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SEEP AND SPRING INVENTORY OF THE NEICO STATE LANDS COAL LEASES (ML-21568 AND 21589) AND ADJACENT AREAS

Prepared for

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SEEP AND SPRING INVENTORY OF THE NEICO STATE LANDS COAL LEASES (ML-21568 AND 21589) AND ADJACENT AREAS

1.0 INTRODUCTION

Nevada Electric Investment Company (NEICO) has the rights to coal leases on land owned by the State of Utah in Sec. 36, T. 15 S., R. 6 E. and Sec. 2, T. 16 S., R. 6 E., SLBM. One of the steps necessary to obtaining a permit for a mining operation is delineation of the existing hydrologic resources. These resources must be defined not only within the permit area, but must also within the area adjacent to the proposed permit boundary.

In July and October, 1987 and again in October and November, 1989, field investigations were conducted by EarthFax Engineering, Inc. of Salt Lake City, Utah to identify the location and characteristics of all seeps and springs within the coal lease and adjacent areas. This report presents the results of these inventories as well as an interpretation of the data collected therefrom.

The remainder of this report is divided into three additional sections. Section 2.0 discusses the methods used during the inventory, followed by a presentation and discussion of the results in Section 3.0. Section 4.0 provides a list of references cited in the report.

2.0 METHODS

For the purpose of this investigation, the boundary of the study area was selected to be approximately one mile from the edge of the coal lease (see Figure 1). The study area extended from Horse Canyon on the north to Mill Canyon on the south and from Bald Ridge on the west to a distance of approximately one mile from the lease boundary on the east.

A literature search was conducted prior to conducting the field work to provide general information on the descriptions and locations of the major geologic units. In addition, data collected from previous seep and spring surveys conducted in 1985 for the Crandall Canyon Mine of Genwal Coal Company were utilized in developing the pre-investigation baseline data. The study area was then traversed on horseback and on foot to allow springs and seepage points to be precisely located, examined, and sampled.

Geologic conditions at all seeps and springs were noted in the field, including lithologic and structural controls and the geologic formation from which the seepage issued. Signs of usage were also noted. The flow was measured if under five gallons per minute and visually estimated if greater than five gallons per minute. A sample of the water was collected (if sufficient water was present) and the temperature of the water issuing from the spring was measured at the site. All samples were analyzed in the field for pH and specific conductance.

Due to the steep, often inaccessible, and sometimes heavily vegetated nature of the study area, it is possible that a limited number of seeps and springs at the site were not found during the inventory. In several cases, areas which appeared to produce water a few months during the year were dry during the inventories. However, the seeps and springs that were found are considered representative of local conditions.

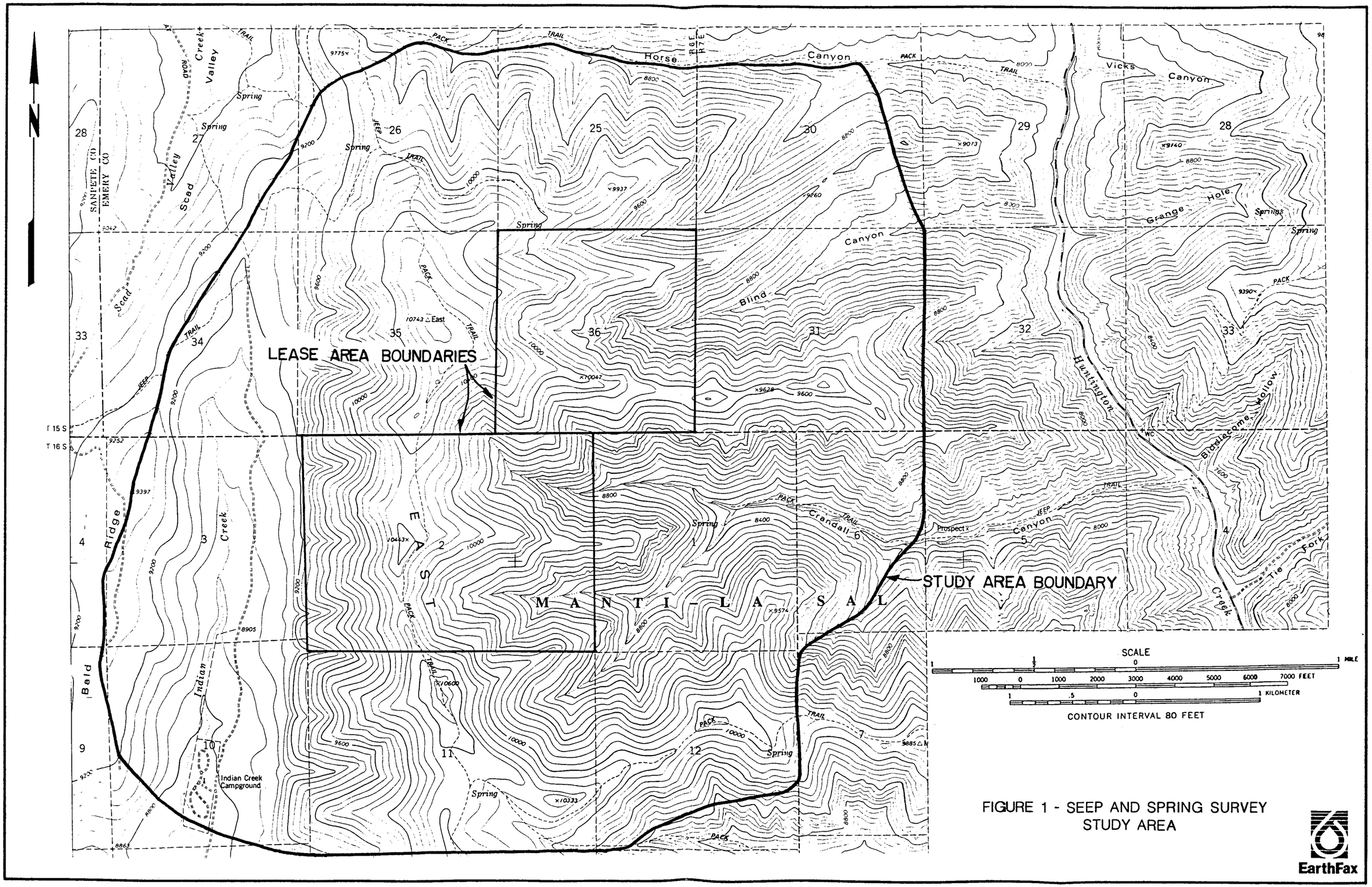


FIGURE 1 - SEEP AND SPRING SURVEY STUDY AREA

3.0 RESULTS AND DISCUSSION

3.1 Geologic Conditions

Four formations outcrop within the study area (Figure 2). Stratigraphic descriptions provided herein were obtained from Doelling (1972), Danielson et al. (1981), and Lines (1985).

The Blackhawk Formation is the principal coal-bearing unit in the region. This formation consists of interbedded layers of sandstone, siltstone, shale, and coal. Although sandstone comprises approximately half of the formation, it is lenticular, with individual beds being traceable for only short distances (Lines, 1985). The Blackhawk is about 1000 feet thick in the coal lease area, with the principal coal seam (the Hiawatha seam) occurring near the bottom of the formation.

The Castlegate Sandstone overlies the Blackhawk Formation and consists of cliff-forming sandstones of fluvial origin. The sandstones are massive and medium to coarse grained. In the area of the coal lease, the Castlegate Sandstone is approximately 200 feet thick.

Overlying the Castlegate Sandstone, the Price River Formation consists predominantly of friable limestones and limy sandstone interbedded with pebbly conglomerates and shales. It forms steep receding slopes and is about 700 feet thick in the coal lease area.

The uppermost formation what outcrops within the study area is the North Horn Formation. This formation mainly consists of limy shale, with interbeds of limestone and sandstone. The North Horn Formation is approximately 1000 feet thick in the coal lease area an serves as a recharge unit to underlying formations as well as supplying water to springs within the formation.

Underlying the Blackhawk Formation and outcropping east of the study area is the Star Point Sandstone. This formation is of significance since it (together with the saturated portions of the Blackhawk Formation) comprises a regional aquifer. The Star Point is a massive sandstone with minor interbeds of shale and siltstone near its base. In the vicinity of the study area, the Star Point Sandstone is 350 to 450 feet thick.

The Joe's Valley Fault along the west edge of East Mountain is the eastern fault boundary of a graben that extends several miles both north and south of the study area (Lines, 1985). Davis

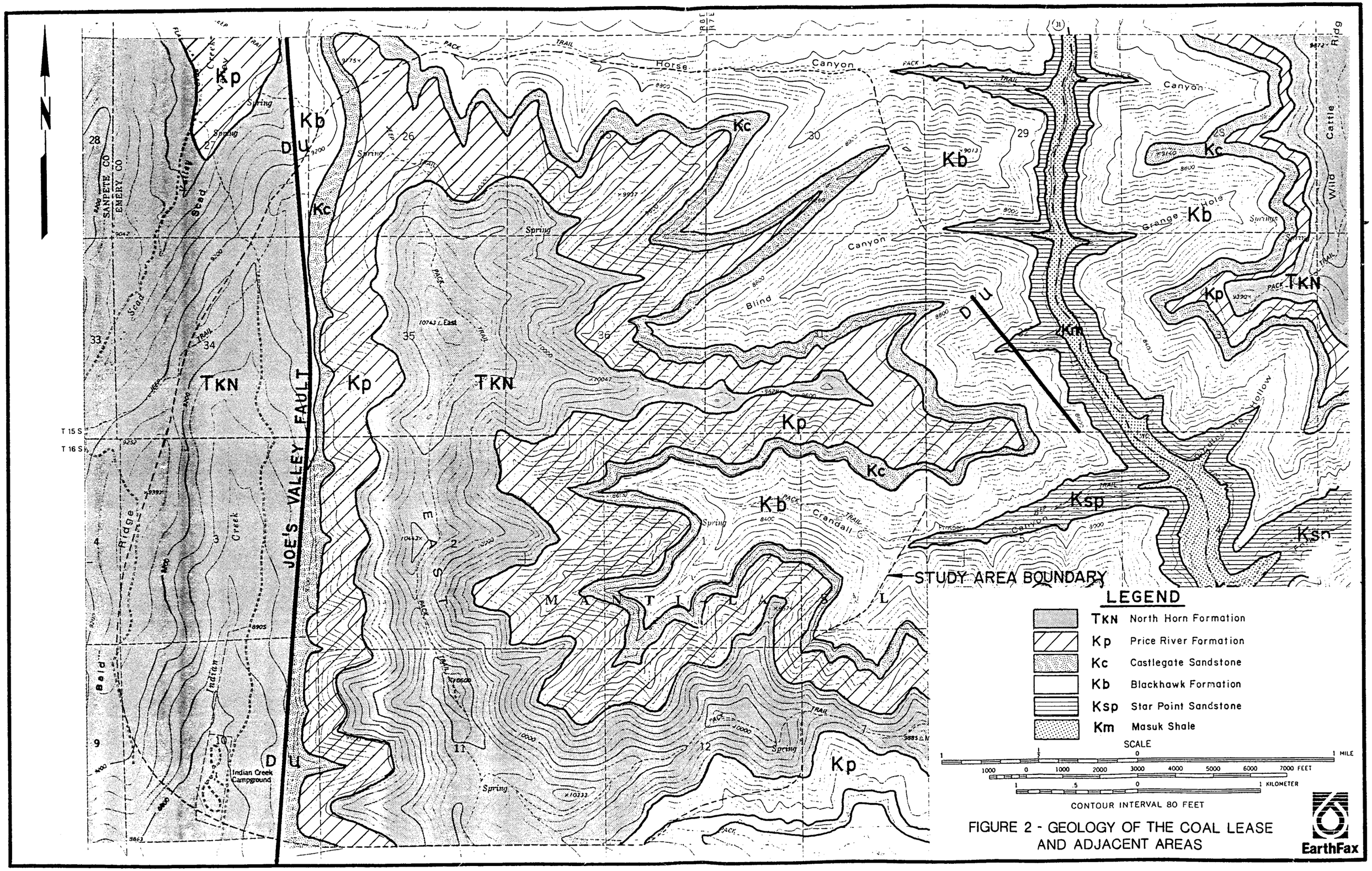


FIGURE 2 - GEOLOGY OF THE COAL LEASE AND ADJACENT AREAS

and Doelling (1977) estimate that the total throw along the fault in this area is about 2300 feet.

3.2 Seepage Occurrence

Locations of the seeps and springs found in the coal lease and adjacent areas are shown on Figure 3. Field data collected during the inventories are contained in Tables 1 (flow conditions and temperature), Tables 2 (pH), Table 3 (specific conductance) and Table 4 (geologic unit and use).

Springs and seeps within the coal lease and adjacent areas tend to be grouped within a given locale while other areas with relatively similar surface conditions are noticeably devoid of springs and seeps. This occurs primarily in response to changes in the structure of the geologic units within each formation or topographic area.

The dip of the bedrock in the vicinity of the coal lease area is approximately one percent to the southeast. Therefore, a significantly higher number of springs are present in Crandall, Blind and Horse Canyons than are present on the west side of East Mountain.

Numerous landslides are visible on the west side of East Mountain. These slides probably occurred during the excessively wet years of 1982 through 1985. It is probable that seeps and springs aided in creating the unstable conditions which lead to the landslides. Since seepage is not now typically evident at the landslides, these seeps and springs were probably destroyed during the movement of the hillslope.

According to Lines (1985), the Blackhawk Formation and the underlying Star Point Sandstone are categorized jointly as an aquifer in the Wasatch Plateau where they are saturated. The degree of saturation generally increases as the amount of overburden increases. Near deeply incised canyons, the aquifer is naturally drained. The Blackhawk-Star Point aquifer yields water to mines in the area.

In areas such as East Mountain where strata that overlie the Blackhawk-Star Point aquifer are several hundred feet above the bottoms of local canyons, aquifers in the overlying strata are perched. This perching occurs where more-permeable strata overlie less-permeable strata (such as sandstones or fractured limestones overlying shale). Perched aquifers are common in the North Horn and Price River Formations (Lines, 1985) where they yield water to springs.

