JARVIS CREEK COAL REPORT

Nina Harun and Michael Hendricks

Preliminary Interpretive Report 2018-2

This publication is PRELIMINARY in nature and meant to allow rapid release of field observations or initial interpretations of geology or analytical data. It has undergone limited peer review but does not necessarily conform to DGGS editorial standards. Interpretations or conclusions contained in this publication are subject to change.

September 2018
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

STATE OF ALASKA
Bill Walker, Governor

DEPARTMENT OF NATURAL RESOURCES
Andrew T. Mack, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
Steve Masterman, State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov | dggs.alaska.gov

DGGS publications are also available at:

Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Harun, N.T. and Hendricks, M.D., 2018, Jarvis Creek Coal Report: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2018-2, 11p.
http://doi.org/10.14509/30064

JARVIS CREEK COAL REPORT

Nina Harun[1] and Michael Hendricks[1]

INTRODUCTION

In July and August of 2016, the Alaska Division of Geological & Geophysical Surveys (DGGS) conducted a field study in the Jarvis Creek coal field to better characterize these coal deposits. The Jarvis Creek Coal field is located on the north side of the Alaska Range in the Mt. Hayes C-4 quadrangle. It represents the eastern-most coal field in the east-west trending Nenana Coal Province (Wahrhaftig and Hickcox, 1955). Located approximately 10 miles southeast of Donnelly Dome, it is bounded on the west by the Delta River, on the east by Jarvis Creek and on the south by Ruby Creek (fig. 1). The field is three to six miles east of the Richardson Highway and approximately 16 mi^2 in area (Belowich, 1988; PlanGraphics Inc., unpub. data, 1983). The field is accessed from Coal Mine Road, an unmaintained dirt road that extends six miles to Ober Creek. Four-wheeler trails continue east into the field from Coal Mine Road. From 1963 to 1970, there was sporadic mining of a 10-ft. coal seam at the end of Ober Road. Metz and others (1981, as reported in Belowich, 1989) reported that the Delta Coal Company mined a site in the field on Ober Creek.

PREVIOUS WORK

Wahrhaftig and Hickcox (1955) conducted the first detailed study of the Jarvis Creek Coal Field. They described 2,000 ft. (530 m.) of "the coal bearing formation" as "a sequence of interbedded lenses of poorly consolidated sandstone, siltstone, claystone, conglomerate and lignite coal" that unconformably overlies the Precambrian Birch Creek Schist. They divided the Tertiary rocks in the field into three units: a lower unit (Tcl), a middle unit (Tcm), and an upper unit (Tcs) (fig. 1). Belowich (1989) correlated the lower and middle units with the Healy Creek Formation and the upper unit with the Lignite Creek Formation, based on palynology and sandstone petrography data. He noted that the pollen was quite distinct between the lower and middle units, with only pollen from ferns and sphagnum moss in the former, and abundant, diverse angiosperms and gymnosperms in the latter. He described the upper unit as containing *Juglans* (Walnut), *Betulaceae* (Birch), *Pterocarya* (Chinese Walnut), *Alnus* (Alder), *Erica* (Heath), and *Pinus* (Pine). Detailed point-count data indicated that the lower unit was more quartz-rich than the middle and upper units, suggesting an affinity with the Healy Creek Formation (Belowich, 1989). Based on palynological data, Ridgway and others (2007) interpreted the Jarvis Creek coal sections to be equivalent to the Lignite Creek Formation at the Suntrana type section. In the Jarvis section, they noted that the Lignite Creek Formation contained a similar palynomorph assemblage to the Wood

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, Alaska 99709

River and Suntrana sections. They stressed the change in lithological character from the Suntrana type section to Jarvis Creek, noting that the Lignite Creek Formation at Suntrana includes abundant planar and trough cross-bedded sandstone and interbedded conglomerate. In contrast, Ridgeway and others (2007) reported that the Lignite Creek Formation in Jarvis Creek area is comprised of a thick succession of gray shale with numerous (40) interbedded coal seams. They also noted that paleocurrent directions change from north-northwest at Jarvis Creek to southward in the Suntrana area. Wahrhaftig and Hickcox (1955) estimated 60 million tons of coal inferred in

