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UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

STRATIGRAPHIC AND PALEOENVIRONMENT DATA FOR THE URANIUM-BEARING  
LANCE AND FOX HILLS FORMATIONS, CROOK AND NORTHERN  
WESTON COUNTIES, NORTHEASTERN WYOMING

By

Harry W. Dodge, Jr., and J. Dan Powell

With an Appendix on

Palyнологical Evaluation of some Fort Union and Lance Formation samples  
from Crook and Weston Counties, Wyoming, by Bernadine D. Tschudy

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This report is preliminary and has not  
been edited or reviewed for conformity  
with U.S. Geological Survey standards  
and nomenclature.

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STRATIGRAPHIC AND PALEOENVIRONMENT DATA FOR THE URANIUM-BEARING  
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Introduction

The Lance and Fox Hills Formations of latest Cretaceous (Maestrichtian) age in Crook County, Wyoming (fig. 1), are the subjects of increasing uranium exploration activity in the eastern Powder River Basin. At this time no mining is underway, and no major discoveries of uranium-ore concentrations have been announced. Our surface radiometric reconnaissance showed small, low-intensity anomalies in the Lance Formation. Surface exposures show little indication of the alteration that typically accompanies roll-front uranium deposits. There is a strong indication that local structural features and underlying petroleum deposits play a part in uranium localization.

We are studying the Lance and Fox Hills Formations in the Powder River Basin in order to determine uranium host-rock properties and their paleoenvironments. The purpose of this open-file report is to make basic data available to the public as fast as possible. Ultimately, details of stratigraphy, sedimentology, origin, and paleoenvironments of the Lance and Fox Hills will be published as aids to uranium exploration and development by private enterprise.

Geographic descriptions for all numbered localities are shown on table 1, and locations of drill holes shown on figure 2 are described in table 2. Table 3 includes petrographic data from thin section studies, and table 4 shows weight percent of sand derived from sieve analyses.

Figures 3-5 show typical stratigraphic sections of small Lance sandstone channel, and key sedimentary parameters used in interpreting paleoenvironments. Figures 6-13 are rose diagrams depicting the strong unimodal southeast and south paleoflow directions in Lance fluvial channels. Figures 6-11 are from the northern part of the study area; figures 12-13 are from the southern part of the area.

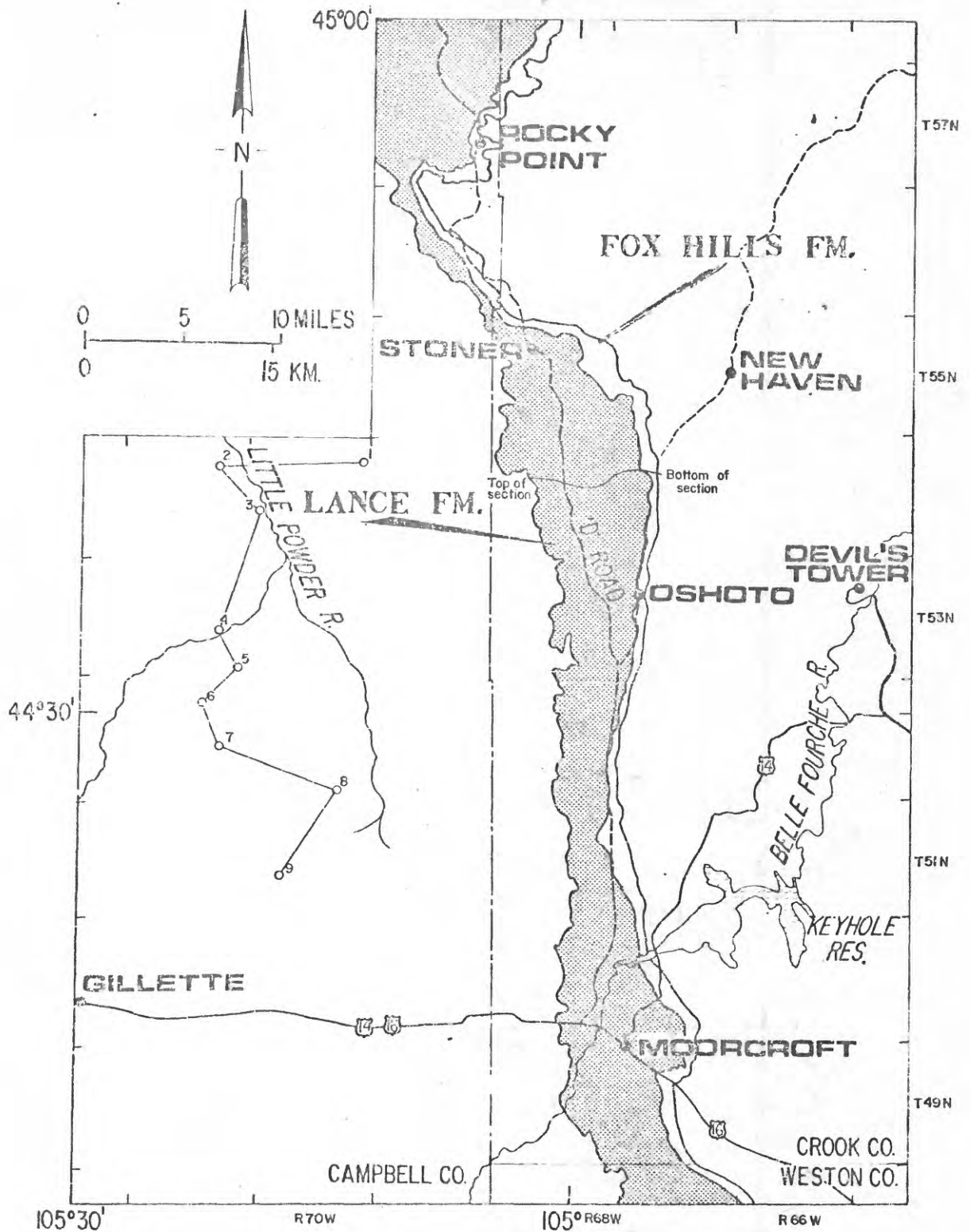


Figure 1.--Index map showing Fox Hills and Lance Formations outcrop and location of measured sections and electrical log cross-sections, Crook, Weston, and Campbell Counties, Wyoming.

Plate 1 is a composite stratigraphic section of the Lance Formation; it shows lithologic sequence and the precise stratigraphic locations of those samples listed in tables 3 and 4, which were collected along the measured section. Data for this composite were collected by standard descriptive field techniques and were tied together by alidade and plane table surveys. All other sample localities are listed in table 1.

### Stratigraphy

Along the western flank of the Black Hills in Crook County, Wyoming (fig. 1), the last major regression of the interior Cretaceous sea is recorded in the upward transition from Pierre Shale to Fox Hills Formation to Lance Formation. Pierre Shale grades upward into progressively more sandy transitional strata and, finally, into light-yellowish-brown, very fine-grained slabby sandstone and silty gray shale of the Fox Hills Formation. The Fox Hills ranges in thickness from 10 to 30 m.

The youngest marine beds are Fox Hills. The Fox Hills-Lance boundary is rarely exposed, but the marine beds of the Fox Hills are directly overlain by fluviodeltaic sandstone and mudstone of the Lance Formation. Robinson, Mapel, and Bergendahl (1964, p. 98) have used the lowest, brown carbonaceous or swelling-clay shale as the Fox Hills-Lance contact.

North and south of Crook County, the upper sandstone of the Fox Hills is widely recognized by Robinson, Mapel, and Bergendahl (1964, p. 96). In Crook County this upper sandstone is absent.

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The Lance Formation consists of fluvial channel sandstone and inter-channel mudstone and sandstone. The channel sandstones are pale-yellowish- or greenish-brown, fine-grained to very fine-grained elongate sand bodies, ranging from less than a metre to over 50 m in thickness. The interchannel sequence is composed of medium- to dark-gray, sandy clay that swells when wet, and pale-reddish-brown to gray, tuffaceous mudstones. The mudstones commonly contain much degraded plant debris, but coal and coaly shale are conspicuously absent. Thin interchannel muddy sandstones are interlayered with the thicker mudstone units.

The Lance Formation is overlain by the Fort Union Formation of Paleocene age. The Fort Union is a sequence of fluvial sandstone and flood-plain mudstones containing coal and coaly shale. The boundary between the Lance and Fort Union Formations was picked at a conspicuous topographic break approximately 3 m below the lowest coal bed in the Fort Union Formation.

#### Paleoenvironments

Interpretations of field observations and the data presented in tables 1 and 2 suggest that the Fox Hills and Lance Formations record a rapid change from nearshore marine conditions to fluviodeltaic conditions. The Fox Hills contains marine fossils at numerous localities along its outcrop. The Lance Formation contains numerous disarticulated bones of dinosaurs and other terrestrial reptiles. In addition, a freshwater environment for all Lance rocks is strongly indicated by the palynologic data contained in the Appendix to this report.

Sedimentary structures and textural data (figs. 3, 4, and 5) indicate a high constructive delta or coastal-plain paleoenvironment for Lance sediments. Streams, both large and small, flowed from northwest to southeast across the western coastal plain of the interior seaway (figs. 6-13).

Our petrographic studies (table 3) suggest that Lance sediments were transported to their present location by streams flowing from uplifts in western Montana and adjacent areas to the south and southwest. Alteration of silicate minerals from primary source rocks in Montana evidently occurred mostly during transport across a coastal plain. *In situ* alteration of feldspars and other relatively unstable silicates in Lance rocks is not a prominent diagenetic feature.



Table 1.--Localities where data were collected in Oshoto  
15-minute quadrangle, Crook County, Wyoming, and  
in northern Weston County, Wyoming

Loc. No.	Description of locality
K74-1	Lower Lance Formation along Alkali Creek 9.7 km N. of Oshoto, 1.6 km E. of Jewell Oil Field, SE 1/4 sec. 7, T. 54 N., R. 67 W., Fowler Ranch.
K74-2	Lower Lance Formation, above that of K74-1, and in same area along east-flowing tributaries to Alkali Creek in the SW 1/4 sec. 7, T. 54 N., R. 67 W., Fowler Ranch.
K74-3	Upper part of Pierre Shale, lower Fox Hill Formation, lowermost Lance Formation, 200 m E. of road from Oshoto to New Haven (= "D" Road), in SW 1/4 NW 1/4 sec. 9, T. 54 N., R. 67 W., Fowler Ranch.
K74-4	Lower Lance Formation along Alkali Creek (downstream from K74-1), 150 m south of Fowler Ranch House, in center of NW 1/4 sec. 8, T. 54 N., R. 67 W.
K74-5	Lower Lance Formation, along Terry Draw, beginning N. of Fowler Ranch House, in NE 1/4 SE 1/4 sec. 6, T. 54 N., R. 67 W., continuing upstream into the E 1/2, NW 1/4 sec. 13, T. 54 N., R. 68 W., McKean Ranch.
K74-6	Upper part of the lower Lance Formation, along Corral Creek, in the NE 1/4 sec. 35, T. 55 N., R. 68 W., McKean Ranch.
K74-7	Lower Lance Formation, in the upper end of Corral Creek, in the SW 1/4 NE 1/4 sec. 14, T. 54 N., R. 68 W. McKean Ranch.
K74-8	Upper part of lower Lance Formation, along Corral Creek, in the NW 1/4 NW 1/4 sec. 11, T. 54 N., R. 68 W., McKean Ranch.
K74-9	Lower Lance Formation, north of Fowler Ranch House, in NW 1/4 sec. 5, T. 54 N., R. 67 W., north side of Terry Draw.

