a comparison to the overthrust province. UGMS geologists were present at Chevron's presentation on two occasions. While we were presented with the industry's interpretations, we were not given an opportunity to analyze the original data.

As a result, for Box-Death Hollow, we were able to evaluate the CO_2 resource potential and corroborate industry's claims as reasonable. For the Uinta boundary dispute, UGMS was only able to advise the Governor that there might be a potential for a significant resource, but we did not have the basic data that were needed for an independent evaluation of industry's claims.

The Utah Wilderness Bill (HR 4516) is now law. The Box-Death Hollow area has not been closed to CO_2 exploration. Wilderness proponents achieved partial environment protection while industry has the opportunity to explore for resources in the northern part of the area and the right to produce the CO_2, if discovered in commercial quantities. Mid-Con is currently drilling a well just north of the wilderness boundary which, if successful, may encourage further exploration inside the compromise area. A compromise was also reached with respect to the north flank of the Uinta Mountains, which leaves open the opportunity to explore for petroleum beneath the north flank fault.

UGMS geologists feel that we were able to provide sound technical advice to the Governor regarding the Box-Death Hollow area. We were somewhat frustrated on the northern Uintas issue because we knew the data we needed for an adequate argument existed but were not available to us to interpret.

If the UGMS is to be involved in the resolution of this type of issue, we must have data with which to work. The 1984 legislature passed a law that allows the UGMS to accept, and maintain as confidential, information provided to us. The donor of the information sets the data's level of confidentiality. When we accept information, it is with the understanding that we can use it in our regional interpretations. The system is in place. Industry and governmental agencies have already shared confidential information with us. This information is invaluable to the state of Utah. I urge you all to share your information with us . . . it's the only way that we can really serve you.

Genevieve Atwood

EARLY URANIUM-VANADIUM MINING IN MONUMENT VALLEY, SAN JUAN COUNTY, UTAH

By WILLIAM L. CHENOWETH [1]

ABSTRACT

IN 1944, the Office of Indian Affairs leased two parcels of land in Monument Valley, San Juan County, Utah, for carnotite mining. One lease, Utah No. 1, located on the eastern tip of Oljeto Mesa, produced nearly 52 tons of ore averaging 4.03% U_3O_8 and 5.50% V_2O_5 in 1944. Since the ore averaged greater than 1.50% U_3O_8, payment was received for the uranium, in addition to the vanadium. This represents the initial mining of uranium ore on the Navajo Indian Reservation.

INTRODUCTION

Although Gregory (1917, p. 148) reported the occurrences of a uranium-vanadium mineral, probably carnotite, in the Shinarump and Chinle rocks of the Monument Valley area, there is virtually no mention of any mining in the Utah portion of Monument Valley until the uranium boom of the 1950s.

The mining of carnotite in the Arizona portion of the Valley during the early 1940s is briefly mentioned in reports on the Monument No. 1 Mine (Witkind, 1961, p. 221) and on the Monument No. 2 Mine (Witkind and Thaden, 1963, p. 68-69).

A report prepared by the General Services Administration (GSA), Indian Trust Accounting Division for the Navajo Tribe gives precise details on pre-1947 mining on the Navajo Indian Reservation. A copy of the uranium-vanadium section of this report (GSA, 1981) has been made available to the Grand Junction Area Office of the Department of Energy.

Two properties in the Utah portion of Monument Valley were active in 1944. Data on those properties in this brief report is summarized from the GSA (1981) document.

LEASING REGULATIONS

The Navajo Indian Reservation was opened to mining by a Congressional Act of May 11, 1938, but with new procedures. This Act gave the Tribal Council the authority to enter into leases for the Reservation's lands with approval of the Secretary of Interior. Prospectors no longer could enter the Reservation and stake a mining claim under regulations similar to those of the United States Mining Law. The new mining regulations contained escalating annual rentals, a base royalty of 10% (mine mouth value), bond requirements, acreage limitations, a term of 10 years which could be extended by production.

On April 9, 1941, the Navajo Tribal Council requested the Secretary of the Interior lease lands for mining purposes to the highest bidder. Leases could be written for a specific parcel of land, or for a large area which could be subsequently reduced in size at the end of a specified time period. As the result of this action, mining companies had to request public lease sales for lands they were interested in.

MONUMENT NO. 3 LEASE

In the summer of 1943 the Vanadium Corporation of America (VCA) requested that the Office of Indian Affairs hold a lease sale for 12.7 acre parcel of land located three miles southwest of Oljeto Trading Post, on the hogback east of Hoskinnini Mesa. VCA was the highest bidder at the October 11, 1943 lease sale with a bonus bid of $500.

The claim, named Monument No. 3, was described as follows — "beginning at a point which is north 44°28'30" west, 3,435.62 feet from Mile Post #205, Utah-Arizona state line and running thence north 47°23' east, 270 feet, thence north 12°26' west, 2,500 feet, thence west 200 feet, thence south 11°37' east, 2,679.91 feet more or less to the point of beginning, containing 12.72 acres more or less."

Lease I-149-IND-6256 was executed with VCA on October 23, 1943, effective January 14, 1944, for a period of ten years. No production was reported from this lease; however, a U.S. Geological Survey engineer's examination of the property noted some rim stripping had been done by VCA (GSA, 1981, exhibit 52).

UTAH NO. 1 LEASE

In February 1944, a group of Blanding, Utah men asked that 40 acres of land on the eastern tip of Oljeto Mesa be made available for leasing. A sale was held on April 10, 1944, with only one bid of $505 received from Wayne E. Carroll, Lee Shumway, E.H. Carroll and Harris Shumway, a partnership d.b.a. Carroll and Shumway.

Lease I-149-IND-6435 was executed on April 25, 1944, effective May 26, 1944, for 40 acres described as the SW¼, NW¼ Section 26, T43S, R15E, San Juan County, Utah. The lease was made for a period of 10 years. Carroll and Shumway designated the lease as Utah No. 1.

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[1] Formerly staff geologist, U.S. Department of Energy; presently consulting geologist, Grand Junction, Colorado.

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FIGURE 1. The shaft of the Trixie gold-silver mine, in Silver Pass Canyon, East Tintic, the most recent ore discovery of the district that has yielded profits. L. P. James photo, 1974.

FIGURE 2. The old Eagle and Blue Bell silver-lead-gold-copper mine, just south of the town of Eureka, was last worked by leasees in the 1950s. L. P. James photo.

THE TINTIC MINING DISTRICT

Continued from Page 1

place, followed closely by Park City. Table 1 shows available production data.

Over the past seven years the Utah Geological and Mineral Survey has been engaged in the partially federally-funded Computerized Resource Inventory Base (CRIB) tabulation of all mineral occurrences in Utah, in cooperation with the Bureau of Land Management and the U.S. Geological Survey. The writer made the compilation for the Eureka quadrangle, covering most of the Tintic district, where he had previously worked for private industry. Bryce T. Tripp of the Utah Geological and Mineral Survey compiled data on the adjacent Tintic Junction and Tintic Mountain quadrangles.

This discussion of the famous old district mainly reviews developments of recent decades, for the literature on geology and past mining is extensive. The excellent work of Lindgren and Loughlin (1919) on the western part of the district remains a classic. The publication of a detailed companion paper by H. T. Morris (1979) on the eastern part of the district was the culmination of many decades of work by the U.S. Geological Survey. Other recent works as well as major earlier papers are listed in the bibliography at the end of this article. Bibliographies by Morris (1979), Buss and Goeltz (1974) and Buss (1951) and summary articles by Shepard, Morris and Cook (1968) and Morris (1968) provide more detailed references.

The commercial center of the Tintic mining district is Eureka, a town of 670 people in 1980. It lies in Juab County, just west of the Utah County line. Mammoth (fig. 4), in a gulch 5 miles to the south and west, has a dozen houses set among old mine dumps, while the outlying villages of Tintic Junction, Elberta, and Goshen are supported by both ranches and miners' paychecks. Some description of the fine, old architecture and the history of the once prosperous mining district were recently captured in a publication by Notarianni (1982).