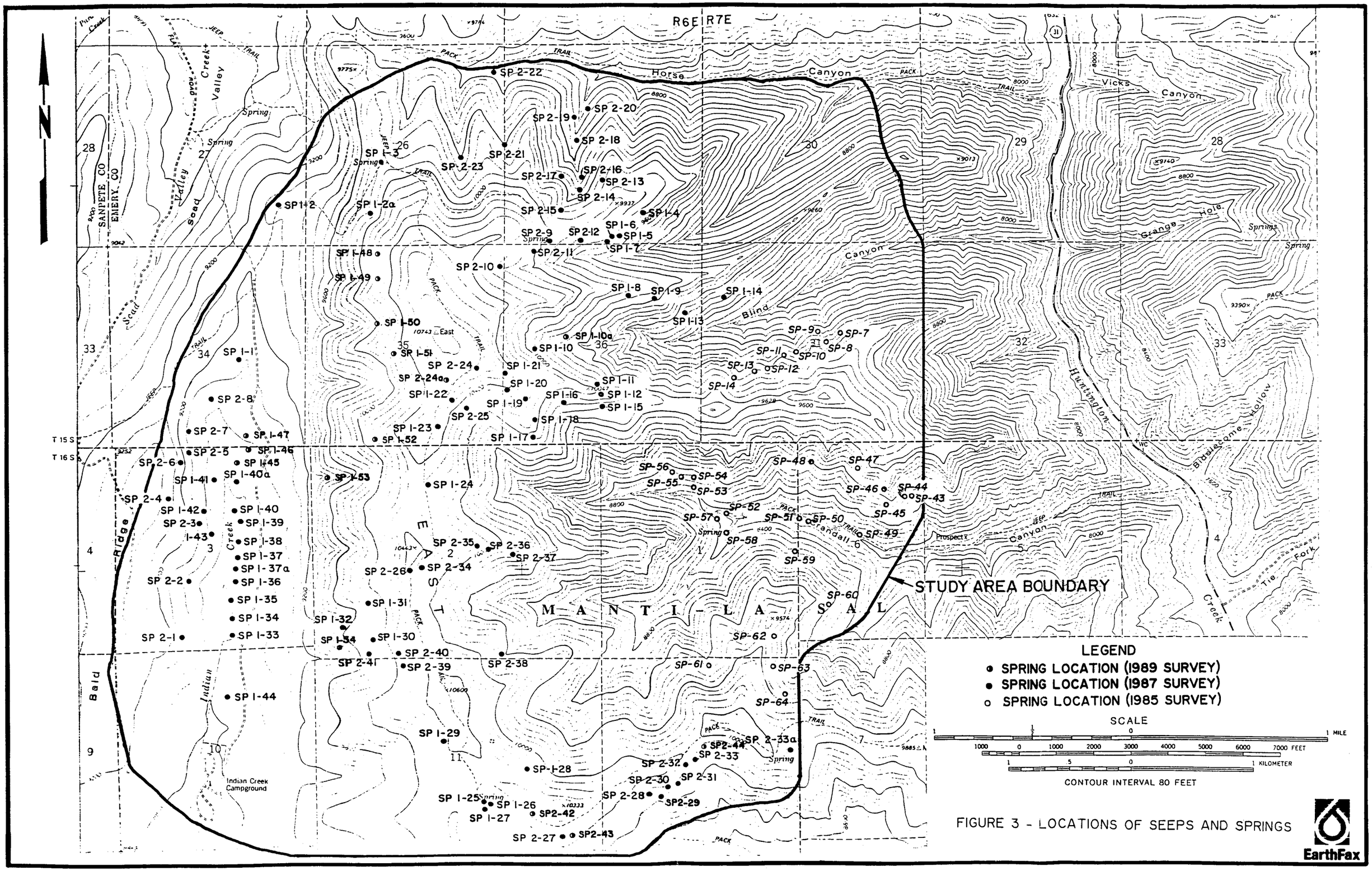


FIGURE 3 - LOCATIONS OF SEEPS AND SPRINGS

Table 1. Results of flow conditions and temperature measurements for the period of June 1985 through October 1989 seep and spring survey in the coal lease and adjacent areas.

	June 85		Oct. 85		July 87		Oct. 87		Oct. 89	
Field Number	Flow (gpm)	Temp (°C)	Flow (gpm)	Temp (°C)	Flow (gpm)	Temp (°C)	Flow (gpm)	Temp (°C)	Flow (gpm)	Temp (°C)
SP-7	10	10.0	Dry	-	-	-	-	-	Dry	-
SP-8	20	3.5	Dry	-	-	-	-	-	Dry	-
SP-9	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-10	40	10.0	Seep	(a)	-	-	-	-	Dry	-
SP-11	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-12	15	3.0	Seep	(a)	-	-	-	-	Dry	-
SP-13	3	7.0	Dry	-	-	-	-	-	Seep	(a)
SP-14	25	5.5	1	6.0	-	-	-	-	1.0	6.0
SP-43	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-44	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-45	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-46	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-47	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-48	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-49	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-50	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-51	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-52	1	12.0	1	7.0	-	-	-	-	<<1	6.7
SP-53	8	5.5	5	5.0	-	-	-	-	Dry	-
SP-54	15	5.5	5	5.5	-	-	-	-	<<1	2.2
SP-55	10	5.5	10	5.5	-	-	-	-	Seep	(a)
SP-56	15	5.5	15	6.5	-	-	-	-	Seep	(a)

Table 1. (continued)

Field Number	June 85 Flow (gpm)	June 85 Temp (°C)	Oct. 85 Flow (gpm)	Oct. 85 Temp (°C)	July 87 Flow (gpm)	July 87 Temp (°C)	Oct. 87 Flow (gpm)	Oct. 87 Temp (°C)	Oct. 89 Flow (gpm)	Oct. 89 Temp (°C)
SP-57	6	5.5	6	4.5	-	-	-	-	Dry	(a)
SP-58	10	5.0	5	9.0	-	-	-	-	4	5.6
SP-59	1	7.0	1	5.0	-	-	-	-	Dry	(a)
SP-60	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-61	15	2.0	1	9.0	-	-	-	-	Dry	-
SP-62	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-63	Seep	(a)	Dry	-	-	-	-	-	Dry	-
SP-64	10	3.0	Dry	-	-	-	-	-	Dry	-
SP1-1	-	-	-	-	<<1	2.9	3	7.0	Seep	(a)
SP1-2	-	-	-	-	2	4.0	Dry	-	Dry	-
SP1-2a	-	-	-	-	5	4.0	1	7.0	.12	2.9
SP1-3	-	-	-	-	<1	2.0	<1	2.0	.25	2.8
SP1-4	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-5	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-6	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-7	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-8	-	-	-	-	<<1	11.0	Dry	-	.2	5.6
SP1-9	-	-	-	-	Seep	(a)	Seep	(a)	Seep	(a)
SP1-10	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-10a	-	-	-	-	-	-	-	-	(b)	-
SP1-11	-	-	-	-	3	4.0	Dry	-	(b)	-
SP1-12	-	-	-	-	Seep	(a)	Seep	(a)	0.1	3.3
SP1-13	-	-	-	-	Seep	(a)	Seep	(a)	Seep	(a)

Table 1. (continued)

Field Number	June 85 Flow (gpm)	June 85 Temp (°C)	Oct. 85 Flow (gpm)	Oct. 85 Temp (°C)	July 87 Flow (gpm)	July 87 Temp (°C)	Oct. 87 Flow (gpm)	Oct. 87 Temp (°C)	Oct. 89 Flow (gpm)	Oct. 89 Temp (°C)
SP1-14	-	-	-	-	Seep	(a)	Seep	(a)	Seep	(a)
SP1-15	-	-	-	-	<<1	5.0	Dry	-	0.1	2.2
SP1-16	-	-	-	-	<<1	11.0	Dry	-	Dry	-
SP1-17	-	-	-	-	10	5.0	2	4.0	Dry	-
SP1-18	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-19	-	-	-	-	<<1	6.0	Dry	-	Dry	-
SP1-20	-	-	-	-	<1	4.0	<1	8.0	(b)	-
SP1-21	-	-	-	-	<1	4.0	Dry	-	(b)	-
SP1-22	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-23	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-24	-	-	-	-	<1	5.0	Seep	(a)	0.1	3.3
SP1-25	-	-	-	-	3	3.6	3	7.0	0.25	4.4
SP1-26	-	-	-	-	2	3.7	2	7.0	0.5	4.4
SP1-27	-	-	-	-	<1	2.8	Dry	-	0.1	5.0
SP1-28	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP1-29	-	-	-	-	<<1	3.0	Dry	-	Seep	(a)
SP1-30	-	-	-	-	<1	3.1	Dry	-	.25	6.8
SP1-31	-	-	-	-	<1	3.3	Dry	-	Seep	(a)
SP1-31a	-	-	-	-	-	-	-	-	Seep	(a)
SP1-32	-	-	-	-	Seep	(a)	Seep	(a)	-	-
SP1-33	-	-	-	-	Seep	(a)	<1	7.0	.5	5.5

Table 1. (continued)

Field Number	June 85 Flow (gpm)	June 85 Temp (°C)	Oct. 85 Flow (gpm)	Oct. 85 Temp (°C)	July 87 Flow (gpm)	July 87 Temp (°C)	Oct. 87 Flow (gpm)	Oct. 87 Temp (°C)	Oct. 89 Flow (gpm)	Oct. 89 Temp (°C)
SP1-34	-	-	-	-	<<1	4.0	15	8.0	<<1	10.8
SP1-35	-	-	-	-	1	11.0	4	7.0	<<1	14.5
SP1-36	-	-	-	-	<<1	4.0	3	8.0	<<1	9.3
SP1-37	-	-	-	-	Seep	(a)	4	5.0	<<1	5.6
SP1-37a	-	-	-	-	<1	4.2	3	7.0	.5	6.5
SP1-38	-	-	-	-	<<1	4.2	2	7.0	<<1	7.4
SP1-39	-	-	-	-	<1	4.1	3	7.0	<<1	9.0
SP1-40	-	-	-	-	<<1	4.4	10	7.0	.5	6.8
SP1-40a	-	-	-	-	Seep	(a)	5	7.0	.125	5.4
SP1-41	-	-	-	-	Seep	(a)	2	7.0	Dry	-
SP1-42	-	-	-	-	1	3.3	<1	10.0	Dry	-
SP1-43	-	-	-	-	<1	3.3	1	7.0	Dry	-
SP1-44	-	-	-	-	3	12.0	5	7.0	Dry	-
SP1-45	-	-	-	-	-	-	-	-	<<1	6.1
SP1-46	-	-	-	-	-	-	-	-	<<1	9.0
SP1-47	-	-	-	-	-	-	-	-	<<1	6.8
SP1-48	-	-	-	-	-	-	-	-	.06	4.1
SP1-49	-	-	-	-	-	-	-	-	Seep	(a)
SP1-50	-	-	-	-	-	-	-	-	Seep	(a)
SP1-51	-	-	-	-	-	-	-	-	.06	7.9
SP1-52	-	-	-	-	-	-	-	-	Seep	(a)
SP1-53	-	-	-	-	-	-	-	-	.25	7.5
SP1-54	-	-	-	-	-	-	-	-	.25	4.9

Table 1. (continued)

Field Number	June 85 Flow (gpm)	June 85 Temp (°C)	Oct. 85 Flow (gpm)	Oct. 85 Temp (°C)	July 87 Flow (gpm)	July 87 Temp (°C)	Oct. 87 Flow (gpm)	Oct. 87 Temp (°C)	Oct. 89 Flow (gpm)	Oct. 89 Temp (°C)
SP2-1	-	-	-	-	4	5.0	Dry	-	1.5	10
SP2-2	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP2-3	-	-	-	-	5	14.0	Dry	-	<<1	5.5
SP2-4	-	-	-	-	10	6.0	Dry	-	Dry	-
SP2-5	-	-	-	-	2	5.0	Dry	-	Dry	-
SP2-6	-	-	-	-	5	5.0	Dry	-	Dry	-
SP2-7	-	-	-	-	4	6.0	Dry	-	Dry	-
SP2-8	-	-	-	-	Seep	(a)	Dry	-	Dry	-
SP2-9	-	-	-	-	5	5.0	1	4.0	.3	4.4
SP2-10	-	-	-	-	2	6.0	Dry	-	Dry	-
SP2-11	-	-	-	-	<<1	6.0	Dry	-	Dry	-
SP2-12	-	-	-	-	Seep	(a)	Dry	-	Dry	-
SP2-13	-	-	-	-	1	6.0	Dry	-	Dry	-
SP2-14	-	-	-	-	1	8.0	Dry	-	Dry	-
SP2-15	-	-	-	-	2	8.0	Dry	-	Dry	-
SP2-16	-	-	-	-	Seep	(a)	(c)	(c)	Dry	-
SP2-17	-	-	-	-	<<1	7.0	(c)	(c)	Dry	-
SP2-18	-	-	-	-	Seep	(a)	(c)	(c)	Dry	-
SP2-19	-	-	-	-	Seep	(a)	(c)	(c)	Dry	-
SP2-20	-	-	-	-	Seep	(a)	(c)	(c)	Dry	-
SP2-21	-	-	-	-	7	5.0	(c)	(c)	Dry	-
SP2-22	-	-	-	-	1	5.0	(c)	(c)	Dry	-
SP2-23	-	-	-	-	5	5.0	(c)	(c)	Dry	-
SP2-24	-	-	-	-	5	3.5	Seep	(a)	Dry	-

Table 1. (continued)

Field Number	June 85 Flow (gpm)	June 85 Temp (°C)	Oct. 85 Flow (gpm)	Oct. 85 Temp (°C)	July 87 Flow (gpm)	July 87 Temp (°C)	Oct. 87 Flow (gpm)	Oct. 87 Temp (°C)	Oct. 89 Flow (gpm)	Oct. 89 Temp (°C)
SP2-24a	-	-	-	-	-	-	-	-	Seep	(a)
SP2-25	-	-	-	-	Seep	(a)	Seep	(a)	Dry	-
SP2-26	-	-	-	-	Seep	(a)	Dry	-	Dry	-
SP2-27	-	-	-	-	4	3.0	1	4.0	.12	4.4
SP2-28	-	-	-	-	2	4.0	<1	4.0	.25	3.8
SP2-29	-	-	-	-	2	4.0	Dry	-	Seep	(a)
SP2-30	-	-	-	-	1	4.0	<<1	4.0	.5	1.1
SP2-31	-	-	-	-	2	6.0	Seep	(a)	Seep	(a)
SP2-32	-	-	-	-	2	4.0	<1	4.0	Seep	(a)
SP2-33	-	-	-	-	2	4.0	Dry	-	Seep	(a)
SP2-33a	-	-	-	-	4	4.0	1	5.0	.12	2.2
SP2-34	-	-	-	-	2	6.0	Dry	-	Dry	-
SP2-35	-	-	-	-	5	6.0	<1	5.0	0.1	.56
SP2-36	-	-	-	-	Seep	(a)	Dry	-	Dry	-
SP2-37	-	-	-	-	6	5.0	Dry	-	0.3	8.9
SP2-38	-	-	-	-	5	4.0	Dry	-	Seep	(a)
SP2-39	-	-	-	-	4	6.0	Dry	-	Dry	-
SP2-40	-	-	-	-	3	5.0	Dry	-	Dry	-
SP2-41	-	-	-	-	3	6.0	Seep	(a)	Seep	(a)
SP2-42	-	-	-	-	-	-	-	-	.25	3.06
SP2-43	-	-	-	-	-	-	-	-	Seep	(a)
SP2-44	-	-	-	-	-	-	-	-	Seep	(a)

(a) Insufficient water to sample
(b) Frozen
(c) Inaccessible due to weather and ground conditions

Table 2. Results of pH measurements for the period of June 1985 through October 1989 seep and spring survey in the coal lease and adjacent areas.