Table 1.--Localities where data were collected--continued

Loc. No.	Description of locality
K74-10	Lower Lance Formation, north of Fowler Ranch House, along Terry Draw, 200 m upstream from locality K74-9, in the W 1/2 NW 1/4 sec. 5, T. 54 N., R. 67 W.
K74-11	Lower Lance Formation, in road ditch along west side of Buffalo Creek road, about 6.4 km from its junction with U.S. Highway 16, in the NE 1/4 sec. 3, T. 48 N., R. 67 W., Weston County, Wyoming.
K74-12-1	Lower Lance Formation, along Miller Creek on west side of dirt road along the south boundary of the NW 1/4 NW 1/4 sec. 13, T. 15 N., R. 68 W.
K74-12-2	Lower Lance Formation, 1.6 km N. of K74-12-1, on small hill 80 m E. of dirt road in the SE 1/4 NE 1/4 sec. 11, T. 51 N., R. 68 W.
K74-12-3	Upper Fox Hills Formation, west side of ridge in NW 1/4 NW 1/4 sec. 6, T. 51 N., R. 67 W., 150 m east of "D" road.
K74-12-5	Lower Lance Formation, on south side of east-west dirt road in SE 1/4 SW 1/4 sec. 35, T. 52 N., R. 68 W.
K74-12-7	Lower Lance Formation, along Al Creek, at stock pond at the center of the E. line of NE 1/4 sec. 35, T. 52 N., R. 68 W.
K74-12-8	Upper Lance Formation, S. of the Miller Creek road, very near the extreme SE corner sec. 28, T. 52 N., R. 68 W.
K74-13-1	Lowermost Fort Union Formation, at top of a small ridge in the center of N 1/2 NE 1/4 sec. 15, T. 52 N., R. 68 W.
K74-13-2	Uppermost Lance Formation, on Cabin Creek, at the center of NE 1/4 SW 1/4 sec. 11, T. 52 N., R. 68 W.
K74-13-3	Upper Lance Formation in slope south of the Little Missouri River, in the SW 1/4 NW 1/4 sec. 26, T. 53 N., R. 68 W.
K74-13-5	Lower part of upper Lance Formation, along the southwestern end of Oshoto Reservoir, along Little Missouri River, NW 1/4 SW 1/4 sec. 18, T. 53 N., R. 67 W.

Table 1.--Localities where data were collected--continued

Loc. No.	Description of locality
K74-13-7	Lower part of upper Lance Formation in N. bank of Deadman Creek in center W 1/2 sec. 13, T. 53 N., R. 68 W.
K74-13-8	Lower part of lower Lance Formation, just N. of Prairie Creek, in SE 1/4 SE 1/4 sec. 23, T. 55 N., R. 68 W.
K74-14	Series of samples from lower part of Upper Lance Formation, in SW face of hill in center E 1/2 sec. 34, T. 55 N., R. 68 W.
K74-15	Lowermost Lance Formation, 2 samples from 3.5 km airline, E. of Stromer, in the extreme NE corner sec. 15, T. 55 N., R. 68 W.
K74-16-1	Lower part of Upper Lance Formation, at top of small conical hill, in SW 1/4 NW 1/4 SE 1/4 sec. 34, T. 55 N., R. 68 W; about 400 m SW of locality K74-14.

Table 2.--Locations of drill holes shown on electrical-log cross section  
(figs. 1 and 2) in Campbell County, Wyoming

- 
- 1.--United Western Oil & Gas Co., #12-1 Gov't.; center NE 1/4 NE 1/4,  
sec. 12, T. 54 N., R. 70 W.
  - 2.--Jerry Enkich & Associates, Enkich-Gov't. #1 Norfolk; SE 1/4 NW 1/4,  
sec. 11, T. 54 N., R. 71 W.
  - 3.--Powder River Oil Co., T. G. Dorough #1 Federal; SE 1/4 SW 1/4,  
sec. 19, T. 54 N., R. 70 W.
  - 4.--Belco Petroleum Corp., Norfolk #1-23; NE 1/4 SW 1/4, sec. 23, T. 53 N.,  
R. 71 W.
  - 5.--Amerada Petroleum Corp., Amerada State "G" #1; NE 1/4 NW 1/4,  
sec. 36, T. 53 N., R. 71 W.
  - 6.--True Oil Co., Sullivan #1-A; SW 1/4 NW 1/4, sec. 10, T. 52 N.,  
R. 71 W.
  - 7.--Davis Oil Co., Johnson Federal #1; NW 1/4 NE 1/4, sec. 23, T. 52 N.,  
R. 71 W.
  - 8.--Shell Oil Co., Gov't. #31-35; NW 1/4 NE 1/4, sec. 35, T. 52 N.,  
R. 70 W.
  - 9.--True Oil Co., McPherson #1; SE 1/4 SE 1/4, sec. 20, T. 51 N.,  
R. 70 W.
-

SOUTH

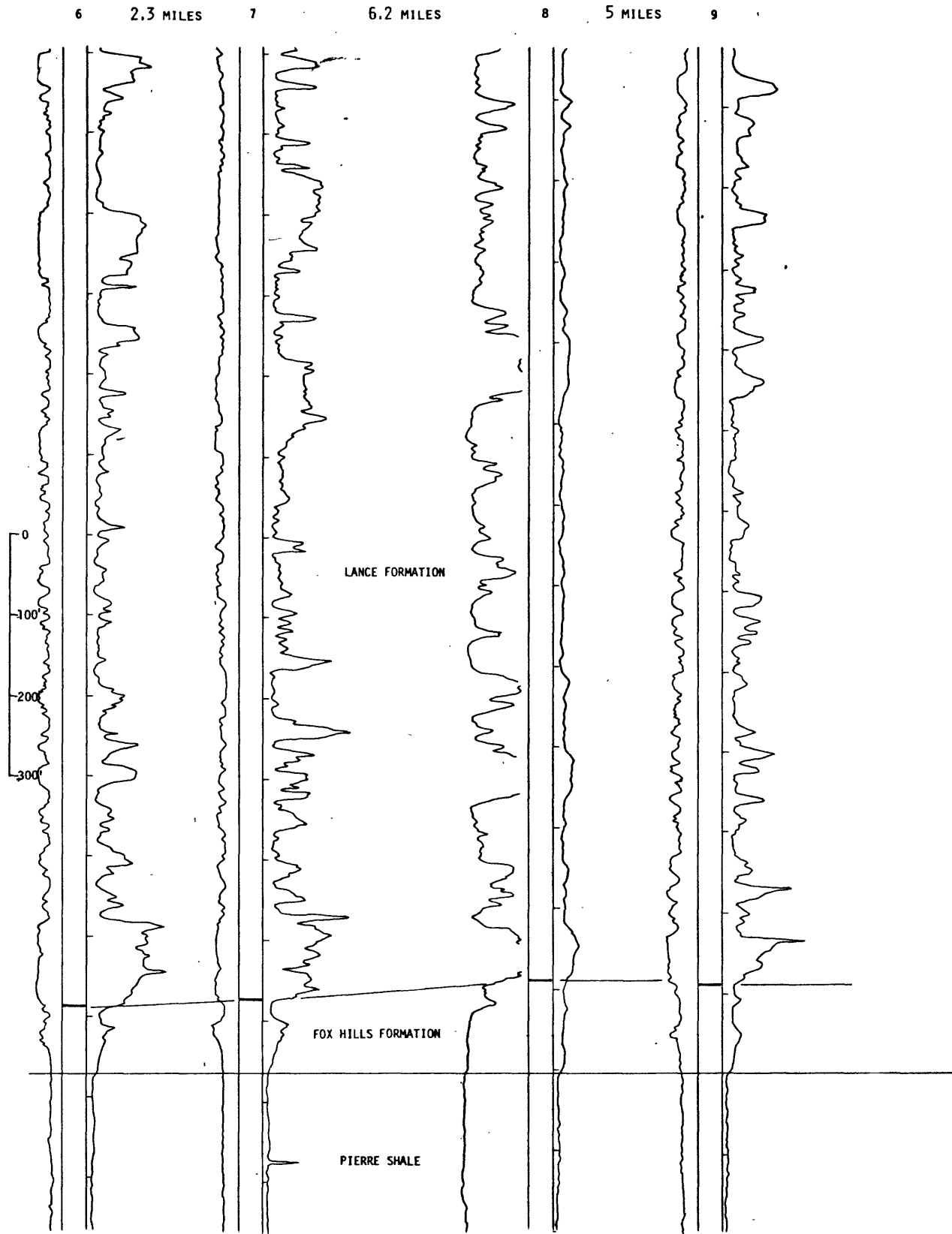


Figure 2.-- Electrical log cross section showing Lance, Fox Hills, and upper Pierre Formations in Campbell County, Wyoming. Datum is base of the Fox Hills Formation. For locations of drill holes, see figure 1.