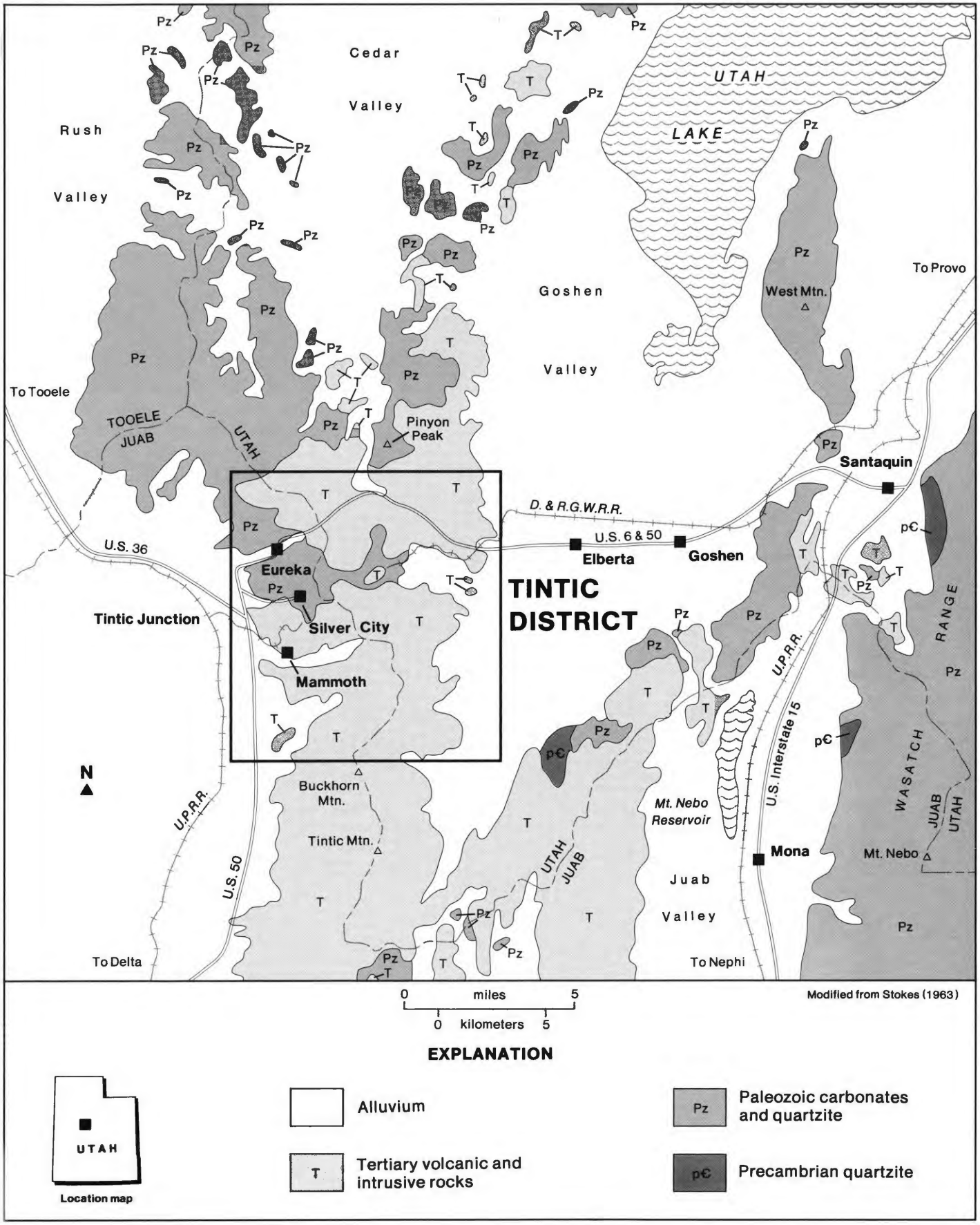

FIGURE 3. Location of the Tintic district, showing regional geology. Adapted from Geologic Map of Utah (W. L. Stokes, compiler, 1963).

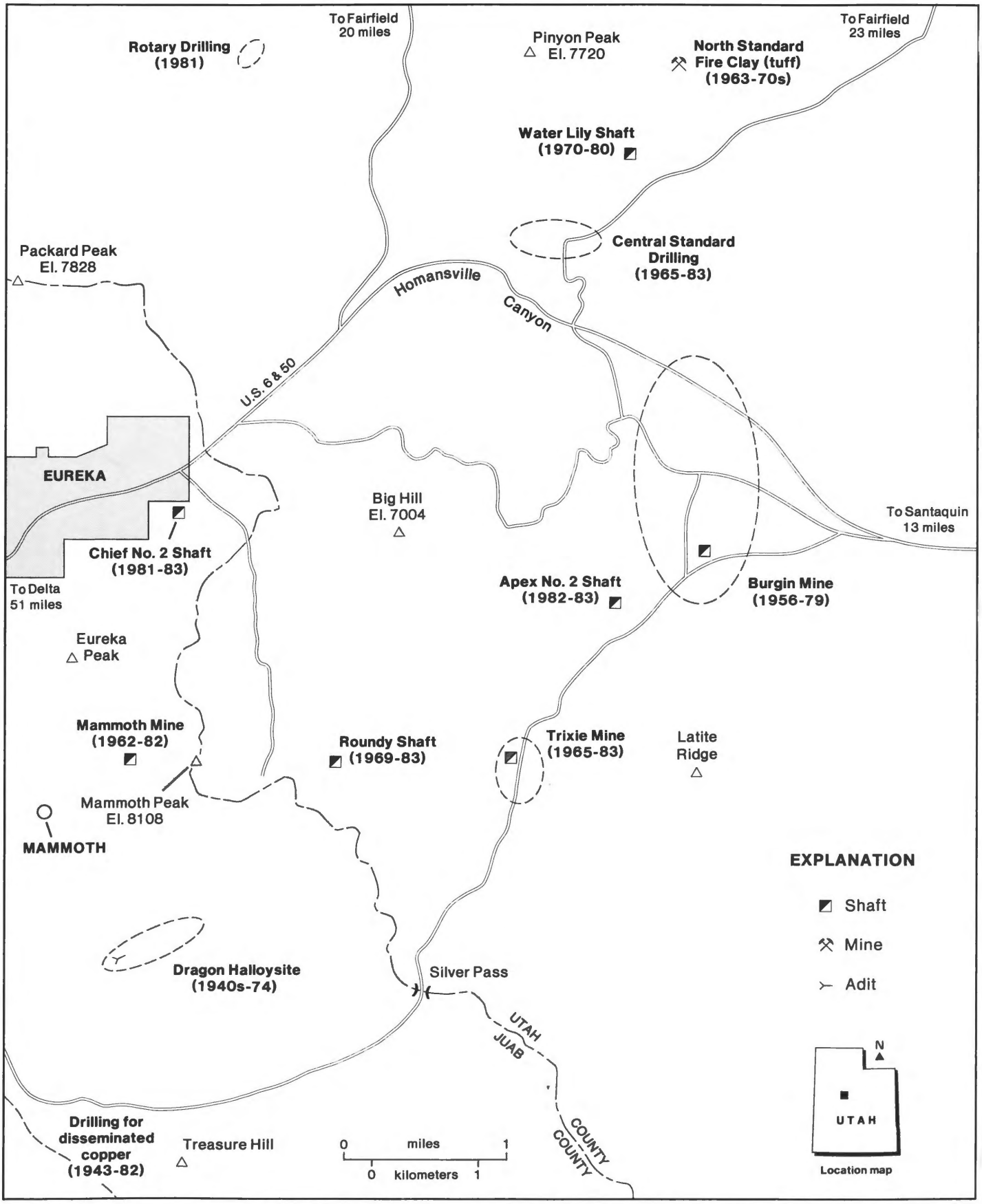

FIGURE 4. Map showing recent mining and exploration activities in the Tintic district, and mines of the recent and distant past. Mines cited in the text are also shown in fig. 6.

FIGURE 5. The complex mineralogy of Tintic ores led to many metallurgical experiments. This chloridization roasting/leaching plant east of Goshen, just south of the highway to Tintic, is a colorful reminder of the old Tintic Standard, once the richest silver mine in the world. L. P. James photo.

The Tintic district proper, as delineated a century ago by miners, has yielded nearly all of the metal production. Most authors have used an arbitrary division of the Tintic district into the East Tintic and Main Tintic mining areas along a north-south meridian of longitude 112° 05′. The area north of the drainage divide, in western Utah County, is known as the North Tintic district, and has yielded small tonnages of oxidized zinc ores. The West Tintic mining district lies seventeen miles southwest of Eureka, on the west side of the West Tintic Mountains and the alluvium-filled Tintic Valley. The relatively small production from this geologically different mineralized area is not included in the discussion here.

METAL PRODUCTION

Tintic ores typically contained a number of metals, as indicated by table 1. Other metals, recovered but often not paid for or acknowledged by ore purchasers, included substantial arsenic, cadmium, antimony, and bismuth. Substantial zinc was later recovered by retreating old slag, and is not reported. Parts of the district contain substantial manganese, of which shipments have been made to the steel works in Utah Valley and elsewhere. Deposits of high grade white clays, both fire clay and a unique halloysite clay used as a catalyst in oil refining, were mined from altered sedimentary and volcanic rocks in both surface and underground workings.

The complex mixtures of metals and minerals in the ores have always created difficulties in their extraction. While the ores were deposited as sulfides, deep oxidation and weathering have both enriched and complicated the character of the ores. The water table at Eureka stands at approximately 1800 feet below the surface (Morris, 1968, p. 1071; Hall, 1949) and at 1100-1500 feet in the East Tintic area (Morris and Lovering, 1965). Ore minerals above this water table include a bewildering variety of carbonates, sulfates, chlorides, chlorovanadates, native metals, and remnant sulfides. This mineralogist's paradise has been a mill metallurgist's nightmare. A variety of processes have been tried (fig. 5), but only a few plants have proved more than marginally successful. Whenever ores were rich enough, the optimum treatment was direct shipment to one of the four big smelters that formerly surrounded Salt Lake City. The closing of three of these plants — at Murray, Midvale, and finally, Tooele — which specialized in lead-silver-zinc ores, as well as the large custom milling plants at Bauer and Midvale, helped bring a recession to the district that is evident today to anyone driving through its towns. The most recent shipments have been gold- and silver-rich siliceous flux for the Garfield smelter and silver-lead-zinc concentrates and oxide ores sent to plants in Montana, Texas, Idaho, and California, all from operations by Kennecott.