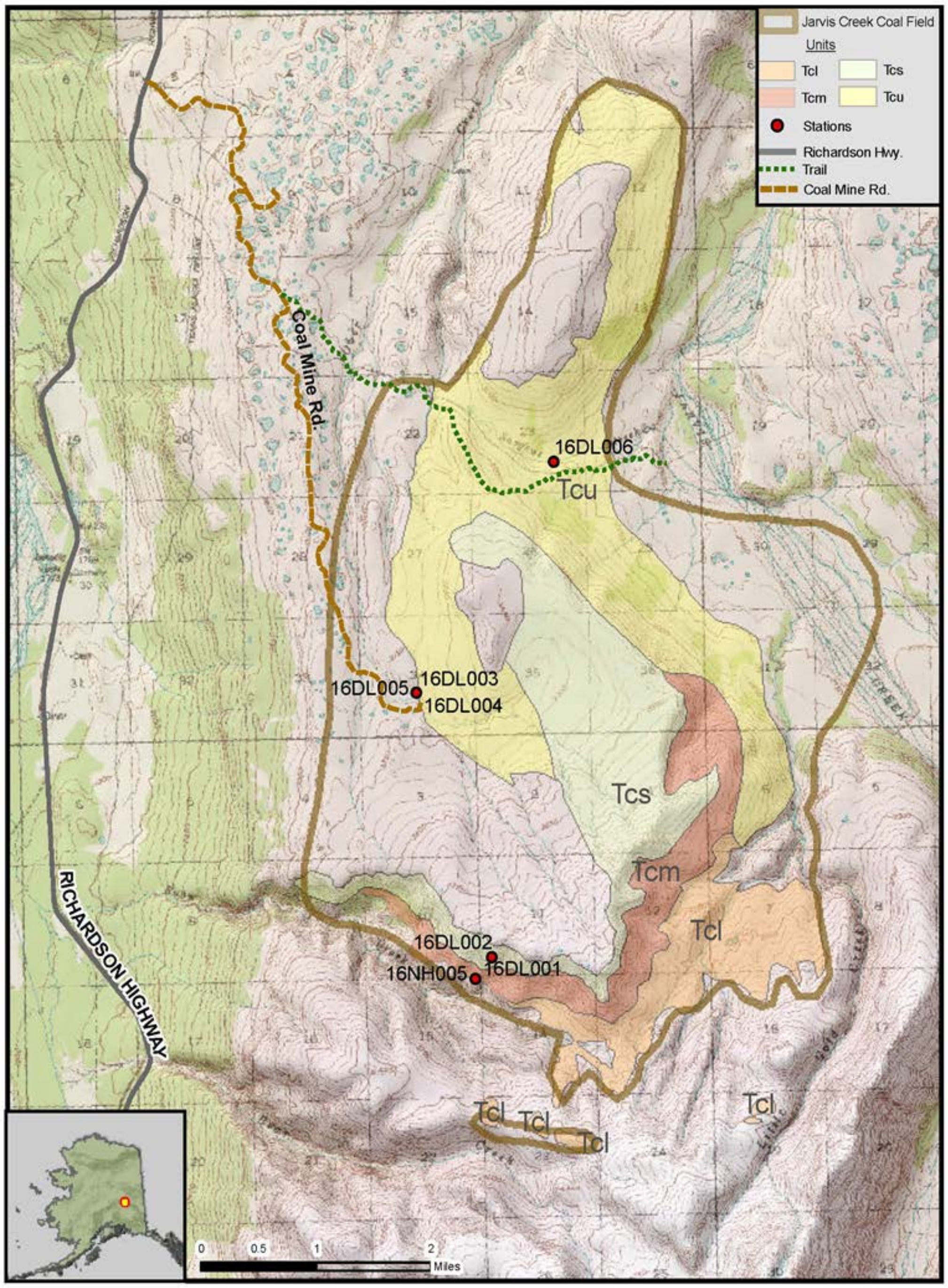

Figure 1. Location map of stations in this study in the Jarvis Creek Coal Field. Modified from Wahrhaftig and Hickcox (1955). Tcu units are tertiary undifferentiated.

the main part of the coal field with an additional four million tons of coal inferred in the northern portion of the coal field.

METHODS

In July and August of 2016, coal-bearing outcrops of the lower, middle, and upper units were examined in three locations in the Jarvis Creek coalfield (fig. 1). These locations include: 1) north of Ruby Creek, 2) the end of Coal Mine Road near the old Ober Creek mine site, and 3) near Sargent Creek in the northern part of the field (fig. 1). All coal samples were collected as channel samples. Eighteen samples were collected from six stations for coal quality (proximate and ultimate analysis), Rock-Eval, hydrous pyrolysis, vitrinite reflectance, and kerogen microscopy analyses.

Geochemical Testing (2005 N. Center Avenue, Somerset, PA) conducted Proximate and Ultimate analyses following the American Society for Testing and Materials standards for coal analyses (ASTM, 2002) (tables 1 and 2).

Weatherford Laboratories (Houston, Texas) analyzed samples for Rock-Eval and vitrinite reflectance (R_o) (table 3). Unfortunately, total organic carbon (TOC) was not measured on any of the samples. Bostick and Daws (1994) showed a close correlation between TOC and “dry basis” carbon from ultimate analysis in low-rank coals (less than 0.8% $R_o$max). The Jarvis Creek coals are low-rank, so “dry basis” carbon from ultimate analysis was used as a proxy for TOC.

Table 1. Jarvis Creek coal proximate analyses.