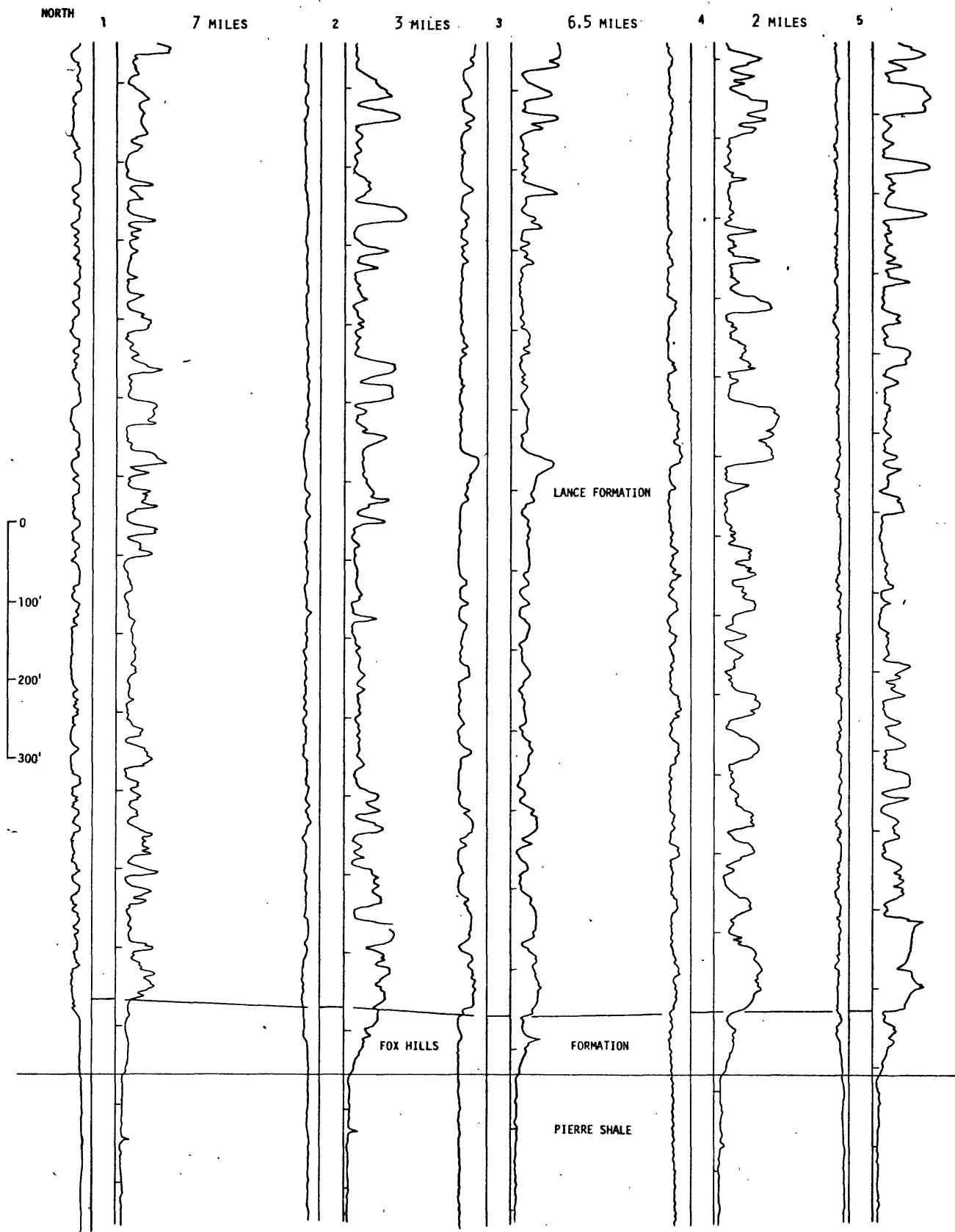


Figure 2. (con't.)

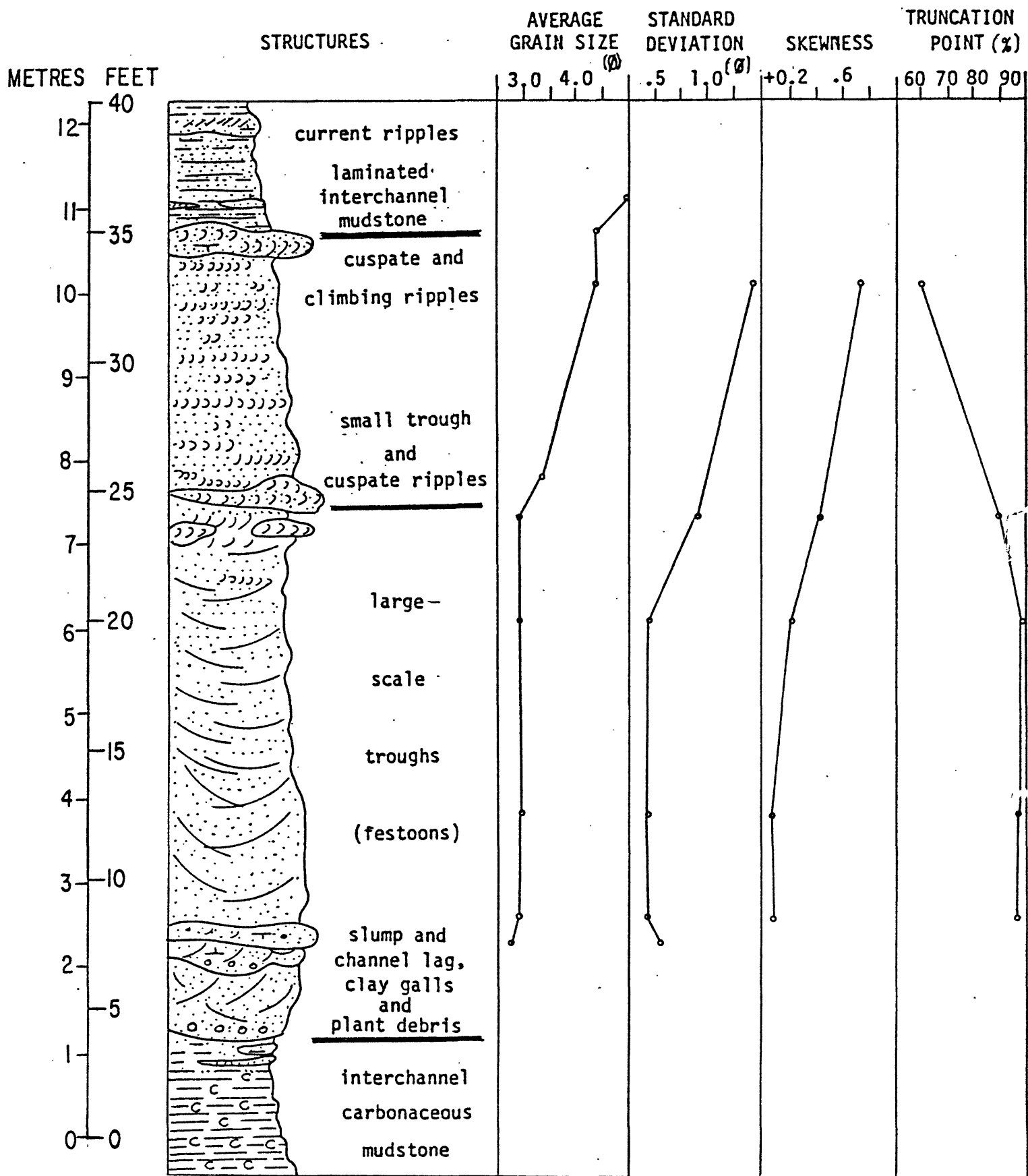


Figure 3.--Structures and textures of Lance channel sandstone, loc. K74-5-6  
Crook County, Wyoming.

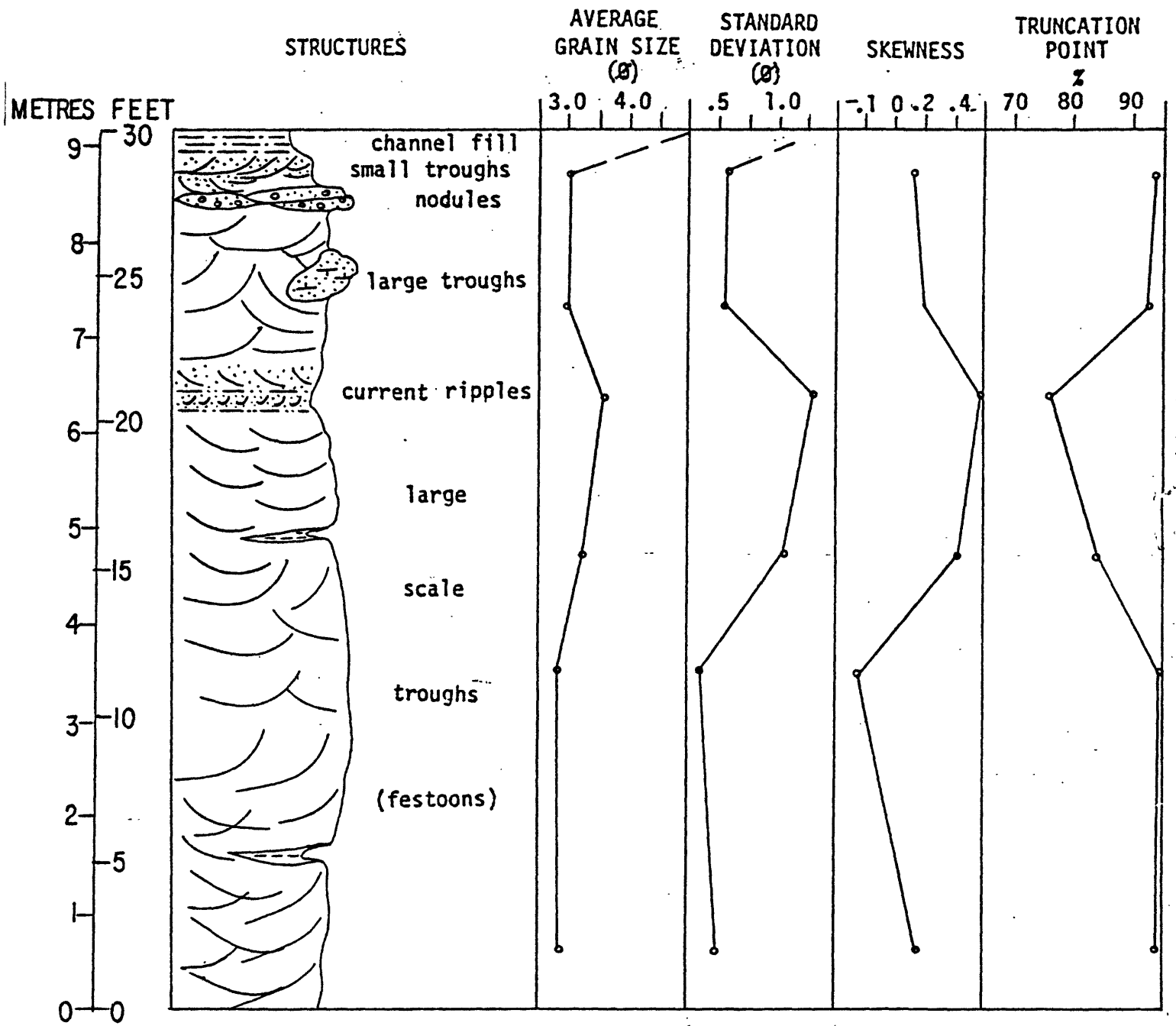


Figure 4.--Structures and textures of Lance channel sandstone, loc. K74-10, Crook County, Wyoming.