GEOLOGY

The country rock of the Tintic district includes a 7000-foot thick sequence of

TABLE 1. Metallic ore and metals produced from Tintic mining district, 1869 to the present (in thousands of English units)

	Ore, short tons/ (in thous.)	Gold, troy oz./ (in thous.)	Silver, troy oz./ (in thous.)	Copper, tons/ (in thous.)	Lead, tons/ (in thous.)	Zinc, tons/ (in thous.)
1869-1975	18,358[1]	2,687.8	269,425	124.6	1,133	207
1976-1982[2]	950	50.6	4,029	1.9	12.7	27.5
TOTAL	**19,313**	**2,738.4**	**273,454**	**137.3**	**1,145.7**	**234.5**

SOURCES:

Data to 1976 from Morris and Mogensen, p. 34.

[1] Total, by H. T. Morris, includes all recorded production 1911-76 and estimates for previous years.

[2] Compiled by L. P. James from annual reports and state tax records. Ore sources: Burgin mine 1976-July 15, 1978; Trixie mine, 1976-November 29, 1982; Mammoth mine, 1977-December, 1980.

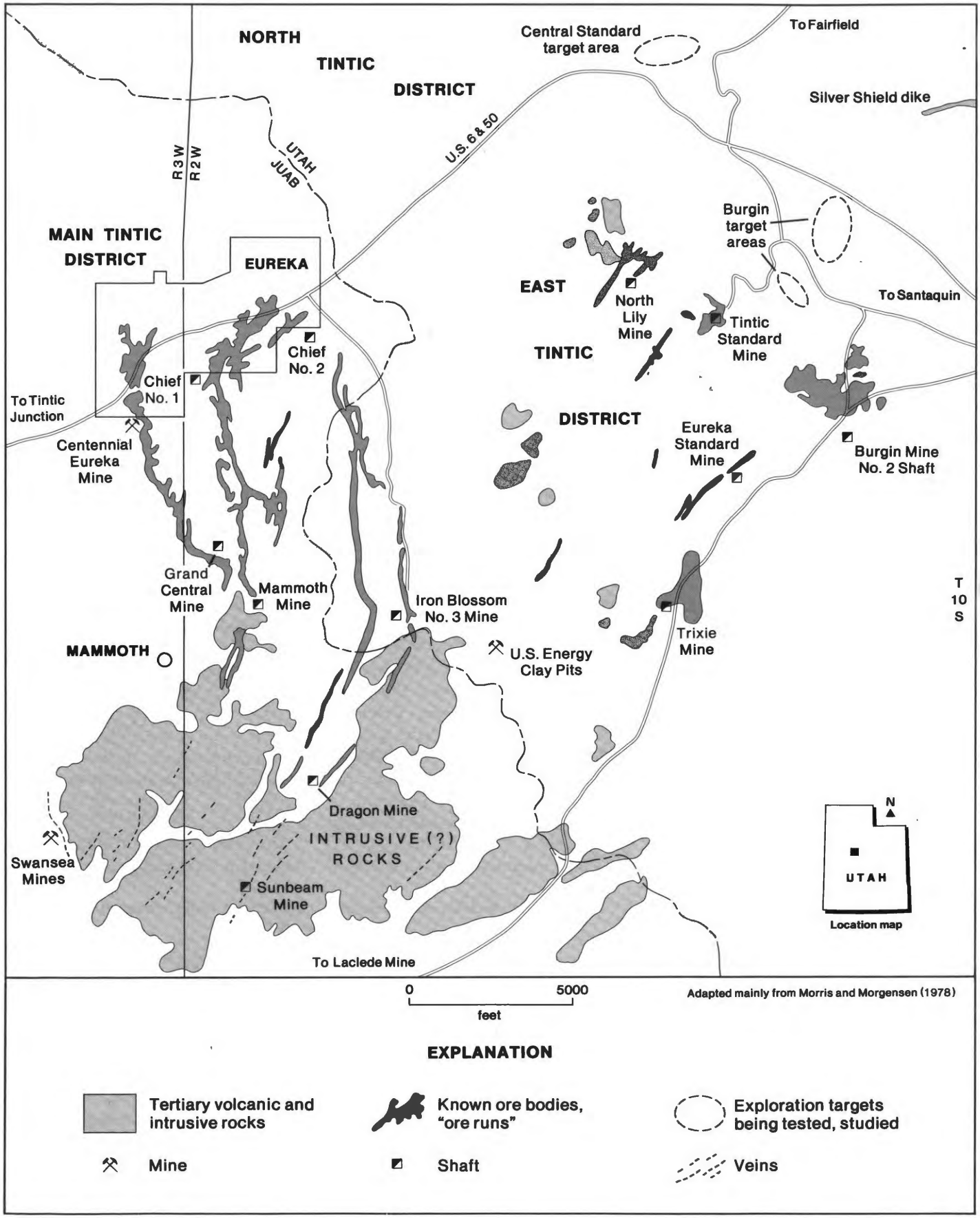

FIGURE 6. Major ore bodies, target areas, and intrusive igneous rocks of the Tintic district. Adapted mainly from Morris and Mogensen (1978).

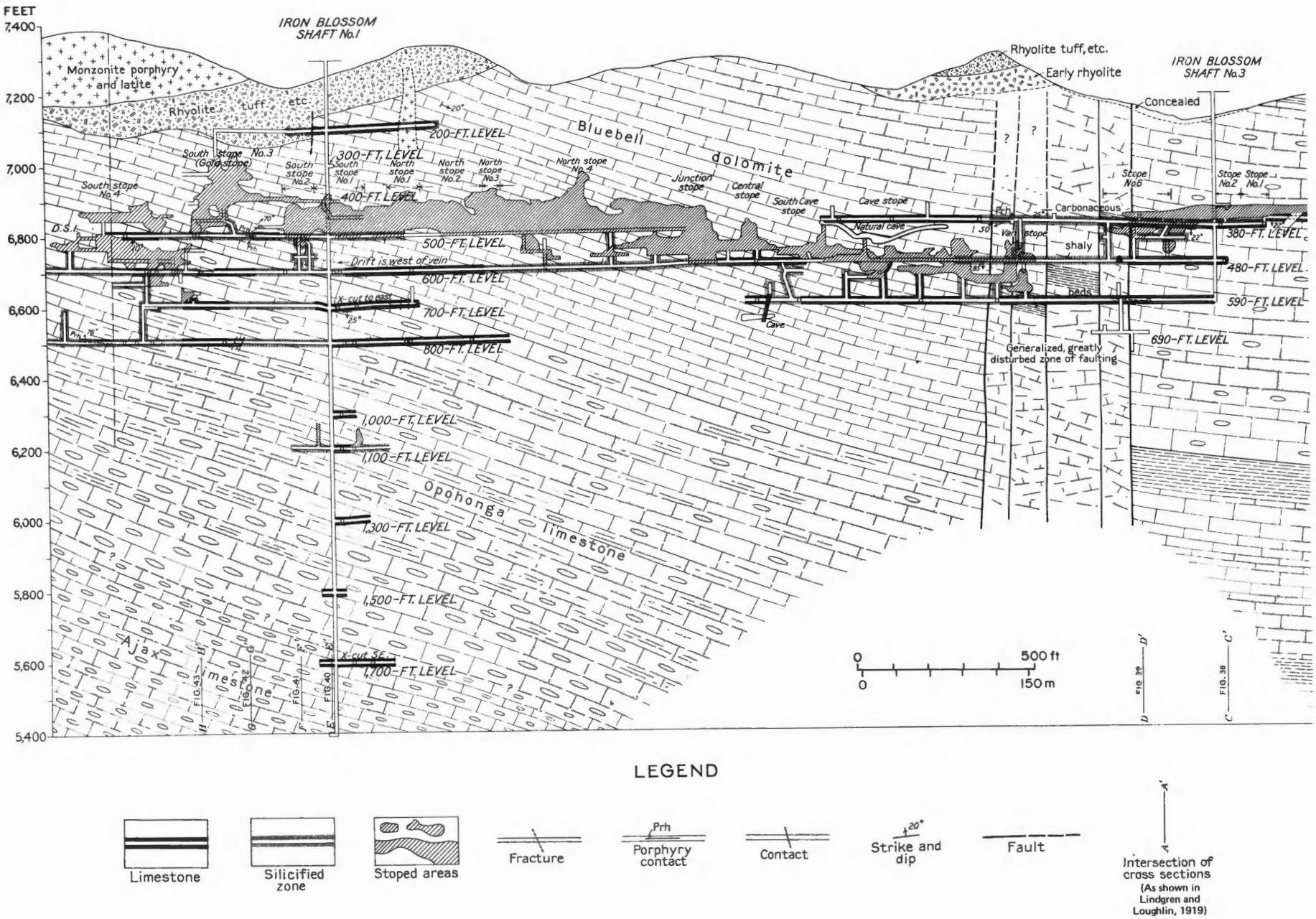

FIGURE 7. Cross section through the central part of the Iron Blossom ore zone, southeast of Eureka. This blind ore body was a miner's dream, producing half a million tons averaging, in different mines, 0.19 ounces per ton gold, 40 ounces per ton silver, 22 percent lead and 0.4 percent copper. From Plate 36, U.S. Geological Survey, Lindgren and Loughlin (1919).

FIGURE 8. Treasure Hill, near the southwest corner of the district, was mined in the 1870s for its narrow, rich veins of silver, gold, copper and lead. L. P. James photo.

