CHAPTER 4

RECONNAISSANCE COAL STUDY IN THE SUSITNA BASIN, 2014

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) conducted fieldwork during the summer of 2014 in the Susitna basin as part of an ongoing evaluation of the hydrocarbon potential of frontier basins, particularly those near the Railbelt region (for example, Decker and others, 2013; Gillis and others, 2013). Topical studies associated with this recent work include sedimentary facies analysis (LePain and others, 2015) and structural geology investigations (Gillis and others, 2015). The Susitna basin contains coal-bearing Paleogene and Neogene strata correlative with formations that host oil and gas in Cook Inlet basin to its south. Isotopic signatures of natural gas reservoired in the Miocene/Pliocene Sterling and Miocene Beluga Formations suggest a biogenic origin for Cook Inlet gas (Claypool and others, 1980). To assess the biogenic gas potential of the Susitna basin, it is important to obtain information from its coal-bearing units.

Characteristics of coal, such as maturity/rank and cleat development are key parameters influencing viability of a biogenic gas system (Laubach and others, 1998). In an early study of the Susitna basin (Beluga–Yentna region), Barnes (1966) identified, analyzed, and recognized potentially valuable subbituminous coal resources at Fairview Mountain, Canyon Creek, and Johnson Creek. Merritt (1990), in a sedimentological study to evaluate surface coal mining potential of the Tertiary rocks of the Susitna basin (Susitna lowland), concluded that the basin contained several billion tons of mineable reserves. This preliminary report offers a brief summary of new information on coals in the Susitna Basin acquired during associated stratigraphic studies (see LePain and others, 2015).

FIELD OBSERVATIONS AND SAMPLING

In this study, coal from the Miocene Tyonek(?) and Pliocene Sterling(?) Formations (Reed and Nelson, 1980) were examined and collected in the western and northern portions of the Susitna Basin (fig. 4-1). Twenty-two coal samples were collected from 11 localities for coal quality, high-pressure methane adsorption (HPMA), vitrinite reflectance, and Rock-Eval pyrolysis to aid in the determination of gas potential in the basin (fig. 4-1).

The Susitna basin study area contains lignite to subbituminous coal beds ranging from 10 cm to 3 m thick in the Tyonek(?) and Sterling(?) Formations. Coal rank (subbituminous versus lignite) was difficult to ascertain in the field. In several locations subbituminous coal was similar in field appearance to lignite coal. Lignite coal is brownish-black in color with a dull luster and includes abundant plant debris, whereas subbituminous coal is brown to black with a dull to vitreous luster. Sixteen coal samples were analyzed for proximate and ultimate analyses by Geochemical Testing Laboratories (table 4-1)

The best-exposed coal beds are at Fairview Mountain (sample 14DL007), in the northern portion of the basin (fig. 4-2b). Seven coal beds were identified in the Tyonek(?) Formation that ranged in thickness from 10 cm to 1 m. Six of these coal beds are contained in five major (minimum 1 m thick) coal intervals that also contain interbedded carbonaceous mudstone. The lowest coal in the section (at 23 m) is subbituminous A, whereas the upper coal (at 70 m) is subbituminous B. Coal beds elsewhere in the study area, as in this section, are often interbedded with or overlain by carbonaceous mudstone.

To understand basin-wide hydrocarbon and water flow patterns, it is important to understand coal cleat development in the coal beds. Coal cleats are opening-mode fractures in coal beds that control effective porosity and permeability within the coal bed (Laubach and others, 1998). Upon depressuring of the reservoir through removal of water, adsorbed methane in the coal matrix migrates into the cleats. Cleats, as a natural fracture network, define permeability conduits that therefore control coal bed methane production with dewatering of the coal (Laubach and others, 1998). Coal beds from eight localities were described in detail, including coal cleat measurements and orientations. Where present, coal face and butt cleats were measured and described (fig 4-2a). Twenty-two cleat orientations and 27 cleat length, frequency, and aperture width measurements were recorded (fig 4-1, table 4-1).