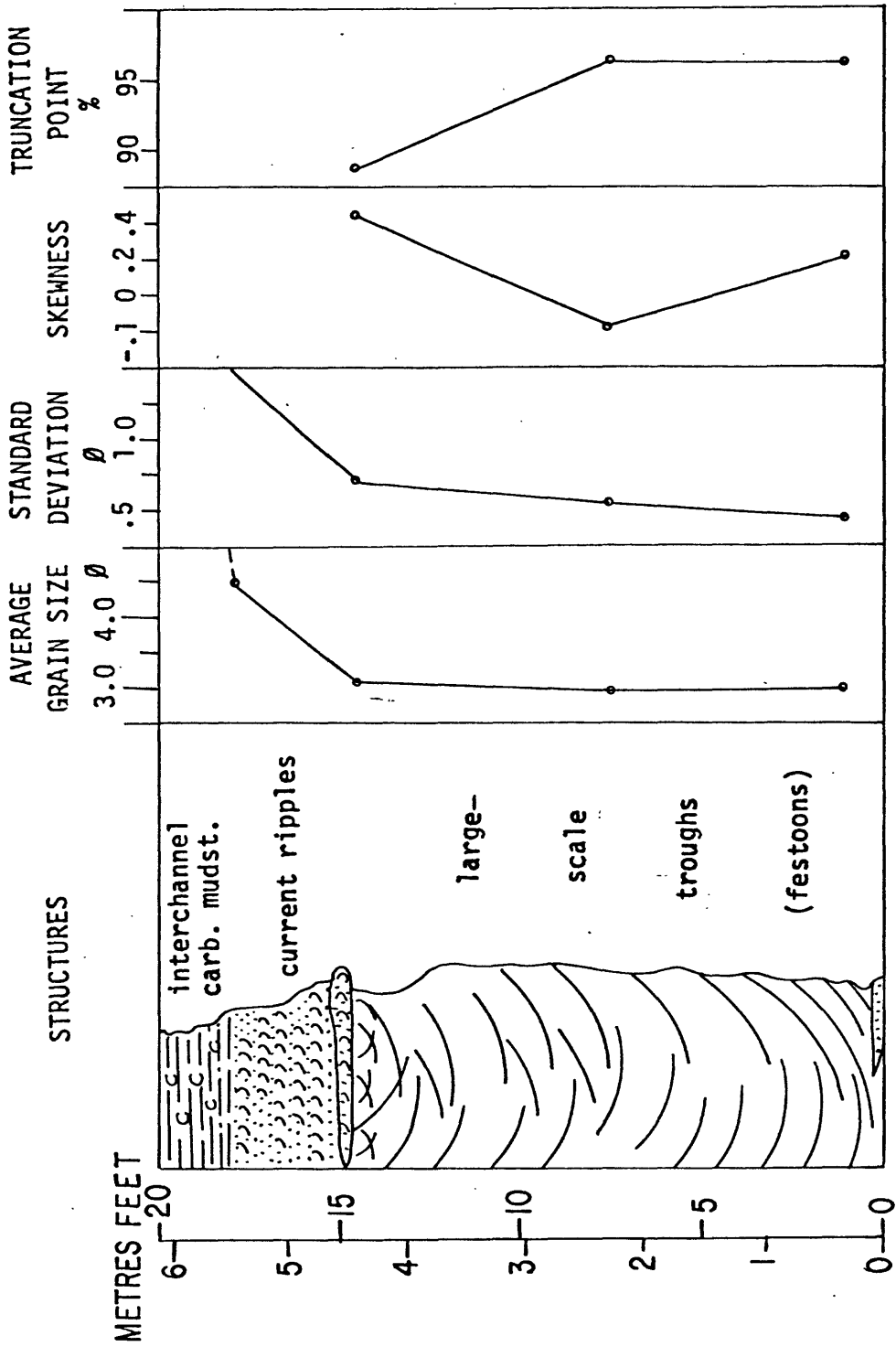
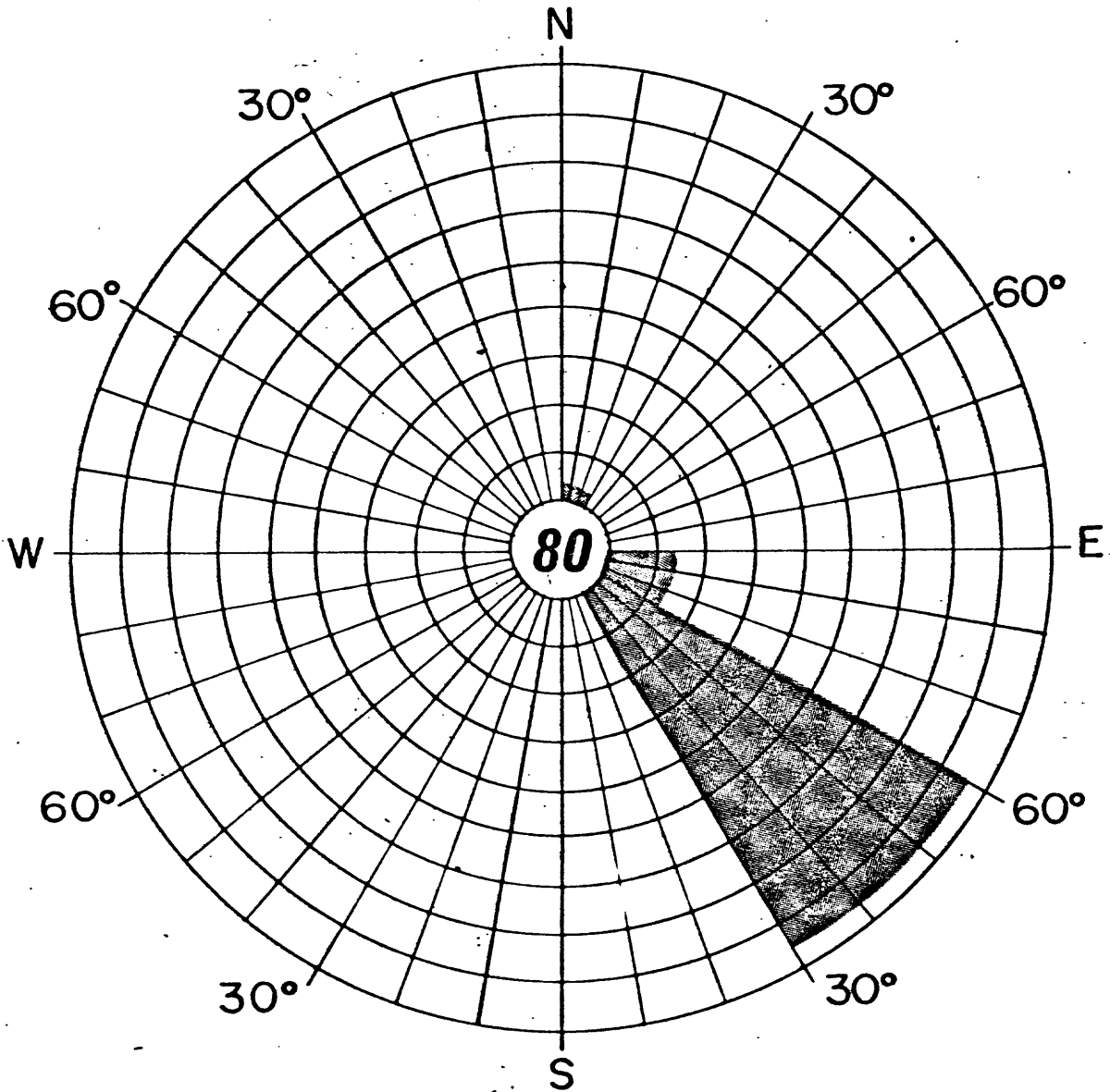
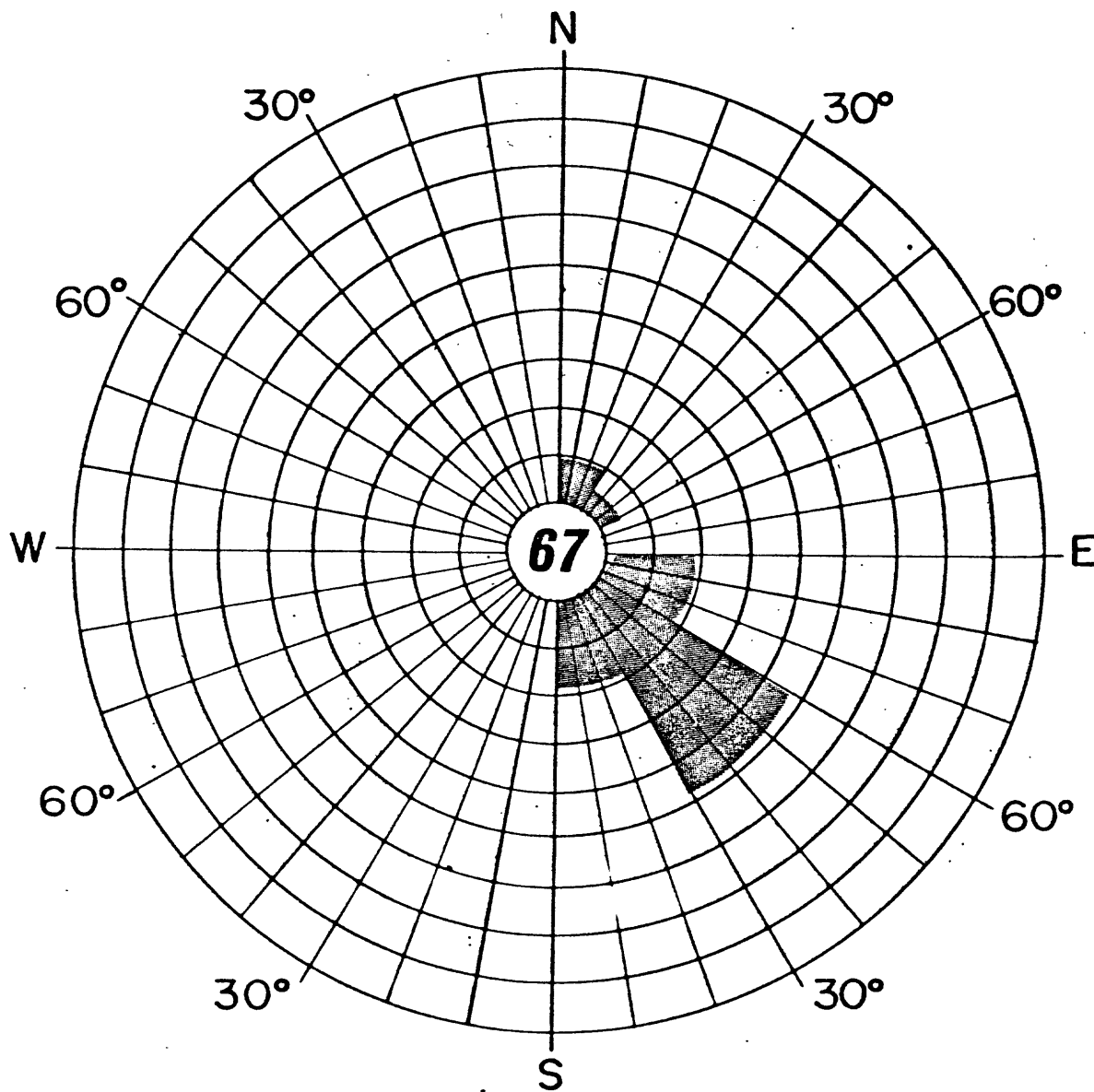


Figure 5.--Structures and textures of Lance channel sandstone, loc. K74-5-1, Crook County, Wyoming.