Paleozoic sedimentary strata dominated by carbonate rocks. This overlies the thick, basal Cambrian Tintic Quartzite, equivalent to the Prospect Mountain Quartzite of eastern Nevada. The Paleozoic rocks include unusual thicknesses of dolomite interbedded with limestones and some thin quartzites and shales. A discussion of regional paleogeography is given by Stewart and Suczek (1977). The carbonate rocks are the main host rocks for the ores, and have been subdivided by mining and government geologists over many decades.

Both high-angle normal and low-angle thrust faults, predominantly striking north-south, have broken and repeated the Paleozoic section. The district lies near the eastern edge of the north-trending Sevier orogenic belt, which is characterized by a series of overthrusts. The development of a north-trending plunging fold, the concealed East Tintic anticline, and the adjacent Tintic syncline to the west were accompanied by local thrusting. The folded and intensely faulted Paleozoic rocks were eroded prior to the Oligocene (mid-Tertiary) intrusion of igneous rocks of intermediate composition. Emplacement of quartz latite and monzonite stocks was accompanied by volcanism, depositing thousands of feet of lavas and ash flows atop the former erosion surface. The elliptical Silver City stock, 1.5 miles long, is the geological center of the mining district. Morris (1975) has postulated that explosive volcanic eruptions led to the collapse of a caldera, buried by subsequent volcanism, lying to the south of the mining area. Potassium-argon apparent ages on the intrusive rocks range from 31 to 34 million years.

A more recent igneous event in the northeastern part of the district formed the Silver Shield dike and quartz latite flows, dated at 18 million years, or mid-Miocene.

The mines of the eastern end of the district struck hot, saline waters at depth, in what Lovering and Morris (1965) call the East Tintic thermal area. Temperatures as high as 140°F have been measured at the water table in mines and drill holes east of the Eureka Lilly fault. The saline waters, a cause of many problems in the mines, are high in chlorides and apparently have a different source than other waters of the district. Lovering and Morris believe these waters rise in a fracture zone in the footwall of the East Tintic thrust plate, and are distributed by structures related to the thrust. They postulate concealed Quaternary volcanic rocks as the heat sources, and possible leaching of salts from deep Cretaceous rocks beneath a thrust fault east of the district as the source of the brines.

It is evident that these high salinity fluids do not readily mix with overlying cooler ground waters. The thermal area has been evaluated (and apparently rejected) by Phillips Petroleum as a commercial geothermal resource.

ORE DEPOSITS

ALTHOUGH regional syntheses (e.g. Shawe and others, 1978) commonly relate ores to east-west linear tectonic zones, local north-northeasterly faults apparently localized emplacement of the igneous rocks and obviously localized ores (Morris, 1979). Thrust faults (e.g. Billingsley and Crane, 1933; James, 1982) and karst-like features (e.g. Callahan, 1977) also localized ores. The northeast trend of fissures is also apparent in other metal districts of the state (Stokes, 1963).

The extreme degree of faulting prepared the carbonate and quartzite units for the entry of heated ore fluids, shortly after the emplacement of the Oligocene igneous rocks. A series of north-south "ore runs", long, narrow zones extending northward like fingers from the vicinity of the Silver City stock, contain major ore deposits in the main or western sector of the district (figures 6 and 7). These are called "mantos" (Spanish for cloak) by the ore-deposits geologist, and replace or fill cavities in the carbonate rocks. In many areas they are quite unspecific as to which host units they occupy in. Great "chimneys" or "pipes" of ore were mined from near surface to 2500 feet or more below the surface in the main Tintic area, as in the Chief Consolidated, Centennial Eureka, Grand Central, and other mines.

Water problems, low metal prices, and depth, as well as pinching out of the ore bodies, led to cessation of mining at the bottoms of some of the mines. Figure 6 outlines some of the major ore runs and ore bodies. The eastern side of the district, where thrust faulting rather than vertical faults and beds characterize the geology, has more compact, bedded ores, to the good fortune of the already-burdened mining engineer. But heavy ground and hot water often slowed progress here.

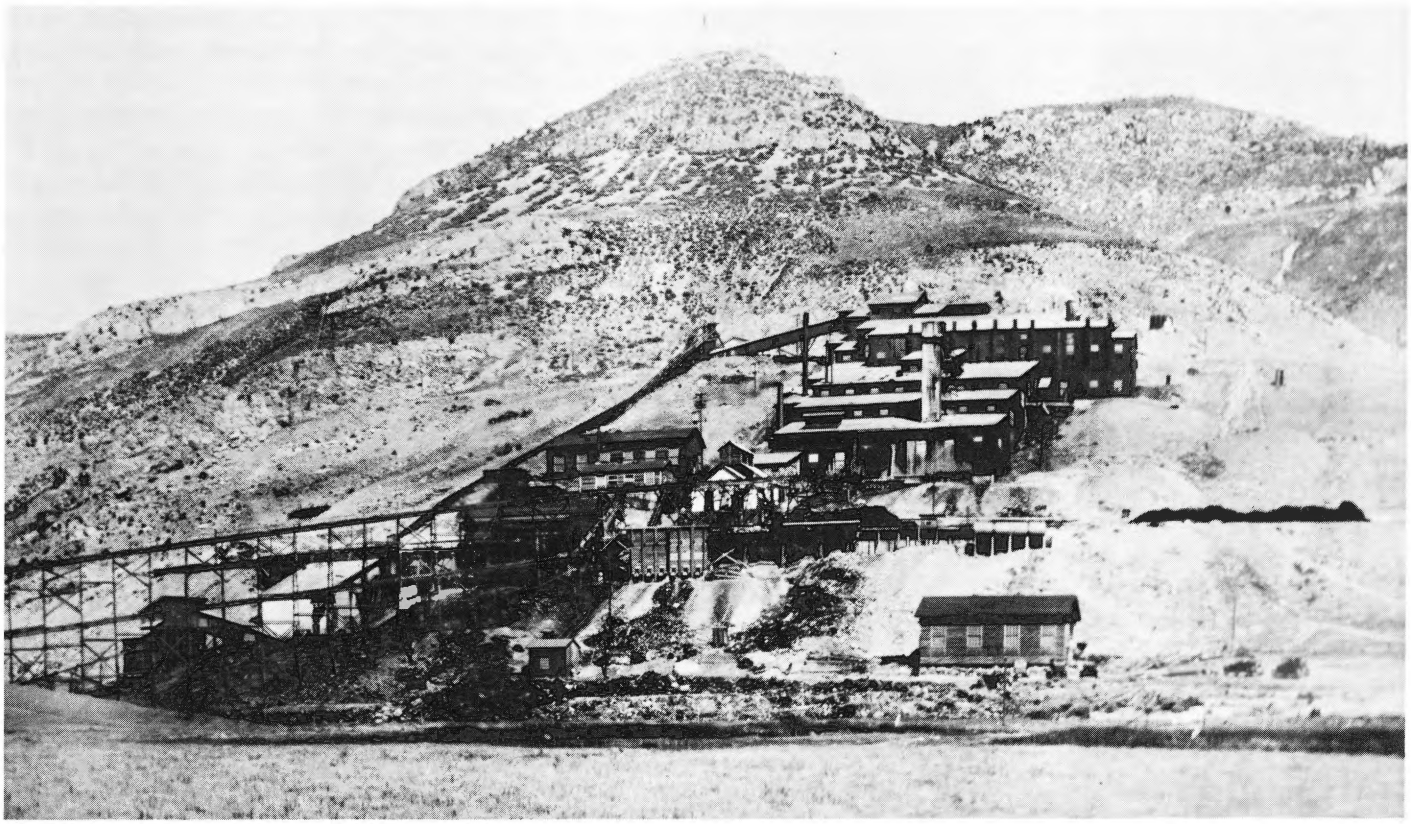

FIGURE 9. The Harold reduction mill of the Tintic Standard Mining Company in the 1920s (c.f. fig. 5). A. P. Mogenson collection.

The southerly projection of the "ore runs" into the igneous rocks follows an irregular series of fractures, or fissure veins. These narrow zones have been mined for copper-silver ores, and a few were reasonably good producers in the early days. They extend southward into another intrusive, the Sunrise Peak monzonite porphyry, where they were especially productive on the northeast side of Treasure Hill (fig. 8). The intrusive rocks tend to contain a perched water table, which does not drain away as readily as in the adjacent sedimentary rocks. Here the deepest operations, 900 feet in the Swansea and 500 feet at the Laclede mines, were typically mined only to relatively shallow depths because economics did not favor huge investment in drainage tunnels and steam-powered pumping plants.

Fissure-type veins have yielded more substantial tonnages of gold-dominated siliceous ores in the eastern part of the district, chiefly from quartzite. As this is written, development of such ores at the Trixie mine by Sunshine Mining Company is the only active mining in the district (fig. 1). The mine was put into full production by Kennecott in 1976, mining ore from north-south fissures and from pebble-dike zones. Faddies and others (1983) and Pape (1971) have described the mine in more detail.

The Eureka Standard mine, now held by South Standard Mining Company, struck rich gold ore in a fissure vein in 1928. From a production of only 363,000 tons of ore, the mine yielded 243,000 oz. of gold, and during 1932 was the fifth largest gold producer in the United States.

