

Palynology Evaluation Results from the Provo, Duchesne, and Rush Valley 30' x 60' Quadrangles, Utah

by

Utah Geological Survey and Gerald Waanders¹

¹ *Consulting Palynologist, Garnet Valley, Pennsylvania
(formerly San Marcos and Encinitas, CA)*

Suggested citation:

Utah Geological Survey and Waanders, G., 2020, Palynology evaluation results from the Provo, Duchesne, and Rush Valley 30' x 60' quadrangles, Utah: Utah Geological Survey Open-File Report 720, 60 p., <https://doi.org/10.34191/OFR-720>.



OPEN-FILE REPORT 720
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES
2020

Blank pages are intentional for printing purposes.

INTRODUCTION

This Open-File Report makes available reports from palynology evaluations completed to determine the age and depositional environment of rock samples collected during geologic investigations funded or partially supported by the Utah Geological Survey (UGS) and the U.S. Geological Survey National Cooperative Geologic Mapping Program (STATEMAP). Table 1 provides the sample numbers and locations for the palynology data. The references listed in table 1 generally provide additional information such as sample location, geologic setting, and significance or interpretation of the samples in the context of the area where they were collected. The palynology reports were prepared by Gerald Waanders, Consulting Palynologist, Garnet Valley, Pennsylvania (formerly San Marcos and Encinitas, California), under contract to the UGS (see appendix). Waanders prepared and evaluated rock samples submitted by the UGS. The UGS did not receive slides, mounts or photographs from Waanders. These data are technical in nature and interpretation requires considerable training and experience in applicable palynologic techniques and systematics, as well as an understanding of stratigraphic palynology.

DISCLAIMER

This open-file release is intended as a data repository for information gathered in support of various UGS projects. The data are presented as received from Gerald Waanders and do not necessarily conform to UGS technical, editorial, or policy standards; this should be considered by an individual or group planning to take action based on the contents of this report. The Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding the suitability of this product for a particular use. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

ACKNOWLEDGMENTS

Geologic mapping of the Provo, Duchesne, and Rush Valley 30' x 60' quadrangles was funded by the UGS and U.S. Geological Survey, National Cooperative Geologic Mapping Program (NCGMP). Provo was funded through USGS STATEMAP award numbers 99HQAG0138 (1999-2000), 01HQAG100 (2001-02), 02HQAG055 (2002-03), 03HQAG0096 (2003-04), 04HQAG0040 (2004-05), 05HQAG0084 (2005-06), and 06HQAG0037 (2006-07). Duchesne was funded through USGS STATEMAP award numbers G12AC20226 (2012-13), G13AC00169 (2013-14), G14AC00214 (2014-15), G15AC00249 (2015-16), and G16AC00191 (2016-17). Rush Valley was funded through USGS STATEMAP award numbers 08HQAG0096 (2008-09), G09AC00152 (2009-10), G10AC00386 (2010-11), and G12AC20226 (2012-13).

REFERENCES

- Biek, R.F., Hylland, M.D., Welsh, J.E., and Lowe, M., 2003, Geologic map of the Center Creek quadrangle, Wasatch County, Utah: Utah Geological Survey Map 192, 25 p., 2 plates, scale 1:24,000, <https://doi.org/10.34191/M-192>.
- Chidsey, T.C. (editor), 2016, Paleozoic shale-gas resources of the Colorado Plateau and eastern Great Basin, Utah—multiple frontier exploration opportunities: Utah Geological Survey Bulletin 136, 240 p., appendices A–U. [Appendix O. Palynology and Thermal Maturation Report] <https://doi.org/10.34191/B-136>.
- Clark, D.L., Kirby, S.M., and Oviatt, C.G., 2012, Interim geologic map of the Rush Valley 30' x 60' quadrangle, Tooele, Utah and Salt Lake Counties, Utah: Utah Geological Survey Open-File Report 593, 65 p., 2 plates, scale 1:62,500, <https://doi.org/10.34191/OFR-593>.
- Clark, D.L., Kirby, S.M., and Oviatt, C.G., in review, Geologic map of the Rush Valley 30' x 60' quadrangle, Tooele, Utah and Salt Lake Counties, Utah: Utah Geological Survey Map, scale 1:62,500.
- Constenius, K.N., Clark, D.L., King, J.K., and Ehler, J.B., 2011, Interim geologic map of the Provo 30' x 60' quadrangle, Utah, Wasatch, and Salt Lake Counties, Utah: Utah Geological Survey Open-File Report 586DM, 42 p., 2 plates, scale 1:62,500, contains GIS data, DVD, <https://doi.org/10.34191/OFR-586DM>.

- Constenius, K.N., Coogan, J.K., Clark, D.L., and King, J.K., in preparation, Geologic map of the Provo 30' x 60' quadrangle, Utah, Wasatch, and Salt Lake Counties, Utah: Utah Geological Survey Map, scale 1:62,500.
- Sprinkel, D.A., 2018, Interim geologic map of the Duchesne 30' x 60' quadrangle, Duchesne and Wasatch Counties, Utah: Utah Geological Survey Open-File Report 689, 37 p., 2 plates, scale 1:62,500, <https://doi.org/10.34191/OFR-689>.
- Sprinkel, D.A., in preparation, Geologic map of the Duchesne 30' x 60' quadrangle, Duchesne and Wasatch Counties, Utah: Utah Geological Survey Map, scale 1:62,500.
- Sprinkel, D.A., Doelling, H.H., Kowallis, B.J., Waanders, G.L., and Kuehne, P.A., in preparation, Stratigraphy, correlation, and paleogeography of the Arapien, Carmel, and Twin Creek Formations (Middle Jurassic) of Utah and surrounding states: Utah Geological Survey Bulletin. [measured section, Monks Hollow]

Table 1. Summary of sample numbers and locations for palynology data from the Provo, Duchesne, and Rush Valley 30' x 60' quadrangle areas.

Sample Number	30' x 60' Quadrangle	7.5' Quadrangle	UTM easting 27-12	UTM northing 27-12	Latitude WGS84 (° N)	Longitude WGS84 (° W)	Waanders Report Date	Collector	Reference
CC42299-1	Provo	Center Creek	478438	4474755	40.42500	111.25490	5-May-99	Biek	Biek and others, 2003
CC42299-2	Provo	Center Creek	478438	4474755	40.42500	111.25490	5-May-99	Biek	Biek and others, 2003
CC42299-3 [not 433]	Provo	Center Creek	478438	4474755	40.42500	111.25490	5-May-99	Biek	Biek and others, 2003
CC52099-1 ^A	Provo	Center Creek	478438	4474755	40.42500	111.25490	1-Jun-99	Biek	Biek and others, 2003
CC61099-1 ^A	Provo	Center Creek	478438	4474755	40.42500	111.25490	22-Jul-99	Biek	Biek and others, 2003
CC7899-1	Provo	Center Creek	478438	4474755	40.42500	111.25490	22-Jul-99	Biek	Biek and others, 2003
CC7899-2	Provo	Center Creek	478438	4474755	40.42500	111.25490	22-Jul-99	Biek	Biek and others, 2003
JC99-1 ^A	Provo	Heber Mountain	484925	4473174	40.41089	111.17840	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-4 ^A	Provo	Heber Mountain	485648	4471291	40.39395	111.16983	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-6 ^A	Provo	Wolf Creek Summit	492335	4473593	40.41477	111.09106	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-7	Provo	Wolf Creek Summit	494801	4471442	40.39541	111.06198	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-8	Provo	Jimmies Point	494187	4466783	40.35343	111.06918	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-9 ^A	Provo	Heber Mountain	485001	4472646	40.40615	111.17749	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-10	Provo	Heber Mountain	485001	4472646	40.40615	111.17749	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-11	Provo	Heber Mountain	485977	4471306	40.39408	111.16595	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-13	Provo	Heber Mountain	486559	4471057	40.39185	111.15909	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-14	Provo	Heber Mountain	485944	4470642	40.38810	111.16633	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-15	Provo	Heber Mountain	482648	4475107	40.42827	111.20529	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-16	Provo	Heber Mountain	484829	4472453	40.40440	111.17950	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-17	Provo	Wolf Creek Summit	491702	4470620	40.38798	111.09849	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-18	Provo	Wolf Creek Summit	491659	4470611	40.38790	111.09900	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-19	Provo	Co-op Creek	488656	4468433	40.36824	111.13433	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
JC99-22	Provo	Jimmies Point	491076	4467417	40.35912	111.10581	10-Apr-00	Coogan	Constenius and others, 2011, in prep.
KNC92699-23A	Provo	Co-op Creek	487481	4464329	40.33125	111.14809	10-Apr-00	Constenius	Constenius and others, 2011, in prep.
KNC92699-23B	Provo	Co-op Creek	487481	4464329	40.33125	111.14809	10-Apr-00	Constenius	Constenius and others, 2011, in prep.
KNC92699-23C	Provo	Co-op Creek	487481	4464329	40.33125	111.14809	10-Apr-00	Constenius	Constenius and others, 2011, in prep.
MH092203-1	Provo	Billies Mountain	466795	4435566	40.07155	111.39014	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-2 ^A	Provo	Billies Mountain	466810	4435569	40.07158	111.38996	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-3 ^A	Provo	Billies Mountain	466810	4435569	40.07115	111.38942	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-4	Provo	Billies Mountain	466856	4435521	40.07115	111.38942	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-5	Provo	Billies Mountain	466874	4435546	40.07138	111.38921	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-6	Provo	Billies Mountain	466887	4435564	40.07154	111.38906	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
MH092203-7	Provo	Billies Mountain	466921	4435555	40.07146	111.38866	22-Sep-03	Sprinkel	Sprinkel and others, in prep.
KNC101505-3	Provo	Aspen Grove	454293	4471102	40.39111	111.53928	12-Dec-05	Constenius	Constenius and others, 2011, in prep.
KNC101505-7	Provo	Aspen Grove	453399	4470204	40.38298	111.54975	12-Dec-05	Constenius	Constenius and others, 2011, in prep.
Gulf Banks 1_10,100-10,3xx	Provo	Spanish Fork	443015	4441154	40.12062	111.66950	23-Jan-08	Constenius	Constenius and others, 2011, in prep.
Gulf Banks 1_10,750-11,000	Provo	Spanish Fork	443015	4441154	40.12062	111.66950	23-Jan-08	Constenius	Constenius and others, 2011, in prep.
Gulf Banks 1_11,750-12,000	Provo	Spanish Fork	443015	4441154	40.12062	111.66950	23-Jan-08	Constenius	Constenius and others, 2011, in prep.
Gulf Banks 1_12,740-13,000	Provo	Spanish Fork	443015	4441154	40.12062	111.66950	23-Jan-08	Constenius	Constenius and others, 2011, in prep.

Table 1. Continued.