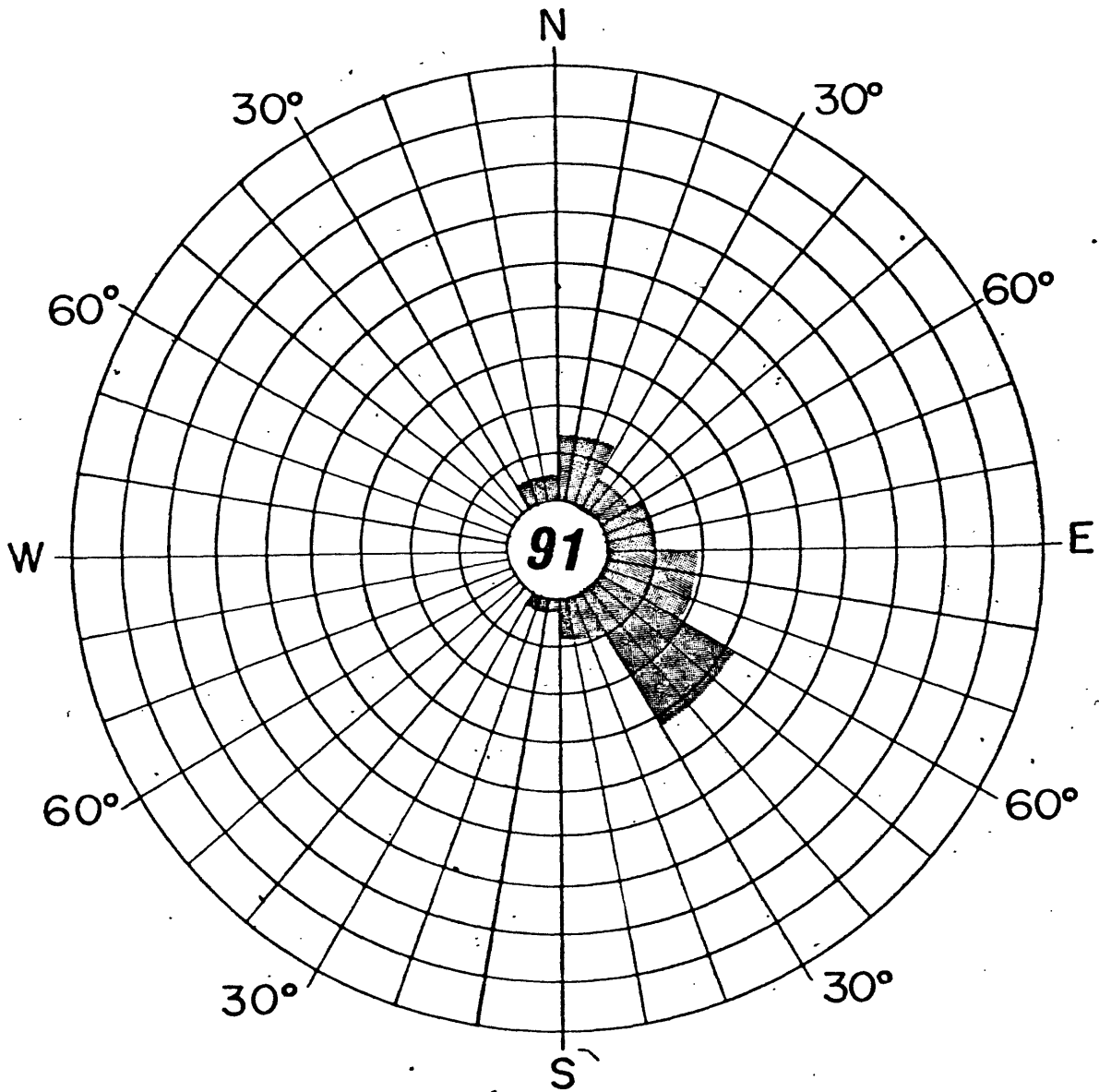
***LOWER LOWER LANCE N.***

Figure 6.--Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



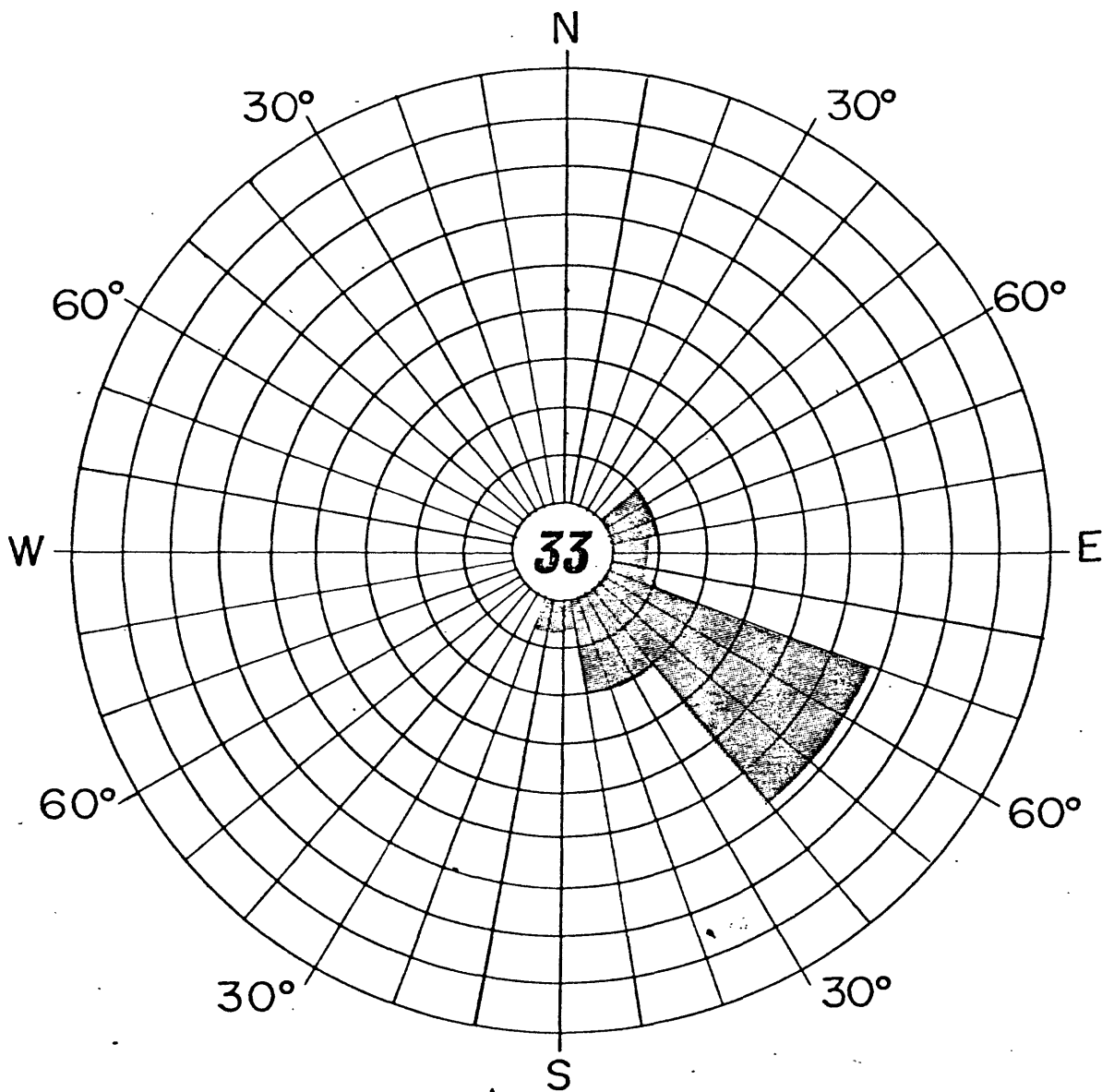
**MIDDLE LOWER LANCE N.**

Figure 7.--Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



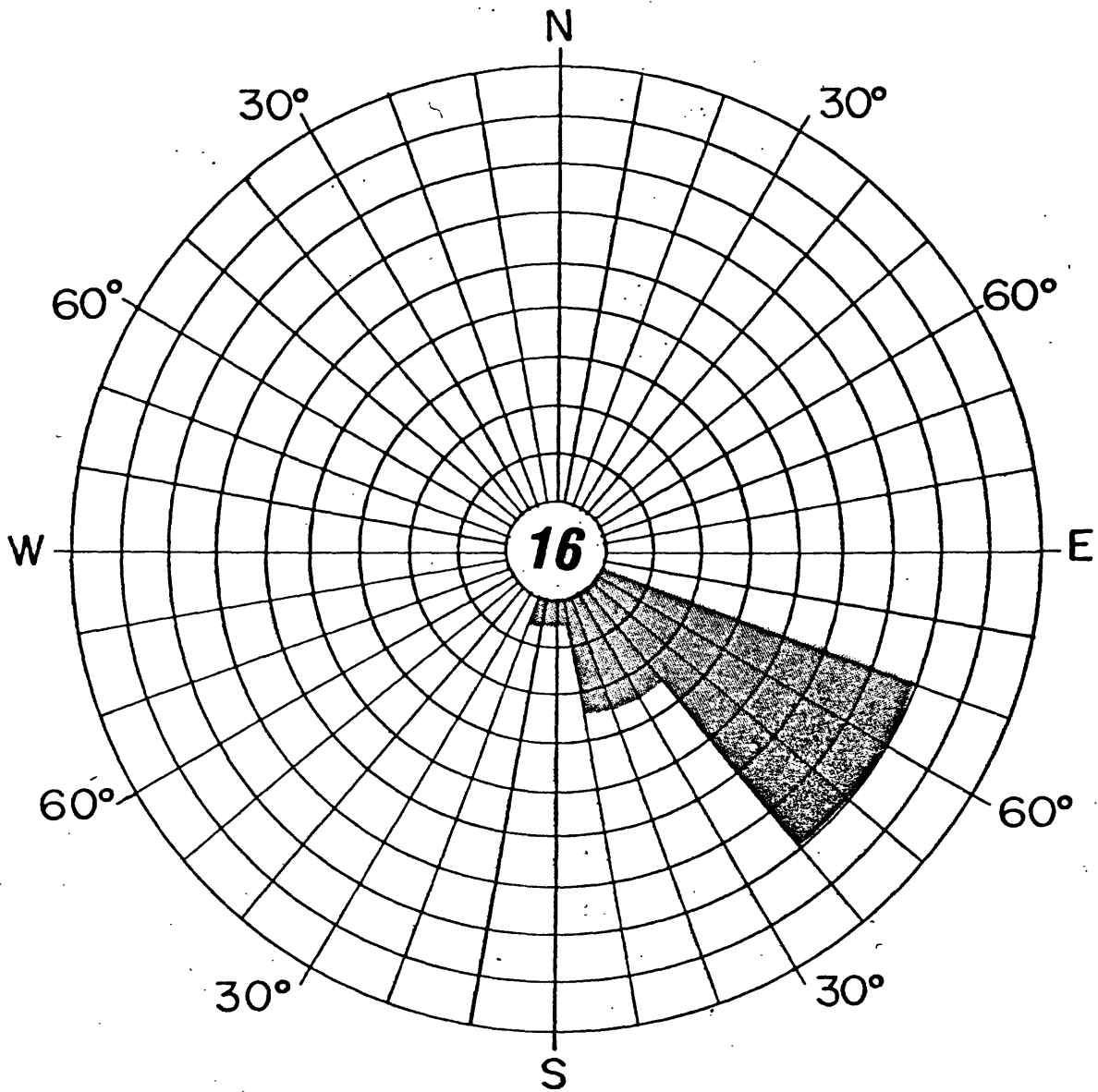
***UPPER LOWER LANCE N.***

Figure 8.--Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



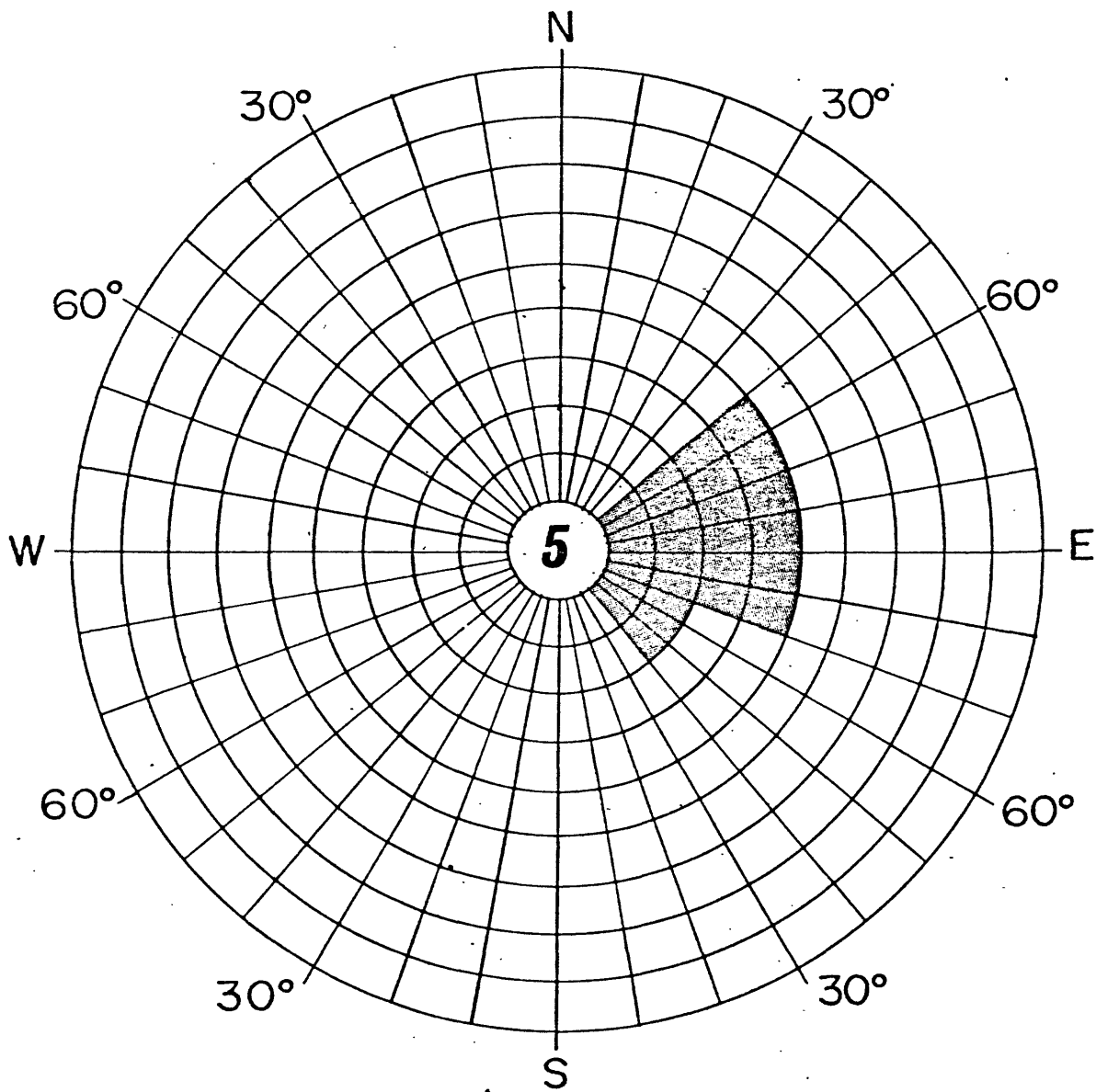
***LOWER UPPER LANCE N.***

Figure 9.--Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



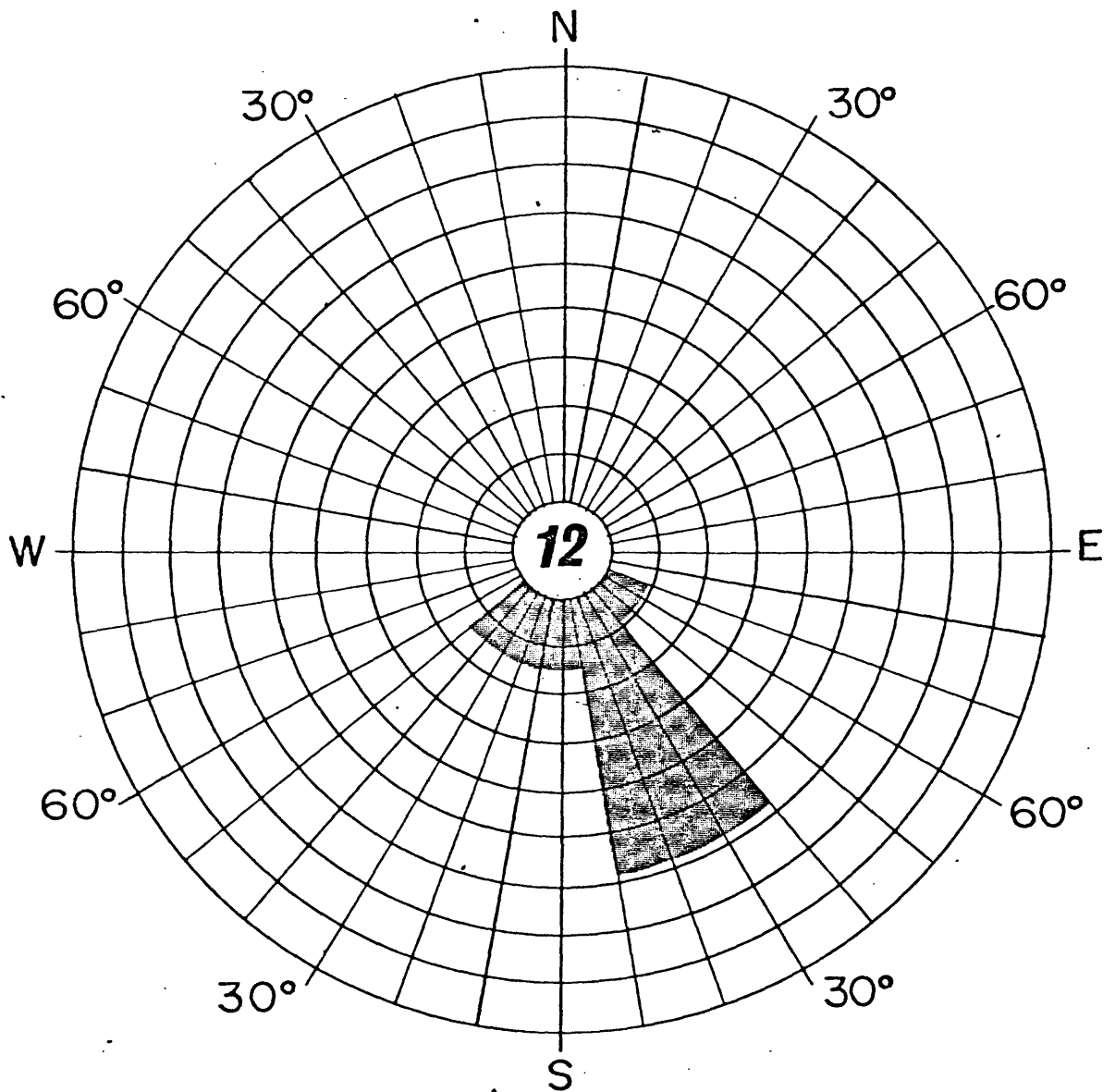
***MIDDLE UPPER LANCE N.***

Figure 10. Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



***UPPER UPPER LANCE N.***

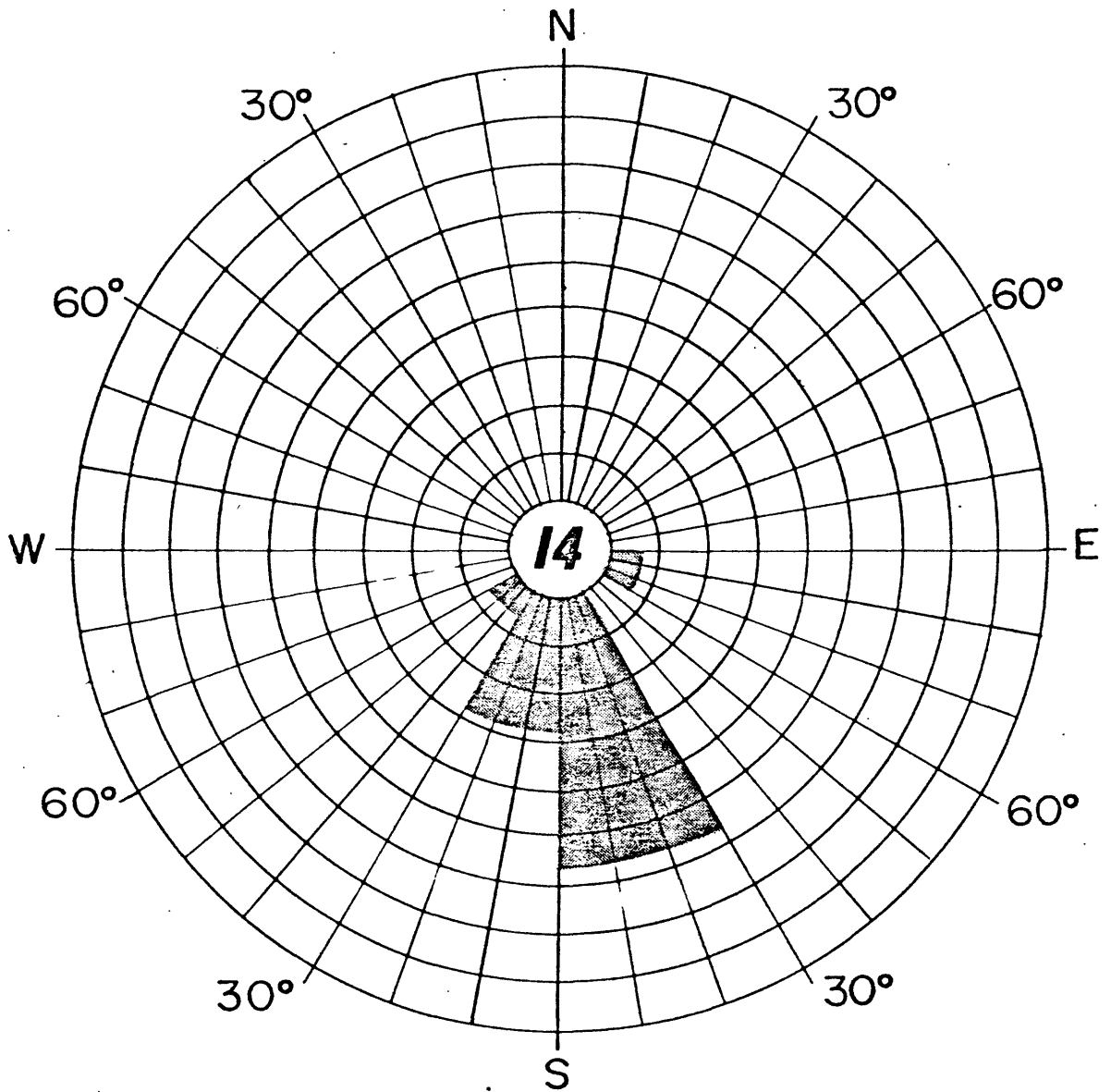
Figure 11.--Diagram showing paleoflow directions in Lance Formation, northern Crook County, Wyoming. Number of measurements shown in center.



***LOWER LANCE S.***

Figure 12.--Diagram showing paleoflow directions in Lance Formation, southern Crook County, Wyoming. Number of measurements shown in center.





***UPPER LANCE S.***

Figure 13.--Diagram showing paleoflow directions in Lance Formation, southern Crook County, Wyoming. Number of measurements shown in center.

Table 3.--Petrographic data from 46 thin sections of sandstones in the Lance Formation, northeastern Wyoming.

[Compositional values are expressed as percentages. SRF = sedimentary rock fragments; MRF = metamorphic rock fragments; VRF = volcanic rock fragments; PRF = plutonic rock fragments; leaders(--) indicate no information]

Loc. No. K-74-	Quartz	Plagioclase		K-Feldspar		Rock fragments					Micas		Average maximum grain size (mm)	Sorting $\sigma_1 \phi$	Remarks	
		Altered	Fresh	Altered	Fresh	Chert	Meta-quartzite	SRF	MRF	VRF	PRF	Muscovite				Biotite