ORE DISCOVERY AND METAL EXTRACTION

THE earliest finds were a combination of surface outcrop recognition and persistence in sinking shafts through low grade or barren material into blind ore bodies. The main district was well established by the late 1870s, as were the outlying former towns of Diamond (southeast of Treasure Hill), Silver City (northwest of Treasure Hill), and Robinson (west of Mammoth). A variety of operators persisted in sinking shafts, undoubtedly the most difficult and frustrating job in mining, into a number of untested geological environments in the district. Walter Fitch, a Michigan iron operator who sank a shaft on a single claim just south of Eureka, was rewarded with the discovery of the blind Chief Consolidated ore bodies (fig. 6). These ore bodies became the largest base metal producer of the Eureka camp and, for a few years, the world's second largest silver producer. Jesse Knight, a rancher who had keenly observed mining in Tintic and other limestone districts, mortgaged his land to drive an adit into Godiva Mountain, east of known discoveries. He struck the rich Iron Blossom ore run (fig. 7) and founded the liquorless camp of Knightville. He also introduced many local people to mining as an investment (Mines and Methods, 1909). Both Fitch and Knight had the foresight to acquire additional ground, and became important powers in the mining world. Both died wealthy, but spent a vast amount of their winnings in additional acquisitions and exploration ventures in Tintic. Their heirs continued exploring in the district. Emil J. Raddatz, a persistent mine operator and promoter, and his engineer, James W. Wade, sank shafts for years

into altered volcanic rocks far east of the Iron Blossom run. In 1916 they made the best discovery of all, the massive Tintic Standard ore bodies. Lindgren (1933) once characterized this as the richest silver mine in the world. It supported the town of Dividend. Other stock companies sank shafts in every conceivable environment, most of them without finding ore. The public's money backed most Tintic ventures, and intermittent discovery of rich but small ore bodies kept the Intermountain Stock Exchange in Salt Lake City an exciting place.

THE NATURE of Tintic ore helped develop two important institutions in Utah. First there were lessees, skilled, independent miners who followed narrow ore shoots and sometimes hand sorted high-grade ore. Their one-ton cars of high-grade rock were hoisted individually to the surface, and put in separate bins and railroad cars. A few of these men rose from laborers to capitalists. One mineralized fault in the Chief Number One mine was named the Millionaire Row fissure. Second were the custom smelters of Salt Lake, who negociated for and blended the products of various mines. Backed by large companies, the smelters developed their own geological staffs and often their own prospects. International Smelting, an Anaconda subsidiary operating the Tooele lead and copper plants, found the rich North Lily ore body in 1927. Reinvestment of public and private money, by several major and many small companies, followed.

Kennecott was the last big entry into district exploration. Starting as a joint venture with the Longyear drilling company and others, they explored the northwest corner of the district, with one deep and a dozen shallow drill holes. They also drilled 30 holes (1943-1981) in a porphyry-type copper showing in the southwest corner west of Diamond. Three holes exceeded 3000 feet in depth. The U.S. Geological Survey had long studied an area east of the Tintic Standard mine, where altered volcanic rocks lay above projections of favorable sediments. Mineralization was found in USGS drill holes and was followed by Bear Creek (Kennecott) drilling of significant lead-silver-zinc ore. Two shafts into the hot, unstable ground led to production of 1.85 million tons from the Burgin mine between 1963 and 1978. Sunshine Mining Company, the current lessee, has since announced probable and possible reserves totalling 1.74 million tons, containing 22.3 million ounces of silver, 281,000 tons of lead and 119,000 tons of zinc (Sunshine Mining Co., 1982).

Industrial-mineral development was conducted by the same companies. Chief Consolidated operated a lime quarry, while International Smelting held partial ownership of the Dragon halloysite clay operation at an old metal mine east of Silver City. The Dragon pit and shaft workings followed limestone beds, thoroughly replaced by endellite and halloysite clays but still containing chert marker beds, down into a zone with low clay, and high pyrite content. U.S. Energy Corp. mined similar material from pits east of the Iron Blossom mine area in the 1970s. The Dragon closed in 1974, after producing about 1.25 million tons of clay (Anaconda Minerals Company, oral communication, 1983). Fire clay was produced from altered volcanic rocks on the North Standard property, in the northeast corner of the district.

ALL OF these developments naturally had effects beyond the Tintic. Buildings were erected in Salt Lake City and Provo with Eureka silver. Smelters and railroads prospered. When these failed to cooperate with the Tintic Standard mine, the largest of several chloridization-roasting plants was built east of Goshen (fig. 9) to produce lead, copper and silver directly from low grade ores (Utah Architect, 1974). Salt, pyritic ore, coal, and oxidized silver ore were roasted together and leached, and the metals precipitated. The colorful ruins (fig. 5) of the plant, destroyed by fire in the 1930s, remain a local landmark. A similar plant, financed by George H. Dern, was built near Silver City. (Dern later became governor of Utah and U.S. Secretary of War.)

The Chief Consolidated Company erected a massive flotation plant and an innovative volatization plant in the 1920s, just as base metal prices crashed. The plant was dismantled to raise cash just before World War II, so the substantial tonnages of lead and zinc ores the Chief produced for wartime had to be milled at Caselton, near Pioche, Nevada, and at Bauer, in Tooele Valley, where there were modern custom flotation plants.

CURRENT ACTIVITIES

IN 1970 Kennecott's exploration drilling intercepted gold values in the Homansville fault area, northeast of Eureka and northwest of the Burgin Mine. Surface drilling and core recovery proved difficult and unreliable, despite improvements in wire line core systems. The old Water Lillie prospect shaft was rehabilitated to provide entry for underground drilling, but caving of the shaft in 1980 ended the work. This Central Standard prospect is one area currently being evaluated by Sunshine Mining Company. New Park Mining Co. (C.A. Steen) extended workings on the bottom (2600) level of the Mammoth mine in 1960, developing new ore.

Kennecott also drove a new adit, south of the old Beck Tunnel in Burriston Canyon, into the old Iron Blossom workings. During the 1970s percussion drilling and sampling failed to find another bonanza ore run, but led to shipment of a small tonnage of argentiferous flux ore. Kennecott's exploration drifts in the Mammoth mine, notably on the 2400 level, were more extensive. Connection to the old Grand Central workings was made for ventilation, and a substantial tonnage of the ore developed in the 1960s was mined and hoisted to the tunnel level (table 1). Drilling has also failed to find a major ore body.

Exploration of the east end of the Chief Consolidated mine, southeast of Eureka, has been conducted by ASARCO during the past several years. The Chief Number 2 shaft has been rehabilitated to the 1450 level, and surface drilling conducted. Anaconda Minerals has drilled several holes in the central and eastern parts of the district in the past decade. Several other companies, large and small, have conducted surface and underground explo-

ration in the district. Core and rotary drilling of prospects will undoubtedly continue.

THE DISTRICT remains a testing ground for new ideas. The USGS, in partnership with the National Aeronautics and Space Administration, has conducted studies on multispectral scanners for sensing alteration and biogeochemical patterns (e.g. Milton, 1983). Theses on mineralogy and geochemistry have been completed or are in progress at the Universities of Arizona, Missouri, Utah, and elsewhere.

The biggest current undertaking is the deepening of the old Apex Standard Number 2 shaft by Sunshine Mining Company. This shaft, sunk in the 1930s, has been rehabilitated. Preparations are underway to drive from the 1300 foot level station to provide better access, ventilation and drainage for the Burgin ore bodies. Sunshine also leases the Eureka Standard mine, and plans exploratory drifting toward the old workings. It appears probable that precious and base metals will be produced from Tintic long into the future, contributing tax dollars and employment to Utah.

CONCLUSIONS

The ores of the Tintic district formed near the interface between intrusive igneous rocks and permeable Paleozoic sedimentary rocks and beneath a cover of volcanic rocks. The ores show complex but distinct zoning patterns, from copper to high silver to zinc-lead ores low in precious metals. A system similiar to the porphyry copper deposits, famous at Bingham and in the southwestern states, has been tested in the southwest corner of the district. It is low in grade, but few details on it are yet available (Parry and others, in press). The ore runs that made the main Tintic district famous tend to slope or pitch parallel to the contact of the volcanic rocks with the underlying eroded sedimentary rocks. This suggests the paleowater table had an effect on ore deposition. Some workers have emphasized the igneous origins of all ores (e.g. Lindgren and Loughlin, 1919), while others (Callahan, 1966, 1977) have compared Tintic to the Mississippi Valley district of the central United States, where igneous rocks are unimportant.

The district bridges a conceptual "gap" between porphyry copper systems with gold-arsenic (enargite) rich upper portions and intensely-argillized pyritic gold vein systems that lack underlying mineralized intrusive rocks. (Tintic has both). The mines of Tintic are an example of the efficacy of porous carbonate sediments as precipitators of base metals from heated waters.

The district contains known reserves and resources of zinc-lead ore (whose recovery is made difficult by depth, water, and lack of smelters), ores with high precious metals content (of which known deposits are being explored), and geologic environments to tempt the prospector and explorationist. Based on past mining statistics, the big company may have difficulty proving a large, easily mineable ore reserve. The disappearance of the leaser and the custom smelter from the region has changed some of the economics of mining. But the Tintic district clearly will remain important in Utah's metals industry.