Sample_id	Lab_id	Collector	Date	Analysis date	Moisture (%)	Ash (%)	Volatile Matter (%)	Fixed Carbon (%)
16DL001a	16-264597	LePain, David	7/26/2016	8/11/2016	11.61	49.61	25.55	13.23
16DL002a	16-264598	LePain, David	7/26/2016	8/11/2016	19.85	42.67	22.54	14.94
16DL003a	16-266784	LePain, David	8/24/2016	9/10/2016	16.16	20.24	37.8	25.8
16DL004a	16-266785	LePain, David	8/24/2016	9/10/2016	16.45	34.69	35.26	13.6
16DL005a	16-266786	LePain, David	8/24/2016	9/10/2016	16.03	34.71	37.44	11.82
16DL006a	16-266787	LePain, David	8/24/2016	9/10/2016	19.77	10.22	38.94	31.07

RESULTS AND CONCLUSIONS

Coal Quality Analyses

Our coal quality data indicate the coals range from lignite B to bituminous C, with the majority classified as lignite B (table 1 and 2). The heat content ranges from 4,275 to 11,732 BTU. With the exception of sample 16DL006a (10.22), ash content is high and ranges from 20.24 to 49.61. Sulfur content is low (0.17 to 0.73) and consists predominately of organic sulfur. The proxied “TOC” values vary from 27.49 to 61.61 and are consistent with low rank coals.

Table 2. Jarvis Creek coal ultimate analyses, sulfur types, equilibrium moisture, BTU, and coal ranking.

Sample_id	Hydrogen (%)	Carbon (%)	Nitrogen (%)	Ultimate Sulfur (%)	Ultimate Oxygen (%)	Ultimate Ash (%)	Sulfate Sulfur (%)	Pyritic Sulfur (%)	Organic Sulfur (%)	Equilibrium Moisture (%)	BTU	Coal Ranking
16DL001a	3.85	24.21	0.23	0.17	21.93	49.61	0	0	0.17	15.44	4275	Lignite B
16DL002a	4.36	25.32	0.35	0.46	26.84	42.67	0	0.09	0.37	19.77	4523	Lignite B
16DL003a	5.66	45 .65	1.07	0.56	26.82	20.24	0.03	0.03	0.50	20.43	8357	Sub bituminous C
16DL004a	4.6	33.53	0.73	0.73	25.72	34 .69	0.02	0.08	0.63	21.68	5959	Lignite B
16DL005a	4.49	33 .51	0.67	0.6	26 .02	34 .71	0.03	0.08	0.49	20 .71	5880	Lignite B
16DL006a	5.95	49.43	2.19	0.67	31.54	10.22	0.01	0.06	0.6	24.15	11732	Bituminous C

Table 3. Rock-Eval, vitrinite reflectance, and TOC analyses for the Jarvis Creek field samples. *Note TOC value has been proxied by percent "dry basis" carbon from ultimate analysis. **S1**, **S2** units = mg HC/g rock. **S3** units = mg CO_2/g rock.

Sample_id	Field	TOC*	S1	S2	S3	Tmax(°C)	%Ro	HI	OI	S2/S3	S1/TOC *100	PI
16DL001b	Jarvis Creek	27.49	4.03	86.62	4.54	421	0.33	315.10	18.19	19.08	14.65	0.04
16DL002b	Jarvis Creek	31.59	3.97	103.83	19.02	419	0.32	328.68	15.83	5.46	12.57	0.04
16DL003b	Jarvis Creek	54.45	6.65	129.65	12.77	414	0.27	238.11	9.18	10.15	12.21	0.05
16DL004b	Jarvis Creek	40.14	3.34	78.93	18.19	411	0.33	196.64	12.46	4.34	8.32	0.04
16DL005b	Jarvis Creek	39.90	1.01	46.41	15.89	381	0.34	116.32	12.53	2.92	2.54	0.02
16DL006b	Jarvis Creek	61.61	2.85	74.74	20.46	397	0.32	121.31	8.12	3.65	4.63	0.04

Rock-Eval and Vitrinite Reflectance

Rock-Eval, TOC, and vitrinite reflectance analyses indicate the quality, quantity, and thermal maturity of the organic component, respectively (Stanley and others, 2013). The TOC in weight percent is a measure of the quantity of the organic component. As noted earlier, "dry basis" carbon from ultimate analysis was used as a proxy for TOC. The hydrogen content is an indication of the quality of the organic component as a petroleum source rock and is derived from the hydrogen-to-carbon ratio through kerogen elemental analyses. We used data from Rock-Eval analyses as a proxy for this elemental data, however, Peters (1986) and Stanley and others (2013) indicate that Rock-Eval data should be used cautiously in this manner. In Rock-Eval analyses, the S1 peak measures the amount of hydrocarbons (mg/g) that can be thermally distilled from the sample (essentially hydrocarbons already in the rock at the time of sampling); the S2 peak indicates the amount of hydrocarbons (mg/g) generated by pyrolytic degradation of the kerogen in the sample and is an indicator of hydrocarbon generation potential; the S3 peak records the amount of CO_2 generated during pyrolysis (Peters, 1986). Tmax °C is the temperature at which the maximum amount of S2 hydrocarbons are generated (Peters, 1986).