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP-7	8.36	-	-	-	-
SP-8	7.95	-	-	-	-
SP-9	(a)	-	-	-	-
SP-10	7.90	(a)	-	-	-
SP-11	(a)	-	-	-	-
SP-12	7.66	(a)	-	-	-
SP-13	8.57	-	-	-	(a)
SP-14	8.10	7.74	-	-	7.80
SP-43	(a)	-	-	-	-
SP-44	(a)	-	-	-	-
SP-45	(a)	-	-	-	-
SP-46	(a)	-	-	-	-
SP-47	(a)	-	-	-	-
SP-48	(a)	-	-	-	-
SP-49	(a)	-	-	-	-
SP-50	(a)	-	-	-	-
SP-51	(a)	-	-	-	-
SP-52	7.99	8.00	-	-	8.30
SP-53	7.31	7.95	-	-	-
SP-54	7.35	8.07	-	-	8.47
SP-55	7.36	7.59	-	-	(a)
SP-56	7.61	7.90	-	-	(a)

Table 2. (continued)

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP-57	7.35	7.56	-	-	-
SP-58	7.40	7.70	-	-	7.88
SP-59	7.43	7.86	-	-	-
SP-60	(a)	-	-	-	-
SP-61	7.36	8.16	-	-	-
SP-62	(a)	-	-	-	-
SP-63	(a)	-	-	-	-
SP-64	7.33	-	-	-	-
SP1-1	-	-	7.71	7.24	(a)
SP1-2	-	-	7.81	-	-
SP1-2a	-	-	7.80	7.97	8.68
SP1-3	-	-	7.61	7.61	7.70
SP1-4	-	-	(a)	(a)	-
SP1-5	-	-	(a)	(a)	-
SP1-6	-	-	(a)	(a)	-
SP1-7	-	-	(a)	(a)	-
SP1-8	-	-	7.54	-	7.99
SP1-9	-	-	(a)	(a)	(a)
SP1-10	-	-	(a)	(a)	-
SP1-10a	-	-	-	-	(c)
SP1-11	-	-	7.76	-	(c)
SP1-12	-	-	(a)	(a)	8.09
SP1-13	-	-	(a)	(a)	(a)

Table 2. (continued)

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP1-14	-	-	(a)	(a)	(a)
SP1-15	-	-	7.40	-	8.16
SP1-16	-	-	8.80	-	-
SP1-17	-	-	7.85	7.85	-
SP1-18	-	-	(a)	(a)	-
SP1-19	-	-	8.05	-	-
SP1-20	-	-	8.01	8.27	(c)
SP1-21	-	-	7.90	-	(c)
SP1-22	-	-	(a)	(a)	-
SP1-23	-	-	(a)	(a)	-
SP1-24	-	-	7.86	(a)	8.22
SP1-25	-	-	7.76	7.81	7.80
SP1-26	-	-	7.74	7.78	7.97
SP1-27	-	-	7.69	-	8.17
SP1-28	-	-	(a)	(a)	-
SP1-29	-	-	7.63	-	(a)
SP1-30	-	-	7.47	-	8.49
SP1-31	-	-	7.59	-	(a)
SP1-31a	-	-	-	-	(a)
SP1-32	-	-	(a)	(a)	-
SP1-33	-	-	(a)	8.27	7.03

Table 2. (continued

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP1-34	-	-	8.16	8.14	7.63
SP1-35	-	-	8.26	8.30	8.02
SP1-36	-	-	7.51	7.65	7.59
SP1-37	-	-	(a)	7.67	7.29
SP1-37a	-	-	7.42	7.56	7.13
SP1-38	-	-	7.29	7.24	7.22
SP1-39	-	-	8.17	7.48	6.69
SP1-40	-	-	7.17	7.17	7.27
SP1-40a	-	-	(a)	7.78	6.85
SP1-41	-	-	(a)	7.63	-
SP1-42	-	-	7.43	8.15	-
SP1-43	-	-	7.49	7.46	-
SP1-44	-	-	7.80	7.76	-
SP1-45	-	-	-	-	6.92
SP1-46	-	-	-	-	6.94
SP1-47	-	-	-	-	7.61
SP1-48	-	-	-	-	8.01
SP1-49	-	-	-	-	(a)
SP1-50	-	-	-	-	(a)
SP1-51	-	-	-	-	8.79
SP1-52	-	-	-	-	(a)
SP1-53	-	-	-	-	7.65
SP1-54	-	-	-	-	7.90

Table 2. (continued)

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP2-1	-	-	7.72	-	8.25
SP2-2	-	-	(a)	(a)	-
SP2-3	-	-	8.15	-	8.28
SP2-4	-	-	8.17	-	-
SP2-5	-	-	7.56	-	-
SP2-6	-	-	7.70	-	-
SP2-7	-	-	8.19	-	-
SP2-8	-	-	(a)	-	-
SP2-9	-	-	7.56	7.76	8.37
SP2-10	-	-	8.71	-	-
SP2-11	-	-	8.11	-	-
SP2-12	-	-	(a)	-	-
SP2-13	-	-	7.94	-	-
SP2-14	-	-	8.24	-	-
SP2-15	-	-	8.60	-	-
SP2-16	-	-	(a)	(b)	-
SP2-17	-	-	8.53	(b)	-
SP2-18	-	-	(a)	(b)	-
SP2-19	-	-	(a)	(b)	-
SP2-20	-	-	(a)	(b)	-
SP2-21	-	-	8.58	(b)	-
SP2-22	-	-	8.21	(b)	-
SP2-23	-	-	8.84	(b)	-
SP2-24	-	-	7.93	(a)	8.17

Table 2. (continued)

Field Number	June 85 pH (units)	Oct. 85 pH (units)	July 87 pH (units)	Oct. 87 pH (units)	Oct. 89 pH (units)
SP2-24a	-	-	-	-	(a)
SP2-25	-	-	(a)	(a)	-
SP2-26	-	-	(a)	-	-
SP2-27	-	-	7.46	7.60	8.02
SP2-28	-	-	7.78	8.01	8.36
SP2-29	-	-	7.57	-	(a)
SP2-30	-	-	8.01	8.05	8.41
SP2-31	-	-	7.73	(a)	(a)
SP2-32	-	-	7.56	8.28	(a)
SP2-33	-	-	7.85	-	(a)
SP2-33a	-	-	7.66	7.80	8.29
SP2-34	-	-	7.85	-	-
SP2-35	-	-	7.79	7.87	8.21
SP2-36	-	-	(a)	-	-
SP2-37	-	-	7.50	-	8.30
SP2-38	-	-	7.76	-	(a)
SP2-39	-	-	8.01	-	-
SP2-40	-	-	7.56	-	-
SP2-41	-	-	7.64	(a)	(a)
SP2-42	-	-	-	-	(a)
SP2-43	-	-	-	-	(a)
SP2-44	-	-	-	-	(a)

(a) Insufficient water to sample
(b) Inaccessible due to weather and ground conditions
(c) Frozen

Table 3. Results of specific conductance (umhos/cm @ 25° C) for the period of June 1985 through October 1989 seep and spring survey in the coal lease and adjacent areas.

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP-7	440	-	-	-	-
SP-8	280	-	-	-	-
SP-9	(a)	-	-	-	-
SP-10	220	(a)	-	-	-
SP-11	(a)	-	-	-	-
SP-12	250	(a)	-	-	-
SP-13	100	-	-	-	(a)
SP-14	150	340	-	-	380
SP-43	(a)	-	-	-	-
SP-44	(a)	-	-	-	-
SP-45	(a)	-	-	-	-
SP-46	(a)	-	-	-	-
SP-47	(a)	-	-	-	-
SP-48	(a)	-	-	-	-
SP-49	(a)	-	-	-	-
SP-50	(a)	-	-	-	-
SP-51	(a)	-	-	-	-
SP-52	600	540	-	-	392
SP-53	490	470	-	-	-
SP-54	500	500	-	-	352
SP-55	480	530	-	-	(a)
SP-56	490	470	-	-	(a)

Table 3. (continued)

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP-57	480	470	-	-	-
SP-58	500	500	-	-	470
SP-59	690	520	-	-	-
SP-60	(a)	-	-	-	-
SP-61	450	450	-	-	-
SP-62	(a)	-	-	-	-
SP-63	(a)	-	-	-	-
SP-64	440	-	-	-	-
SP1-1	-	-	360	440	(a)
SP1-2	-	-	280	-	-
SP1-2a	-	-	280	320	292
SP1-3	-	-	190	250	280
SP1-4	-	-	(a)	(a)	-
SP1-5	-	-	(a)	(a)	-
SP1-6	-	-	(a)	(a)	-
SP1-7	-	-	(a)	(a)	-
SP1-8	-	-	420	-	282
SP1-9	-	-	(a)	(a)	(a)
SP1-10	-	-	(a)	(a)	-
SP1-10a	-	-	-	-	(b)
SP1-11	-	-	360	-	(b)
SP1-12	-	-	(a)	(a)	340
SP1-13	-	-	(a)	(a)	(a)

Table 3. (continued)

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP1-14	-	-	(a)	(a)	(a)
SP1-15	-	-	380	-	326
SP1-16	-	-	280	-	-
SP1-17	-	-	390	410	-
SP1-18	-	-	(a)	(a)	-
SP1-19	-	-	400	-	-
SP1-20	-	-	360	350	(b)
SP1-21	-	-	370	-	(b)
SP1-22	-	-	(a)	(a)	-
SP1-23	-	-	(a)	(a)	-
SP1-24	-	-	310	(a)	389
SP1-25	-	-	490	330	294
SP1-26	-	-	430	340	282
SP1-27	-	-	450	-	282
SP1-28	-	-	(a)	(a)	-
SP1-29	-	-	470	-	(a)
SP1-30	-	-	440	-	992
SP1-31	-	-	430	-	(a)
SP1-31a	-	-	-	-	(a)
SP1-32	-	-	(a)	(a)	-
SP1-33	-	-	(a)	390	410

Table 3. (continued)

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP1-34	-	-	480	460	550
SP1-35	-	-	470	480	375
SP1-36	-	-	490	500	390
SP1-37	-	-	(a)	450	325
SP1-37a	-	-	500	490	363
SP1-38	-	-	480	470	360
SP1-39	-	-	460	450	360
SP1-40	-	-	530	690	310
SP1-40a	-	-	(a)	490	350
SP1-41	-	-	(a)	450	-
SP1-42	-	-	490	420	-
SP1-43	-	-	470	460	-
SP1-44	-	-	490	480	-
SP1-45	-	-	-	-	315
SP1-46	-	-	-	-	340
SP1-47	-	-	-	-	305
SP1-48	-	-	-	-	380
SP1-49	-	-	-	-	(a)
SP1-50	-	-	-	-	(a)
SP1-51	-	-	-	-	350
SP1-52	-	-	-	-	(a)
SP1-53	-	-	-	-	310
SP1-54	-	-	-	-	642

Table 3. (continued)

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP2-1	-	-	430	-	474
SP2-2	-	-	(a)	(a)	-
SP2-3	-	-	380	-	458
SP2-4	-	-	400	-	-
SP2-5	-	-	410	-	-
SP2-6	-	-	410	-	-
SP2-7	-	-	410	-	-
SP2-8	-	-	(a)	-	-
SP2-9	-	-	250	270	234
SP2-10	-	-	300	-	-
SP2-11	-	-	270	-	-
SP2-12	-	-	(a)	-	-
SP2-13	-	-	230	-	-
SP2-14	-	-	200	-	-
SP2-15	-	-	210	-	-
SP2-16	-	-	(a)	(c)	-
SP2-17	-	-	210	(c)	-
SP2-18	-	-	(a)	(c)	-
SP2-19	-	-	(a)	(c)	-
SP2-20	-	-	(a)	(c)	-
SP2-21	-	-	320	(c)	-
SP2-22	-	-	350	(c)	-
SP2-23	-	-	290	(c)	-
SP2-24	-	-	310	(a)	360

Table 3. (continued)

Field Number	June 85 Specific Cond.	Oct. 85 Specific Cond.	July 87 Specific Cond.	Oct. 87 Specific Cond.	Oct. 89 Specific Cond.
SP2-24a	-	-	-	-	(a)
SP2-25	-	-	(a)	(a)	-
SP2-26	-	-	(a)	-	-
SP2-27	-	-	440	380	410
SP2-28	-	-	400	380	328
SP2-29	-	-	410	-	(a)
SP2-30	-	-	370	380	413
SP2-31	-	-	390	(a)	(a)
SP2-32	-	-	410	350	(a)
SP2-33	-	-	410	-	(a)
SP2-33a	-	-	450	430	421
SP2-34	-	-	320	-	-
SP2-35	-	-	360	340	350
SP2-36	-	-	(a)	-	-
SP2-37	-	-	390	-	377
SP2-38	-	-	410	-	-
SP2-39	-	-	370	-	-
SP2-40	-	-	440	-	(a)
SP2-41	-	-	440	(a)	(a)
SP2-42	-	-	-	-	421
SP2-43	-	-	-	-	(a)
SP2-44	-	-	-	-	(a)

(a) Insufficient water to sample
(b) Frozen
(c) Inaccessible due to weather and ground conditions

Table 4. Geology and use of springs in the coal lease and adjacent areas.

Field Number	Geology	Use
SP-7	From snow patch at top of Castlegate SS.	Wildlife
SP-8	From snow patch at top of Castlegate SS.	Wildlife
SP-9	From sandstone/shale interface Castlegate SS/Blackhawk Fm.	None
SP-10	From snow patch at base of Castlegate SS.	Wildlife
SP-11	From colluvium over sandstone of Castlegate SS.	None
SP-12	From base of sandstone (Price River Fm.) in channel bottom.	Wildlife
SP-13	From sandstone at head of slide in Price River Fm.	Wildlife
SP-14	From fractured sandstone and soil in Price River Fm.	Wildlife
SP-43	From colluvium over sandstone in Blackhawk Fm.	None
SP-44	From colluvium over sandstone in Blackhawk Fm.	None
SP-45	From colluvium over sandstone in Blackhawk Fm.	None
SP-46	From sandstone bedding plane in Castlegate SS.	None
SP-47	From sandstone bedding plane in Castlegate SS.	None
SP-48	From colluvium over sandstone in Blackhawk Fm.	None

Table 4. (Continued).

Field Number	Geology	Use
SP-49	From sandstone bedding plane in road cut in Blackhawk Fm.	None
SP-50	From sandstone/shale interface in slump in Blackhawk Fm.	None
SP-51	From sandstone/shale interface in slump in Blackhawk Fm.	None
SP-52	From colluvium over sandstone in Blackhawk Fm., w/travertine.	Wildlife
SP-53	From fractured sandstone with travertine in Blackhawk Fm.	Wildlife
SP-54	From fractured sandstone with travertine in Blackhawk Fm.	Wildlife
SP-55	From fractured sandstone with travertine in Blackhawk Fm.	Wildlife
SP-56	From fractured sandstone with travertine in Blackhawk Fm.	Wildlife
SP-57	From fractured sandstone with travertine in Blackhawk Fm.	Wildlife
SP-58	From fractured sandstone in Blackhawk Fm.	Wildlife
SP-59	From colluvium over sandstone in Blackhawk Fm.	Wildlife
SP-60	From sandstone bedding plane in Castlegate SS.	None
SP-61	From fractured sandstone in Price River Fm.	Wildlife
SP-62	From sandstone/shale interface in Price River Fm.	None
SP-63	From sandstone/shale interface in Price River Fm.	None

Table 4. (Continued).