ACKNOWLEDGEMENTS

Persons too numerous to list, most of them in the mining industry, provided information on past activities in the district. Grateful acknowledgement is made to H. T. Morris, W. M. Shepard, J. Quigley, S. C. Potter, A. P. Mogensen, W. T. Parry, J. Ballantyne, R. B. Mulchay, E. S. McIntyre, J. D. Sell, S. M. Hansen, P. Notarianni, V. Gillerman, the Longyear Company, Kennecott, and the Anaconda Minerals Division, Atlantic Richfield Company. Various members of the Illustrations and Economic Geology sections, Utah Geological and Mineral Survey, also assisted with this article. ■

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UTAH MINERAL PRODUCTION SUMMARY, 1983

By MARTHA RYDER SMITH

The income from sales of non-fuel minerals in Utah increased from $622.5 million in 1982 to $659.6 million in 1983, according to preliminary figures reported by the U.S. Bureau of Mines (table 1).

Metals: Copper was Utah's most important non-fuel mineral, in spite of the slow demand and low prices. Total production in 1983 was 167,510 metric tons, valued at $248,358,000, down from 1982's 189,090 metric tons valued at $309,778,000.

Production of gold rose as Getty Mining Company's Mercur gold operation got under way in Tooele County; total gold production for the state, including that produced as a by-product of copper, was 237,930 troy ounces, valued at $101,120,000. In spite of operation of Rancher Exploration and Development Corporation's Escalante silver mine, in Iron County, the state's total production of silver dropped slightly, to 4,259,000 troy ounces, but values increased by more than 40 percent, from $34.5 million dollars in 1982 to $49.0 million in 1983, because of a rise in silver prices.

Production of molybdenum, a by-product of copper, also dropped, as did vanadium, reflecting the slump in steel production. Other metals produced in Utah were beryllium and magnesium; no production of iron was reported in 1983.

Non-metals: Production and total value of non-metallic minerals increased, led by Portland cement, gilsonite, phosphate rock, crushed stone, potassium salts, construction sand and gravel, lime, and salt. Declines were reported to the U.S. Bureau of Mines by producers of potassium salts and salt, because of the unusually high precipitation in 1983 that diluted the Great Salt Lake brines which are the source of the salts. The production of dimension stone, masonry cement, and industrial sand was also reduced.

Energy Minerals: No figures are available for 1983 production of oil, gas and uranium, and for income from production of fuel minerals.

Coal production dropped from 17,650,000 short tons in 1982 to 11,982,000 short tons in 1983 (with 16 of 17 active mines reporting), as a result of the decreased demand (table 2). Most of the coal (85.5 percent) was produced from the Wasatch Plateau coal field; 13.8 percent came from the Book Cliffs field, and 0.7 percent from the Emery coal field. Ten percent of the total production was shipped to Pacific Rim counties; 48 percent was sold or used in Utah, and 37.2 percent was shipped to other states. Only 4.8 percent was unsold at the end of the year.

MINERAL INDUSTRY ACTIVITY, 1983[2]

COAL

JANUARY — Price River Coal Company laid off 100 employees, put coal mine at Helper on standby.

FEBRUARY — U.S. Fuel Co. laid off 57 employees at its Hiawatha Mine. **Plateau Mining Co.** laid off 15 employees at its mine south of Price. **Kaiser Steel** recalled 212 miners at its Sunnyside mine, idle since December 28, 1982. The Utah Division of Water Resources is studying the feasibility of a slurry pipeline to carry coal from Carbon and Emery Counties to IPP power plant near Lyndyl, in Millard Co.

MARCH — Plateau Mining Co. laid off an additional 20 employees; 280 are still at work.

APRIL — A massive mudslide at Thistle Junction in Spanish Fork Canyon has blocked highway and rail traffic between Price area and northwest Utah, causing major problems for coal companies in Carbon and Emery Counties. 250,000 tons of coal per month had been shipped through this area from **Plateau Mining Co., U.S. Fuel Co., Tower Resources Co.** and **Co-Op Mining**. U.S. Fuel shut down its Hiawatha mine; Plateau and Co-Op are stockpiling ore. **Price River Coal Co.** plans to reopen its #5 mine, with a single shift. **Intermountain Power Plant** has signed contracts with **Plateau Mining Co.** and **Skyline Mines**, to provide coal for the new power plant now under construction near Lyndyl. **Rio Grande Railroad** and **Consolidation Coal Co.** have cancelled plans for a 62-mile railroad between Price and Consolidation's Emery Coal Mine due to the soft market for coal.

MAY — Mountain Fuel Resources, the **Department of Energy,** and **Ford, Bacon and Davis** dedicated a new $6 million coal gassification plant in West Jordan, Salt Lake County. Gas will be used to fire brick at Mt. Fuel's Interstate Brick plant.

JUNE — Of 22 coal mines in Utah, eight are closed or not operational; ten have reduced work schedules, four have moderately reduced production.

AUGUST — Coastal States Energy Corp. has contracts to supply up to 25 million tons of coal to IPP plant near Lyndyl from its Skyline mine near Scofield and the SUFCO mine near Salina.

METALS

JANUARY — Kennecott Minerals laid off 160 employees at its Bingham Canyon operations in Salt Lake County. About 5,000 workers are still employed. **Geneva Steel Co.** laid off 100 workers at the U.S. Steel Geneva Works, Orem, in Utah County, and closed one of its three open-hearth furnaces because of the poor market for steel.

FEBRUARY — In February, 60-80 employees were called back by Geneva Steel Co. and the third open-hearth furnace reopened. U.S. Steel closed its Desert Mound iron mine, the only mine which had been shipping iron ore in Utah, in 1982. **American Consolidated Mining Co.** is installing a new modifed cyanide leaching process at

TABLE 1. Non-fuel mineral production in Utah, 1982-83 [1]

Mineral	1983[p] Quantity	1983[p] Value (thousands)	1982	1982 Value (thousands)
Clays[2] ..... thousand short tons	183	$994	206	$1,261
Copper (recoverable content of ores, etc.) ..... metric tons	189,090	309,778	167,510	284,358
Gem stones	NA	80	NA	80
Gold (recoverable content of ores, etc.. ..... troy ounces	174,940	65,762	237,930	101,120
Gypsum ..... thousand short tons	231	2,363	267	2,906
Lime..... do.....	286	15,121	292	15,720
Salt..... do.....	1,227	23,210	747	15,579
Sand and gravel:				
Construction ..... do.....	7,579	14,920	9,700	17,400
Silver (recoverable content of ores, etc.) ..... thousand troy ounces	4,342	34,522	4,259	48,978
Stone:				
Crushed ..... thousand short tons	2,500[p]	9,800[p]	4,300	21,000
Dimension ..... do.....	3[p]	280[p]	3	250
Combined value of asphalt (native), beryllium concentrate, cement, clays (fuller's earth), iron ore, lead (1982), magnesium compounds, molybdenum, perlite (1983), phosphate rock, potassium salts, sand and gravel (industrial, 1982), sodium sulfate, vanadium.	XX	145,669	XX	150,929
TOTAL	**XX**	**622,499**	**XX**	**659,581**

SOURCE: Lorraine B. Burgin, *Mineral Industry Surveys*, "The mineral industry of Utah in 1983", Annual Preliminary, January 13, 1984, U.S. Bureau of Mines, Denver, Colorado.

[p] Preliminary. NA — Not available. XX — Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Excludes fuller's earth, value included with "Combined value" figure.

its Tooele County operations (gold). **Amax** is considering expansion of its plant at Rowley on the southwest shore of Great Salt Lake, where it produces magnesium metal from brines. **Azerado Minerals** is doing a feasibility study on tailings at the **Mayflower** mine (silver, lead) near Park City. Kennecott reported $188 million loss for 1982 (copper).

MARCH — Kennecott Minerals changed its name to **Kennecott**. 75 more salaried employees were laid off in Salt Lake County.

APRIL — Kennecott and 14 unions have agreed to freeze salaries for the next three years, but will keep cost-of-living adjustments. This is the first time in 20 years that there has been no strike of the copper industry. **Getty Minerals** has started processing ore at its Mercur Gold mine and poured its first gold brick on 4-21. It plans to produce 230 ounces of gold per day for the next 14-17 years. **Sunshine and HMC Mining Co.** have agreed to buy Kennecott's Tintic Division. **Johnson Matthey Refining Co.** dedicated its new $10 million gold-silver refinery in Salt Lake City.

MAY — Kennecott announced layoff of 80 more salaried employees in Salt Lake County.

JUNE — Sunshine Mining announced that it will resume development of the Apex No. 2 shaft in the Bingham mine in the Tintic Mining district, Utah County, to find a water-free access to the Burgin lead-silver ore body. **Freeport Minerals** has begun exploration of the old Horn Silver mine near Milford in Beaver County. **Ranchers Exploration and Development Corp.** has produced 570,000 ounces of silver in the first half of 1983 from its Escalante silver mine in Iron County.

SEPTEMBER — Kennecott laid off 120 more employees at Bingham Canyon, in Salt Lake County, but 200 have been recalled to work in the concentrators.

NOVEMBER — Musto Exploration plans to reopen the 60-year-old Apex copper mine near St. George to produce germanium and gallium for use in the manufacture of electronics. **Toledo Mining Co.** is doing exploratory work at the Horn Silver Mining and Toledo Mining Co. gold-silver and megnetite properties near Milford, Beaver County.