Six coal samples were analyzed for vitrinite reflectance and Rock-Eval pyrolysis (table 3). Rock-Eval pyrolysis and vitrinite reflectance data indicate that all of the samples are immature in relation to the onset of oil generation. Mean vitrinite reflectance values are low and range from 0.27 to 0.34 (%Ro) (table 3). Tmax values range from 397 °C to 421 °C and indicate immature organic matter (fig. 2).

Production index (PI), hydrogen index (HI) and oxygen index (OI) were calculated from the Rock-Eval data. The production index (PI) is the ratio of the S1 and S2 peaks (PI= (S1)/(S1+S2)) and is an important measure of the thermal maturity of the sample, with values less than 0.1 indicating immature organic matter (Peter, 1986). The PI for Jarvis Creek coal samples ranges from 0.02 to 0.05, indicating immature organic matter (figs. 2 and 3). In a plot of the hydrogen index (HI) (HI = S2*100/TOC) vs. Tmax, Jarvis Creek samples plot in the thermally immature Type II-III (mixed oil-gas prone) to Type III (gas prone) fields (fig. 4). Similarly, Jarvis Creek coal samples plot close to the Type II kerogen curve in a hydrogen index (HI) vs. vitrinite reflectance plot (fig. 5). Type II kerogen indicates a rock has the potential to generate both oil and gas when thermally mature. The onset of oil generation corresponds to a vitrinite reflectance of at least 0.55 %Ro (Peters, 1986). The range of vitrinite reflectance values obtained from our samples (0.27 and 0.34 Ro%) indicates the coals are submature. The HI vs. OI plot indicates these samples fall into the mixed Type II-III and Type III kerogen fields (fig. 6). However, Peters (1986) cautions against using HI vs. OI plots with coals, as they may misrepresent organic matter quality. The HI and S2/S3 ratio are also measures of the quality of the organic matter (Peters and Casa, 1994). In a plot of HI vs. S2/S3, half of these samples fall into the Type III (gas) field, whereas the remaining samples fall into the Type II (oil) and Type II/III (oil & gas) fields (fig. 5). Sample 16DL02b contains the highest HI index and a mid-range S2/S3 ratio. Lower than expected TOC for this sample would result in a higher HI index.

The rank of the Jarvis Creek coal samples ranges from lignite B to bituminous C. Rock-Eval and vitrinite reflectance results indicate that the samples contain immature organic matter. Furthermore, organic matter quality indicators point to predominately Type III (gas-prone) and Type II-III (mixed oil–gas-prone) kerogen.