Field Number	Geology	Use
SP-64	From fractured sandstone in Price River Fm.	Wildlife
SP1-1	Alluvium on valley floor	Wildlife
SP1-2	Alluvium on valley floor	Developed
SP1-2a	Alluvium on valley floor	Wildlife
SP1-3	From fractured sandstone in Price River Fm.	Developed
SP1-4	From fractured sandstone in Price River Fm.	Wildlife
SP1-5	From fractured sandstone in Price River Fm.	Wildlife
SP1-6	From fractured sandstone in Price River Fm.	Wildlife
SP1-7	From fractured sandstone in Price River Fm.	Wildlife
SP1-8	From fractured limestone in North Horn Fm.	Wildlife
SP1-9	From fractured limestone in North Horn Fm.	Wildlife
SP1-10	Contact between North Horn and Price River Fms.	Wildlife
SP1-10a	Contact between North Horn and Price River Fms.	Wildlife
SP1-11	From fractured limestone in North Horn Fm.	Developed
SP1-12	From fractured limestone in North Horn Fm.	Wildlife
SP1-13	From fractured limestone in North Horn Fm.	Wildlife

Table 4. (Continued).

Field Number	Geology	Use
SP1-14	From fractured limestone in North Horn Fm.	Wildlife
SP1-15	From fractured limestone in North Horn Fm.	Wildlife
SP1-16	From fractured limestone in North Horn Fm.	Wildlife
SP1-17	From fractured limestone in North Horn Fm.	Wildlife
SP1-18	From fractured limestone in North Horn Fm.	Wildlife
SP1-19	From fractured limestone in North Horn Fm.	Wildlife Livestock
SP1-20	From fractured limestone in North Horn Fm.	Wildlife Livestock
SP1-21	From fractured limestone in North Horn Fm.	Wildlife Livestock
SP1-22	From fractured limestone in North Horn Fm.	Wildlife
SP1-23	From fractured limestone in North Horn Fm.	Wildlife
SP1-24	From fractured limestone in North Horn Fm.	Wildlife Livestock
SP1-25	From fractured limestone in North Horn Fm.	Wildlife
SP1-26	From fractured limestone in North Horn Fm.	Wildlife
SP1-27	From fractured limestone in North Horn Fm.	Wildlife
SP1-28	From fractured limestone in North Horn Fm.	Wildlife

Table 4. (Continued).

Field Number	Geology	Use
SP1-29	From fractured limestone in North Horn Fm.	Wildlife
SP1-30	From fractured limestone in North Horn Fm.	Wildlife
SP1-31	From fractured limestone in North Horn Fm.	Wildlife
SP1-31a	From fractured limestone in North Horn Fm.	Wildlife
SP1-32	From fractured sandstone in Price River Fm.	Wildlife
SP1-33	From alluvium in valley floor deposits.	Wildlife
SP1-34	From alluvium in valley floor deposits.	Wildlife
SP1-35	From alluvium in valley floor deposits.	Wildlife
SP1-36	From alluvium in valley floor deposits.	Wildlife
SP1-37	From alluvium in valley floor deposits.	Wildlife
SP1-37a	From alluvium in valley floor deposits.	Wildlife
SP1-38	From alluvium in valley floor deposits.	Wildlife
SP1-39	From alluvium in valley floor deposits.	Wildlife
SP1-40	From alluvium in valley floor deposits.	Wildlife
SP1-40a	From alluvium in valley floor deposits.	Wildlife

Table 4. (Continued).

Field Number	Geology	Use
SP1-41	From alluvium in valley floor deposits.	Wildlife
SP1-42	From alluvium in valley floor deposits.	Wildlife
SP1-43	From alluvium in valley floor deposits.	Wildlife
SP1-44	From alluvium in valley floor deposits.	Wildlife
SP1-45	From alluvium in valley floor deposits.	Wildlife
SP1-46	From alluvium in valley floor deposits.	Wildlife
SP1-47	From alluvium in valley floor deposits.	Wildlife
SP1-48	From fractured sandstone in Price River Fm.	Wildlife
SP1-49	From fractured sandstone in Price River Fm.	Wildlife
SP1-50	From fractured sandstone in Price River Fm.	Wildlife
SP1-51	From fractured sandstone in Price River Fm.	Wildlife
SP1-52	From fractured sandstone in Price River Fm.	Wildlife
SP1-53	From alluvium in valley floor deposits.	Wildlife
SP1-54	From fractured sandstone in Price River Fm.	Wildlife
SP2-1	From fractured limestone in North Horn Fm.	Wildlife

Table 4. (Continued).

Field Number	Geology	Use
SP2-2	Bottom of channel over limestone (North Horn Fm.)	None
SP2-3	Colluvium over limestone from 200' x 150' area.	Wildlife
SP2-4	From fractured limestone in North Horn Fm.	Wildlife
SP2-5	From fractured limestone in North Horn Fm. w/travertine.	Wildlife
SP2-6	From fractured limestone in North Horn Fm.	Wildlife
SP2-7	From fractured limestone in North Horn Fm.	Wildlife
SP2-8	Bottom of channel over limestone (North Horn Fm.).	None
SP2-9	From fractured limestone in North Horn Fm.	Developed
SP2-10	From fractured limestone in North Horn Fm.	Wildlife
SP2-11	Head of slump in ss/sh in Price River Fm.	None
SP2-12	Colluvium/sandstone in Price River Fm.	None
SP2-13	From fractured sandstone in Price River Fm.	Wildlife
SP2-14	From fractured limestone in Price River Fm.	Wildlife
SP2-15	From fractured sandstone in Price River Fm.	Wildlife
SP2-16	From sandstone/shale interface in Price River Fm.	None

Table 4. (Continued).

Field Number	Geology	Use
SP2-17	From fractured limestone in Price River Fm.	Wildlife
SP2-18	From fractured sandstone in Price River Fm. (Diffuse)	None
SP2-19	Colluvium/Alluvium adjacent to channel.	None
SP2-20	Colluvium/alluvium adjacent to channel.	None
SP2-21	From fractured limestone in Price River Fm.	Wildlife
SP2-22	From fractured limestone at head of slump in the Price River Fm.	None
SP2-23	From fractured limestone Price River Fm.	Wildlife
SP2-24	From fractured sandstone in Price River Fm.	Wildlife
SP2-24a	From fractured sandstone in Price River Fm.	Wildlife
SP2-25	From colluvium over limestone in North Horn Fm.	None
SP2-26	Sandstone over shale at head of small slump in North Horn Fm.	None
SP2-27	Colluvium in channel bottom in Price River Fm.	Developed
SP2-28	Sandstone/shale interface in Price River Fm.	Wildlife
SP2-29	From fractured sandstone in Price River Fm.	Wildlife
SP2-30	Fractured sandstone/shale interface in Price River Fm.	Wildlife

Table 4. (Continued).

Field Number	Geology	Use
SP2-31	Fractured sandstone/shale interface in Price River Fm.	Wildlife
SP2-32	Fractured sandstone/shale interface in Price River Fm.	Wildlife
SP2-33	Fractured sandstone/shale interface in Price River Fm.	Wildlife
SP2-33a	Fractured sandstone in the Price River Fm.	Wildlife
SP2-34	Fractured sandstone/shale interface in Price River Fm.	Wildlife
SP2-35	Fractured sandstone/shale interface in Price River Fm.	Wildlife
SP2-36	Fractured limestone swale in North Horn Fm.	Wildlife
SP2-37	From fractured limestone in North Horn Fm.	Wildlife
SP2-38	From fractured limestone in North Horn Fm.	Wildlife
SP2-39	From fractured limestone in North Horn Fm.	Wildlife
SP2-40	From fractured limestone in North Horn Fm.	Wildlife Livestock
SP2-41	From fractured limestone in North Horn Fm.	Wildlife
SP2-42	Fractured sandstone in the Price River Fm.	Wildlife
SP2-43	Fractured sandstone in the Price River Fm.	Wildlife
SP2-44	Fractured sandstone in the Price River Fm.	Wildlife

As indicated by the data presented in Table 4, approximately one third of the inventoried seeps and springs issue from the North Horn Formation. An additional one-fourth of the sources issue each from the Price River Formation and from colluvial/alluvial deposits. The remaining seeps and springs were found issuing in approximately equal numbers from the Castlegate Sandstone and the Blackhawk Formation.

Approximately 60 percent of all the seeps and springs found during the early-season inventories had flows of one gallon per minute or less. These flows typically decreased by the time of the late-season inventories, with most of the low-flow sources issuing only as seeps or being dry.

Notable exceptions to the decreasing-flow generality occurred at those springs issuing from alluvium in the bottom of Little Joes Valley near Indian Creek. Flows in these springs all increased substantially between the July 1987 and October 1987 surveys. In addition, much of the valley floor east of the creek became noticeably wetter during the intervening period.

A review of local geologic conditions suggests that two sources of recharge affect the flow of springs near Indian Creek but do not influence other springs in the study area. First, groundwater in the shallow alluvium and colluvium on the west-facing side of East Mountain flows downhill toward the valley and discharges into the valley alluvium. The arrival of this water later in the season is due to the lag time as snowmelt-derived groundwater flows through the soil toward the valley.

Secondly, springs adjacent to Indian Creek appear to be associated with the Joes Valley Fault. Discharge from this fault is likely also affected by the delayed recharge from the mountain.

Less than 10 percent of the seeps and springs found within the study area issue from the regional coal-bearing formation (the Blackhawk Formation). Of the sources found issuing from the Blackhawk Formation, one-third issued as seeps in June 1985 (but were dry in October 1985) while the remaining two-thirds issued at rates in excess of five gallons per minute.

Seeps and low-flow springs issuing from the Blackhawk Formation typically occur at the interface between overlying sandstone lenses and less-permeable underlying shale layers. The low seepage rates are the result of the low hydraulic conductivity of the Blackhawk Formation in its unfractured state. Laboratory permeability data provided by Lines (1985) from a core collected approximately 10 miles south of the coal lease area indicate that

sandstone units of the Blackhawk Formation have an average horizontal hydraulic conductivity of only 1.3×10^{-2} foot per day and an average vertical hydraulic conductivity of only 3.8×10^{-3} foot per day. Shales and siltstones within the Blackhawk Formation were found to have maximum horizontal and vertical hydraulic conductivities of 1.0×10^{-7} and 1.2×10^{-8} foot per day, respectively. These values, which are typical of unfractured sandstone and shale (Freeze and Cherry, 1979), indicate that the units are not conducive to rapid water movement.

The relatively low hydraulic conductivity of the shale units within the Blackhawk Formation compared with the sandstone units limits the downward movement of groundwater through the unfractured portions of the formation. Thus, as water recharges the Blackhawk Formation (either through snowmelt or rainfall directly onto the formation or through subsurface seepage from an overlying formation) it is forced to flow horizontally to the surface upon encountering a siltstone or shale layer. This creates locally perched groundwater conditions, with the recharge area for seeps and small springs with the Blackhawk being restricted in size.

Notable exceptions to the above generality concerning the Blackhawk Formation occur at the remainder of the study-area Blackhawk springs (SP-53 through SP-58 located in Crandall Canyon). These springs discharged from fractured sandstone at rates of 5 to 15 gallons per minute during both the early- and late-season inventories. Travertine deposits are common at these springs, suggesting that the recharge area for these springs is dominated by limestone (probably the North Horn Formation and the Price River Formation on East Mountain). The fractured Blackhawk Formation, therefore, probably serves more as a conveyance medium rather than a significant source of water to the springs.

3.3 Usage of Springs

Usage of springs issuing from the North Horn Formation tends to be high, with both wildlife and domestic stock utilizing the water. Since the upper elevations of East Mountain are heavily utilized by sheep in the summer months, many of the springs have been developed with troughs to provide a more stable water supply.

Springs issuing from the Price River Formation showed signs of significant use by wildlife but lesser usage by domestic stock. Slopes in the outcrop areas of this formation are steeper than in areas overlain by the North Horn Formation, thus accounting for the lower usage by domestic stock.

Usage of water issuing from the Castlegate Sandstone and the Blackhawk Formation is limited except in the bottom of Crandall Canyon (due primarily to inaccessibility and low flow rates). Those springs issuing from the fractured Blackhawk Formation in the bottom of Crandall Canyon (SP-53 through SP-58) showed signs of wildlife use. No signs of domestic stock usage were noted at springs issuing from the Castlegate Sandstone or the Blackhawk Formation.

3.4 Field Water-Quality Results

Results of the field water-quality measurements are summarized in Figure 4. Specific conductance was typically lowest and pH highest in springs issuing from the North Horn and Price River Formations. These phenomena occur due to the generally higher topographic position and higher lime content of the formations, respectively.

Average temperatures in the springs varied only about 2° C throughout the area, with averages being slightly less in springs issuing from the North Horn and Price River Formations. This may result from the probable shallow nature of springs issuing from the Blackhawk Formation and the alluvial/colluvial materials (thus increasing water temperatures).

3.5 Laboratory Water-Quality Results

Water-quality samples were collected for laboratory analyses from selected springs within the survey boundary area. The springs selected for analyses are those springs which are identified on the published USGS topographic maps. These springs were identified in the field (Figure 3) by EarthFax as:

- SP 58
- SP1-3
- SP1-25
- SP2-9
- SP2-33a

The laboratory analyses provide data concerning the major cations and anions, metals and nutrient content of the water issuing from the springs. The results of the laboratory analyses are presented in Appendix A.

