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CLIFFS MINERALS, INC.
EASTERN GAS SHALES PROJECT
ILLINOIS #1 - EFFINGHAM COUNTY

PHASE III REPORT
MECHANICAL CHARACTERIZATION RESULTS
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Prepared by

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MECHANICAL CHARACTERIZATION RESULTS

The purpose of mechanical characterization of samples from the EGSP-Illinois #1 core is to determine the direction of preferred planes of weakness in the Devonian gas shales at the Effingham County well site.

A series of samples, representing one hundred feet of core taken from the Illinois #1 well, were tested by other contractors through MERC in Morgantown, West Virginia. The raw lab data was interpreted and put into report form by the Rock Mechanics Research Facility at Michigan Technological University, Houghton, Michigan. The tested core intervals extend from 3,005 feet to 3,105 feet below surface. The lithological depth intervals were not available for this core.

The physical property tests employed were directional ultrasonic velocity measurements, point load induced fracturing and directional tensile strength testing. Table 1 is a summary of the mechanical property testing results.

TABLE 1

EGSP-Illinois #1
Effingham County

Frequency Distribution of Preferred Direction of Fracturing

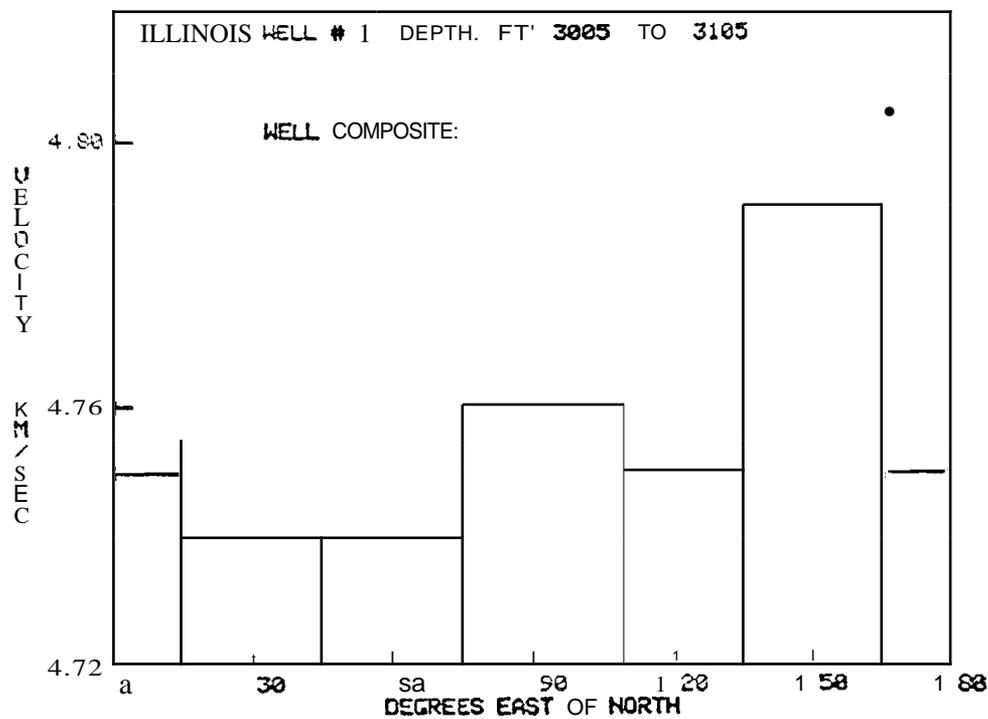
Orientation in Degrees East of North

Test							<u>Total</u>
Velocity*						X	6
Point Load	5	5	5	6	1	4	26
DTS*	X						44

* Preferred direction of fracturing determined from calculated averages.

In ultrasonic velocity testing, minimum velocity values are assumed to be perpendicular to the preferred direction of fracturing because large numbers of microcracks encountered along this direction will impede propagation of the sonic wave. Ultrasonic velocity measurements indicate N1500E+15° as the preferred direction in the six velocity samples. Figure 1 is a histogram of average velocities. Calculated velocity results are presented in Table 2.

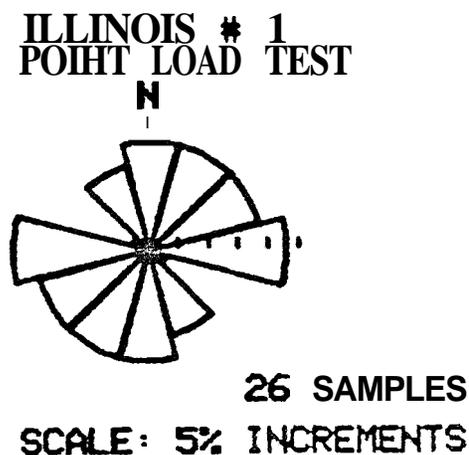
FIGURE 1
Histogram of Velocity Results



In point load testing, fractures induced by applying a point load to the central axis of a disc are assumed to propagate parallel to the preferred direction of fracturing. Point load induced fractures do not indicate a statistically significant preferred direction of fracturing in the 26 induced fractures. Figure 2 illustrates the frequency distribution rose diagram of preferred direction of fracturing as indicated by point load induced fracturing. Individual point load results are presented in Table 3 and Table 4.