Sample Number	30' x 60' Quadrangle	7.5' Quadrangle	UTM easting 27-12	UTM northing 27-12	Latitude WGS84 (° N)	Longitude WGS84 (° W)	Waanders Report Date	Collector	Reference
P-1	Provo	Orem	444226	4463682	40.32366	111.65725	13-Apr-09	Morgan	Chidsey, 2016
P-2	Provo	Orem	444388	4463981	40.32636	111.65537	13-Apr-09	Morgan	Chidsey, 2016
P-3	Provo	Orem	445980	4464721	40.33313	111.63669	13-Apr-09	Morgan	Chidsey, 2016
P-4	Provo	Bridal Veil Falls	447416	4464614	40.33226	111.61977	13-Apr-09	Morgan	Chidsey, 2016
P-5	Provo	Bridal Veil Falls	447452	4464649	40.33258	111.61935	13-Apr-09	Morgan	Chidsey, 2016
E-Lake-1	Provo	Soldiers Pass	424613	4452336	40.21990	111.88676	13-Apr-09	Morgan	Chidsey, 2016
P-9-1	Provo	Orem	444612	4462765	40.31542	111.65262	5-Oct-09	Morgan	Chidsey, 2016
P-9-2 [^]	Provo	Orem	444258	4462811	40.31581	111.65679	5-Oct-09	Morgan	Chidsey, 2016
KNC101811-0	Duchesne	Tabby Mountain	510781	4468805	40.37160	110.87373	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
KNC101811-1	Duchesne	Tabby Mountain	510781	4468805	40.37160	110.87373	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
KNC101811-2	Duchesne	Tabby Mountain	510781	4468805	40.37160	110.87373	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
KNC101811-3	Duchesne	Tabby Mountain	510781	4468805	40.37160	110.87373	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
KNC101811-4 [^]	Duchesne	Tabby Mountain	510781	4468805	40.37160	110.87373	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
KNC101811-5	Duchesne	Tabby Mountain	510750	4468676	40.37044	110.87410	15-Nov-11	Constenius	Sprinkel, 2018, in prep.
Red Creek 06122018-1	Duchesne	Tabby Mountain	510778	4468542	40.36923	110.87377	28-Jun-18	Sprinkel	Sprinkel, 2018, in prep.
Red Creek 06122018-2 [^]	Duchesne	Tabby Mountain	510753	4468569	40.36947	110.87406	28-Jun-18	Sprinkel	Sprinkel, 2018, in prep.
Red Creek 06122018-3 [^]	Duchesne	Tabby Mountain	510766	4468572	40.36950	110.87391	28-Jun-18	Sprinkel	Sprinkel, 2018, in prep.
Current Creek 06122018-1 [^]	Provo	Jimmies Point	495932	4465946	40.34590	111.04862	28-Jun-18	Sprinkel	Sprinkel, 2018, in prep.
AR-1	Rush Valley	Allens Ranch	413473	4436379	40.07508	112.01553	5-Oct-09	Morgan	Chidsey, 2016
AR-2	Rush Valley	Allens Ranch	406199	4429330	40.01080	112.09980	5-Oct-09	Morgan	Chidsey, 2016
AR-3	Rush Valley	Allens Ranch	406196	4429338	40.01087	112.09984	5-Oct-09	Morgan	Chidsey, 2016
1928	Rush Valley	Fivemile Pass	398926	4446425	40.16395	112.18767	29-Dec-10	Clark and Kirby	Clark and others, 2012, in review
1944	Rush Valley	Ophir	392415	4467140	40.34973	112.26759	29-Dec-10	Clark and Kirby	Clark and others, 2012, in review
2097	Rush Valley	Fivemile Pass	399206	4454944	40.24072	112.18572	29-Dec-10	Clark and Kirby	Clark and others, 2012, in review
2101	Rush Valley	Mercur	400279	4457873	40.26723	112.17356	29-Dec-10	Clark and Kirby	Clark and others, 2012, in review

Notes:

[^] = Barren sample

APPENDIX

Gerald Waanders

Consulting Palynologist

1611-C Rancho Santa Fe Road

San Marcos, California 92069

(760) 744-7471, FAX: (619) 759-9028

May 5, 1999

TO: Mr. Robert F. Biek
Utah Geological Survey
1594 West N. Temple, Suite 3110
P. O. Box 146100
Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 3 Utah outcrop samples: CC42299-1, CC42299-2 and CC42299-3 from about 35 miles southeast of Salt Lake City (received 4/30/99).

PALYNOLOGY REPORT

CC42299-1

Spores and Pollen:

Taxodiaceae (contaminant?)	(R)
tricolporate sp. (contaminant?)	(R)
Root hairs and soil fungi	(A)

Organic Recovery: 90% Woody, 5% Cuticular and 5% Amorphous

AGE: Indeterminate

ENVIRONMENT: Nonmarine, Fluvial or Floodplain

CC42299-2

Spores and Pollen:

Taxodiaceae (contaminant?)	(R)
Root hairs and soil fungi	(A)

Organic Recovery: 100% Cuticular

AGE: Indeterminate

ENVIRONMENT: Nonmarine, ?Lacustrine

RE: Palynology Analysis of 3 Utah outcrop samples: CC42299-1, CC42299-2 and CC42299-3 from about 35 miles southeast of Salt Lake City (received 4/30/99)

CC43399-3

Spores and Pollen:

Taxodiaceae (contaminant?)	(R)
?spiny palynomorph	(R)
Root hairs and soil fungi	(A)

Organic Recovery: 50% Woody and 50 Cuticular

AGE: Indeterminate

ENVIRONMENT: Nonmarine, ?Swamp/Lacustrine

Analysis By:


Gerald Waanders

Gerald Waanders
Consulting Palynologist
1611-C Rancho Santa Fe Road
San Marcos, California 92069
(760) 744-7471, FAX: (619) 759-9028
June 1, 1999

TO: Mr. Robert F. Biek
Utah Geological Survey
1594 West N. Temple, Suite 3110
P. O. Box 146100
Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 1 Utah outcrop samples: CC52099-1 from about 35 miles southeast of Salt Lake City (received 5/26/99).

PALYNOLOGY REPORT

CC52099-1

Barren of Palynomorphs

Organic Recovery: 100% Woody/Inertinite

AGE: Indeterminate

ENVIRONMENT: Probable Nonmarine

Analysis By:


Gerald Waanders

Gerald Waanders
Consulting Palynologist

1611-C Rancho Santa Fe Road
 San Marcos, California 92069
 (760) 744-7471; FAX: (858) 759-9028
 July 22, 1999

TO: Mr. Robert F. Biek
 Utah Geological Survey
 1594 West N. Temple, Suite 3110
 P. O. Box 146100
 Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 3 Utah outcrop samples from Wasatch County:
 CC61099-1, CC7899-1 and CC7899-2 (received as two shipments dated 7/1/99
 and 7/12/99).

PALYNOLOGY REPORT

CC61099-1

Barren of Palynomorphs

Organic Recovery: 100% Woody/Inertinite

AGE: Indeterminate

ENVIRONMENT: Probable Nonmarine

CC7899-1

Spores and Pollen:

<i>Araucariacites australis</i>	(A)
<i>Classopollis classoides</i>	(A)
<i>Deltoidospora</i> spp.	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Liliacidites peroreticulatus</i>	(R)
<i>Parvisaccites radiatus</i>	(R)
<i>Rugubivesiculites reductus</i>	(R)
Taxodiaceae	(F)
<i>Tricolporopollenites granulocuneus</i>	(R)
Undifferentiated Bisaccates	(A)

RE: Palynology Analysis of 3 Utah outcrop samples from Wasatch County:

CC7899-1 (continued)

Microplankton:

<i>Aptea polymorpha</i>	(R)
<i>Canninginopsis colliveri</i>	(R)
<i>Florentinia cooksoniae</i>	(R)
Microforaminifera linings	(R)
<i>Spiniferites ramosus</i>	(R)

Organic Recovery: 20% Amorphous, 30% Cuticular and 50% Woody

AGE: Middle to Late Cenomanian

ENVIRONMENT: Nearshore Marine, Lagoonal or Estuarine

CC7899-2

Spores and Pollen:

<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>Cicatricosisporites brevilaesuratus</i>	(R)
<i>Classopollis classoides</i>	(A)
<i>Deltoidospora</i> spp.	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Gleicheniidites senonicus</i>	(F)
<i>Leptolepidites tenuis</i>	(R)
<i>Liliacidites peroreticulatus</i>	(F)
<i>Parvisaccites radiatus</i>	(R)
<i>Rugubivesiculites reductus</i>	(R)
Taxodiaceae	(F)
<i>Tricolpites</i> sp. A (Nichols & Jacobson)	(R)
Undifferentiated Bisaccates	(R)

Microplankton:

<i>Canninginopsis colliveri</i>	(R)
<i>Circulodinium distinctum</i>	(R)

Organic Recovery: 5% Amorphous, 15% Cuticular and 70% Woody


RE: Palynology Analysis of 3 Utah outcrop samples from Wasatch County:

CC7899-2 (continued)

AGE: Middle to Late Cenomanian

ENVIRONMENT: Nearshore Marine, Beach or Deltaic

Analysis By:


Gerald Waanders

Gerald Waanders
Consulting Palynologist

1611-C Rancho Santa Fe Road
San Marcos, California 92069
(760) 744-7471, FAX: (858) 759-9028
April 10, 2000

TO: Mr. Jon King
Mr. Jim C. Coogan
Utah Geological Survey
1594 West N. Temple, Suite 3110
P. O. Box 146100
Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 21 Utah outcrop samples: Ogden Quadrangle 99-18 to -22 and Provo Quadrangle JC99-1, -4, -6, -7, -8, -9, -10, -11, -13, -14, -15, -16, -17, -18, -19, -22. P.O. No. 305469, 3/6/2000.

PALYNOLOGY REPORT

Ogden 99-18, 1810'fwi, 1100'fni, sec. 12, T4NR7E, Porcupine Ridge, 7.5' Quad.

Barren of Palynomorphs: Abundant soil fungi and root hairs.

Organic Recovery: 25% Woody, 25% Cuticular and 50% Amorphous

AGE: Indeterminate

ENVIRONMENT: Indeterminate

Ogden 99-19, 1790'fel, 1050'fsl, sec. 12, T4NR7E, Porcupine Ridge, 7.5'Quad.

Barren of Palynomorphs: Abundant soil fungi & root hairs

Organic Recovery: 75% Woody, 15% Cuticular and 10% Amorphous

AGE: Indeterminate

ENVIRONMENT: Indeterminate

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Ogden 99-20, 2100'fel, 1200'fsl, sec. 12, T4NR7E, Porcupine Ridge, 7.5' Quad.

Spores and Pollen:

<i>Araucariacites australis</i>	(A)
<i>Appendicisporites potomacensis</i>	(R)
<i>Cicatricosisporites dorogensis</i>	(R)
<i>C. hallei</i>	(R)
<i>Classopollis classoides</i> (tetrads)*	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Divisisporis enormis</i>	(R)
<i>Exesipollenites tumulus</i>	(F)
<i>Gleicheniidites senonicus</i>	(A)
<i>Lycopodiumsporites</i> spp.	(R)
<i>Sphagnumsporites</i> spp.	(R)
<i>Rugubivesiculites reductus</i>	(R)
Taxodiaceae	(A)
<i>Trilobosporites minor</i>	(R)
Undifferentiated Bisaccates	(A)

Microplankton:

<i>Baltisphaeridium fimbriatum</i>	(R)
<i>Cometodinium whitei</i>	(R)
<i>Ovoidinium verrucosum</i> *	(R)
<i>Pseudoceratium regium</i> *	(R)
<i>Spinidinium vestitum</i> *	(R)
<i>Subtilisphaera terrula</i>	(R)

Organic Recovery: 10% Woody, 10% Cuticular and 90% Amorphous

AGE: Late Albian

ENVIRONMENT: Nearshore Marginal Marine, Lagoonal/Estuarine

Ogden 99-21, 1575'fel, 640'fsl, sec. 11, T4NR7E, Porcupine Ridge, 7.5 Quad.