The data indicate that the water issuing from the springs is markedly different between springs. However, the overall groundwater quality is considered good for all the springs sampled. The water issuing from the fractured Blackhawk Formation possess

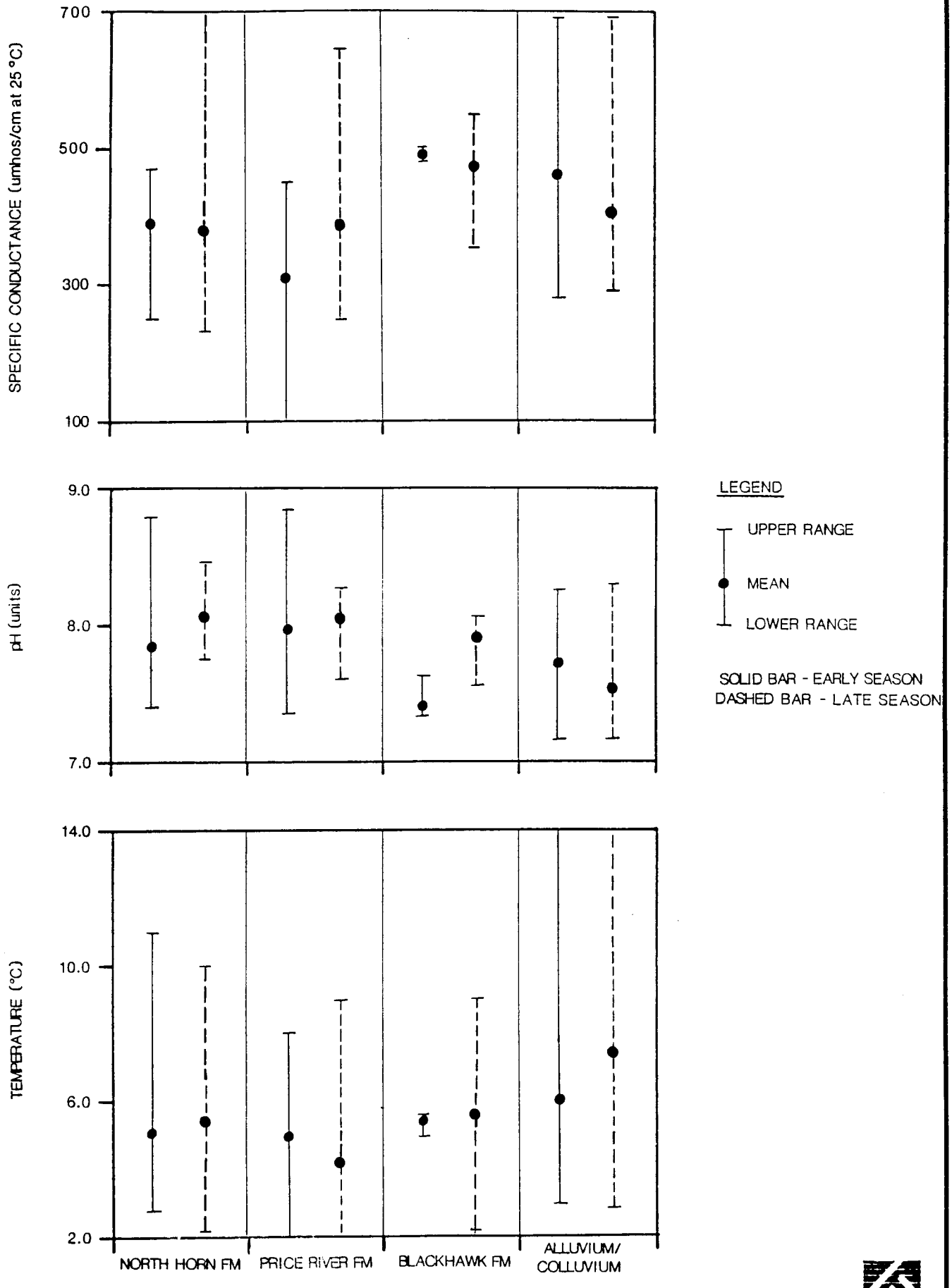


FIGURE 4 - FIELD WATER-QUALITY SUMMARY

EarthFax

slightly higher values for pH, total dissolved solids and electrical conductivity. Whereas, the Price River Formation has the lowest values for pH, total dissolved solids and electrical conductivity.

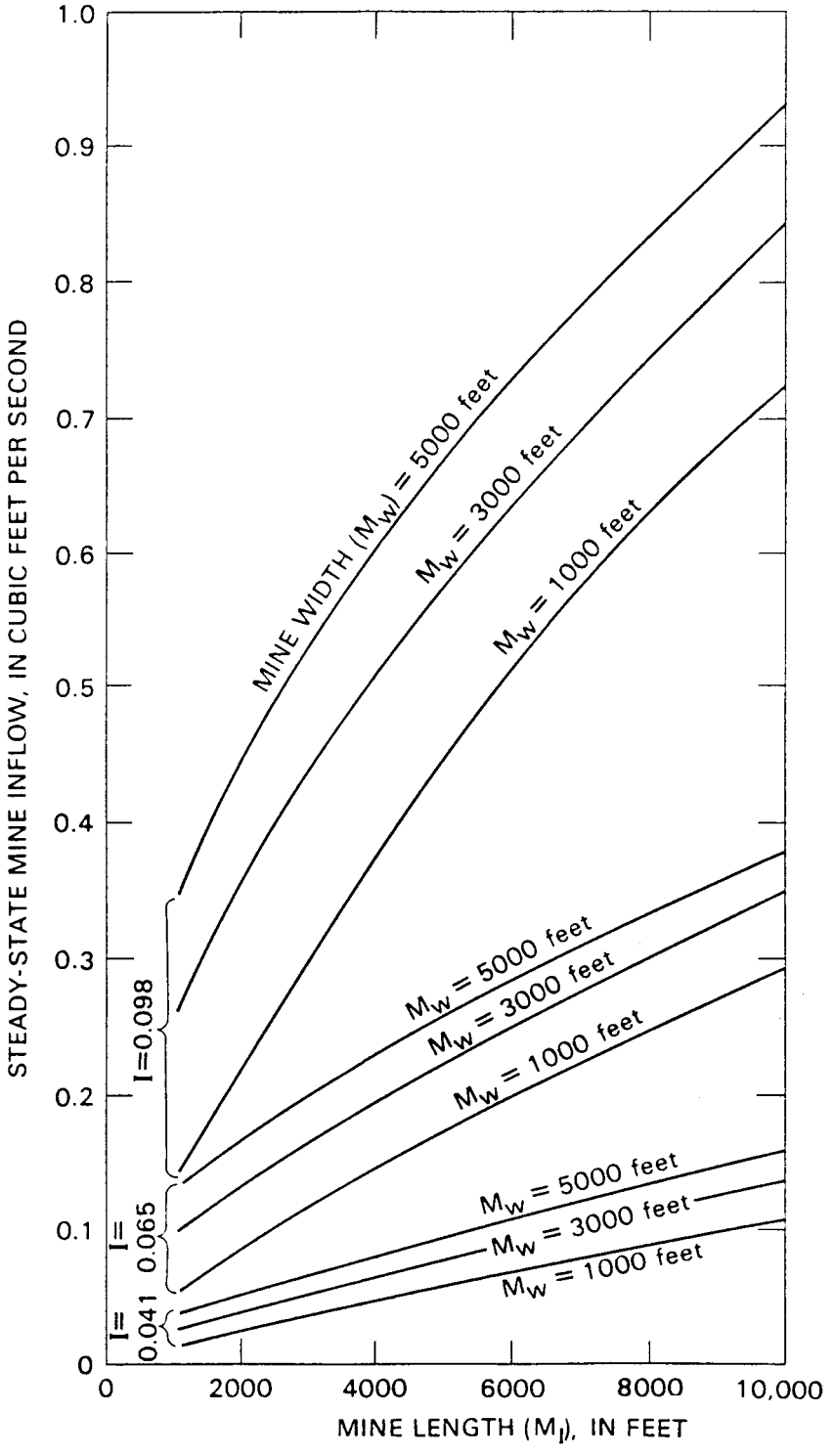
3.6 Potential Impacts of Mining

The primary potential for impacts to the groundwater system from mining will occur from mine dewatering (resulting in removal of water from the aquifers) and subsidence (resulting in physical alteration of the aquifers). Although these impacts cannot be quantified until a mine plan is developed, a general discussion of the potential for impacts can be provided.

Due to the topographic location of the coal lease areas, it is assumed that all the mine workings within the lease areas will be in the saturated portion of the Blackhawk Formation. Thus, groundwater inflow to the mine workings can be expected. Based on modeling results presented by Lines (1985) for the Trail Mountain area (approximately 10 miles south of the NEICO coal lease areas), potential inflow rates to the workings are presented in Figure 5. Assuming that the hydraulic gradient in the Blackhawk-Star Point aquifer beneath East Mountain is similar to that beneath Trail Mountain as reported by Lines (1985), a hydraulic gradient (I) of 0.065 can be used for Figure 5.

According to Figure 5, if the mine width is 1000 feet and the mine length is 5000 feet, a steady-state inflow of approximately 0.17 cubic feet per second (76 gallons per minute) can be expected. Alternatively, if the mine is 5000 feet wide and 10,000 feet long, an inflow of about 0.38 cubic feet per second (170 gallons per minute) can be expected. Dewatering may affect the flow of springs SP-52 through SP-58 but should not directly affect other springs in the study area since the remaining springs appear to be perched, with no direct hydraulic connection to the potential mine workings. Effects can be better quantified after the mine workings have been designed.

Subsidence is the fracturing or downwarping of overburden that occurs when coal is removed. Fractures that result from subsidence can extend several hundred feet upward through overlying perching beds. If this was to occur, water in the perched aquifer would be diverted downward, thus decreasing discharges at springs fed by the perched aquifer. Some of this diverted water could also flow sufficiently downward to intercept the mine workings, thus increasing discharges from the mine.



SOURCE: LINES (1985)

FIGURE 5 - PROJECTED INFLOW TO MINE WORKINGS

EarthFax

Lines (1985) points out that, due to similarities in water quality between the various formations, adverse impacts to water quality would probably not result from subsidence effects. The quality of water in the Blackhawk-Star Point aquifer could increase slightly if the enhanced permeability of the formation created by subsidence fractured increased groundwater flow rates through the aquifer and decreased the time of contact between rock and water.

4.0 REFERENCES

Danielson, T.W., M.D. ReMillard, and R.H. Fuller. 1981. Hydrology of the Coal-Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah. U.S. Geological Survey Water-Resources Investigations Report 81-539. Salt Lake City, Utah.

Davis, F.D. and H.H. Doelling. 1977. Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Areas, Wasatch Plateau, Utah. Utah Geological and Mineral Survey Bulletin 112. Salt Lake City, Utah.

Doelling, H.H. 1972. Central Utah Coal Fields: Sevier-San Pete, Wasatch Plateau, Book Cliffs, and Emery. Utah Geological and Mineral Survey Monograph 3. Salt Lake City, Utah.

Lines, G.C. 1985. The Groundwater System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah. U.S. Geological Survey Water-Supply Paper 2259. Washington, D.C.

APPENDIX A

CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Earthfax Engineering
7324 South 1300 East #100
Midvale, UT 84047

LAB NO: U045417

DATE SAMPLED: 10-13-89

TIME SAMPLED:

SAMPLED BY: R.B.G.

LOCATION: Genwal SP 58

COMMENTS:

PARAMETER	DETECTED
Alkalinity as $CaCO_3$, mg/l	240
Ammonia as NH_3-N, mg/l	0.36
Arsenic as As, mg/l	0.032
Barium as Ba, mg/l	<.01
Bicarbonate as HCO_3, mg/l	288
Boron as B, mg/l	0.118
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	75.9
Carbonate as CO_3, mg/l	2.7
Chloride as Cl, mg/l	13.8
Chromium as Cr (Hex), mg/l	<.01
Chromium as Cr (Tot), mg/l	<.01
Acidity as $CaCO_3$, mg/l	<10
Aluminum as Al, mg/l	<.1
Molybdenum as Mo, mg/l	<.01
Sulfide as H_2S, mg/l	<.1

PARAMETER	DETECTED
Conductivity, umhos/cm	537
Copper as Cu, mg/l	<.01
Fluoride as F, mg/l	<.1
Hardness as $CaCO_3$, mg/l	293
Hydroxide as OH, mg/l	0
Iron as Fe (Diss), mg/l	<.01
Iron as Fe (Tot), mg/l	0.025
Lead as Pb, mg/l	<.01
Magnesium as Mg, mg/l	40.2
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	<.0002
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	0.292
Nitrite as NO_2-N, mg/l	0.019
Ortho Phosphate as PO_4-P, mg/l	<.01
Potassium as K, mg/l	0.9
Selenium as Se, mg/l	<.002
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	3.7
Sulfate as SO_4, mg/l	59.2
Total Dissolved Solids, mg/l	303
Turbidity, NTU	0.67
Zinc as Zn, mg/l	<.01
pH Units	8.17
TSS, mg/l	<1
Cation, meq/l	6.24
Anion, meq/l	6.34

Rex Henderson

CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Earthfax Engineering
7324 South 1300 East #100
Midvale, UT 84047

LAB NO: U045416

DATE SAMPLED: 10-13-89

TIME SAMPLED:

SAMPLED BY: R.B.G.

LOCATION: Genwal SP 1-3

COMMENTS:

PARAMETER	DETECTED
Alkalinity as $CaCO_3$, mg/l	156
Ammonia as NH_3-N, mg/l	0.68
Arsenic as As, mg/l	<.01
Barium as Ba, mg/l	0.020
Bicarbonate as HCO_3, mg/l	190
Boron as B, mg/l	0.112
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	52.4
Carbonate as CO_3, mg/l	0
Chloride as Cl, mg/l	12.4
Chromium as Cr (Hex), mg/l	<.01
Chromium as Cr (Tot), mg/l	<.01
Acidity as $CaCO_3$, mg/l	<10
Aluminum as Al, mg/l	<.1
Molybdenum as Mo, mg/l	<.01
Sulfide as H_2S, mg/l	<.1

PARAMETER	DETECTED
Conductivity, umhos/cm	306
Copper as Cu, mg/l	<.01
Fluoride as F, mg/l	<.1
Hardness as $CaCO_3$, mg/l	151
Hydroxide as OH, mg/l	0
Iron as Fe (Diss), mg/l	<.01
Iron as Fe (Tot), mg/l	0.070
Lead as Pb, mg/l	<.01
Magnesium as Mg, mg/l	10.6
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	<.0002
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	0.412
Nitrite as NO_2-N, mg/l	0.019
Ortho Phosphate as PO_4-P, mg/l	<.01
Potassium as K, mg/l	0.2
Selenium as Se, mg/l	<.002
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	3.7
Sulfate as SO_4, mg/l	9.2
Total Dissolved Solids, mg/l	163
Turbidity, NTU	1.6
Zinc as Zn, mg/l	0.025
pH Units	7.49
TSS, mg/l	<1
Cation, meq/l	3.70
Anion, meq/l	3.66

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CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

LAB NO: U045972

DATE SAMPLED: 11-2-89

TIME SAMPLED:

SAMPLED BY:

LOCATION: SP1-25

COMMENTS:

PARAMETER	DETECTED
Alkalinity as $CaCO_3$, mg/l	210
Ammonia as NH_3-N, mg/l	0.81
Arsenic as As, mg/l	<.01
Barium as Ba, mg/l	<.01
Bicarbonate as HCO_3, mg/l	256
Boron as B, mg/l	0.24
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	54.7
Carbonate as CO_3, mg/l	0
Chloride as Cl, mg/l	10.1
Chromium as Cr (Hex), mg/l	<.01
Chromium as Cr (Tot), mg/l	<.01
Aluminum as Al, mg/l	<.1
Molybdenum as Mo, mg/l	<.01
Sulfide as H_2S, mg/l	<.1
TSS, mg/l	3.0

PARAMETER	DETECTED
Conductivity, umhos/cm	375
Copper as Cu, mg/l	0.032
Fluoride as F, mg/l	<.1
Hardness as $CaCO_3$, mg/l	246
Hydroxide as OH, mg/l	0
Iron as Fe (Diss), mg/l	<.01
Iron as Fe (Tot), mg/l	<.01
Lead as Pb, mg/l	<.01
Magnesium as Mg, mg/l	16.9
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	<.0002
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	0.67
Nitrite as NO_2-N, mg/l	<.005
Phosphate as PO_4-P, mg/l	<.01
Potassium as K, mg/l	0.3
Selenium as Se, mg/l	<.002
Silica as SiO_2 (Diss), mg/l	12.4
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	6.8
Sulfate as SO_4, mg/l	9.8
Total Dissolved Solids, mg/l	247
Turbidity, NTU	0.9
Zinc as Zn, mg/l	<.01
pH Units	7.90
Cation, meq/l	4.48
Anion, meq/l	4.69

Rex Henderson

CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

6100 S. STRATLER
MURRAY, UTAH 84107
(801) 262-7299

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION
CLIENT: Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047
LAB NO: U045974
DATE SAMPLED: 11-2-89
TIME SAMPLED:
SAMPLED BY:
LOCATION: SP2-9

COMMENTS:
.....