1-3	56	3	4	2	3	11	3	14	--	--	--	--	1	----	+3 percent interstitial clay.	
2-2	37	--	2	11	2	7	8	25	1	3	3	1	--	----	Trace fresh hornblende.	
4	62	2	2	2	1	7	1	17	5	--	--	1	0.145	0.467	4 percent authigenic chlorite in cement.	
5-1	54	--	--	7	4	5	--	25	2	--	--	--	2	0.170	0.511	1 percent heavy minerals.
5-3	48	--	--	6	6	5	6	13	10	4	--	--	2	----	Chloritized rock fragments.	
5-6a	49	--	4	6	--	8	3	17	10	2	1	--	0.195	0.592	Plagioclase very large (0.4 mm).	
5-6d	51	--	4	7	--	3	5	21	4	1	1	2	0.118	0.656	1 percent hornblende, plagioclase very fresh.	
5-8	52	2	8	4	--	6	5	16	4	--	1	--	0.155	0.744	1 percent organic grains; dumortierite.	
7-4d	56	3	5	11	--	4	2	12	3	--	--	1	0.112	0.579	2 percent heavy minerals.	
7-6	57	--	2	9	--	7	1	13	7	--	--	--	3	0.175	0.711	1 percent FeO grains; altered biotite.
7-7-2	54	1	2	7	1	7	2	14	7	--	1	2	0.190	0.587	1 percent heavy minerals.	
7-12	58	4	2	12	--	6	4	8	--	2	2	2	----	----	Heavy outcrop weathering.	
8	22	7	1	18	--	6	3	26	3	5	3	2	0.270	0.820	Possibly freshwater algal structures, 6 percent.	
8-1c	32	2	2	12	2	8	8	20	6	6	2	--	2	0.300	0.567	Trace fresh hornblende; sausseritized feldspar.
8-2b	33	5	4	9	1	11	9	17	5	4	2	1	0.380	1.004	Sausseritized feldspars.	
8-3a	25	1	8	18	2	10	15	15	2	2	--	1	----	----	FeO + calcite-cemented nodule (algal?).	
8-5	10	--	--	--	--	--	--	5	--	--	--	--	----	----	Carbonate nodule (algal?).	
8-6c	26	--	4	14	6	2	4	24	12	--	2	2	0.137	0.802	Biotite altered to limonite.	
8-7c	33	2	2	18	6	4	2	22	4	2	--	--	3	0.182	0.873	Zoned feldspar, chloritized volcanic rock fragments; hornblende 2 percent.
8-8b	40	--	1	20	--	4	10	10	8	--	4	--	3	0.130	0.987	Biotite altered to limonite, weathered.
9e	54	--	2	12	4	4	6	8	4	--	4	--	3	0.130	0.554	Biotite altered to limonite, weathered.
10e	60	--	--	7	4	8	4	8	8	--	--	2	0.138	0.539	Biotite altered to limonite, weathered.	