PRELIMINARY RESULTS

Although coal rank was difficult to ascertain in the field, our coal quality proximate and ultimate analyses indicate that Tyonek(?) and Sterling (?) Formation coal sampled from Susitna basin localities range from subbituminous A to lignite A

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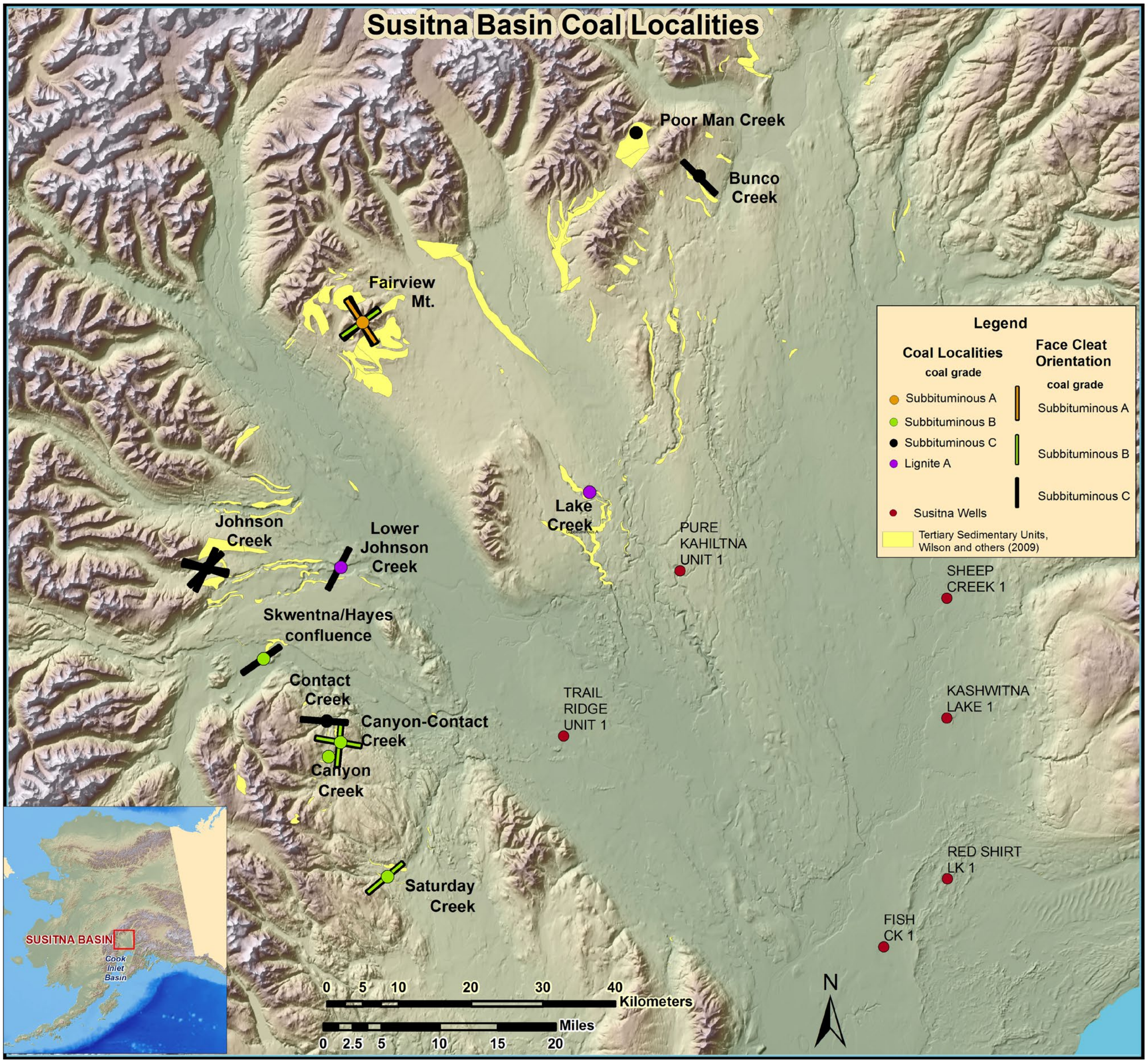

Figure 4-1. Map of study area showing localities and face cleat orientations color coded by coal rank.

(figure 4-1; table 4-1). In several locations subbituminous coal was similar in field appearance to lignite coal. Lignite coal is brownish-black in color with a dull luster and includes abundant plant debris, whereas subbituminous coal is brown to black with a dull to vitreous luster.