TAR SAND, OIL SHALE

FEBRUARY — Geokinetics plans to fire up its 2 largest retorts at Kamp Kerogen, 60 miles south of Vernal, Uintah County. The project involves drilling shallow wells into shale deposits, blasting the beds, and using fire-flood techniques to drive the kerogen to recovery wells.

AUGUST — Geokinetics reported that it has extracted 75,000 barrels of oil from shale using its fire-flood process.

URANIUM-VANADIUM

JANUARY — Energy Fuels Nuclear plans to lay off 100 men and put its mill at Blanding on standby until the price of uranium improves. The mill, opened in 1980, is the most modern in the country. **Atlas Corp.** won a multi-million dollar contract for 300,000 pounds of U_3O_5 in the first weeks of January. The price of uranium is the lowest in four years.

AUGUST — Rio Algom Corp. has subleased the Mi-Vida mine in

TABLE 2. Utah coal production, 1982 and 1983 [P]

	Coal Production, 1982		Coal Production, 1983 [P]	
Total for State	**17,624,989 short tons of raw coal**		**16/17 mines reporting 11,982,173 short tons of raw coal**	
	Short tons	**Percent of total**	**Short tons**	**Percent of total**
By County				
Carbon	8,678,219	49.0	4,547,262	38.9
Emery	6,699,274	38.0	5,204,158	43.4
Sevier	2,247,496	13.0	2,230,753	18.6
By Coal Field				
Wasatch Plateau	12,872,917	73.0	10,248,365	85.5
Book Cliffs	3,899,966	22.0	1,646,093	13.8
Emery	852,106	5.0	87,715	0.7
Distribution of Utah Coal				
Pacific Rim	2,435,254	13,8	1,299,633	10.0
Other States	5,228,405	29.7	4,843,204	37.2
Utah Use	8,394,926	47.5	6,245,681	48.0
Other/Unsold	1,566,403	9.0	619,886	4.8
Utah Coal Use by Major Industry				
Industrial		19.0		17.3
Coking/Metallurical		7.0		2.7
Space Heating		3.0		2.7
Power Generating		62.0		75.2
Other/Unsold		9.0		2.2
Utah Coal Distribution to Out of State Destinators				
TOTAL	**7,663,660**		**6,159,417**	
Pacific Rim		31.8		22.7
California		24.3		12.7
Mid-West States		22.8		17.5
Nevada		15.9		35.7
Northwest States		2.2		4.7
Arizona		1.6		5.9
Montana		0.9		0.6
Wyoming		0.3		0.0
Colorado		0.2		0.2

Source: UGMS staff. [P] Preliminary figures.

San Juan County, from Minerals West. **Minerals West** operated the mine from 1975 to mid-1982, when it was closed because of depressed prices.

SEPTEMBER — Atlas Minerals Corp. is stockpiling uranium and vanadium at its mine and mill near Moab in San Juan County in anticipation of an increase in prices.

NOVEMBER — Union Carbide is laying off 25 miners at its LaSal mine because of the depressed uranium market. **Rio Algom Corp.** has increased production of uranium at its mill south of LaSal in San Juan County. Eight new employees have been hired; the price of uranium is now $23.50, up from $18.50 a year ago.

SOURCES AND NOTES:

[1] No figures are available for 1983 production of oil, gas and uranium, and for income from production of fuel minerals.

[2] Selected from *Management Digest*, January-December 1983, published by the Utah Mining Association.

Final 1983 non-fuel mineral production data can be obtained from U.S. Bureau of Mines State Liason Officer, Intermountain Field Operations Center, Denver Federal Center, Building 20, Denver, Colorado 80225.

Oil and Gas drilling and production data for 1981 and 1982 has been published in UGMS Circulars 73 and 74. Monthly production data for 1984 can be obtained from the *Production Report*, Utah Division of Oil, Gas and Mining, 4241 State Office Building, Salt Lake City, UT 84114. ■

UGMS STAFF RECEIVE INCENTIVE AWARDS

At a staff meeting on July 23, 1984, Genevieve Atwood, UGMS Director, and Kenneth Poulson, Chairman, UGMS Board, presented incentive awards to the following UGMS employees:

Kent Brown, Cartographer, Editorial Section, has saved the State thousands of dollars by developing in-house, photo-lab capabilities which were previously contracted out. He was recognized with this award for various cost-savings efforts in photo-lab work.

Fitzhugh D. Davis, Geologist, County Mapping Section, in addition to his usual mapping projects, which he completed in a timely manner, Fitz was assigned the extra responsibility of compiling an inventory of the 1983 wet-year geologic hazards occurrences. Given short notice and a quick deadline, he finished one month before schedule with accurate, thorough, and understandable results.

Hellmut H. Doelling, Senior Geologist, Geologic Mapping Program, has not only brought an entire new program up to speed (the quadrangle mapping project) but has completed a large mapping project of the Arches National Park as part of the UGMS review of the Paradox Basin geology.

Dan Foster, Geologist, Energy Section, was innovative in developing a software program, with Department of Natural Resources guidance, for use with the National Coal Resource Data System (NCRDS). It allows for the entry of stratigraphic data directly into the U.S. Geological Survey computer in Reston, Virginia, thereby saving the USGS time and money in the use of contract personnel, and reflecting favorably on the UGMS.

Klaus D. Gurgel, Head, Editorial Section, has saved the State over $10,000 in printing charges by carefully bidding and monitoring the production of UGMS maps and reports. His staff's performance and morale has greatly increased in the past year in spite of budgetary vacancies and an extraordinary workload.

Bruce N. Kaliser, Chief, Hazards Section, has performed an outstanding service in assessing the risk represented by slope failures along the Wasatch Front, providing warnings and recommending actions to mitigate the risk. Working very long hours and sometimes under hazardous conditions, he enabled State and local governments to deal more effectively with the events of 1984.

William Lund, Chief, Site Investigations Section, is cooperative and highly responsive to the needs of the UGMS and other State agencies and local governments. His section consistently produces high quality work and reports. His exceptional service on the Resource Development Coordinating Council (RDCC) has been of great benefit to the Department of Natural Resources.

Carolyn Olsen, Phototypesetter/Graphic Arts Technician, Editorial Section, dedication and professionalism make her a most valuable employee, always interested in putting out an outstanding product. Her award was in recognition of the several weeks that she covered two positions at the same time.

Charles G. (Jack) Oviatt, Geologist, Quadrangle Mapping Section, with his expertise in Quaternary geology, has coached and assisted his fellow workers in reaching the highest standards of their profession, helping to acquire quickly what the UGMS would have taken years to achieve naturally. Such service is invaluable and will benefit the State for years to come.

James W. Parker, Cartographer, Editorial Section, has given the Survey excellent peformance in geologic cartography since February 1979 (part-time) and full-time since September 1982. His work on Project BOLD was of extra service to the Department of Natural Resources.

Bryce Tripp, Geologist, Mineral Section, in obtaining the software "GIPSY", implementing its use, and making the data available in printed and electronic form, has made the vast amount of information in the Computerized Resource Information Bank (CRIB) files accessible to this division and others. He has saved the division and State much time with his singular and extraordinary work.

Annona Youngdell, Secretary, Economic & Mapping Programs, has demonstrated innovative effort beyond that described in her work program, saving the Survey time and money through her organization and efficiency in handling program accounting and financial requirements. Her initiation of a tickler system has ensured timely response to action requirements. ■

NEW UGMS PUBLICATIONS

- Bulletin 120, Bibliography of Utah coal, 1869 through 1982, by Dan A. Foster and Archie D. Smith, compilers, 248 p., 2 figs. Price $15.00 over-the-counter.
- Special Studies 65, Economic potential of the P.R. Springs oil-impregnated deposit, by Keith Clem, 35 p., iv, 22 figs, appendices. Price $7.50 over-the-counter.
- Circular 75, Summary of oil and gas activities in Utah, 1982, by Karl W. Brown, 56 p., vi, 1 fig., 4 tables. Price $7.50 over-the-counter.

Orders must be pre-paid. Postage rates: Orders less than $10.00, add $2.00; $10.00 - $24.99, add $4.00; $25.00 - $50.00, add $8.00; $50.00 - $100.00, add $12.00; more than $100.01, add 12%; add $1.50 for tube for rolled map (maximum of four map sheets per tube).

UTAH EARTHQUAKE ACTIVITY
April to June 1984

By WILLIAM D. RICHINS[1]

THE University of Utah Seismograph Stations records an 85-station network designed for local earthquake monitoring within Utah, southeast Idaho, and western Wyoming. During April to June 30, 1984, 130 earthquakes were located within the Utah region (fig. 1).

The largest earthquake during this time period occurred on May 12, within Pocatello Valley on the Idaho-Utah border near Snowville, Utah. This earthquake had a magnitude of 3.0 and was apparently not felt by local residents. Other significant aspects of earthquake activity shown in fig. 1 include (from north to south):

(1) a magnitude 2.7 earthquake approximately 25 km west of Salt Lake City on June 10 felt in Magna,

(2) a cluster of events 50 km west of Provo near Mercur. These events are probably local blasting,

(3) a magnitude 2.6 shock in the vicinity of Wallsburg 25 km east of Provo on May 5,

(4) continued small magnitude activity within Goshen Valley 40 km southwest of Provo with magnitudes less than 2.7,

(5) clustered small magnitude earthquake activity in the vicinity of active coal mining northwest and southwest of Price in central Utah and,

(6) on-going activity scattered throughout a northeast-southwest trending belt between Richfield and Cedar City in southwest Utah.