10g	50	--	3	11	6	3	--	14	4	--	2	2	0.125	0.529	Biotite altered to limonite, weathered.	
11b	61	--	2	18	5	--	--	8	2	2	--	--	0.081	0.883	Terrig. clay in matrix (5 percent).	
11i	40	--	4	12	2	8	--	20	4	--	6	--	2	0.177	0.411	2 percent hematite grains.
12-1	60	--	2	11	--	2	5	10	4	--	2	1	----	----	Much composite stained quartz.	
12-2	48	4	2	14	6	6	4	6	2	2	6	1	0.160	0.910	Rounded feldspar.	
12-3	58	--	6	14	4	--	2	10	6	--	--	--	0.100	0.600	Minor chaledonic cement.	
12-5	54	4	--	14	3	2	--	12	2	--	10	--	1	0.140	0.480	Plutonic rock fragments altered; 20 percent elongate quartz.
12-7	70	--	2	10	2	4	--	4	--	--	8	--	0.130	0.410	20 percent elongate quartz.	
12-8	56	--	2	16	2	4	2	10	2	--	6	--	0.170	0.765	Much angular quartz.	
13-2	40	--	3	12	2	2	8	12	12	--	6	3	0.142	0.444	Minor clay matrix.	
13-3	64	--	2	8	--	5	--	12	6	--	2	--	0.140	0.520	Minor clay matrix.	
13-5	51	6	4	12	2	4	2	10	4	--	4	--	0.163	0.364	Angular and round feldspars.	
13-7	55	--	4	10	4	2	6	3	4	2	8	--	2	0.147	0.470	Fresh, angular microcline.
13-8	40	3	4	6	5	8	8	2	6	6	14	2	0.177	0.340	1 percent fresh hornblende.	
14-1	46	2	2	20	--	6	4	6	3	--	6	2	0.188	0.540	1 percent heavy minerals.	
14-2	64	--	6	14	--	2	4	2	--	--	8	--	0.133	0.550	Minor clay matrix.	
14-3B	48	--	2	16	6	4	2	8	6	--	6	1	0.167	0.780	Large twinned Kspar; perthite.	
14-4	56	--	2	12	2	4	8	6	--	--	10	--	0.140	0.540		
14-5	60	--	2	6	2	--	6	14	6	--	3	1	0.142	0.770	Minor clay matrix.	
14-6	51	--	2	16	2	6	8	8	2	2	2	--	0.124	0.800	Large, elongate chert.	
14-7	58	--	2	12	2	6	6	8	4	--	2	--	0.096	1.080	5 percent clay matrix.	
15-1B	55	--	2	11	2	4	4	7	2	6	6	1	0.121	0.445	Fresh plutonic rock fragments, porphyry.	
15-2A	52	--	--	8	4	2	4	12	2	8	8	--	0.153	0.780	Fresh plutonic rock fragments and hornblende.	
16-1	70	2	--	14	4	4	2	2	--	--	2	--	0.073	1.11	Very fine grained, no clay.	