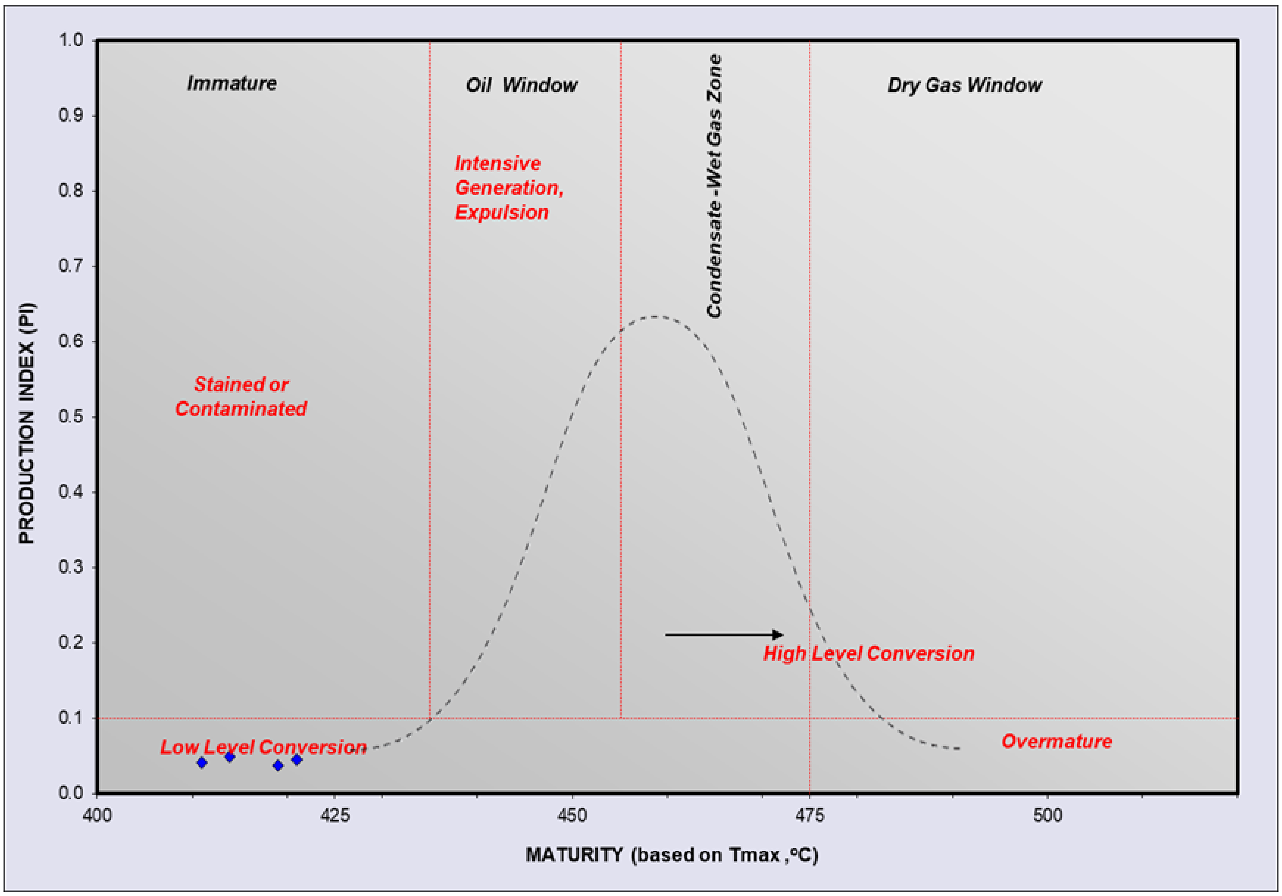

Figure 2. Production index (PI) vs. Tmax (oC) as a measure of maturity.

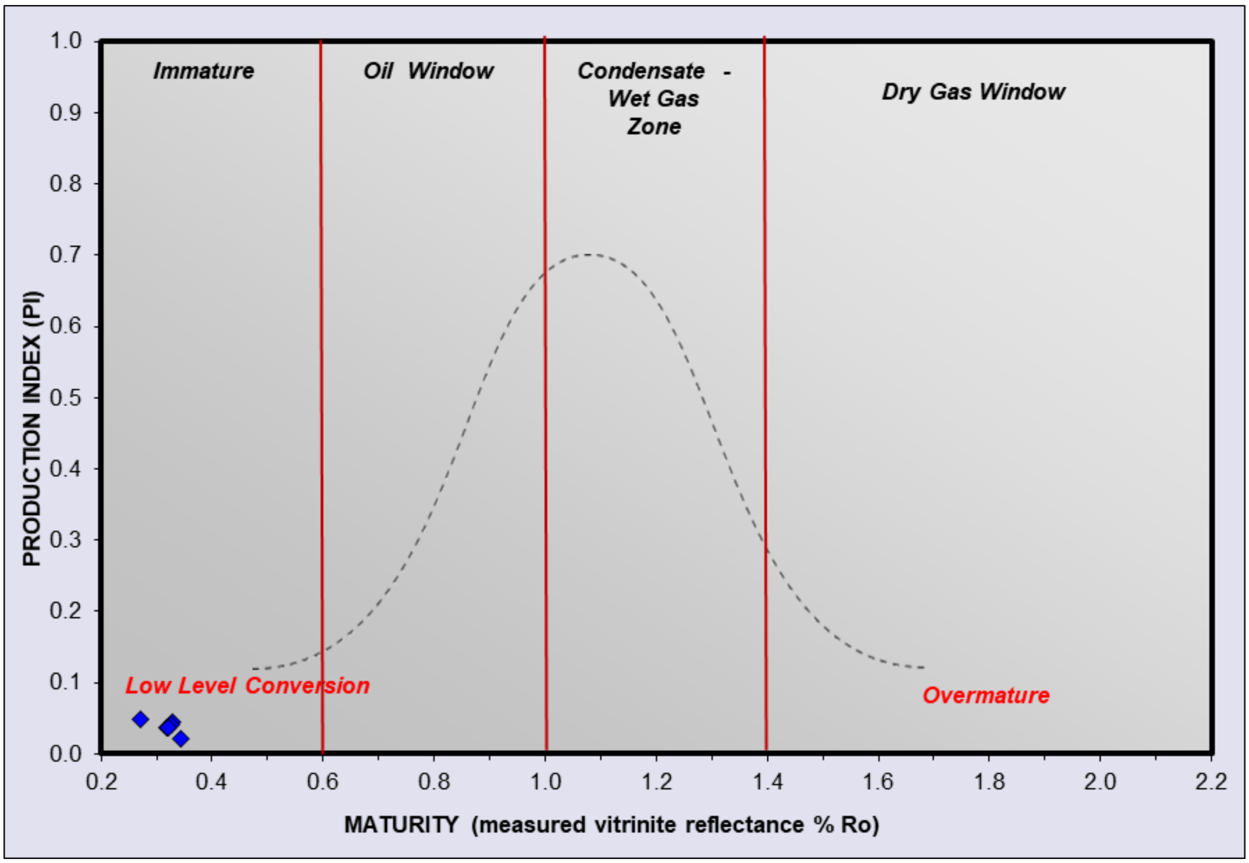

Figure 3. Production index (PI) vs. vitrinite reflectance (% Ro).