FIGURE 2

Frequency Distribution Rose Diagram of Point Load Results



In directional tensile strength testing, compressive loads are applied across the diameter of the specimen in order to induce diametrical fractures and thus determine tensile strength normal to the loading axis. Samples from a given interval are tested with the loading axis in six different orientations by this method. The preferred direction of fracture will be parallel to the loading axis in the specimen for which the lowest tensile strength value was obtained. The 44 directional tensile strength measurements indicate $N00E+15^\circ$ as the preferred plane of weakness in this well. Figure 3 is a histogram of average directional tensile strength on the given load axis. Calculated tensile strengths are presented in Table 5.

FIGURE 3

Histogram of Directional Tensile Strengths

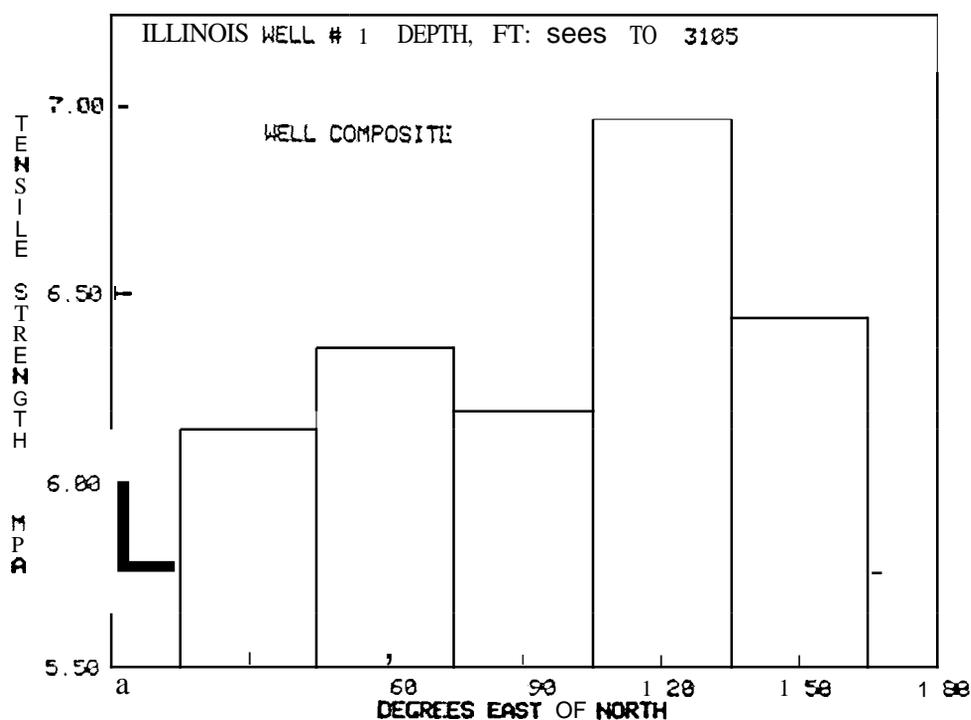


TABLE 2

EGSP-Illinois #1
Effingham County

Directional P Wave Velocities
Average Velocities in km/sec and Orientation

Depth	Degrees East of North					
	0°	30°	60°	90°	120°	150°
3,006'	5.72	5.75	5.72	5.69	5.69	5.72
3,042'	4.46	4.48	4.48	4.48	4.48	4.46
3,054'	4.41	4.41	4.41	4.43	4.41	4.41
3,066'	4.46	4.46	4.46	4.48	4.48	
3,102'	5.18	5.15	5.15	5.20	5.20	5.20
3,105'	4.24	4.21	4.22	4.27	4.21	4.17
Average	4.75	4.74	4.74*	4.76	4.75	4.79

* Minimum velocity

TABLE 3

EGSP-Illinois #1
Effingham CountyFrequency of Fractures Induced by Point Load
Depth is Midpoint of 10 ft. Interval

<u>Depth</u>	Orientation in Degrees East of North						<u>Total</u>
	0°	30°	60°	90°	120°	150°	
3,008'	0	1	1	0	0	0	2
3,015'	0	1	0	2	0	2	5
3,045'	2	1	0	1	0	0	4
3,053'	0	0	0	0	0	1	1
3,065'	1	1	3	3	1	0	9
3,073'	1	0	0	0	0	0	1
3,096'	0	1	0	0	0	0	1
3,104'	1	0	1	0	0	1	3
Total	5	5	5	6	1	4	26

TABLE 4

EGSP-Illinois #1
Effingham CountyPoint Load Index = load/T^2

<u>Depth</u>	MFa						
3,008'	6.42	7.57	6.64				
3,015'	1.83	3.79	2.9	2.3	2.31	1.09	2.7
3,045'	1.83	3.3					
3,053'	1.69						
3,065'	2.83	1.63	1.12	1.65	4.12	2.54	2.02
	2.23	3.68					1.84
3,073'	1.98						
3,096'	4.57	3.42	3.20	2.85	3.77	8.83	7.48
	6.77	7.83	5.83				

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