Spores and Pollen:

<i>Araucaricites australis</i>	(R)
<i>Chomotriletes fragilis</i>	(C)
<i>Concavissimisporites punctatus</i> *	(R)
<i>Exesipollenites tumulus</i>	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Ogden 99-21 (Continued)

Microplankton:

<i>Oligosphaeridium complex</i>	(R)
<i>Ovoidinium verrucosum</i> *	(R)
<i>Pseudoceratium regium</i> *	(R)
<i>Tasmanites</i> spp.	(R)

Organic Recovery: 95% Woody 5% Cuticular

AGE: Late Albian

ENVIRONMENT: Marginal Marine, Beach/Deltaic

Ogden 99-22, 2375'fel, 100'fnl, sec. 34, T9NR5E, Meachum Ridge, 7.5' Quad.

Barren of Palynomorphs

Organic Recovery: 75% Woody, 5% Cuticular and 20% Amorphous

AGE: Indeterminate

ENVIRONMENT: Indeterminate

Provo JC99-1, 1630'fnl/360'fwl, 7-1S-11W, Heber Mountain, Kcm

Barren of Palynomorphs: Abundant root hairs and soil fungi.

Organic Recovery: 90% Woody 5% Cuticular and 5% Amorphous

AGE: Indeterminate

ENVIRONMENT: ?Probable Nonmarine, Fluvial/Floodplain

Provo JC99-4, 2600'fnl/2330'fel. 18-1S-11W, Heber Mountain, Kcm/Kd/Kf?

Barren of Palynomorphs

Organic Recovery: 90% Woody and 10% Cuticular

AGE: Indeterminate

ENVIRONMENT: ?Probable Nonmarine, Fluvial/Floodplain

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-6, 400'fml/1800'fwl, 12-1S-11W, Wold Creek Summit, Kcm

Barren of Palynomorphs

Organic Recovery: 100% Woody/Inertinite

AGE: Indeterminate

ENVIRONMENT: Probable Nonmarine, Fluvial/Floodplain

Provo JC99-7, 2100'fml/1300'fwl, 18-1s-11W, Wolf Creek Summit, Kmowry

Spores and Pollen:

<i>Aequitriradites spinulosus</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Callialasporites dampieri*</i>	(R)
<i>Camazonosporites insignis</i>	(R)
<i>Cerebropollenites mesozoicus*</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>C. hallei</i>	(R)
<i>C. potomacensis</i>	(R)
<i>C. venustus</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Deltoidospora</i> spp.	(F)
<i>Ephedripites</i> spp.	(R)
<i>Exesipollenites tumulus</i>	(A)
<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Gleicheniidites senonicus</i>	(A)
<i>Klukisporites pseudoreticulatus</i>	(R)
<i>Liliacidites crassatus*</i>	(R)
<i>Matonisporites crassiangularatus</i>	(R)
<i>Perinopollenites</i> spp.	(A)
Undifferentiated Bisaccates	(A)
Taxodiaceae	(A)
<i>Trilobosporites minor</i>	(R)

Microplankton:

<i>Cribroperidinium edwardsi</i>	(F)
<i>Circulodinium distinctum</i>	(R)
<i>Oligosphaeridium complex</i>	(R)
<i>Ovoidinium verrucosum*</i>	(R)
<i>Palaeoperidinium cretaceum</i>	(R)
<i>Pseudoceratium regium*</i>	(R)
<i>Subtilisphaera terrula</i>	(R)
<i>Tasmanites</i> spp.	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-7 (Continued)

Organic Recovery: 60% Woody, 15% Cuticular and 25% Amorphous

AGE: Middle to Late Albian

ENVIRONMENT: Nearshore marine, Lagoonal/Deltaic

Provo JC99-8, 1420'fsl/710'fel, 36-1S-11W, Jimmies Mountain, Kf

Spores and Pollen:

<i>Appendicisporites problematicus</i>	(R)
<i>Araucariacites australis</i>	(F)
<i>Cicatricosisporites brevilaesuratus*</i>	(R)
<i>C. crassiterminatus*</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Divisisporis enormis</i>	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
Taxodiaceae	(R)
<i>Trilobosporites minor</i>	(R)

Organic Recovery: 90% Woody and 10% Cuticular

AGE: ?Probable Cenomanian

ENVIRONMENT: Nonmarine, Swamp/Fluvial

Provo JC99-9, 1790'fsl/710'fel, 13-1S12W, Heber Mountain, Trl

Barren of Palynomorphs: Abundant root hairs and soil fungi

Organic Recovery: 90% Woody and 10% Cuticular

AGE: Indeterminate

ENVIRONMENT: Indeterminate

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-10, 1880'fsl/610'fwl, 18-1S-11W, Heber Mountain, Kd

Spores and Pollen:

<i>Appendicisporites auritus</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>C. hallei</i>	(R)
<i>C. sp.</i>	(R)
<i>Cingulatisporites distaverrucosus</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Densoisporites vellatus</i>	(R)
<i>Gabonisoris sp.</i>	(R)
<i>Klukisporites pseudoreticulatus</i>	(R)
<i>Laevigatosporites spp.</i>	(R)
<i>Liliacidites inaequalis</i>	(R)
<i>Perinopollenites halonatus</i>	(R)
<i>Phyllocladidites sp.</i>	(R)
<i>Pilosisorites trichopapillosus*</i>	(R)
Taxodiaceae	(R)
<i>Tricolpites crassimurus</i>	(R)
<i>Trilobosporites perversulentus*</i>	(R)
Undifferentiated Bisaccates	(C)

Microplankton:

<i>Circulodinium distinctum</i>	(R)
---------------------------------	-----

Organic Recovery: 90% Woody and 5% Cuticular

AGE: Middle to Late Albian

ENVIRONMENT: Marginal Marine, Beach/Estuarine

Provo JC99-11, 1950'fsl/390'fel, 18-1S-11W, Heber Mountain, Kd

Spores and Pollen:

<i>Acanthotriletes varispinosus</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites hallei</i>	(R)
<i>Cingulatisporites distaverrucosus</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Deltoidospora spp.</i>	(F)
<i>Divisisporis enormis</i>	(R)
<i>Exesipollenites tumulus</i>	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-11 (Continued)

<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Liliacidites peroreticulatus*</i>	(R)
<i>Lycopodiacidites intraverrucatus</i>	(R)
<i>Phyllocladidites</i> spp.	(R)
<i>Retitricolpites vulgaris*</i>	(R)
Taxodiaceae	(F)
<i>Tsugaepollenites</i> sp.	(R)
Undifferentiated Bisaccates	(R)

Microplankton:

<i>Baltisphaeridium fimbriatum</i>	(R)
<i>Cribroperidinium edwardsi</i>	(R)
<i>Circulodinium distinctum</i>	(R)
<i>Leberidocysta chlamydata</i>	(R)
<i>Ovoidinium scabrosum*</i>	(R)
<i>Palaeoperidinium cretaceum</i>	(R)

Organic Recovery: 95%Woody and 5% Cuticular

AGE: Late Albian

ENVIRONMENT: Nearshore Marginal Marine, Beach/Deltaic

Provo JC99-13, 1960'fsl/750'fwl, 17-1S-11W, Heber Mountain, Kcm

Spores and Pollen:

<i>Cirratriradites teter</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Concavissimisporites punctatus*</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Microreticulatisporites</i> spp.	(R)
Undifferentiated Bisaccates	(R)

Microplankton:

<i>Cribroperidinium edwardsi</i>	(R)
<i>Leberidocysta chlamydata</i>	(R)
<i>Oligosphaeridium complex</i>	(R)
<i>Ovoidinium verrucosum*</i>	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-13 (Continued)

Organic Recovery: 95% Woody and 5% Cuticular

AGE: **?Probable Late Albian**

ENVIRONMENT: **Nearshore Marginal Marine, Beach/Deltaic**

Provo JC99-14, 600'fsl/1400'fel, 18-1S-11W, Heber Mountain, Kd/Kf

Spores and Pollen:

<i>Acanthotriletes varispinosus</i>	(R)
<i>Araucariacites australis</i>	(F)
<i>Appendicisporites auritus*</i>	(R)
<i>A. unicus*</i>	(R)
<i>Camarozonosporites insignis</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>C. hallei</i>	(R)
<i>Cingulatisporites distaverrucosus</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Concavisporites juriensis*</i>	(R)
<i>Exesipollenites tumulus</i>	(A)
<i>Deltoidospora</i> spp.	(A)
<i>Divisisporis enormis</i>	(F)
<i>Foraminisporis dailyi</i>	(R)
<i>Gleicheniidites senonicus</i>	(F)
<i>G. apilobatus*</i>	(R)
<i>Laevigatosporites</i> spp.	(R)
<i>Leptolepidites verrucatus</i>	(R)
<i>Matonisporites excavatus</i>	(R)
<i>Perinopollenites halonatus</i>	(R)
<i>Punctatosporites scabratus</i>	(R)
<i>Quadrapollis krempii*</i>	(R)
<i>Sphagnumsporites</i> spp.	(R)
Taxodiaceae	(A)
Undifferentiated Bisaccates	(F)

Microplankton:

<i>Tasmanites</i> sp.	(R)
-----------------------	-----

Organic Recovery: 90% Woody and 10% Cuticular

AGE: **?Probable Cenomanian**

ENVIRONMENT: **Nonmarine, Fluvial/Shallow Lacustrine**

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-15, 2710'fsl/500'fwl, 31-4S-7W, Heber Mountain, Kcm

Spores and Pollen:

<i>Araucariacites australis</i>	(R)
<i>Appendicisporites auritus*</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Punctatosporites scabratus</i>	(R)

Organic Recovery: 100% Woody/Inertinite

AGE: ?Middle Cretaceous

ENVIRONMENT: Nonmarine, Fluvial/Floodplain

Provo JC99-16, 1210'fsl/60'fwl, 7-1S-11W, Heber Mountain, Kd/Kf

Spores and Pollen:

<i>Cicatricosisporites australiensis</i>	(R)
<i>C. hallei</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Lusatisporis circumundulatus</i>	(R)
Taxodiaceae	(R)
Undifferentiated Bisaccates	(R)

Microplankton:

<i>Aptea polymorpha*</i>	(R)
<i>Chlamydomorphella nyei*</i>	(R)
<i>Circulodinium distinctum</i>	(R)
<i>Cribroperidinium edwardsi</i>	(R)
<i>Cyclonephelium vannophorum*</i>	(R)
<i>Florentinia ferox</i>	(R)
<i>Hystriochodinium pulchrum</i>	(R)
<i>Isabelidinium acuminata</i>	(F)
<i>Kiokansium polypes*</i>	(F)
? <i>Luxadinium propatum*</i>	(R)
<i>Oligosphaeridium complex</i>	(R)
<i>Palaeoperidinium cretaceum</i>	(R)
<i>Pseudoceratium regium</i>	(R)
<i>Spiniferites ramosus</i>	(R)
<i>Subtilisphaera</i> sp.	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-16

Organic Recovery: 70% Woody, 10% Cuticular and 20% Amorphous

AGE: Late Cenomanian to Turonian (T6)

ENVIRONMENT: Nearshore Open Marine Shelf

Provo JC99-17, 570'fsl/1590'fwl, 14-1S-11W, Wolf Creek Summit, Kf

Spores and Pollen:

<i>Acanthotriletes varispinosus</i>	(R)
<i>Apiculatisporis</i> sp. A	(R)
<i>Appendicisporites auritus*</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites brevilaesuratus*</i>	(R)
<i>C. hallei</i>	(R)
<i>Cingulatisporites distaverrucosus*</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Clavatisporites hughesii*</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Divisisporis enormis</i>	(R)
<i>Exesipollenites tumulus</i>	(F)
<i>Foraminisporis dailyi</i>	(R)
<i>F. wonthaggiensis</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Lycopodiumsporites</i> spp.	(R)
Taxodiaceae	(F)
<i>Trilobosporites minor</i>	(R)
Undifferentiated Bisaccates	(R)

Organic Recovery: 60% Woody, 30% Cuticular and 10% Amorphous

AGE: ?Probable Cenomanian

ENVIRONMENT: Nonmarine, Swamp/Deltaic

Provo JC99-18, 570'fsl/1425'fwl, 14-1S-11W, Wolf Creek Summit, Kf

Spores and Pollen:

<i>Apiculatisporis</i> sp. A*	(R)
<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>C. brevilaesuratus*</i>	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-18 (Continued)

<i>C. crassiterminatus*</i>	(R)
<i>C. hallei</i>	(R)
<i>C. venustus</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Concavissimisporites punctatus*</i>	(R)
<i>Eucommiidites minor*</i>	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Deltoidospora</i> spp.	(C)
<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Foveotrilites</i> sp.	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Klukisporites pseudoreticulatus</i>	(R)
<i>Liliacidites crassatus</i>	(R)
<i>L. peroreticulatus*</i>	(R)
<i>Parvisaccites radiatus</i>	(R)
<i>Perotrilites</i> sp.	(R)
<i>Selaginella sinuites</i>	(R)
Taxodiaceae	(A)
<i>Tsugaepollenites</i> sp.	(R)
Undifferentiated Bisaccates	(C)

Microplankton:

<i>Aptea polymorpha*</i>	(R)
<i>Apteodinium</i> sp.	(R)
<i>Baltisphaeridium fimbriatum</i>	(R)
<i>Chlamydomphorella nyei</i>	(R)
<i>Circulodinium distinctum</i>	(R)
<i>Cleistosphaeridium</i> spp.	(R)
<i>Coronifera oceanica</i>	(R)
<i>Cribroperidinium edwardsi*</i>	(R)
<i>Cyclonephelium vannophorum</i>	(R)
<i>Florentinia ferox</i>	(R)
<i>Hystrichodinium pulchrum</i>	(R)
<i>Isabelidinium acuminatum</i>	(F)
Microforaminifera linings	(R)
<i>Oligosphaeridium complex</i>	(F)
<i>O. pulcherrimum*</i>	(R)
<i>Palaeohystrichophora infusorioides</i>	(R)
<i>Palaeoperidinium cretaceum*</i>	(R)
<i>Pareodinia ceratophora*</i>	(R)
<i>Pseudoceratium retusum*</i>	(R)
<i>Spiniferites cingulatus</i>	(R)
<i>Surculosphaeridium longifurcatum</i>	(R)
<i>Tasmanites</i> spp.	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22:

Provo JC99-18 (Continued)

Organic Recovery: 80% Woody, 5% Cuticular and 15% Amorphous

AGE: Late Cenomanian to Turonian (T6)

ENVIRONMENT: Nearshore, Open Marine

Provo JC99-19, 1300'fml/2225'fwl, 28-1S-11W, Co-op Creek, Kf

Spores and Pollen:

<i>Appendicisporites auritus*</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Camarozonosporites insignis</i>	(R)
<i>Cicatricosisporites brevilaesuratus*</i>	(R)
<i>C. hallei</i>	(R)
<i>Classopollis classoides</i>	(R)
<i>Deltoidospora</i> spp.	(F)
<i>Gleicheniidites senonicus</i>	(C)
<i>Klukisporites pseudoreticulatus</i>	(R)
<i>Rugubivesiculites</i> sp.	(R)
Taxodiaceae	(A)
Undifferentiated Bisaccates	(A)

Microplankton:

<i>Circulodinium distinctum</i>	(R)
<i>Cleistosphaeridium</i> spp.	(R)
<i>Cometodinium whitei</i>	(R)
<i>Coronifera oceanica</i>	(R)
<i>Cribooperidium edwardsi*</i>	(R)
<i>Dinopterygium cladoides*</i>	(R)
<i>Florentinia cooksoniae*</i>	(R)
<i>F. stellatum</i>	
<i>Hystrichodinium pulchrum</i>	(R)
<i>Isabelidium acuminatum</i>	(R)
<i>Odontochitina operculata</i>	(F)
<i>Oligosphaeridium complex</i>	(R)
<i>Palaeohystrichophora infusorioides</i>	(R)
<i>Palaeoperidium cretaceum</i>	(R)
<i>Spiniferites ramosus</i>	(C)
<i>Veryhachium</i> sp.	(R)

RE: Paly. Analysis of 21 o/c samples: Ogden 99-18 to -22 and Provo JC99-1 to -22.

Provo JC99-19 (Continued)

Organic Recovery: 50% Woody, 25% Cuticular and 25% Amorphous

AGE: Late Cenomanian to Turonian (T6)

ENVIRONMENT: Nearshore Open Marine

Provo JC99-22, 690'fsl/370'fel, 27-1S-11W, Jimmies Mountain, Kmv

Spores and Pollen:

<i>Cicatricosisporites hallei</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Leptolepidites verrucatus</i>	(R)
Taxodiaceae	(R)
Undifferentiated Bisaccates	(R)

Organic Recovery: 90% Woody, 5% Cuticular and 5% Amorphous

AGE: Middle to Late Cretaceous (Undifferentiated)

ENVIRONMENT: Nonmarine, Fluvial/Floodplain

Analysis By:


Gerald Waanders

Gerald Waanders**Consulting Palynologist**

1611-C Rancho Santa Fe Road

San Marcos, California 92069

(760) 744-7471, FAX: (858) 759-9028

April 10, 2000

TO: Mr. Jon King
 Mr. Kurt Constenius
 Utah Geological Survey
 1594 West N. Temple, Suite 3110
 P. O. Box 146100
 Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 3 Utah outcrop samples: Provo Quadrangle KNC92699-23A, -23B and -23C. P.O. No. 305469, 3/6/2000.

PALYNOLOGY REPORT**KNC92699-23A, 1500'fel/100'fsl, 5-2S-11W, Co-op Creek, Kmv****Spores and Pollen:**

<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites</i> sp.	(R)
<i>Converrucosisporites ponderosus</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Divisisporis enormis</i>	(R)
<i>Exesipollenites tumulus</i>	(R)
<i>Foveotrilites</i> sp.	(R)
<i>Laevigatosporites</i> sp.	(R)
<i>Lycopodiumsporites</i> spp.	(R)
<i>Perotrilites</i> sp.	(R)
<i>Polypodiaceoisporites</i> sp.	(R)
<i>Proteacidites thalmanni</i> *	(R)
Taxodiaceae	(F)
<i>Trilobosporites minor</i>	(R)
Undifferentiated Bisaccates	(R)

Organic Recovery: 70% Woody and 30% Cuticular

AGE: Probable Campanian

ENVIRONMENT: Swamp/Shallow Lacustrine

RE: Paly. Analysis of 3 o/c spls: Provo Quad. KNC92699-23A, -23B and -23C.

KNC92699-23B, 1500'fel/100'fsl, 5-2S-11W, Co-op Creek, Kmv

Spores and Pollen:

<i>Araucariacites australis</i>	(C)
<i>Deltoidospora</i> spp.	(R)
<i>Divisisporis enormis</i>	(R)
<i>Laevigatosporites</i> sp.	(R)
<i>Proteacidites retusus*</i>	(R)
Taxodiaceae	(R)
<i>Trilobosporites minor</i>	(R)

Organic Recovery: 70% Woody and 30% Cuticular

AGE: Probable Campanian

ENVIRONMENT: Swamp/Fluvial

KNC92699-23C, 1500'fel/100'fsl, 5-2S-11W, Co-op Creek, Kmv

Spores and Pollen:

<i>Araucariacites australis</i>	(F)
<i>Converrucosisporites ponderosus</i>	(R)
<i>Deltoidospora</i> spp.	(R)
<i>Foveotricolporites johnhenryensis</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Klukisporites</i> sp.	(R)
<i>Laevigatosporites</i> sp. A (Orlansky)	(R)
<i>Lycopodiumsporites</i> spp.	(R)
<i>Proteacidites retusus*</i>	(R)
? <i>Sapotaceoidaepollenites</i> sp.	(R)
Taxodiaceae	(R)
<i>Tricolporopollenites granulocuneus</i>	(R)
<i>Tricolporopollenites kruschii</i>	(R)
Undifferentiated Bisaccates	(R)

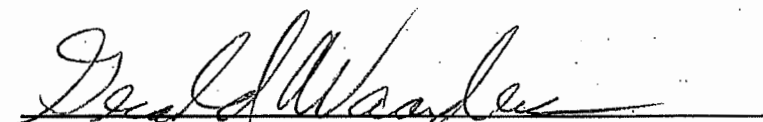
Organic Recovery: 50% Woody and 50% Cuticular

AGE: Probable Campanian

ENVIRONMENT: Swamp/Shallow Lacustrine

RE: Paly. Analysis of 3 o/c spls: Provo Quad. KNC92699-23A, -23B and -23C.

Analysis By:


Gerald Waanders

Jerry Waanders
1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
FAX: (858) 759-9028
Email: waanpaly@adelphia.net

Palynology analysis of 13 Jurassic outcrop samples received from Doug Sprinkel:
MH092203-1, -2, -3, -4, -5, -6, -7.

PALYNOLOGY REPORT

Thirteen samples were processed and analyzed for palynomorphs. A list of the taxa found and their relative abundances is provided for each sample examined (R=rare, F=frequent, C=common and A=abundant). An estimate of the kerogen content (total organic recovery), paleoenvironment and age is also indicated.