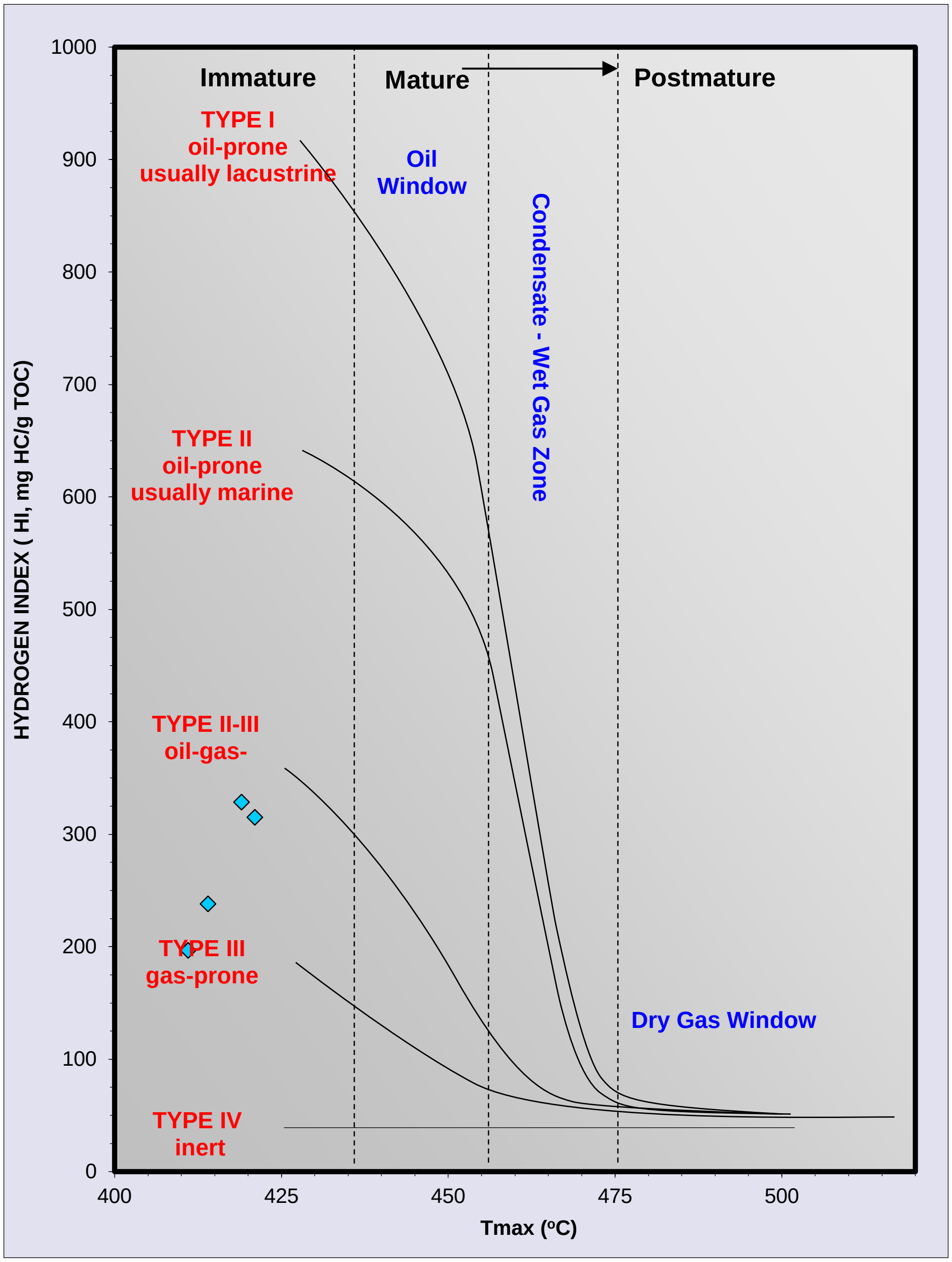

Figure 4. Hydrogen index vs. Tmax indicating that these samples fall into the immature gas, and oil-gas prone fields.