Table 4.--Sieve analysis data--Sandstones in the Lance Formation,  
Crook County, Wyoming

Sample No.	Weight-percent sand held on sieve size ( $\phi$ )											
	-0.5	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5-8.0	>8.0
K74-2a				0.04	0.3	2.0	13.2	59.6	20.1	2.0	2.08	0.52
K74-2b		0.01	0.01	0.02	0.4	15.1	41.0	33.8	6.6	1.1	1.18	0.67
K74-2c	0.02	0.06	0.05	0.09	1.1	26.9	40.9	24.2	4.4	0.1	0.87	0.43
K74-2d			0.01	0.03	0.28	4.95	30.90	48.24	12.07	1.72	1.35	0.43
K74-2-1		0.02	0.03	0.04	1.1	27.9	46.7	18.6	3.7	0.8	0.80	0.39
K74-3						0.01	0.22	3.36	37.31	36.00	19.93	3.15
K74-5-1a					0.04	0.45	9.93	55.79	25.18	4.68	2.46	0.87
K74-5-1b				0.20	1.81	5.67	10.94	43.3	30.22	5.20	2.15	0.49
K74-5-1c			0.01	0.03	0.08	0.29	6.38	39.80	34.98	9.09	7.45	0.69
K74-5-3a				0.01	0.11	1.27	24.18	43.68	22.39	3.33	2.82	2.19
K74-5-3b				0.01	0.01	0.08	2.45	28.56	40.2	11.37	11.19	6.14
K74-5-5b				0.01	0.14	12.52	60.68	12.33	5.57	2.59	3.58	2.59
K74-5-6a			0.03	0.11	0.48	5.53	30.49	44.92	13.17	2.04	2.28	0.96
K74-5-6b			0.01	0.07	0.53	4.55	26.17	49.43	15.19	1.91	1.61	0.55
K74-5-6c			0.02	0.04	0.41	4.02	34.93	40.93	14.89	2.19	1.73	0.84
K74-5-6d			0.03	0.10	0.49	1.32	9.63	37.94	33.54	7.73	6.20	3.02
K74-5-6e			0.01	0.02	0.10	1.00	1.55	3.93	20.67	33.16	35.48	4.09
K74-5-7			0.01	0.02	0.24	6.68	26.61	30.57	22.76	6.16	5.23	1.71
K74-7-5				0.01	0.03	0.37	11.29	55.09	26.59	4.21	1.75	0.65
K74-7-7-1				0.06	0.28	7.22	18.76	49.36	18.28	6.60	2.12	1.32
K74-7-8				0.11	0.58	2.12	7.78	21.92	39.78	15.58	9.53	2.60
K74-8-7b			0.01	0.07	3.05	36.00	41.72	12.61	3.11	0.84	0.86	1.69
K74-8-8a		0.01	0.01	0.08	1.79	21.38	40.72	26.49	4.01	0.95	2.47	2.08
K74-9a				0.01	0.08	2.50	25.97	50.30	14.23	2.83	2.09	1.18
K74-9b				0.02	0.51	7.31	24.81	50.56	11.83	2.18	1.87	0.91
K74-9c				0.01	0.08	1.82	25.10	49.82	16.43	3.15	2.77	0.82
K74-9d					0.03	0.62	10.99	42.70	33.13	8.12	2.98	1.42
K74-10a				0.04	0.06	3.44	19.66	51.19	17.28	3.28	3.92	1.13
K74-10b				0.02	0.08	4.08	31.19	52.23	7.66	1.81	2.12	0.80
K74-10c				0.01	0.03	1.25	9.76	26.11	37.19	10.76	11.21	3.68
K74-10d		0.08	0.04	0.03	0.04	1.35	9.41	19.02	35.00	14.65	16.80	3.57
K74-11				0.01	1.15	1.66	15.91	38.57	26.64	5.61	6.37	4.09
K74-11d			0.04	0.91	7.23	11.96	27.90	28.74	11.15	3.80	4.15	4.12
K74-11e			0.05	0.73	4.13	6.69	23.68	32.54	13.82	4.92	7.71	5.72
K74-11f			0.01	0.01	4.90	6.82	20.67	44.45	15.84	2.39	3.18	1.72
K74-11h			0.02	0.08	0.08	4.63	4.83	8.93	37.73	20.55	17.69	5.47
K74-F			0.01	0.02	0.11	0.54	1.84	9.27	64.77	9.64	8.33	5.48

#### Reference

Robinson, C. S., Mapel, W. J., and Bergendahl, M. H., 1964, Stratigraphy and structure of the northern and western flanks of the Black Hills uplift, Wyoming, Montana, and South Dakota: U.S. Geol. Survey Prof. Paper 404, 134 p.

## Appendix

### Palynological evaluation of some Fort Union and Lance Formation samples from Crook and Weston Counties, Wyoming

By

Bernadine D. Tschudy

Seven samples were submitted for palynological evaluation. All were productive and were given USGS paleobotany locality numbers as follows:

<u>Sample No.</u>	<u>Locality</u>	<u>USGS paleobotany loc. no.</u>
K74-1	SE 1/4 sec. 7, T. 54 N., R. 67 W., Crook County, Wyo.	D5190
K74-2	SW 1/4 sec. 7, T. 54 N., R. 67 W. Crook County, Wyo.	D5191
K74-5a	SE 1/4 sec. 1, T. 54 N., R. 68 W., Crook County, Wyo.	D5192
K74-7-16	NW 1/4 sec. 16, T. 54 N., R. 68 W., Crook County, Wyo.	D5193
K74-10f	NW 1/4 sec. 5, T. 54 N., R. 67 W., Crook County, Wyo.	D5194-A
K74-10h	NW 1/4 sec. 5, T. 54 N., R. 67 W., Crook County, Wyo.	D5194-B
K74-11g	C sec. 3, T. 48 N., R. 67 W., Weston County, Wyo.	D5195

The specimens identified from these seven samples are shown below:

Formation	Lower Fort Union	Lower Lance	Lower Lance	Lower Lance	Lower Lance	Lower Lance
Sample No.	K74-7-16	K74-1	K74-2	K74-5a	K74-10f	K74-10h
USGS paleobotany loc. no.	D5193	D5190	D5191	D5192	D5194-A	D5194-B
Taxa:						
Deltoideospora	X					
Cyathidites	X	X	X	X	X	
Laevigatosporites	X	X	X	X	X	X
cf. 0-p26	X					
S1-sm 6	X					
Liliacidites	X			X	X	
Arecipites Columellus	X					
Ovoidites Ligneolus	X			X		
Schizosporis Parvus	X					
Kurtzipites	X		X	X	X	X
Tricolpites Hians	X	X	X	X	X	X
Tricolpites	X				X	
Anguloluminosus						
C3 syn-sm	X					
Pandaniidites	X					X
Carpinus Subtriangula	X	X	X			X

The specimens identified from these seven samples are shown below:--Continued

Formation-----	Lower Fort Union	Lower Lance	Lower Lance	Lower Lance	Lower Lance	Lower Lance
Sample No.-----	K74-7-16	K74-1	K74-2	K74-5a	K74-10f	K74-10h
USGS paleobotany-----	D5193	D5190	D5191	D5192	D5194-A	D5194-B
Loc. no.						
Taxa:						
P3-sm	X				X	
P3-rt plus P3-r	X					X
Alnipollenites	X	X	X	X	X	X
Ulmipollenites	X			X	X	X
cf Lecaniella	X			X	X	X
cf Nevesisporites		X				
Osmundacidites		X		X		
Leptolepidites		X	X			
Stereisporites		X				
Gleicheniidites		X			X	
Polycingulatisporites		X		X		
Balmeisporites		X	X	X	X	X
TT - sm TC-sm & TO-sm		X	X	X	X	X

The specimens identified from these seven samples are shown below:--Continued

Formation-----	Lower Fort Union	Lower Lance	Lower Lance	Lower Lance	Lower Lance	Lower Lance
Sample No.-----	K74-7-16	K74-1	K74-2	K74-5a	K74-10f	K74-10h
USGS paleobotany	-----D5193	D5190	D5191	D5192	D5194-A	D5194-B
Loc. no.						
Taxa:						
<i>Liliacidites dividius</i>	X			X		
S1-sm	X					X
<i>Abietinapollenites</i>	X	X	X		X	X
<i>Aquilapollenites</i>	X	X	X		X	X
<i>Quadrilobus</i>						
<i>Aquilapollenites</i>	X			X		X
<i>Attenuatus</i>						
cf <i>Aquilapollenites</i>	X					
<i>Argutus</i>						
<i>Aquilapollenites</i>	X			X	X	X
<i>Delicatus</i>						
<i>Proteacidites</i>	X	X	X	X	X	X
<i>Erdtmanipollis</i>	X			X	X	X
cf <i>Zlivisporis</i>		X	X	X	X	
<i>Kuylisporites</i>		X				
T0-rt & TT-P		X	X	X		
<i>Liliacidites complexus</i>		X	X	X		X



The specimens identified from these seven samples are shown below:--Continued

Formation-----	Lower Fort Union	Lower Lance	Lower Lance	Lower Lance	Lower Lance	Lower Lance
Sample No.-----	K74-7-16	K74-1	K74-2	K74-5a	K74-10f	K74-11g
USGS paleobotany-----	D5193	D5190	D5191	D5192	D5194-A	D5195
loc. no.						
Taxa:						
Inaperturotetradiates		X			X	
cf. I. Scabratus						
Tricolpites reticulatus		X	X	X	X	X
Cranwellia		X	X	X		X
Wodehouseia		X	X	X	X	X
Taxodiaceapollenites		X			X	
Aquilapollenites reticulatus		X	X	X	X	X
Aquilapollenites		X			X	X
Catenireticulatus						
cf C3P-13		X		X		
cf Pulcheripollenites		X				X
Azolla massula		X		X		
Undulatisporites				X		X
Hannisporis				X		
T0-sm 29				X		
cf Lycopodiumsporites				X		
Facetus						

The specimens identified from these seven samples are shown below:--Continued

Formation-----	Lower Fort Union	Lower Lance	Lower Lance	Lower Lance	Lower Lance	Lower Lance
Sample No.-----	K74-7-16	K74-2	K74-5a	K74-10f	K74-10h	K74-11g
USGS paleobotany loc. no.	D5193	D5191	D5192	D5194-A	D5194-B	D5195
Taxa:						
TC-sm 4			X			
Aquilapollenites senonicus			X			
Aquilapollenites bertillonites			X			
Aquilapollenites reductus			X			
Aquilapollenites conatus			X			X