1. MH092203-1, Unit 3, Arapian.

Spores and Pollen:

Undifferentiated Bisaccates (R)

Microplankton:

Alga sp. A (?) (R)

Kerogen Content: 25% Cuticular and 75% Woody

T.A.I: 2.5

AGE: Indeterminate

ENVIRONMENT: Nearshore marine/ Estuarine

2. MH092203-2, Unit 4, Arapian.

Barren of Palynomorphs

Kerogen Content: Indeterminate

T.A.I: Indeterminate

AGE: Indeterminate

ENVIRONMENT: Indeterminate

RE: Paly. analysis of 13 Jurassic outcrop samples received from Doug Sprinkel:
MH092203-1, -2, -3, -4, -5, -6, -7.

3. MH092203-3, Unit 4 base, Arapian.

Barren of Palynomorphs

Kerogen Content: 76%Amorphous, 5% Cuticular and 20% Woody

T.A.I: 2.5

AGE: Indeterminate

ENVIRONMENT: Indeterminate

4. MH092203-4, Unit 10, Arapian.

Spores and Pollen:

<i>Araucariacites australis</i>	(R)
<i>Baculatisporites</i> sp.	(R)
<i>Callialasporites dampieri</i>	(A)
<i>C. triangulus</i>	(R)
<i>Cerebropollenites mesozoicus</i>	(R)
<i>Classopollis classoides</i>	(A)
<i>Deltoidospora</i> spp.	(A)
<i>Densoisporites microrugulatus</i>	(F)
<i>Exesipollenites tumulus</i>	(C)
<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Leptolepidites psarosus</i>	(R)
<i>Rubinella</i> spp.	(R)
<i>Sphagnumsporites regium</i>	(R)
Taxodiaceae	(F)
<i>Trilobosporites jurassica</i>	(R)
Undifferentiated Bisaccates	(A)

Microplankton:

<i>Barbatocysta verrucosum</i>	(F)
<i>Epiplosphaera reticulata</i>	(F)
<i>Leptodinium subtile</i>	(A)
<i>Lithodinia deflandrei</i>	(R)
<i>Pareodinia ceratophora</i>	(R)
<i>Rynchodiniopsis cladophora</i>	(R)
<i>Tasmanites</i> spp.	(A)
<i>Tytthodiscus</i> spp.	(F)

Kerogen Content: 80% Amorphous, 10% Cuticular and 10% Woody

RE: Paly. analysis of 13 Jurassic outcrop samples received from Doug Sprinkel:
MH092203-1, -2, -3, -4, -5, -6, -7.

T.A.I: 2.5

AGE: Bathonian

ENVIRONMENT: Nearshore Marine Shelf

5. MH092203-5, Unit 10, 5' above base, Arapian.

Spores and Pollen:

<i>Araucariacites australis</i>	(F)
<i>Callialasporites dampieri</i>	(A)
<i>Cerebropollenites mesozoicus</i>	(R)
<i>Classopollis classoides</i>	(A)
<i>Deltoidospora</i> spp.	(A)
<i>Dictyophyllidites harrisii</i>	(R)
<i>Exesipollenites tumulus</i>	(A)
Taxodiaceae	(R)
<i>Trilobosporites jurassica</i>	(R)
Undifferentiated Bisaccates	(F)
<i>Verrucosisporites</i> spp.	(R)

Microplankton:

<i>Barbatacysta verrucosum</i>	(A)
<i>Ctenidodinium</i> sp.	(R)
<i>Diacanthum filipicatum</i>	(R)
<i>Leptodinium subtile</i>	(R)
<i>Lithodinia deflandrei</i>	(F)
<i>Sentusidinium rioulti</i>	(R)
<i>Tasmanites</i> sp.	(F)
<i>Tytthodiscus</i> sp.	(R)
<i>Valensiella ovula</i>	(F)

Kerogen Content: 90% Amorphous, 5% Cuticular and 5% Woody

T.A.I: 2.5

AGE: Bathonian

ENVIRONMENT: Nearshore Marine Shelf

RE: Paly. analysis of 13 Jurassic outcrop samples received from Doug Sprinkel:
MH092203-1, -2, -3, -4, -5, -6, -7.

6. MH092203-6, Unit 21, base of unit, Arapian.

Spores and Pollen:

<i>Araucariacites australis</i>	(F)
<i>Callialasporites dampieri</i>	(C)
<i>C. triangulus</i>	(R)
<i>Classopollis classoides</i>	(F)
<i>Deltoidospora</i> spp.	(C)
<i>Osmundacidites wellmanni</i>	(R)
Undifferentiated Bisaccates	(F)

Microplankton:

<i>Barbatacysta verrucosum</i>	(F)
<i>Lithodinia deflandrei</i>	(R)
<i>Tasmanites</i> sp.	(R)
<i>Valensiella vermiculata</i>	(R)

Kerogen Content: 50% Amorphous, 15% Cuticular and 35% Woody

T.A.I: 2.5

AGE: Bathonian

ENVIRONMENT: Nearshore Marine, Lagoonal/Estuarine

7. MH092203-7, Unit 24, near top, Arapian.

Spores and Pollen:

<i>Araucariacites australis</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Cerebropollenites mesozoicus</i>	(F)
<i>Callialasporites dampieri</i>	(A)
<i>C. triangulus</i>	(R)
<i>Cingulatisporites distaverrucosus</i>	(R)
<i>Classopollis classoides</i>	(F)
<i>Deltoidospora</i> spp.	(A)
<i>Densoisporites microrugulatus</i>	(F)
<i>Exesipollenites tumulus</i>	(F)
<i>Trilobosporites jurassica</i>	(R)
Undifferentiated Bisaccates	(R)

RE: Paly. analysis of 13 Jurassic outcrop samples received from Doug Sprinkel:
MH092203-1, -2, -3, -4, -5, -6, -7.

Microplankton:

<i>Barbatacysta verrucosum</i>	(F)
<i>Leptodinium subtile</i>	(F)
<i>Lithodinia deflandrei</i>	(A)
<i>Michrystidium lymensis</i>	(R)
<i>Rynchodiniopsis cladophora</i>	(R)
<i>Tytthodiscus</i> sp.	(R)
<i>Valiensiella ovula</i>	(R)

Kerogen Content: 30% Amorphous, 20% Cuticular and 50% Woody

T.A.I: 2.5

AGE: Bathonian

ENVIRONMENT: Nearshore Marine, Lagoonal/Estuarine

Gerald Waanders

Gerald Waanders
Consulting Palynologist

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
FAX: (858) 759-9028
Email: waanpaly@adelphia.net

December 12, 2005

TO: Mr. Jon K. King
Utah Geological Survey
1594 West N. Temple, Suite 3110
P. O. Box 146100
Salt Lake City, Utah 84114-6100

RE: Palynology Analysis of 2 outcrop samples collected by Kurt Constenius:
KNC101505-3 and KNC101505-7.

PALYNOLOGY REPORT

Two samples were processed and analyzed for palynomorphs. An estimate of the total organic recovery, kerogen content and age is provided below.

1. **KNC101505-3, Manning Canyon Shale, Provo River, Lat: 40 23.468,
Long: 111 32.352, Mmc.**

Palynomorphs:

<i>Lycospora</i> spp.	(R)
<i>Densosporites</i> spp.	(R)

HCl Reaction: None

Organic Recovery: Excellent

Kerogen Content: 30% Amorphous, 10% Cuticular and 70% Woody

T.A.I: 1.3-2.0% Equivalent R₀

AGE: Carboniferous, Chesterian to Morrowan

ENVIRONMENT: Swamp/Deltaic

RE: Palynology Analysis of 2 Outcrop samples: KNC101505-3 and KNC101505-7.

2. KNC101505-7, Manning Canyon Shale, Provo River Cyn., Lat: 40 22.981, Long: 111 32.980, Mmc.

Palynomorphs:

<i>Lycospora</i> spp.	(F)
<i>Punctatisporites</i> spp.	(R)

HCl Reaction: Strong

Organic Recovery: Very Good

Kerogen Content: 30% Amorphous, 10% Cuticular and 60% Woody

T.A.I: T.A.I: 1.3-2.0% Equivalent R₀

AGE: Carboniferous, Chesterian to Morrowan

ENVIRONMENT: Deltaic/Estuarine

Analysis By:

Gerald Waanders

Gerald Waanders
Consulting Palynologist

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
FAX: (858) 759-9028
Email: waanpaly@roadrunner.com

January 23, 2008

TO: Dr. Kurt Constenius
8790 Shadow Mountain Drive
Tucson, Arizona 85704-6628

RE: Palynology analysis of 4 samples from the Gulf Oil Banks #1 Well, Sec. 13,
8S-2E, Utah Co., Utah (10,110-13,000').

PALYNOLOGY REPORT

Four Samples from the subject well were processed and analyzed for palynomorphs. The results are provided in Figures 1 and 2 and summarized below.

Samples 10,110-10,3??' and 10,750-11,000'.

AGE: Early to Middle Miocene

ENVIRONMENT: Shallow Deltaic to Lacustrine

The palynomorphs recovered from these two samples are comprised mostly of conifer and juglandaceous pollen (walnut). This suggests a mid-temperate climate that is most indicative of an Early to Middle Miocene age for the Utah area. The highest sample (10,110-10,3??') was richest in total organic content and consisted of mostly amorphous kerogens indicating lacustrine conditions. The lower sample was somewhat higher in land-derived kerogens suggesting a shallower paleoenvironment.

Good to very good organic recoveries of amorphous and cuticular kerogens suggest source rock potential for oil. Fair organic recoveries indicate poor to fair source rock potential. The visual T.A.I values for this interval are 0.3-0.4% estimated vitrinite reflectance and at earliest stages of liquid hydrocarbon generation. These samples gave off a strong petroliferous odor when treated with acids.

RE: Palynology analysis of 4 samples from the Gulf Oil Banks #1 Well, Sec. 13, 8S-2E, Utah Co., Utah.

Samples 10,750-12,000 and 12,740-13,000'.

AGE: Mixed Assemblage, Late Eocene to Middle Miocene

ENVIRONMENT: Deltaic to Shallow Lacustrine

As noted for the two samples above, these two lower samples are also dominated by conifers and juglandaceous pollen. However, among the rare pollen occurrences, there are taxa that show conflicting ages. In addition to the *Juglans* pollen, a few specimens of Compositae pollen were found to help support the Miocene age. On the other hand, *Holkopollenites chemardensis*, *Momipites coryloides*, and *Cupanieidites* sp. suggest an age possibly as old as Late Eocene to Early Oligocene. These older taxa were all found in one sample from 11,750-12,000'. Due to the large size of the intervals sampled it is difficult to determine whether these occurrences suggest an older age below 11,750' or whether some sediment recycling has occurred.

The organic recoveries were fair and consisted of mixed woody, cuticular and amorphous kerogens. The palynomorph recoveries were all land-derived indicating a deltaic or shallow lacustrine paleoenvironment.

Fair organic recoveries indicate poor to fair source rock potential. The visual T.A.I values for this interval are 0.3-0.4% estimated vitrinite reflectance and at the early stages of liquid hydrocarbon generation. These samples gave off a strong petroliferous odor when treated with acids.