PARAMETER	DETECTED
Alkalinity as $CaCO_3$, mg/l	167
Ammonia as NH_3-N, mg/l	0.36
Arsenic as As, mg/l	<.01
Barium as Ba, mg/l	<.01
Bicarbonate as HCO_3, mg/l	204
Boron as B, mg/l	0.23
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	43.1
Carbonate as CO_3, mg/l	0
Chloride as Cl, mg/l	11.1
Chromium as Cr (Hex), mg/l	<.01
Chromium as Cr (Tot), mg/l	<.01
Aluminum as Al, mg/l	<.1
Molybdenum as Mo, mg/l	<.01
Sulfide as H_2S, mg/l	<.1
TSS, mg/l	5.0

PARAMETER	DETECTED
Conductivity, umhos/cm	310
Copper as Cu, mg/l	0.032
Fluoride as F, mg/l	<.1
Hardness as $CaCO_3$, mg/l	208
Hydroxide as OH, mg/l	0
Iron as Fe (Diss), mg/l	<.01
Iron as Fe (Tot), mg/l	0.020
Lead as Pb, mg/l	<.01
Magnesium as Mg, mg/l	16.6
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	<.0002
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	1.86
Nitrite as NO_2-N, mg/l	<.005
Phosphate as PO_4-P, mg/l	<.01
Potassium as K, mg/l	0.6
Selenium as Se, mg/l	<.002
Silica as SiO_2 (Diss), mg/l	13.8
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	7.3
Sulfate as SO_4, mg/l	7.4
Total Dissolved Solids, mg/l	200
Turbidity, NTU	1.2
Zinc as Zn, mg/l	0.022
pH Units	7.69
Cation, meq/l	3.87
Anion, meq/l	3.84

Mn (Tot)

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CHEMICAL AND BACTERIOLOGICAL ANALYSES

6100 S. STRATLER
MURRAY, UTAH 84107
(801) 262-7299

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

LAB NO: U045973

DATE SAMPLED: 11-2-89

TIME SAMPLED:

SAMPLED BY:

LOCATION: SP2-33a

COMMENTS:

PARAMETER	DETECTED
Alkalinity as $CaCO_3$, mg/l	292
Ammonia as NH_3-N, mg/l	0.50
Arsenic as As, mg/l	<.01
Barium as Ba, mg/l	<.01
Bicarbonate as HCO_3, mg/l	356
Boron as B, mg/l	0.26
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	67.1
Carbonate as CO_3, mg/l	0
Chloride as Cl, mg/l	10.1
Chromium as Cr (Hex), mg/l	<.01
Chromium as Cr (Tot), mg/l	<.01
Aluminum as Al, mg/l	<.1
Molybdenum as Mo, mg/l	<.01
Sulfide as H_2S, mg/l	<.1
TSS, mg/l	70

PARAMETER	DETECTED
Conductivity, umhos/cm	459
Copper as Cu, mg/l	0.045
Fluoride as F, mg/l	<.1
Hardness as $CaCO_3$, mg/l	292
Hydroxide as OH, mg/l	0
Iron as Fe (Diss), mg/l	0.10
Iron as Fe (Tot), mg/l	0.59
Lead as Pb, mg/l	<.01
Magnesium as Mg, mg/l	37.4
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	<.0002
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	0.71
Nitrite as NO_2-N, mg/l	0.0051
Phosphate as PO_4-P, mg/l	<.01
Potassium as K, mg/l	0.6
Selenium as Se, mg/l	<.002
Silica as SiO_2 (Diss), mg/l	14.4
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	8.2
Sulfate as SO_4, mg/l	34.6
Total Dissolved Solids, mg/l	276
Turbidity, NTU	28
Zinc as Zn, mg/l	0.13
pH Units	8.05
Cation, meq/l	6.84
Anion, meq/l	6.85

Rex Henderson

RECEIVED
JAN 30 1991
DIVISION OF
OIL, GAS & MINING

BPB

BOREHOLE 7

CLIENT COAL SYSTEMS INC/NEICO

AREA Tie Fork, Utah

COUNTRY USA

DATE LOGGED 8-25-89

DEPTH SCALE 24:1

2 OF 2 LOGS

SEAM THICKNESS LOG

BOREHOLE DATA	REFER TO LITHOLOGY LOG
OPERATION DATA	REFER TO LITHOLOGY LOG

EQUIPMENT AND RECORDING DATA

COAL COMBINATION SONDE

SIDEWALL POSITION

LOG	TAPING			PANEL			CAL COEFF
	LOG TAPED	RECORD SPEED	DIRECT or REPLAY	SPEED	TC SECS	NORM	
CALIPER	yes	7	r	7	1	-	-
B R DENSITY	yes	7	r	7	1/3	6.2	.62

SOURCE. SONDE AND CALIBRATION

REFER TO LITHOLOGY LOG

SONDE TYPE:
COAL
COMBINATION
SONDE

LOG SUITE:
CALIPER
B.R. DENSITY

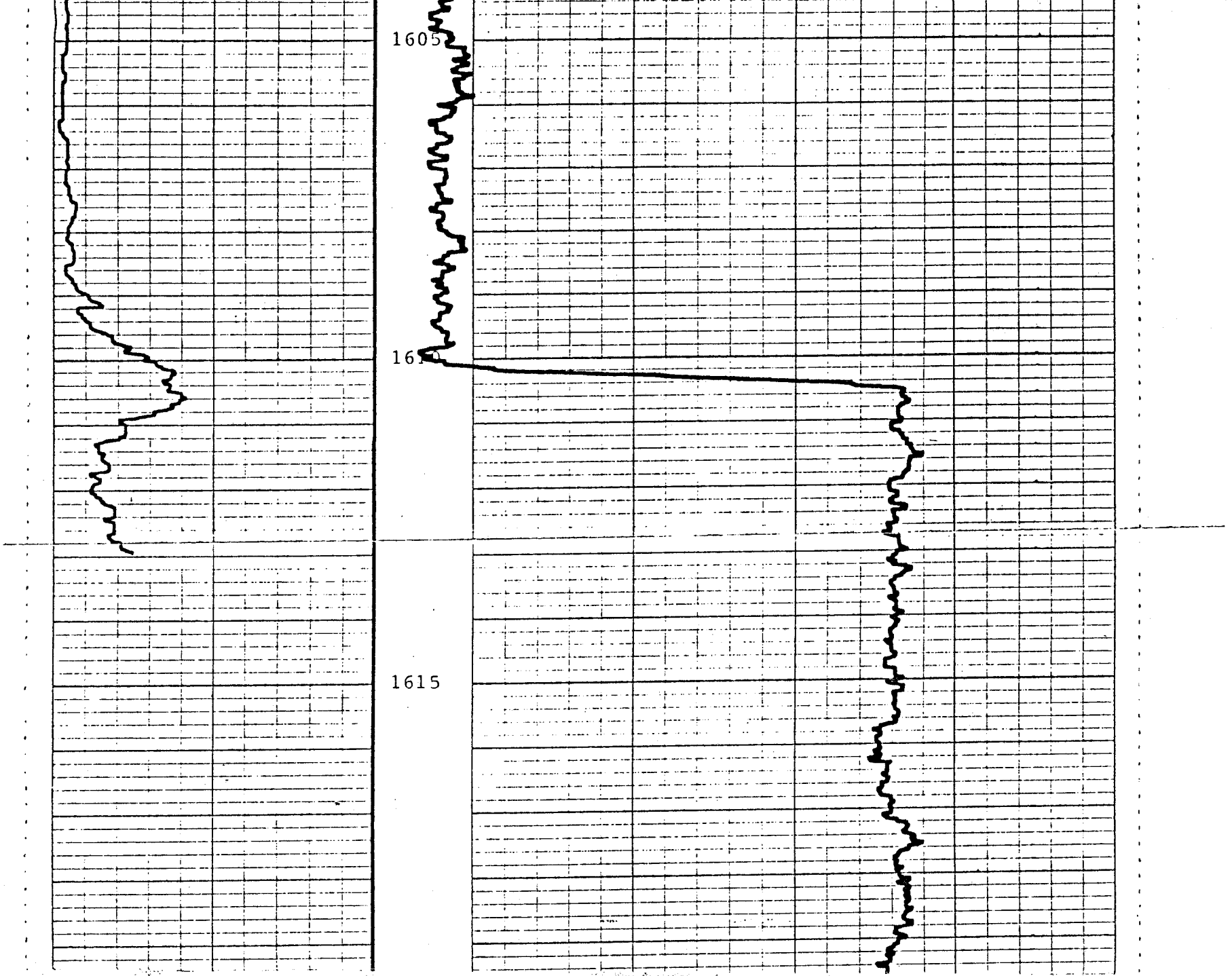
SEAM THICKNESS LOG INTERVALS

FROM	1620'	1560'	1515'
TO	1590'	1545'	1495'
INTERVAL	30'	15'	20'

FROM		INTERVAL TOTAL
TO		
INTERVAL		65'

REMARKS

DH-7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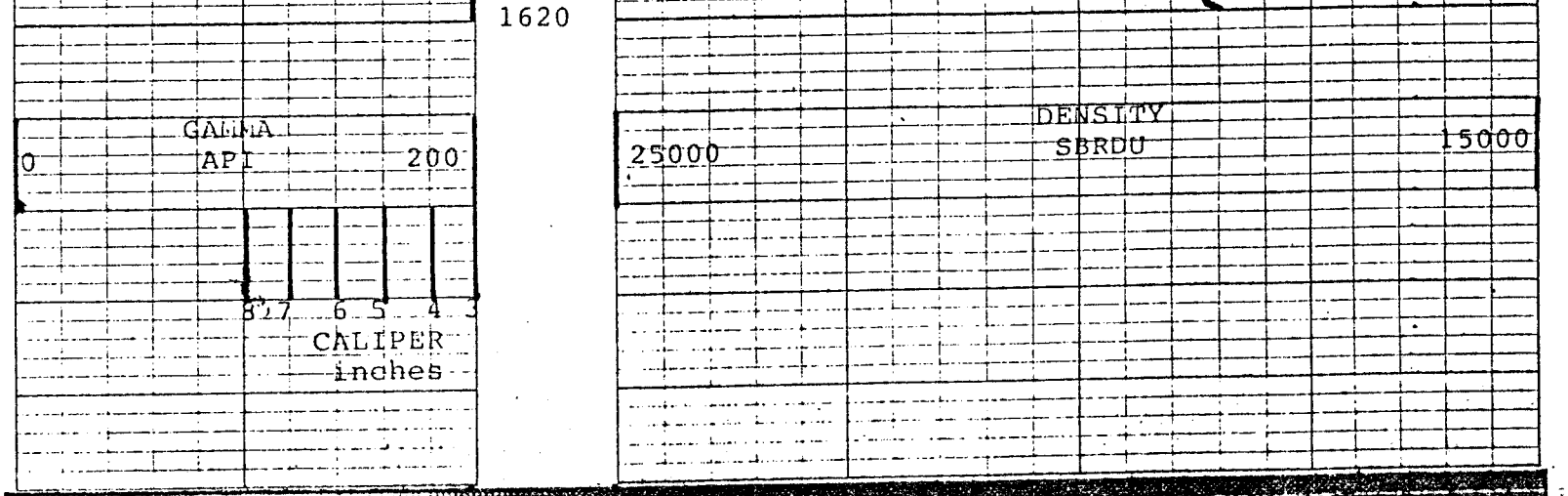