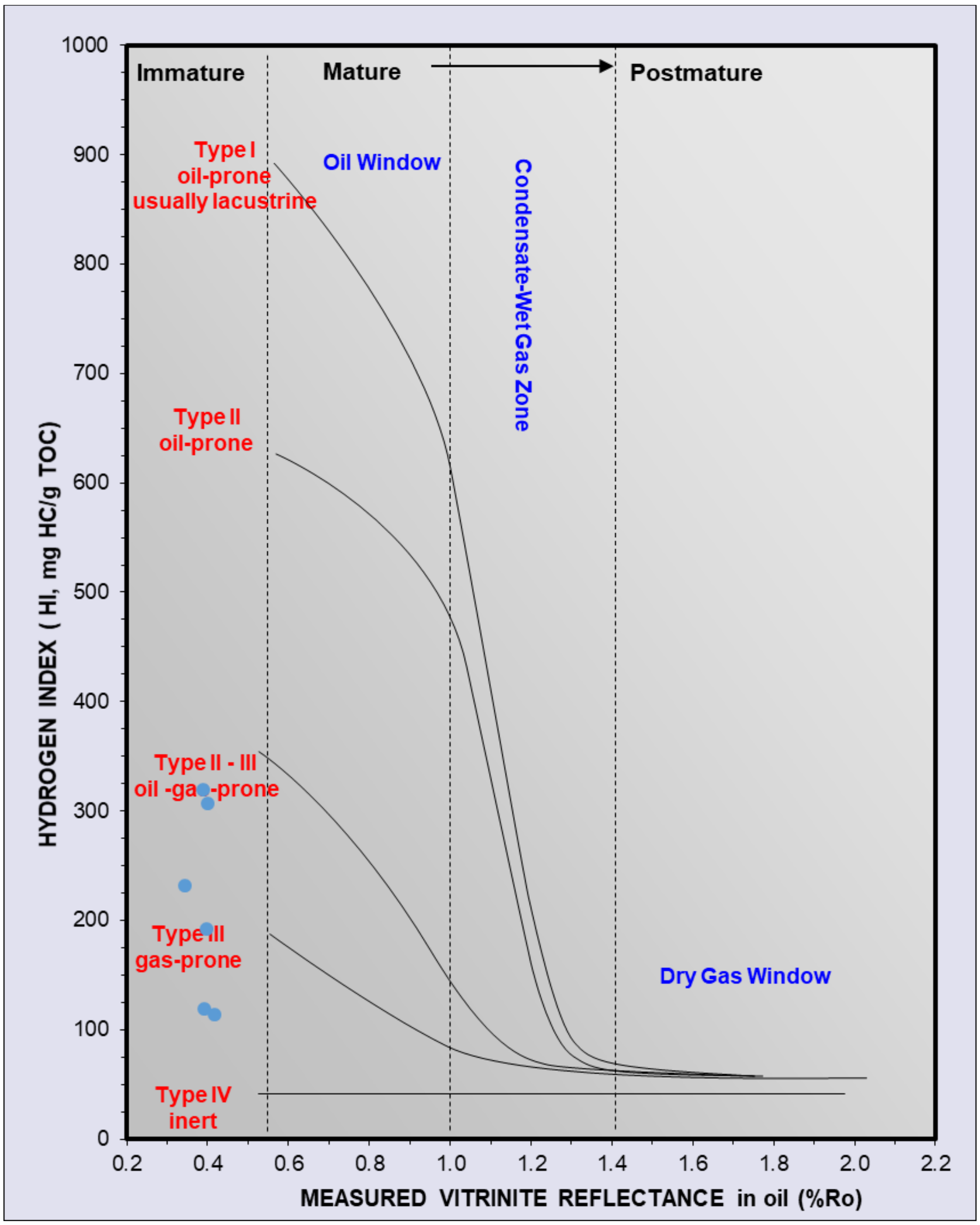

Figure 5. Hydrogen index vs. vitrinite reflectance (%Ro) indicating that these samples fall into the immature gas, and oil-gas prone fields.