Analysis By:

Gerald Waanders

Gerald Waanders
Consulting Palynologist

Figure 1

1/23/2008

Age	Sample	SPORES AND POLLEN																	
		<i>Juglans</i> spp.	Tasmanaceae	Taxodiaceae	Undifferentiated Bisaccates	<i>Disvisisporis enormis</i>	<i>Ephedra distachya</i>	Onagraceae	Palmae?	<i>Alnus</i> sp.	Compositae sp.	<i>Cryptomeria</i> sp.?	<i>Cupanioidites</i> sp.	<i>Ephedripites</i> sp.	<i>Holcopollenites chemardensis</i>	<i>Momipites coryloides</i>	<i>Tricolpites hians</i>	<i>Tsuga</i> sp.	
Early-Middle Miocene	10,110-10,3??	F	R	R	F														
	10,750-11,000	A	R	A	A	R	R	R	R										
Mixed Assemblage Late Eocene to Middle Miocene	11,750-12,000	A	R	F	A		F	R		R	R	R	R	R	R	R	R	F	
	12,740-13,000	C		R	A		R				R					R			

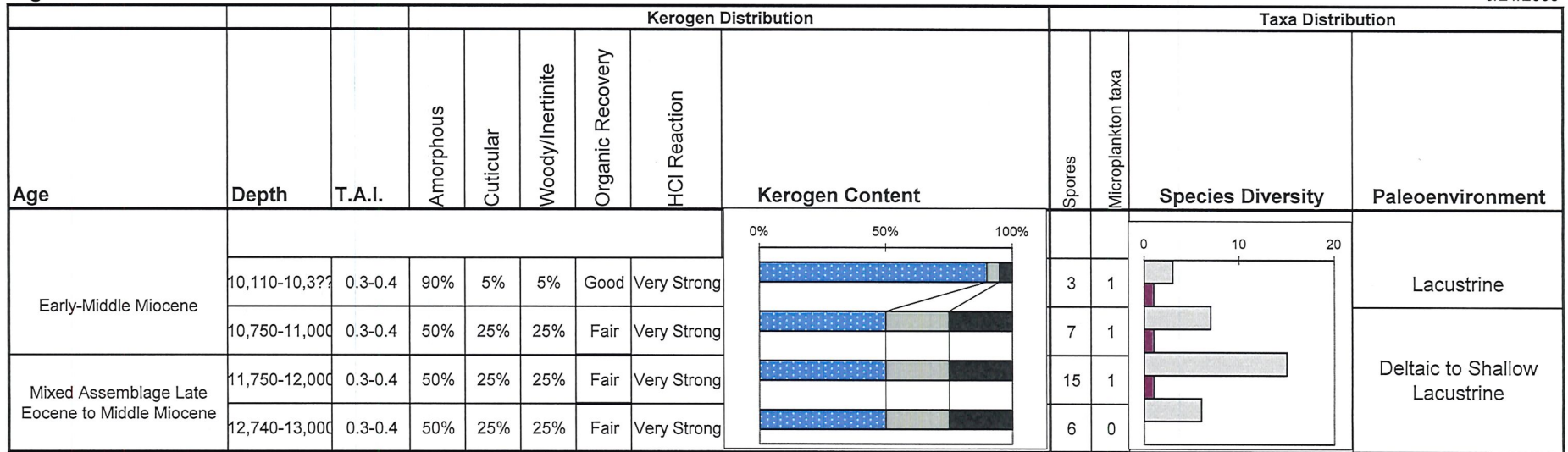
Gulf Oil Banks #1
 Sec. 13, 8S-2E
 Utah Co., Utah

R = Rare, less than 6 specimens/slide
 F = Frequent, 6 to 15 specimens/slide
 C = Common, 16 to 30 specimens/slide
 A = Abundant, over 30 specimens/slide

Gerald Waanders
Consulting Palynologist

Figure 2

9/21/2005



Gulf Oil Banks #1
Sec. 13, 8S-2E
Utah Co., Utah

1475 Rancho Encinitas Drive, Encinitas, CA 92024
(858) 759-0180, FAX: (858) 759-9028, E-mail: waanpaly@adelphia.net

Gerald Waanders
Consulting Palynologist

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
FAX: (858) 759-9028
Email: waanpaly@adelphia.net

April 13,2009

TO: Mr. Craig D. Morgan
Utah Geological Survey,
P.O. Box 146100
Salt Lake City, UT 84114

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

PALYNOLOGY AND THERMAL MATURATION REPORT

The data generated from this analysis has been assembled in four separate Excel files for the samples collected from Provo Canyon, Soldier Canyon, the North Springs well and the Miller Creek well. A summary of the findings for these four sections is provided below along with results on four additional samples collected in the East Lake Mts., Santaquin Cyn. and Mill Creek-Porter Fork.

Provo Canyon: Samples P-1 to P-5, (See attached Figures)

The lower three samples from the section (P-1 to p-3) produced some long ranging Paleozoic palynomorphs. The combination of *Punctatisporites*, *Lycospora* and *Densosporites* with little else to work with is typical of middle to late Chesterian ages for the Great Basin area. These palynomorphs do range higher in the section, but usually contain some additional taxa when found in the Morrowan. *Raistrickia nigra* which was found in the lowest sample (P-1) does not range above middle Chesterian.

There were no marine palynomorphs found, but the lower samples from the interval were calcareous and had high proportions of amorphous kerogens suggesting restricted marine or lacustrine conditions at the base and grading upwards to swamp conditions.

The samples collected from this section are rather unusual, if they are placed in a correct vertical sequence. The lowest two samples (P-1 and P-2) are of a much lower TAI value than the remaining three samples (P-3-P-5). Typically, TAI values should increase with age and depth in a normal section. This reversal may suggest more localized faulting or intrusions. The lower samples with the 0.7-0.8 R_0 equivalent values suggest peak gas generation, The higher samples with the values at 1.5-2.0 R_0 are at past peak generation

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

for gas. The lower two samples (P-1 and P-2) had the highest organic content and the best source rock potential. The total organic recoveries from the remaining three samples were much smaller.

Soldier Canyon: Samples SC-1 to S C-9, (See attached Figures)

The Soldier Canyon samples carry a very similar palynomorph assemblage to that which was found in Provo Canyon. The samples that were productive produced the same typical mix of *Punctatisporites*, *Lycospora*, *Densosporites* and *Raistrickia nigra* to suggest a middle to late Chesterian age for the whole suite of samples. Sample SC-7 was barren and SC-5 was weathered and also unreliable regarding an age.

There were no marine palynomorphs found, but samples SC-2 to SC-5 from the interval were calcareous and had high proportions of amorphous kerogens suggesting restricted marine or lacustrine conditions. The remaining samples had higher concentrations of woody kerogens and were more typical of swamp deposition.

The TAI values for the entire section were consistent and in a range of 1.5-2.0 R_0 . This suggests past peak generation for gas. The total organic recoveries were good to very good for the middle three samples SC-3, SC-5 and SC-7 and only poor to fair for the remaining samples.

E-Lake-1, East Lake Mts.6/19/07, Clay pit black shale sample.

Spores and Pollen:

Punctatisporites sp.

(R)

HCl Reaction: None

Organic Recovery: Poor

Kerogen Content: 70% Amorphous, 10% Cuticular and 20% Woody/Inertinite

T.A.I: 1.5-2.0 R_0 Equivalent

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

Nebo-1, Santaquin Canyon, 9/24/08, lower Mc.

Spores and Pollen:

<i>Acanthotriletes hastatus</i>	(R)
<i>Calamospora</i> sp.	(R)
<i>Convolutispora florida</i>	(R)
<i>Convolutispora</i> sp.	(R)
<i>Densosporites</i> spp.	(A)
<i>Grandispora spinosa</i>	(R)
<i>Knoxisporites hageni</i>	(R)
<i>Lycospora</i> spp.	(A)
<i>Microreticulatisporites hortensis</i>	(R)
<i>Savitrissporites nux</i>	(R)
<i>Punctatisporites</i> spp.	(A)
<i>Schulzospora rara</i>	(F)
<i>Spelaeotriletes aranaceus</i>	(R)
<i>Tripartites vetustus</i>	(R)
<i>Verrucosisporites</i> sp.	(R)

HCl Reaction: None

Organic Recovery: Good

Kerogen Content: 10% Amorphous, 5% Cuticular and 85% Woody/Inertinite

T.A.I.: 1.0-1.5 R₀ Equivalent

AGE: Meramecian (Late Visean)

ENVIRONMENT: Swamp

MilCk-1, Mill Creek-Porter Fork, Mdo.

Spores and Pollen:

<i>Acanthotriletes hastatus</i>	(R)
<i>Densosporites</i> sp.	(R)
<i>Lycospora</i> spp.	(F)
<i>Punctatisporites</i> sp.	(R)
<i>Schulzospora rara</i>	(F)

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

HCl Reaction: None

Organic Recovery: Very Good

Kerogen Content: 80% Amorphous, 10% Cuticular and 10% Woody/Inertinite

T.A.I.: 0.8-1.1.0 R₀ Equivalent

AGE: Chesterian? (Namurian B-C?)

ENVIRONMENT: Lacustrine

MilCk-2, Mill Creek-Porter Fork, Mdo.

Palynomorphs:

Leiosphaera spp. (F)
Densosporites sp.? (R)

HCl Reaction: None

Organic Recovery: Trace

Kerogen Content: 50% Cuticular and 50% Woody/Inertinite

T.A.I.: 1.0-1.5 R₀ Equivalent

AGE: Indeterminate

ENVIRONMENT: Deltaic?

NS-1 to NS-9, North Springs #1 Well, Mdo, API #4300710791 (see attached Figures).

10,200-10,500'

Age: Chesterian? (Namurian B-C?)

Environment: Lacustrine

T.A.I.: 0.7-0.8% Estimated R₀

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

The low diversity of spores consisting mostly of a combination of *Punctatisporites*, *Lycospora* and *Densosporites* with little else to work with is typical of middle to late Chesterian ages for the Great Basin area. However, these taxa can range higher and lower and therefore the age must be somewhat tentative. The samples in this interval were calcareous and consisted of mostly amorphous kerogens indicating lacustrine or restricted marine conditions.

10,500-10,800'

Age:	Early Chesterian (Namurian A)
Environment:	Swamp/Shallow Lacustrine
T.A.I.:	0.7-0.8% Estimated R_0

Early Chesterian is indicated at this point in the well by an increase in spore diversity and by the first occurrences of *Schulzospora rara*. The kerogens from this interval are woodier and the samples were less calcareous than those above indicating shallower lacustrine or swamp conditions.

10,800-11,050'

Age:	Meramecian (Early Visean)
Environment:	Swamp/Shallow Lacustrine
T.A.I.:	0.7-0.8% Estimated R_0

Meramecian is indicated at this point in the well by additional increases in spore diversity and by the first occurrences of *Waltzispora planiangularata* and *W. polita*. The kerogens from this interval are similar to those in the interval above and suggest shallower lacustrine or swamp conditions.

The TAI values for this entire well section were set at 0.7-0.8 R_0 equivalent. This indicates peak generation for oil and early generation for gas. The kerogens recovered are mixed and capable of generating both oil and gas. The organic recoveries ranged from fair to very good suggesting the same for source rock potential.