The best exposed coal beds are at Fairview Mountain in the northern portion of the study area (fig. 4-2b). The lower (23 m) and upper (70 m) coal beds at Fairview Mountain are ranked subbituminous A and subbituminous B, respectively. Coal collected from Saturday Creek (14DL008a), the tributary of Canyon Creek (14A09a), the Skwentna/Hayes confluence (14DL010a), and Canyon/Contact Creek (14NH100a) are subbituminous B grade coal (fig 4-2a). One of the best exposures was at Canyon Creek, where a 2-m-thick subbituminous B coal bed was well exposed at the creek bottom.

Subbituminous C coal beds were sampled from the Tyonek(?) Formation throughout the study area at Contact Creek (11DL005), Lake Creek (lowest coal bed; 11DL009), Bunco Creek (11DL011), Johnson Creek (14DL011), and Poorman Creek (14DL012) sections. At Johnson Creek (14DL011) subbituminous C beds contain alternating discontinuous vitreous layers (1 cm thick) with fissile coal layers (2–3 cm thick).

Coals from Sterling(?) Formation exposed at Lake Creek and lower Johnson Creek in the western portion of the basin, were ranked lignite A. These coal beds were characterized by an abundance of woody material.

Table 4-1. Table of coal quality data.

Sample	Location	Formation	Latitude	Longitude	COAL ANALYSIS						Apparent rank
					Total Moisture	Fixed Carbon	Volatile matter	BTU	Ash	Sulfur	
11DL005-5.6a1	Contact Creek		61.87	-151.71	21.62	34.44	39.07	8,728	4.87	0.16	*Subbituminous C*
11DL005-5.6a2	Contact Creek		61.87	-151.71	23.02	32.99	37.14	8,342	6.85	0.18	*Subbituminous C*
11DL009.20.15a	Lake Creek	Sterling?	62.14	-150.99	18.84	18.10	31.60	5,533	31.46	0.30	*Subbituminous C*
11DL009-36.1a	Lake Creek	Sterling	62.14	-150.99	17.37	17.60	29.42	4,973	35.61	0.49	*Lignite A*
11DL011.10a	Bunco Creek	Tyonek	62.53	-150.65	15.56	13.86	18.60	3,855	51.98	0.26	*Subbituminous C*
11DL011-25.5a	Bunco Creek	Tyonek	62.53	-150.65	16.71	17.52	29.55	5,358	36.22	0.23	*Subbituminous C*
14A09a	Tributary off of Canyon Creek	Tyonek?	61.83	-151.71	17.84	31.24	32.38	7,807	18.54	0.44	*Subbituminous B*
14DL007-23.1a	Fairview Moun-tain	Tyonek	62.36	-151.58	17.89	36.98	38.81	9,421	6.32	0.32	*Subbituminous A*
14DL007-70.1a	Fairview Moun-tain	Tyonek	62.36	-151.58	20.19	29.50	34.62	7,535	15.69	0.22	*Subbituminous B*
14DL008a	Saturday Creek		61.68	-151.56	15.08	25.58	29.82	6,599	29.52	0.34	*Subbituminous B*
14DL010a	Skwentna/Hayes confluence	Tyonek	61.95	-151.87	15.55	32.71	43.41	8,787	8.33	0.22	*Subbituminous B*
14DL011-1.4a	Johnson Creek	Tyonek	62.07	-152.01	18.64	26.05	32.51	7,034	22.80	0.38	*Subbituminous C*
14DL011-12.75a	Johnson Creek	Tyonek	62.07	-152.01	19.83	31.54	36.16	8,060	12.47	0.33	*Subbituminous C*
14DL012b	Poor Man Creek	Sterling	62.59	-150.82	17.18	22.73	29.02	6,073	31.07	0.34	*Subbituminous C*
14DL014-2.0a	Lower Johnson Creek	Sterling	62.06	-151.66	26.61	18.20	30.20	5,123	24.99	0.41	*Lignite A*
14NH100a	Canyon/Contact Creek	Tyonek	61.85	-151.67	19.58	39.76	36.37	9,412	4.29	0.24	*Subbituminous B*

Figure 4-2a. Coal cleats in the Tyonek(?) Formation at Contact Creek.