BOREHOLE 7

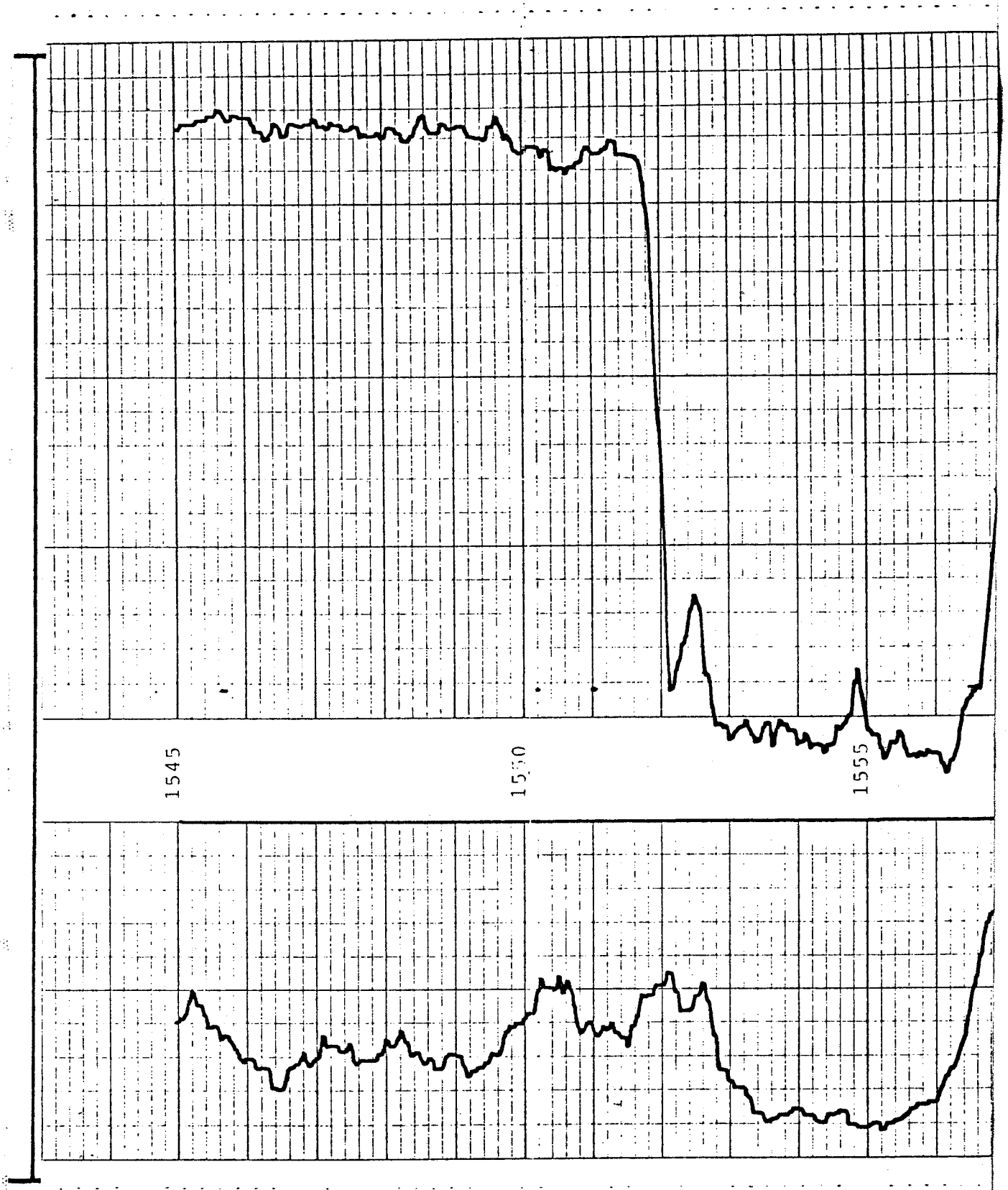
CLIENT COAL SYSTEMS INC/NEICO

AREA Tie Fork, Utah

COUNTRY USA

SEAM THICKNESS LOG

MY 88002 R



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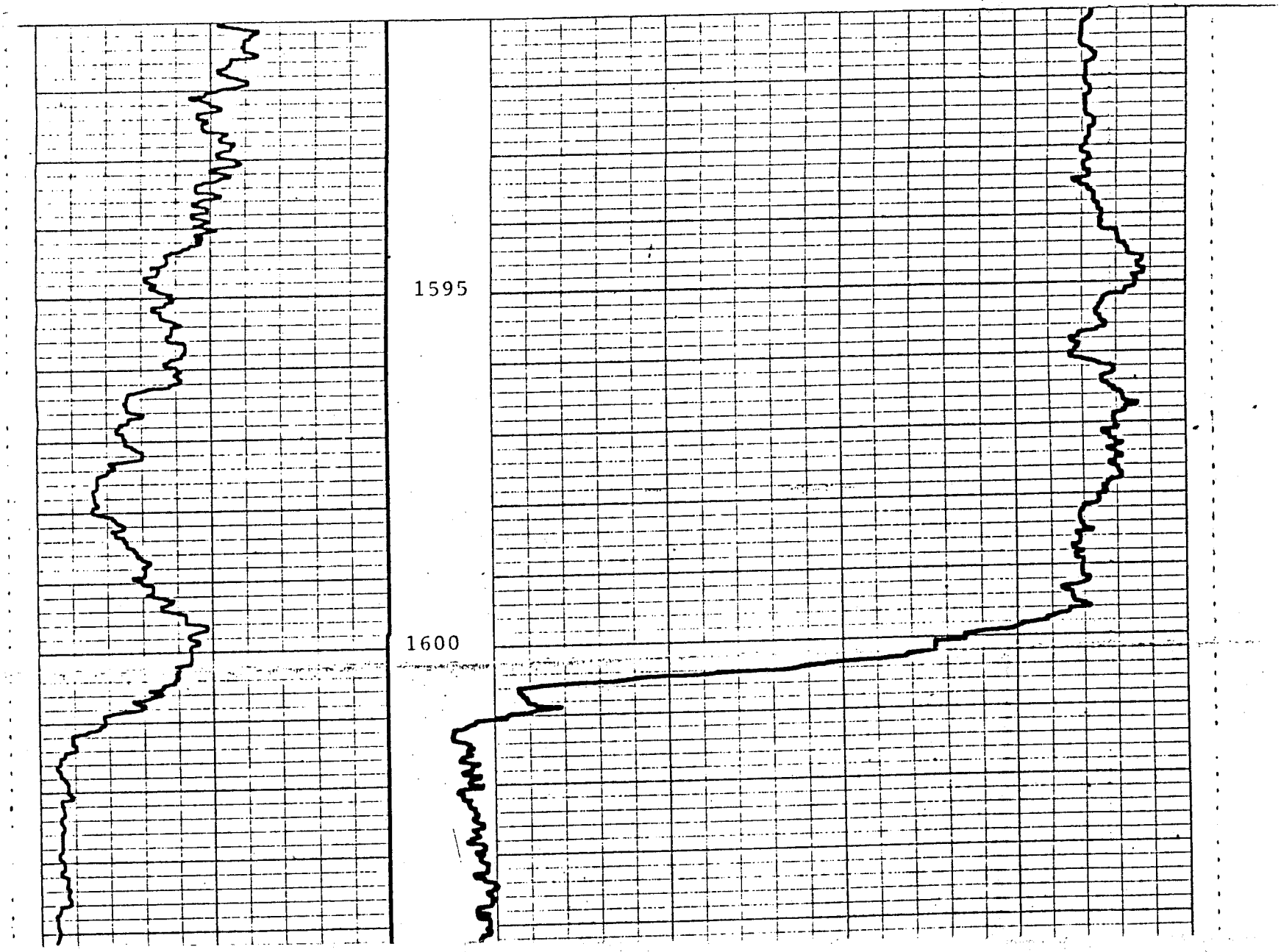
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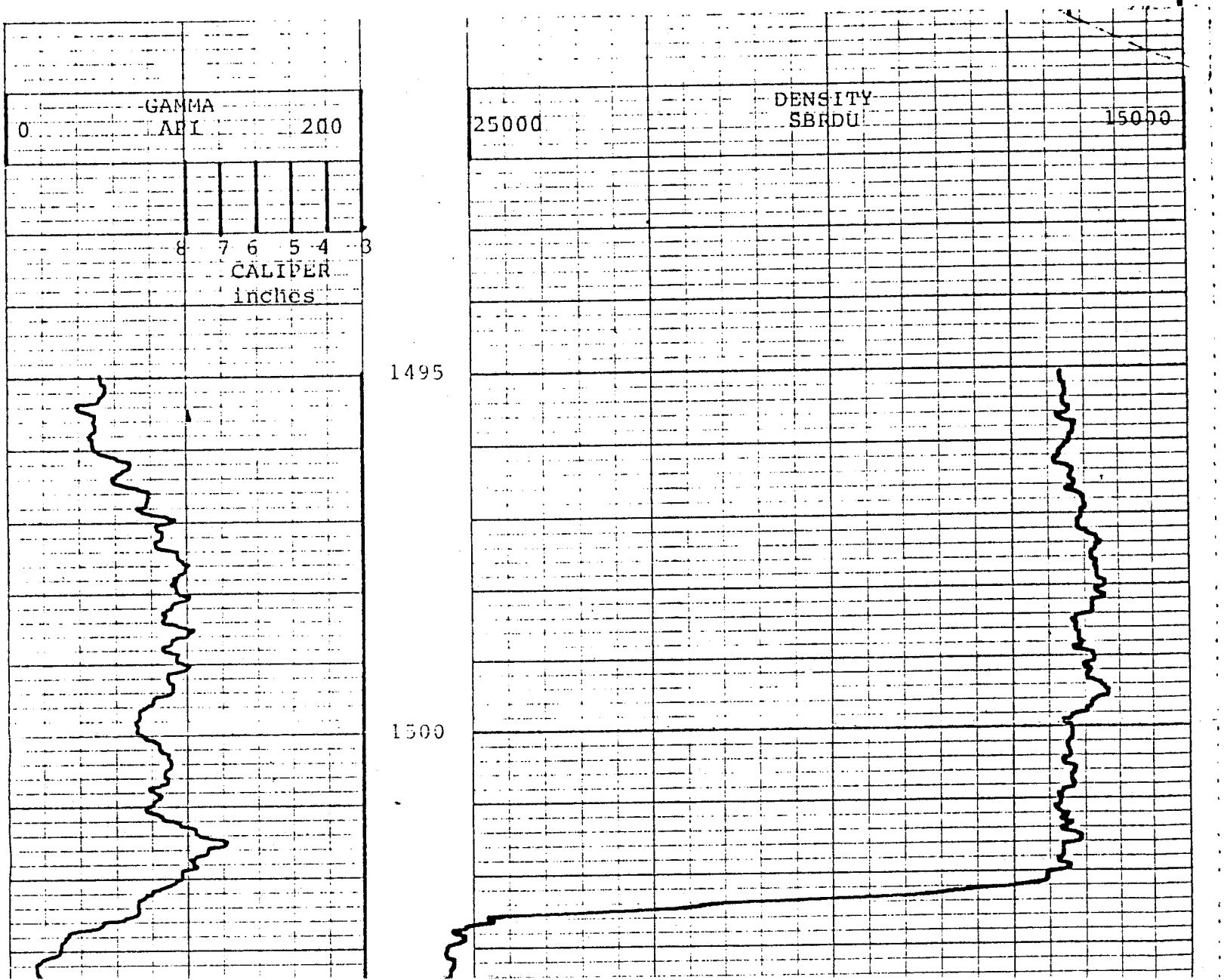
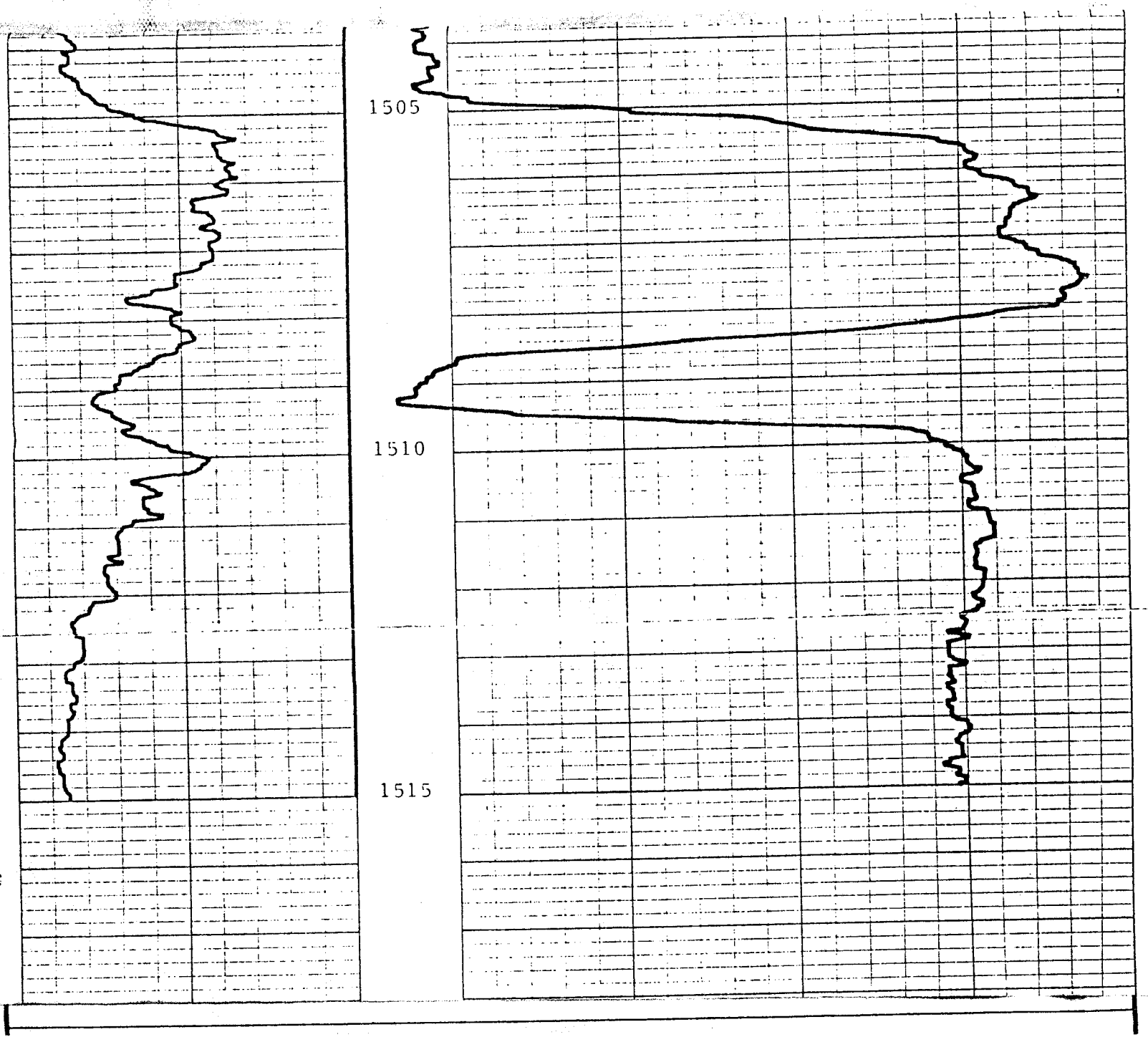
B P B SEAM THICKNESS LOG

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1515

Confidential

LITHOLOGIC LOG OF EXPLORATION WELL DH-7 (NVP-7)
IS CONFIDENTIAL

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
WELL NO: DH-7

DATE BEGIN: 7-31-89 DATE END: 8-25-89
DRILLER: SMITH LOGGER: I.L.
GROUND WATER EL: 8266' SURFACE EL: 9669'
COORDINATES: NE1/4 SW1/4 SE1/4, SEC 36, T15S R6E
FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
NORTH HORN	LOWER TERTIARY - UPPER CRETACEOUS	CR	0		Sandstone: fine-grained, white to light tan, dark grey shale seams 1/4 to 1/2 in. thick and shale clasts 1/16 to 1/2 in. in length. Surface casing to 8.5 ft.
					Sandstone: medium- to coarse-grained, white to light grey, shale clasts.
					Shale: black, carbonaceous.
					Sandstone: medium-grained, grey to white, yellow-tan staining, carbonaceous fragments.
			50		Sandstone: medium-grained, white, light tan, yellow, dark grey, carbonaceous fragments, dark grey shale beds up to 1 in. thick.
					Siltstone - Sandy Siltstone: light to dark grey.
			100		Sandstone: fine- to medium-grained, light to medium grey, shale clasts.
					Shale: grey to black, soft.
PRICE RIVER	UPPER CRETACEOUS	CR	150		Sandstone: medium-grained, yellow, grey, massive, carbonaceous fragments abundant along bedding planes.
					Sandstone: medium-grained, light grey, dark grey shale beds up to 1.5 ft. thick.
					Shale: light to dark grey, minor amounts of fine-grained grey to white sandstone.
					Sandstone: fine- to medium-grained, yellow, grey, fractures filled with carbonaceous matter.
			200		Sandstone: medium- to coarse-grained, gritty, light tan to white, minor amounts of pebbles 1/4 to 1/2 in. diameter and coal fragments from 227.1 to 227.5 ft.
			250		Sandstone: fine-grained, light grey, carbonaceous fragments, fractures filled with carbonaceous matter, carbonaceous seams up to 1/8 in. thick.

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
WELL NO: DH-7

DATE BEGIN: 7-31-89 DATE END: 8-25-89
DRILLER: SMITH LOGGER: I.L.
GROUND WATER EL: 8266' SURFACE EL: 9669'
COORDINATES: NE1/4 SW1/4 SE1/4, SEC 36, T15S R6E
FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
PRICE RIVER	UPPER CRETACEOUS	CR	250–300		Sandstone: medium-grained, dark grey, yellow, tan, contains 1/16 to 1/8 in. thick coal laminae, minor amounts of dark grey variegated sandy shale.
			300–350		Sandstone: fine- to medium-grained, light tan to white, yellow, fractures filled with carbonaceous material.
					Shale: sandy, dark grey.
			350–400		Sandstone: fine- to medium-grained, grey, white, trace amounts of shale and siltstone.
		CR	400–450		Sandstone: coarse-grained, gritty, light grey to white, fractures filled with coal fragments.
			450–500		Sandstone: medium- to coarse-grained, grey-white to yellow-tan, pebble conglomerates locally present, carbonaceous fragments along bedding planes, carbonaceous rich shale filling fractures.