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

MC-1 to NS-10, Miller Creek #1 Well, Mdo, API #4300711029 (see attached Figures).

8,000-8,170'

Age: Stephanian to Wolfcampian
Environment: Swamp/Deltaic
T.A.I.: 0.7-0.8% Estimated R_0

The palynomorphs recovered from these two samples are composed mostly of gymnosperm taxa that are typically found in Late Pennsylvanian and Early Permian aged rocks. Those found that are most significant are *Cordaitina* sp., *Florinites* sp., *Potoniesporites* spp., *Sabonites* sp., *Tumorisporites* sp., and *Vestigisporites* sp. The kerogens recovered from these samples were of low content and mostly woody suggesting fluvial or deltaic conditions.

8,170-8,400'

Age: Chesterian? (Namurian B-C?)
Environment: Lacustrine
T.A.I.: 0.7-0.8% Estimated R_0

The low diversity of spores consisting mostly of a combination of *Punctatisporites*, *Lycospora* and *Densosporites* with little else to work with is typical of middle to late Chesterian ages for the Great Basin area. However, these taxa can range higher and lower and therefore the age must be somewhat tentative. The samples in this interval were moderately calcareous and consisted of mostly amorphous kerogens indicating lacustrine or restricted marine conditions.

8,400-8,700'

Age: Early Chesterian (Namurian A)
Environment: Swamp/Shallow Lacustrine
T.A.I.: 0.7-0.8% Estimated R_0

RE: Palynology and Thermal Maturation Analysis of 35 miscellaneous samples from Basin and Range outcrops and from two oil and gas wells in central Utah.

Early Chesterian is indicated at this point in the well by a small increase in spore diversity and by the first occurrences of *Schulzospora rara*. The kerogens from this interval are woodier than those above indicating shallower lacustrine or swamp conditions.

8,700-9,050'

Age: Meramecian (Early Visean)

Environment: Swamp/Shallow Lacustrine

T.A.I.: 0.7-0.8% Estimated R_0

Meramecian is indicated at this point in the well by a significant increase in spore diversity and by the first occurrences of *Waltzispora polita* and *Tripartites vetustus*. The kerogens from this interval are mixed and suggest shallower lacustrine or swamp conditions.

The TAI values for this entire well section were set at 0.7-0.8 R_0 equivalent. This indicates peak generation for oil and early generation for gas. The kerogens recovered are mixed and capable of generating both oil and gas. The organic recoveries for most of the Mississippian section were good to very good suggesting the same for source rock potential.

Analysis By:

Gerald Waanders

**Gerald Waanders
Consulting Palynologist**

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
FAX: (858) 759-9028
Email: waanpaly@adelphia.net

October 5, 2009

TO: Mr. Craig D. Morgan
Utah Geological Survey,
P.O. Box 146100
Salt Lake City, UT 84114

RE: Palynology and Thermal Maturation Analysis of 13 miscellaneous samples from Utah Basin and Range outcrops.

PALYNOLOGY AND THERMAL MATURATION REPORT

The data generated from this analysis has been assembled in two separate Excel files for the samples collected from Santaquin Canyon and Morgan Valley. A summary of the findings for these two sections is provided below along with results on six additional samples collected in Provo Canyon, Payson Canyon, and Allens Ranch.

Santaquin Canyon: Samples P-9-1 to S-9-3, (See attached Figures)

The three samples from this section all appear to be similar in age and are most likely Chesterian. The palynoflora consists of the usual occurrences of *Lycospora* spp., *Densosporites* spp. and *Punctatisporites* spp.; but also contains rare occurrences of *Crassispora kosankei* and *Raistrickia nigra*.

The lowest sample (S-9-1) had a few scolecodonts suggesting the possibility of marginal marine or lacustrine conditions. The remaining two samples are more typical of swamp conditions.

The TAI values for these samples range from 1.0-1.3 R_0 equivalent (peak gas generation. The kerogens noted were mostly woody (gas generating) and the amounts of kerogen recovered ranged from fair to good.

Morgan Valley: Samples MV-1 to MV-4, (See attached Figures)

The samples from this section show some age variation. In the highest sample (MV4), *Florinites* sp and *Schopfipollenites* sp. were noted to suggest a Morrowan age. The lowest sample has *Spelaetriletes* sp. which is more typical of a Chesterian age. The two samples in the middle of the section are indeterminate and with the taxa present could be either age.

RE: Palynology and Thermal Maturation Analysis of 13 miscellaneous samples from Utah Basin and Range outcrops.

The samples from this section were calcareous and consisted mostly of amorphous kerogens. The only possible marine organisms noted were a few scolecodonts in the lowest sample. This would indicate a lacustrine or marginal marine paleoenvironment for these samples.

The TAI values for the entire section were consistent and in a range of 0.8-1.0 R_0 . This suggests past peak generation for oil and early generation for gas. The total organic recoveries ranged from fair to very good.

P-9-1, Provo Canyon, Mgb, 9/2/09, Great Blue at highway.

Spores and Pollen:

<i>Punctatisporites</i> sp.	(R)
<i>Lycospora</i> sp.	(R)

HCl Reaction: Weak

Organic Recovery: Poor

Kerogen Content: 50% Amorphous, 10% Cuticular and 40% Woody/Inertinite

T.A.I: 1.3-1.5 R_0 Equivalent

AGE: Chesterian?

ENVIRONMENT: Restricted Marine/Lacustrine

P-9-2, Provo Canyon, Mgb, 9/2/09, Great Blue above Olmstead Station.

Barren of Palynomorphs

HCl Reaction: Strong

Organic Recovery: Good

Kerogen Content: 90% Amorphous, 5% Cuticular and 5% Woody/Inertinite

T.A.I: 1.3-1.5 R_0 Equivalent

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine

RE: Palynology and Thermal Maturation Analysis of 13 miscellaneous samples from Utah Basin and Range outcrops.

PAY-9-1, Payson Canyon, Mc, 9/2/09, along highway.

Barren of Palynomorphs

HCl Reaction: Strong

Organic Recovery: Good

Kerogen Content: 70% Amorphous, 15% Cuticular and 15% Woody/Inertinite

T.A.I: 0.8-1.0 R₀ Equivalent

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine

AR-1, Allens Ranch, Md, 7/20/09, poor exposure, Delle Mbr. of Deseret Limestone.

Barren of Palynomorphs

HCl Reaction: Strong

Organic Recovery: Fair

Kerogen Content: 100% Woody/Inertinite

T.A.I: ?

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine?

AR-2, Allens Ranch, Mgb, 7/20/09, Chiulos Mbr. Great Blue Formation.

Spores and Pollen:

<i>Densosporites</i> spp.	(A)
<i>Lycospora</i> spp.	(R)
<i>Punctatisporites</i> spp.	(R)

HCl Reaction: None

Organic Recovery: Good

RE: Palynology and Thermal Maturation Analysis of 13 miscellaneous samples from Utah Basin and Range outcrops.

Kerogen Content: 10% Amorphous, 5% Cuticular and 85% Woody/Inertinite

T.A.I: 1.3-1.5 R₀ Equivalent

AGE: Chesterian?

ENVIRONMENT: Swamp

AR-3, Allens Ranch, Mgb, 7/20/09, Chiulos Mbr. Great Blue Formation.

Barren of Palynomorphs (soil contamination?)

HCl Reaction: None

Organic Recovery: Poor

Kerogen Content: 80% Amorphous, 10% Cuticular and 10% Woody/Inertinite

T.A.I: 0.8-1.0 R₀ Equivalent

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine?

Analysis By:

Gerald Waanders

**Gerald Waanders
Consulting Palynologist**

Figure 1

4/9/2010

Age	Depth	Spores				
		Unidentifiable Palynomorphs	Lycospora spp.	Punctatisporites spp.	Densosporites sp.	Raistrickia nigra
Indeterminate	P5	F				
	P4	F				
Chesterian? (Namurian B-C?)	P3		R	R		
	P2		R		R	
	P1		R	R	R	R

Provo Canyon
Manning Canyon Section

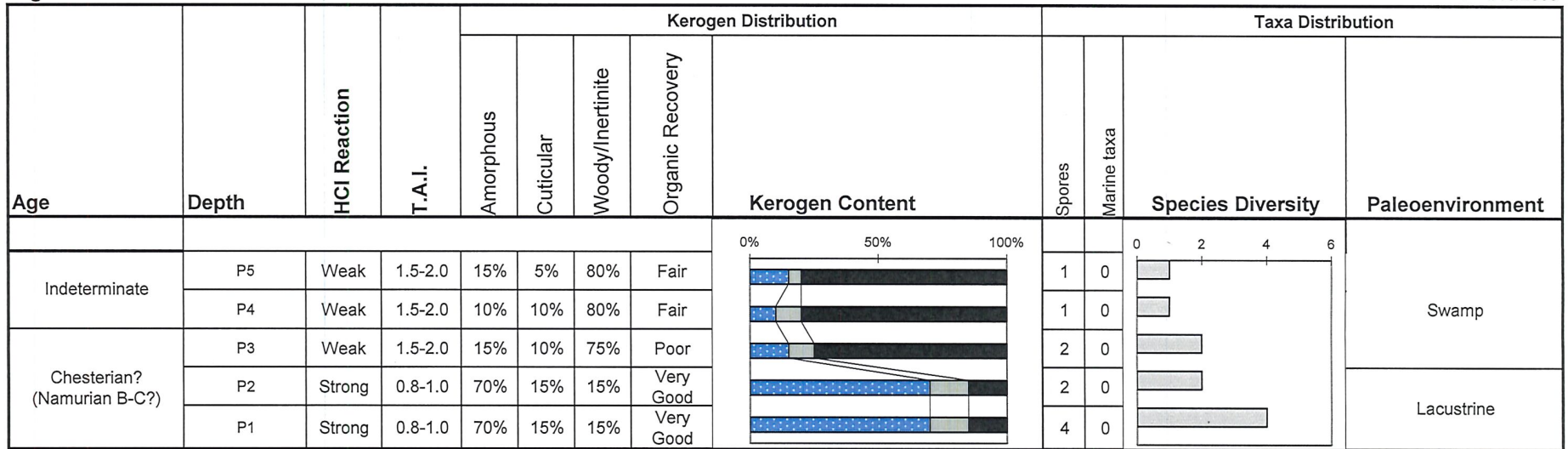
R = Rare, less than 6 specimens/slide
F = Frequent, 6-15 specimens/slide

1475 Rancho Encinitas Drive, Encinitas, CA 92024
(858) 759-0180, FAX: (858) 759-9028, waanpaly@roadrunner.com

**Gerald Waanders
Consulting Palynologist**

Figure 2

4/10/2009



Provo Canyon
Manning Canyon Section

1475 Rancho Encinitas Drive, Encinitas, CA 92024
(858) 759-0180, FAX: (858) 759-9028, waanpaly@roadrunner.com

Gerald Waanders
Consulting Palynologist

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
Email: waanpaly@roadrunner.com

November 15, 2011

TO: Dr. Kurt Constenius
8790 North Shadow Mountain Drive
Tucson, Arizona 85704

Mr. Jon K. King
Utah Geological Survey
P.O. Box 146100
Salt Lake City, UT 84114-6100

RE: Palynology analysis of 6 outcrop samples from the Emery Sandstone and
Currant Creek Fms.