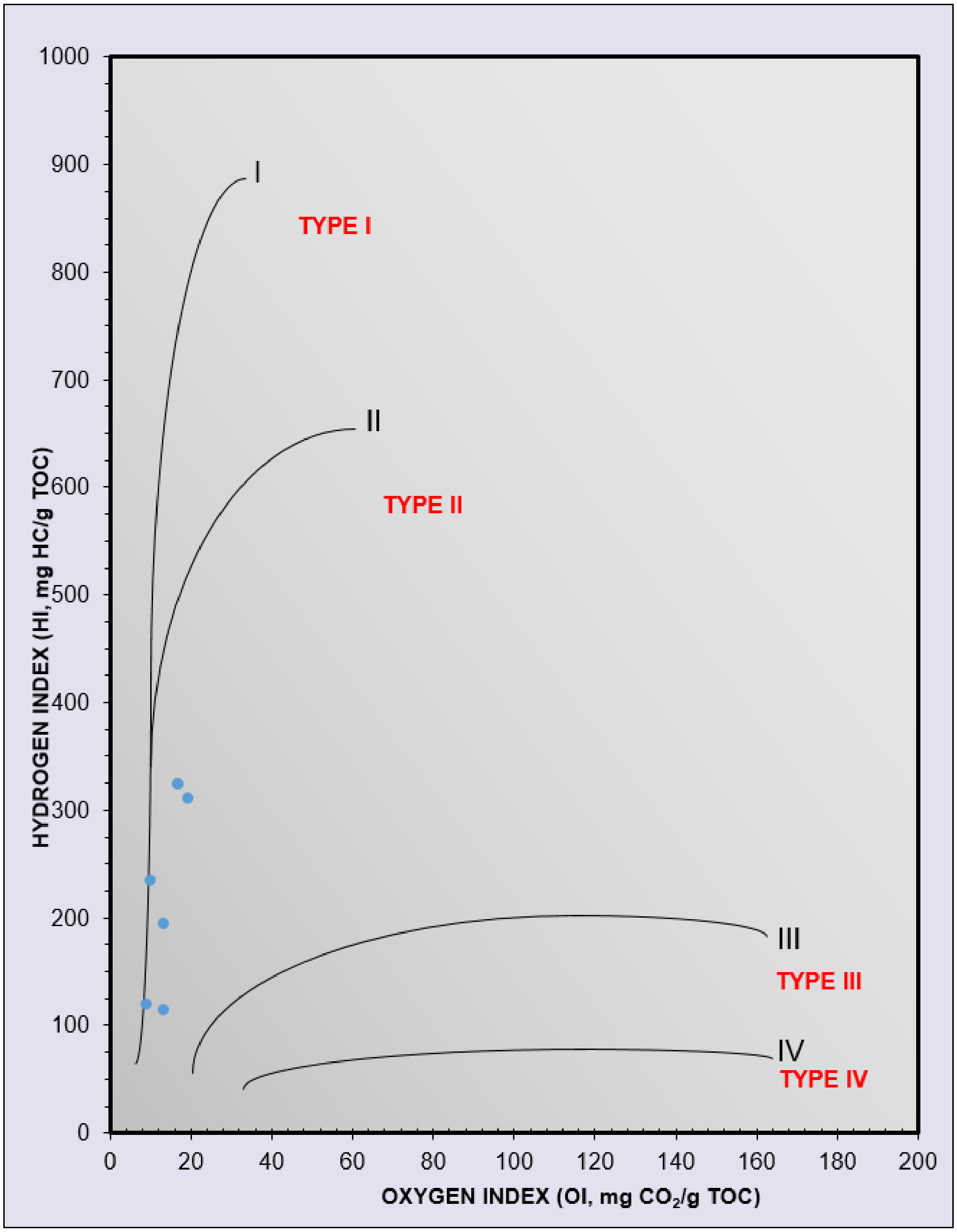

Figure 6. Hydrogen index vs. oxygen index.

ACKNOWLEDGMENTS

This work was made possible by the National Coal Resource Data System (NCRDS) program of the USGS as Y17 Studies of Petroleum Source Potential of Alaska Coal. The authors wish to thank Joe East (USGS) for his help. The authors gratefully acknowledge David LePain for help on all aspects of this project.

REFERENCES

American Society for Testing and Materials, 200 P2, Annual Book of ASTM Standards 20002, v. 05.06, 650 p.

Belowich, M.A., 1987, Basinal trends in coal, petrographic, and elemental composition with applications toward seam correlation, Jarvis Creek Coal Field, Alaska, *in* Rao, P.D., and Walsh, D.E., eds., Focus on Alaska Coal—1986 Proceedings of the Conference: Fairbanks, University of Alaska, Mineral Industry Research Laboratory Report 72, p. 300–335.

Bostick, N. H., and Daws, T. A., 1994, Relationships between data from Rock-Eval pyrolysis and proximate, ultimate, petrographic, and physical analyses of 142 diverse U.S. coal samples: Organic Geochemistry, v. 21, p. 35–49.

Ridgway, K.D., Thoms, E.E., Layer, P.W., Lesh, M.E., White, J.M., and Smith, S.V., 2007, Neogene transpressional foreland basin development of the north side of the central Alaska Range, Usibelli Group and Nenana Gravel, Tanana Basin, *in* Ridgway, K.D., and others, eds., Tectonics Growth of a Collisional Continental Margin - Crustal evolution of southern Alaska: Geological Society of America Special Paper, v. 431, p. 507–547.

Peters, K.E, 1986, Guidelines for evaluating petroleum source rock using programmed pyrolysis: American Association of Petroleum Geologists Bulletin, v. 70, no.3, p. 318–329.

Peters, K.E., and Cassa, M.R., 1994, Applied source rock geochemistry, *in* Magoon, B., and Dow, W.G., eds., The Petroleum System—From Source to Trap: American Association of Petroleum Geologist Memoir 60, p. 93–120.

Stanley, R. G., Lillis, P. G., Pawlewicz, M. J., Haeussler, P. J., 2014, Rock-Eval pyrolysis and vitrinite reflectance results from the Sheep Creek 1 well, Susitna basin, south-central Alaska: U.S. Geological Survey Open-File Report 2013-1307.

Wahrhaftig, C.A., and Hickcox, C.A., 1955, Geology and coal deposits, Jarvis Creek coal field, Alaska: U.S. Geological Survey Bulletin 989-G, p. 353–367, 3 sheets.