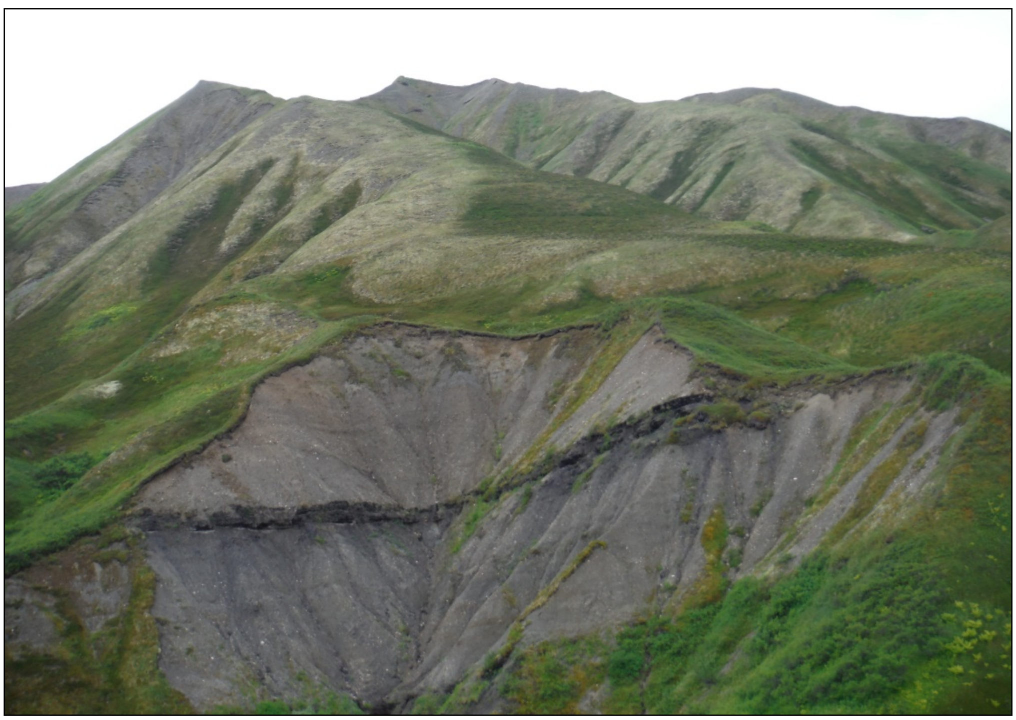

Figure 4-2b. Coal bed in Tyonek(?) Formation at Fairview Mountain.

Cleat development, orientations and densities were variable in the study area (fig 4-1, fig. 4-3). In general, face cleats strike to the northwest and southwest. Cleat orientations (face and butt) are consistently orthogonal to one another. Cleat dip orientations are high-angle, ranging from 55 to 90 degrees.

Cleat orientations show a marked change from Fairview Mountain to the north to the localities to the south (Johnson Creek, Lower Johnson Creek, Skwentna/Hayes confluence, Contact Creek, Canyon-Contact Creek and Saturday Creek). (fig. 4-1, fig. 4-3) Face cleat orientations can show two distinct orientations within a given section. To the south of Fairview Mt. face

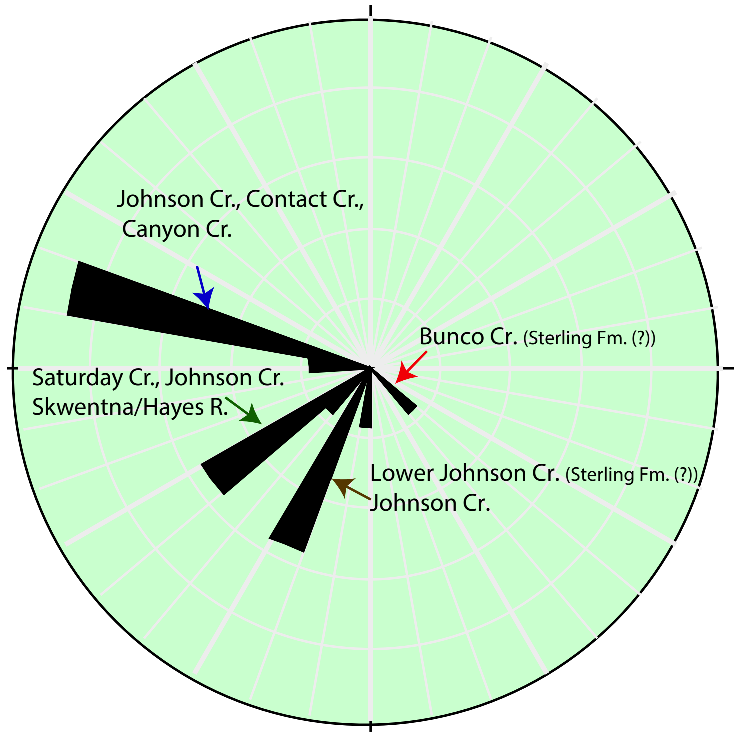

Figure 4-3a. Rose diagram of coal face cleat orientations at all localities excluding Fairview Mountain. Orientations are from the Tyonek(?) Formation, except where noted. N=12.