PALYNOLOGY REPORT

1. KNC101811-0 – Emery Sandstone, Red Creek Mine, 40.37159 110.87373.

Palynomorphs:

<i>Araucariacites australis</i>	(R)
<i>Chomotriletes fragilis</i>	(R)
<i>Classopollis classoides</i>	(R)

HCl Reaction: None

Organic Recovery: Good

Kerogen Content: 10% Amorphous, 30% Cuticular and 60% Woody

T.A.I: 0.3-0.4 (Estimated R₀)

AGE: Cretaceous (Undiff.)

ENVIRONMENT: Swamp/Deltaic

RE: Palynology analysis of 6 outcrop samples from the Emery Sandstone and Currant Creek Fms.

2. KNC101811-1 – Emery Sandstone, Red Creek Mine, 40.37159 110.87373.

Palynomorphs:

Tasmanaceae (R)
Zygmataceae (R)

HCl Reaction: None

Organic Recovery: Fair

Kerogen Content: 70% Amorphous, 15% Cuticular and 15% Woody

T.A.I: 0.3-0.4 (Estimated R_o)

AGE: Indeterminate

ENVIRONMENT: Lacustrine

3. KNC101811-2 – Emery Sandstone, Red Creek Mine, 40.37159 110.87373.

Palynomorphs:

Tasmanaceae (R)

HCl Reaction: None

Organic Recovery: Very Good

Kerogen Content: 20% Amorphous, 10% Cuticular and 70% Woody

T.A.I: 0.3-0.4 (Estimated R_o)

AGE: Indeterminate

ENVIRONMENT: Swamp/Deltaic

4. KNC101811-3 – Emery Sandstone, Red Creek Mine, 40.37159 110.87373.

Palynomorphs:

Araucariacites australis (R)
Deltoidospora spp. (R)

RE: Palynology analysis of 6 outcrop samples from the Emery Sandstone and Currant Creek Fms.

Taxodiaceae (R)
Undifferentiated Bisaccates (R)

HCl Reaction: None

Organic Recovery: Very Good

Kerogen Content: 40% Amorphous, 30% Cuticular and 30% Woody

T.A.I: 0.3-0.4 (Estimated R_o)

AGE: Cretaceous (Undiff.)

ENVIRONMENT: Swamp/Deltaic

5. KNC101811-4 – Currant Creek Fm., Red Creek Mine, 40.37159 110.87373.

Barren of Palynomorphs

HCl Reaction: None

Organic Recovery: Excellent

Kerogen Content: 0% Amorphous, 0% Cuticular and 100% Woody

T.A.I: 0.3-0.4 (Estimated R_o)

AGE: Cretaceous (Undiff.)

ENVIRONMENT: Fluvial/Deltaic

6. KNC101811-5 – Currant Creek Fm., Red Creek Road, 40.37044 110.8415.

To the present date, I have only ever noted *Balmeisporites longirimosus* in the Kaiparowits Fm. in Utah.

Palynomorphs:

**Balmeisporites longirimosus* (A)
Deltoidospora spp. (R)
Leptolepidites verrucatus (R)
Lycopodiumsporites novomexicanum (C)
Tasmanaceae (R)
Taxodiaceae (R)

RE: Palynology analysis of 6 outcrop samples from the Emery Sandstone and Currant Creek Fms.

HCl Reaction: None

Organic Recovery: Very Good

Kerogen Content: 10% Amorphous, 20% Cuticular and 70% Woody

T.A.I: 0.3-0.4 (Estimated R_o)

AGE: Late Campanian to Maastrichtian

ENVIRONMENT: Swamp/Deltaic

Analysis By:

Gerald Waanders

Gerald Waanders
Consulting Palynologist

38 Cassin Hill Road
Garnet Valley, PA 19060-1321
Phone: (610) 358-0863
Email: waanpaly@gmail.com

June 28, 2018

TO: Mr. Douglas A. Sprinkel
Utah Geological Survey
1594 West N. Temple, Suite 3110
P. O. Box 146100
Salt Lake City, Utah 84114-6100

RE: Palynology analysis of 4 outcrop samples collected Red Creek and Current Creek, Utah.

PO#: 316232

PALYNOLOGY REPORT

Four samples were processed and analyzed for palynomorphs. One sample produced palynomorphs, the remaining three were barren. HCl reactions, total organic recoveries, kerogen contents, T.A.I.'s (Thermal Alteration Indices) and paleoenvironments are also provided.

1. Red Creek 06122018-1, 40.36923N, 110.87377W.

Spores and Pollen:

<i>Acanthotriletes varispinosus</i>	(R)
<i>Appendicisporites potomacensis</i>	(R)
<i>Araucariacites australis</i>	(R)
<i>Cicatricosisporites australiensis</i>	(R)
<i>Deltoidospora</i> spp.	(F)
<i>Foraminisporis wonthaggiensis</i>	(R)
<i>Gleicheniidites senonicus</i>	(R)
<i>Klukisporites variegatus</i>	(R)
<i>Liliacidites dividuus</i>	(R)
<i>Momipites tenuipolus</i>	(R)
<i>Rugubivesiculites</i> sp.	(R)
<i>Tricolporopollenites labiatus</i>	(R)
<i>Tripoporopollenites granifer</i>	(R)
Undifferentiated Bisaccates	(F)

RE: Palynology analysis of 4 outcrop samples collected Red Creek and Current Creek, Utah.

Microplankton:

<i>Alterbia</i> sp.	(R)
<i>Cleistosphaeridium</i> sp.	(R)
<i>Spiiferites ramosus</i>	(R)

HCl Reaction: None

Total Organic Recovery: Very Good

Kerogen Content: 5% Amorphous, 10% Cuticular and 85% Woody

T.A.I: 0.3-0.4 Equivalent R_0

AGE: Probable Campanian

ENVIRONMENT: Marginal Marine, Deltaic/Estuarine?

The sample is missing more typical Maastrichtian taxa such as *Proteacidites* and *Balmeisporites* known elsewhere. *Momipites tenuipolus* and *Triporepollenites granifer* which do occur in the sample should not range below Campanian in age.

2. Red Creek 06122018-2, 40.36947N, 110.87406W.

Barren of Palynomorphs

HCl Reaction: None

Total Organic Recovery: Poor

Kerogen Content: 20% Cuticular and 80% Woody

T.A.I: 0.3-0.4 Equivalent R_0

AGE: Indeterminate

ENVIRONMENT: Nonmarine, Floodplain, Deltaic?

RE: Palynology analysis of 4 outcrop samples collected Red Creek and Current Creek, Utah.

3. Red Creek 06122018-3, 40.36950N, 110.87391W.

Barren of Palynomorphs

HCl Reaction: Weak

Total Organic Recovery: Very Good

Kerogen Content: 50% Amorphous, 5% Cuticular and 45% Woody

T.A.I: 0.3-0.4 Equivalent R_0

AGE: Indeterminate

ENVIRONMENT: Marginal Marine, Deltaic/Estuarine?

Carbonate reaction in HCl suggest possible marine conditions.

4. Current Creek 06122018-1, 40.34590N, 111.04862W.

Barren of Palynomorphs

HCl Reaction: None

Total Organic Recovery: Very Good

Kerogen Content: 5% Cuticular and 95% Woody

T.A.I: 0.3-0.4 Equivalent R_0

AGE: Indeterminate

ENVIRONMENT: Nonmarine, Swamp/Deltaic?

Analysis By:

Gerald Waanders

Gerald Waanders
Consulting Palynologist

1475 Rancho Encinitas Drive
Encinitas, California 92024-7031
Phone: (858) 759-0180
Email: waanpaly@roadrunner.com

December 29, 2010

TO: Donald L. Clark, P.G.
Utah Geological Survey,
P.O. Box 146100
Salt Lake City, UT 84114

RE: Palynology and Thermal Maturation Analysis of 4 Great Blue/Manning Canyon
outcrop samples: 1928, 1944, 2097 and 2101.

PALYNOLOGY AND THERMAL MATURATION REPORT

**1928, UTM NAD83 Zone 12N 3988862, 4446630, Great Blue Formation, Poker Knoll
Member, Fivemile Pass 7.5 quadrangle.**

Barren of Palynomorphs

HCl Reaction: None

Organic Recovery: Fair

Kerogen Content: 85% Amorphous, 5% Cuticular and 10% Woody/Inertinite

T.A.I: 1.0-1.3 R₀ Equivalent

AGE: Indeterminate

ENVIRONMENT: Restricted Marine/Lacustrine

RE: Palynology and Thermal Maturation Analysis of 4 Great Blue/Manning Canyon outcrop samples:

1944, UTM NAD83 Zone 12N 392352, 4467346, Great Blue Limestone, Long Trail Shale Member, Ophir 7.5' Quadrangle.

Barren of Palynomorphs

HCl Reaction: None

Organic Recovery: Poor

Kerogen Content: 100% Woody/Inertinite

T.A.I: 1.0-1.3? R₀ Equivalent

AGE: Indeterminate

ENVIRONMENT: Fluvial/Floodplain

2097, UTM NAD83 Zone 12N 399142, 4455150, Great Blue Limestone, upper limestone unit, Fivemile Pass 7.5' Quadrangle.

Spores and Pollen:

Densosporites sp. (R)

Lycospora sp. (R)

HCl Reaction: None

Organic Recovery: Fair

Kerogen Content: 15% Amorphous, 5% Cuticular and 80% Woody/Inertinite

T.A.I: 1.3-1.5 R₀ Equivalent

AGE: Namurian B-C? (Chesterian?)

ENVIRONMENT: Swamp/Deltaic

RE: Palynology and Thermal Maturation Analysis of 4 Great Blue/Manning Canyon outcrop samples:

2101, UTM NAD 83 Zone 12N 400216 4458079, Unit Great Blue Limestone, upper limestone and shale unit, Mercur 7.5' quadrangle.

Spores and Pollen:

<i>Densosporites</i> sp.	(C)
<i>Leiotriletes adnatus</i>	(R)
<i>Lycospora</i> sp.	(C)
<i>Punctatisporites</i> spp.	(F)

HCl Reaction: None

Organic Recovery: Fair

Kerogen Content: 70% Amorphous, 5% Cuticular and 25% Woody/Inertinite

T.A.I: 1.3-1.5 R₀ Equivalent

AGE: Namurian B-C? (Chesterian?)

ENVIRONMENT: Swamp/Lacustrine

The ages indicated for samples 2097 and 2101 are based more on general tendencies than by actual palynomorphs ranges. In general, lower Mississippian assemblages have no *Lycospora* spp.; middle Mississippian assemblages are usually much richer and more diverse in their palynomorph recoveries. If the age were Morrowan, I would expect to see a few additional gymnospermous taxa such as *Florinites* occurring along with the *Lycospora* spp. and *Densosporites* spp.

Analysis By:

Gerald Waanders