[1]Senior staff seismologist, University of Utah Seismograph Stations.

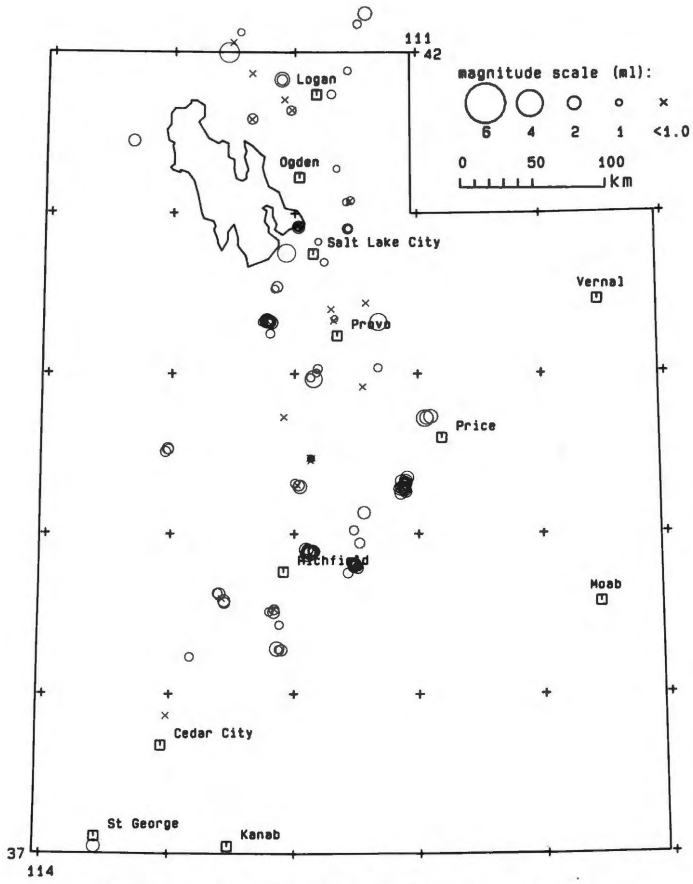

FIGURE 1. Utah Earthquakes: April 1 — June 30, 1984.

A new earthquake bulletin titled **Earthquake Data for the Utah Region, January 1, 1981 to December 31, 1983** was published in August 1984 by the University of Utah Seismograph Stations. A limited number of these volumes are now available for $7.50 over-the-counter (Utah residents add .43¢ sales tax) at UGMS. Additional information on earthquake data within Utah is available by contacting the University of Utah Seismograph Stations, Salt Lake City, Utah 84112 (telephone 801-581-6274). ■

THE TINTIC MINING DISTRICT

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EARLY URANIUM-VANADIUM MINING

Continued from Page 3

Mining commenced in June 1944 and continued through December of that year. Details of the production are given in table 1. Lease I-149-IND-6435 was cancelled by Carroll and Shumway on July 16, 1946.

A U.S. Geological Survey (USGS) engineer examined the property and reported (GSA, 1981, exhibit 52) that the ore was mined by hand from in, and around, chunks of silicified wood in the Shinarump Conglomerate. The ore was lowered from the mesa in tram buckets. At the base of the mesa it was loaded on to trucks and hauled to Thompson, Utah where the ore was loaded on to railroad cars. The USGS reported the ore was sold to Howard Balsley of Moab, Utah.

Mr. Balsley was an ore buyer for Vitro Manufacturing Company of Pittsburgh, Pennslyvania (written communication, 1971). He bought ores with minimum grades 1.50% V_3O_8 and 5.00% V_2O_5 during the years 1934 through 1944. The ores were shipped to Vitro's plant at Canonsburg, Pennsylvania, for the manufacture of ceramic colors, etc. It is the opinion of the writer that the ore from Utah No. 1 Lease was shipped to Canonsburg for processing rather than to Uravan, Colorado as suggested by the USGS.

TABLE 1. Uranium and Vanadium Production, 1944. Lease I-149-IND-6435 Utah No. 1

Month	Pounds of Ore	Pounds U_3O_8	Percent U_3O_8	Pounds V_2O_5	Percent V_2O_5
June	8,732	333.14	3.82	386.71	4.43
July	9,598	386.88	4.03	485.66	5.06
August	18,207	660.67	3.63	1,298.28	7.13
September	34,281	1,280.85	3.74	1,988.91	5.80
October	10,933	438.22	4.01	570.34	5.22
November	5,747	313.37	5.45	307.81	5.36
December	16,265	770.12	4.74	665.98	4.09
TOTAL	**103,763**	**4,183.25**	**4.03***	**5,703.69**	**5.50***

* Average percentage.

THE URANIUM MARKET

During the late 1930s and early 1940s, the carnotite deposits of the Four Corners area were mined for their vanadium content. Beginning in 1942, the Manhattan District Engineers as part of the secret, wartime Manhattan Project, began purchasing a uranium sludge from the vanadium mills at Monticello, Utah and Naturita, Colorado. The recovery of uranium from vanadium mill tailings took place at Durango and Uravan, Colorado. Due to the secrecy of the project, miners were not told about the uranium recovery, or paid for the uranium in their ore.

The Interior Department was aware of the War Department's uranium procurement activities and was concerned that the Navajo Tribe was not receiving uranium royalties. On April 14, 1944, the Vanadium Corporation of America informed the Office of Indian Affairs that they were paying for uranium only if the grade of the ore averaged over 0.75% U_3O_8. Vitro Manufacturing had a higher cutoff at 1.50% U_3O_8 (H.W. Balsley, written communication, 1971).

Carroll and Shumway were paid on a sliding scale ranging from $0.50 per pound U_3O_8 in ore averaging 1.65% $V_3O_8$to 2.65 per pound for ore containing 19.00% U_3O_8. The vanadium prices ranged from $0.25 per pound V_2O_5 in ore averaging 2.40% V_2O_5 to $0.43 per pound for ore containing 13.50% V_2O_5. Carroll and Shumway received $6,289.80 for 103,763 pounds of carnotite ore (GSA, 1981, p. 49).

Production from the Utah No. 1 lease represents the first ore mined on the Navajo Indian Reservation for which uranium was paid for.

LATER DEVELOPMENTS

Records of the Department of Energy show that under the Atomic Energy Commission's ore procurement program, the Monument No. 3 lease produced six tons of ore averaging 0.47% U_3O_8 in 1949.

The area of the Utah No. 1 Lease was acquired on October 6, 1949 by Morgan Nielson of Blanding, Utah as Lease I-149 -IND-8310 and named the Skyline Mine. Nielson produced ore in 1949 and 1950. Barney Cockburn of Artesia, New Mexico acquired the lease in 1950 with Nielson retaining a 7½% interest. Cockburn made shipments in 1950, and in January 1952 he acquired full interest in the lease. On December 3, 1952 the assignment of the lease from Cockburn to Archie Garwood and R.C. Gerlach of Cortez, Colorado was approved. Garwood and Gerlach produced ore in 1952-55. The lease was later cancelled, and Jimmie Goodman acquired the 40-acre tract as Mining Permit No. 401. It was assigned to A and B Mining Company, who did clean up mining in 1960 and 1962. Production from the Skyline Mine was 5,137 tons of ore that averaged 0.30% U_3O_8 and 0.29% V_2O_5.

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EARTHQUAKE WORKSHOP

A workshop on evaluation of regional and urban earthquake hazard and risk in Utah was held at the State Capitol on August 14, 15, and 16. About 140 scientists, engineers, planners and elected officials from Utah and several other states attended the workshop, which was sponsored by the U.S. Geological Survey, Utah Geological and Mineral Survey, Federal Emergency Management Agency, National Bureau of Standards, Utah Division of Comprehensive Emergency Management and the University of Utah.

This was the first of three annual workshops scheduled as part of the Wasatch Front earthquake program. Governor Matheson addressed the opening session. Plenary session were: (1) evaluation of earthquake hazards and risk along the Wasatch Front, (2) responding to earthquake hazards in Utah, (3) implementation of specifications to reduce potential losses from earthquake hazards in Utah and (4) review of draft work plan "Regional and Urban Earthquake Hazards Evaluation: Wasatch Front, Utah". Two technical sessions were concerned with evaluation of earthquake hazards and risk along the Wasatch Front. Papers presented at the workshop will be published as a USGS open-file report in December, 1984.

UGMS Staff Changes

The following staff changes have taken place since last issue of *Survey Notes*:

Vicki May, who job-shared the administrative assistant position, has returned to Ticaboo, Utah to pursue a full-time position with Plateau Resources.

Dan Foster, earth science specialist for the Survey has transferred to the Division of State Lands and Forestry as a research assistant.

Within the Survey, **Karin Budding** has moved from contract geologist to a time-limited geologist position working on a geothermal project funded by the DOE.

GREAT SALT LAKE LEVEL

Date (1984)	Boat Harbor South Arm (in feet)	Saline North Arm (in feet)
July 1	4209.25	4205.35
July 15	4209.10	4205.40
August 1*	4209.05	4205.60
August 15	4208.55	4206.20
Sept. 1	4208.15	4206.60
Sept. 15	4208.00	4206.85

* Southern Pacific Railroad causeway breached
Source: U.S. Geological Survey provisional records

UTAH GEOLOGICAL AND MINERAL SURVEY

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