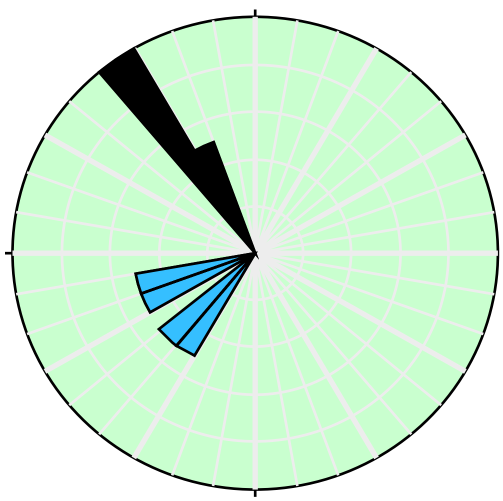

Figure 4-3b. Rose diagram of coal cleat orientations at Fairview Mountain in the Tyonek(?) Formation. Subbituminous A - 23 m; face cleats – black; butt cleats – blue; N=8.

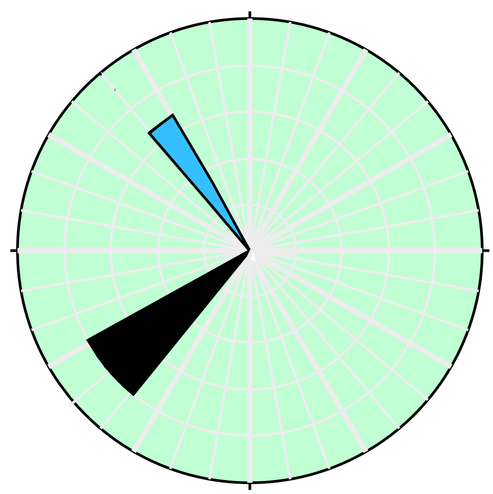

Figure 4-3c. Rose diagram of coal cleat orientations at Fairview Mountain in the Tyonek(?) Formation. Subbituminous B - 70 m; face cleats – black; butt cleats – blue; N=4.

cleat orientations vary but in general are orientated to the west-northwest (274° to 287° azimuth) or to the southwest (225° to 235° azimuth) and (206° to 208° azimuth) (fig. 4-3a). At Fairview Mountain, face and butt cleats are oriented to the northwest (316° to 332° azimuth) and southwest (224° to 237° azimuth). At Fairview Mt. face and cleat orientations switch from the bottom of the section (23 m) to the top coal bed (70 m) (fig. 4-3b, fig. 4-3c). The variations in cleat orientations from the north to the south of the study area may reflect deferring tectonic stress directions in these areas.

In general, cleat development variability could be a function of diagenetic and/or tectonic processes (Laubach and others, 1998). Additionally, the quality of exposure plays an important role in cleat recognition. Lower rank coal, lignite A, seems to contain fewer well recognized cleats in the study area.

Cleat height, frequency and aperture vary throughout the study area but are generally consistent within outcrops. Face cleat height varies from 70 cm to 1 m and butt cleat height varies from 30 to 70 cm. Cleat frequency, measured across the face of the outcrop vary from 4 to 16 face cleats per meter, 9 to 20 butt cleats per meter and 40 to 150 tertiary cleats per meter. Cleat apertures range from closed to 7.5 mm, with averages less than 3 mm. Only small tertiary cleats were filled. No fill material was observed in face or butt cleats.

SUMMARY

As part of the 2014 DGGS Susitna basin study, coal beds in 11 localities of the Tyonek(?) and Sterling(?) Formations were examined and sampled. Preliminary coal-quality analyses of these samples indicate that the older unit (Tyonek[?]) coals range from subbituminous A to subbituminous B in rank and the younger strata (Sterling[?]) coals are lignite A in rank. Cleat development was variable, although face cleats trend to the northwest or southwest. This coal data, along with pending high-pressure methane adsorption (HPMA), vitrinite reflectance, and Rock-Eval pyrolysis data, will offer new constraints on the viability of a coal-related biogenic gas system in the Susitna basin.

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