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
WELL NO: DH-7

DATE BEGIN: 7-31-89 DATE END: 8-25-89
DRILLER: SMITH LOGGER: I.L.
GROUND WATER EL: 8266' SURFACE EL: 9669'
COORDINATES: NE1/4 SW1/4 SE1/4, SEC 36, T15S R6E
FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
PRICE RIVER	UPPER CRETACEOUS	CR	500		
			550		Siltstone: sandy, medium grey, minor amounts of light grey shale.
			600		Sandstone: fine- to coarse-grained, tan, grey, white, carbonaceous material along bedding planes and locally filling fractures.
					Shale: grey to black.
			650		Sandstone: fine-grained, light to medium grey, yellow, tan, carbonaceous fragments abundant along bedding planes.
					Sandstone: coarse-grained, gritty, yellow, tan.
					Siltstone: medium grey, interbedded with grey sandy shale and fine-grained light grey sandstone.
			700		Sandstone: fine-grained, light grey, carbonaceous fragments along bedding planes, carbonaceous-rich shales up to 3 in. thick.
CASTLEGATE	UPPER CRETACEOUS	CR			Sandstone: fine- to coarse-grained, light grey to white, medium to dark grey siltstone present from 726 to 743 ft. grades into overlying sandstone.
			750		

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
WELL NO: DH-7
DATE BEGIN: 7-31-89 DATE END: 8-25-89
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GROUND WATER EL: 8266' SURFACE EL: 9669'
COORDINATES: NE1/4 SW1/4 SE1/4, SEC 36, T15S R6E
FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
CASTLEGATE	UPPER CRETACEOUS	CR	750		Sandstone: fine-grained, grey to white.
					Shale: sandy, dark grey, interbedded with white fine-grained sandstone, coal beds up to 1 in. thick.
					Sandstone: fine-grained, dark grey with grey mottling, carbonaceous fragments.
			800		Shale: sandy, light grey, carbonaceous-rich laminae.
					Sandstone: fine-grained, grey, tan, white, fractures filled with carbonaceous-rich shale.
					Sandstone: medium-grained, light grey, interbedded with grey to white sandy shale, carbonaceous fragments common along bedding planes.
			850		Sandstone: medium-grained, light grey.
					Shale: sandy, light to dark grey, coal bed 4 in. thick at 886 ft.
		CR	900		Sandstone: fine- to medium-grained, grey to white, fractures filled with carbonaceous matter.
					Sandstone: coarse, dark grey.
			950		Siltstone: white to light grey, interbedded with dark grey sandy shale.
BLACKHAWK	UPPER CRETATEOUS	CR	1000		Sandstone: medium- to coarse-grained, gritty, tan-white to white, massive, dark grey siltstone intraclasts present from 1008 to 1011.3 ft.

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
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DATE BEGIN: 7-31-89 DATE END: 8-25-89
DRILLER: SMITH LOGGER: I.L.
GROUND WATER EL: 8266' SURFACE EL: 9669'
COORDINATES: NE1/4 SW1/4 SE1/4, SEC 36, T15S R6E
FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
BLACKHAWK	UPPER CRETACEOUS		1000		
			1050		Siltstone: grey to dark grey, medium-grained sandstone and sandy siltstone beds present from 1054 to 1057.6 ft.
		CR			Sandstone: fine-grained, light grey.
			1100		Siltstone - Sandy Siltstone: grey.
					Sandstone: fine-grained, grey to white, minor amounts of dark to medium grey siltstone and shale beds, 4 in. thick coal at 1126 ft.
			1150		Siltstone: light grey, minor amounts of fine-grained light grey sandstone.
					Coal.
		CR			Siltstone: light grey, thin lenses of black shale containing coal fragments.
			1200		Sandstone: fine-grained, grey, white.
					Shale: sandy, dark grey, interbedded with minor amounts of sandy dark grey siltstone.
					Sandstone: fine-grained, light grey.
			1250		

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
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GROUND WATER EL: 8266' SURFACE EL: 9669'
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FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
BLACKHAWK	UPPER CRETACEOUS	CR	1250		Siltstone: sandy, light grey, 2 in. shale and 1 in. thick coal beds present.
					Sandstone: fine-grained, light grey.
					Siltstone: dark grey.
			1300		Sandstone: medium-grained, light to medium grey, carbonaceous fragments common and fill fractures.
					Siltstone: light grey.
					Sandstone: medium-grained, light grey.
			1350		Siltstone: dark grey, interbedded with grey-white sandy siltstone, coal beds up to 4 in. thick and shale beds up to 2 in. thick present in minor amounts.
					Sandstone: fine-grained, grey, white, black carbonaceous-rich shale present from 1377.5 to 1379.1 ft.
					Coal.
			1400		Siltstone: sandy, dark grey, coal beds up to 4 in. thick and sandstone beds up to 8 in. thick present from 1381 to 1389 ft.
		CR			Coal.
			1450		Siltstone: light grey, coal and carbonaceous shale beds up to 4 in. thick, fine-grained sandstone present from 1468 to 1468 ft.
					Coal: black, vitreous.
					Shale: sandy, dark grey to black.
			1500		Siltstone: light to medium grey, 2 in. thick coal at 1491 ft.

GEOLOGIC LOG

NEICO EAST MTN. EXPLORATION PROGRAM
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GROUND WATER EL: 8266' SURFACE EL: 9669'
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FIRST WATER AT: 1403'

EarthFax

FORMATION	AGE	SAMPLE METHOD (ST = SHELBY TUBE, SS = SPLIT SPOON, CR = CORE, C = CUTTINGS)	DEPTH	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
BLACKHAWK	UPPER CRETACEOUS	CR	1500		Coal.
					Shale: dark grey to black, carbonaceous rich.
					Coal.
					Sandstone: fine- to medium-grained, light grey to white, shale and coal beds up to 1.2 and 3 in. thick, respectively, are present in minor amounts.
			1550		Coal.
					Siltstone: light grey, dark grey to black shale beds up to 2 ft. thick present in minor amounts.
					Coal.
					Siltstone: light to medium grey.
					Sandstone: fine-grained, tan, grey.
			1600		Coal: black, no parting, sharp upper and lower contacts. Hiawatha Coal Seam.
STAR POINT	UPPER CRETACEOUS	CR			Sandstone: medium-grained, tan, grey.
			TD: 1628 ft.		
			1650		

Confidential

GAMMA RAY - DENSITY - CALIPER

BOREHOLE 7

CLIENT COAL SYSTEMS INC/NEICO

AREA Tie Fork, Utah

COUNTRY USA

DATE LOGGED 8-25-89

DEPTH SCALE 120:1

1 OF 2 LOGS

BOREHOLE DATA

PERMANENT DATUM	GROUND LEVEL			
ELEVATION OF P D				
		B P B		DRILLER
MEASUREMENTS FROM		GROUND LEVEL		GROUND LEVEL
DEPTH REACHED		1623'		1628'
CASING SHOE		388'		388'
BIT SIZES	1	3" TO 1628'	2	TO
	3	TO	4	TO
CASING SIZES	1	TO	2	TO

FLUID DATA

NATURE	air
S G	-
LEVEL	-
VISCOSITY	
Rm at meas temp	
B H T	

OPERATION DATA

FIRST READING	1613'
LAST READING	0
INTERVAL LOGGED	1613'
UNIT-TRUCK No	Heli-unit
ENGINEER	C.S.NOVINSKIE/G.CONKLIN
WITNESS	T.THOMPSON

EQUIPMENT AND RECORDING DATA

DEPTHS | CAL COEFF | PANEL | TAPING | EQUIPMENT | LOG

JAN 30 1991

OIL, GAS & MINING

EQUIPMENT AND RECORDING DATA

LOG	EQUIPMENT			TAPING			PANEL			CAL COEFF	DEPTHS		
	SONDE	SOURCE	CALIBRATOR	LOG TAPED	RECORD SPEED	DIRECT or REPLAY	SPEED	TC SECS	NORM		FROM	TO	INTERVAL
GAMMA	207D	-	G7	yes	30	d	30	1	1.6	.16	1613	0	1613
LSD	207D	C005	D1	yes	30	d	30	1	5.3	.53	1623	10	1613
BRD	207D	C005	-	yes	30	d	30	1	6.2	.62	1623	10	1613
CAL	207D	-	C1	yes	30	d	30	1	-	-	1621	8	1613

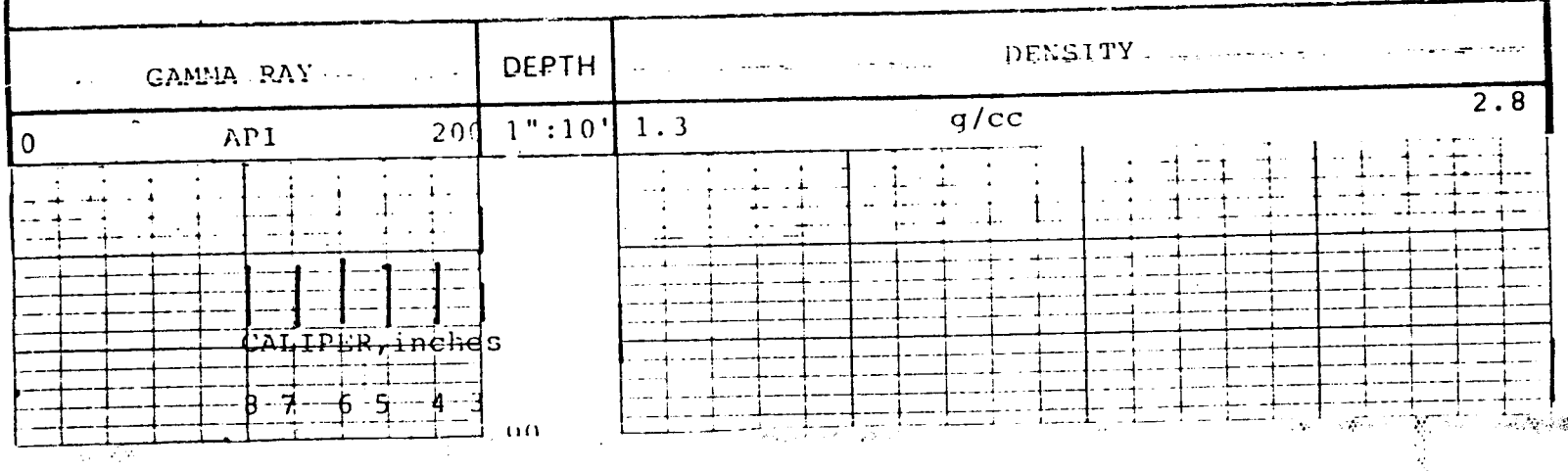
ADDITIONAL SONDES RUN

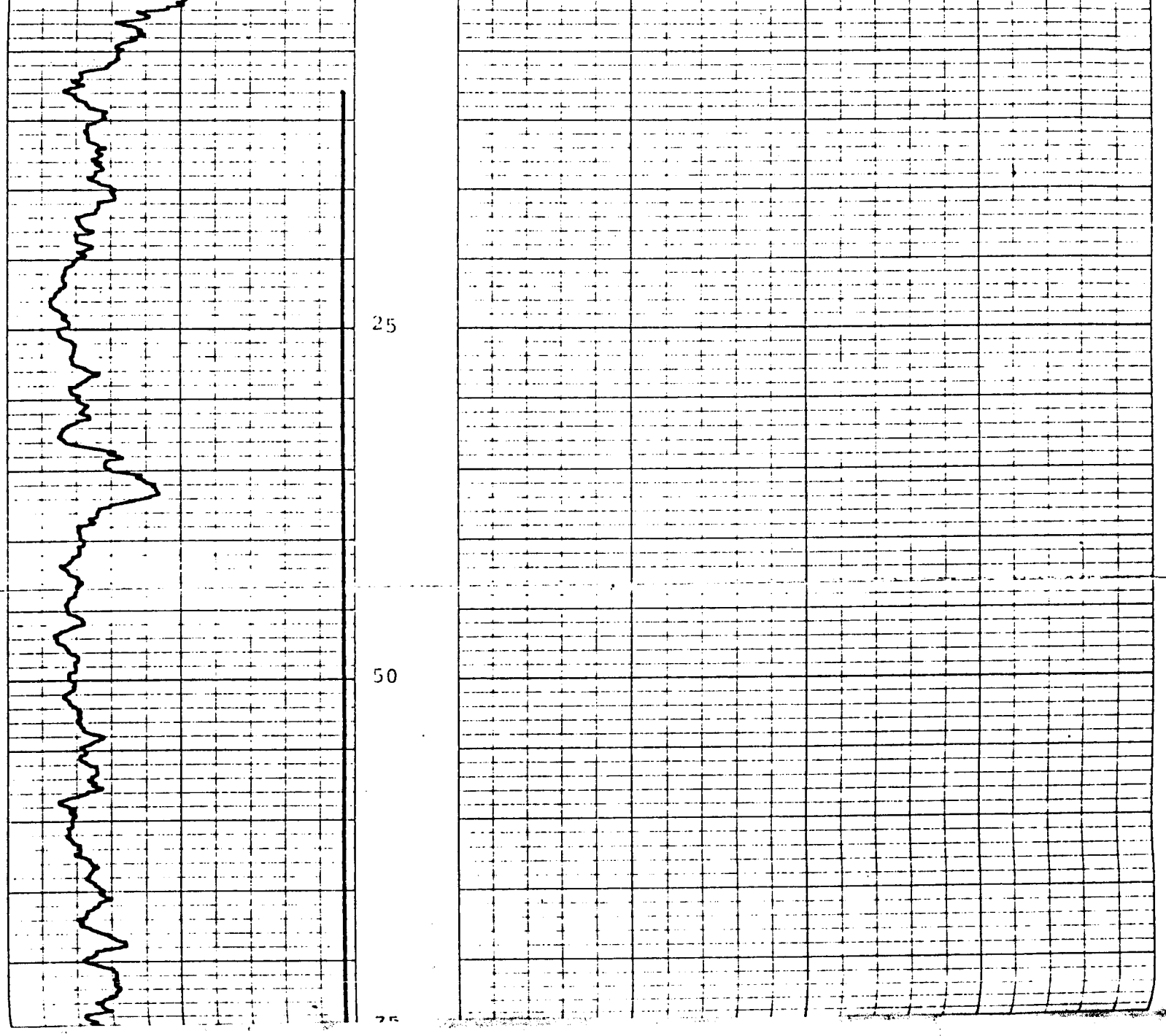
SONDE	LOG	GENERAL SCALE LOG	DETAIL SCALE LOG

REFER TO ADDITIONAL HEADINGS

REMARKS

DENSITY UNCALIBRATED IN FLUID

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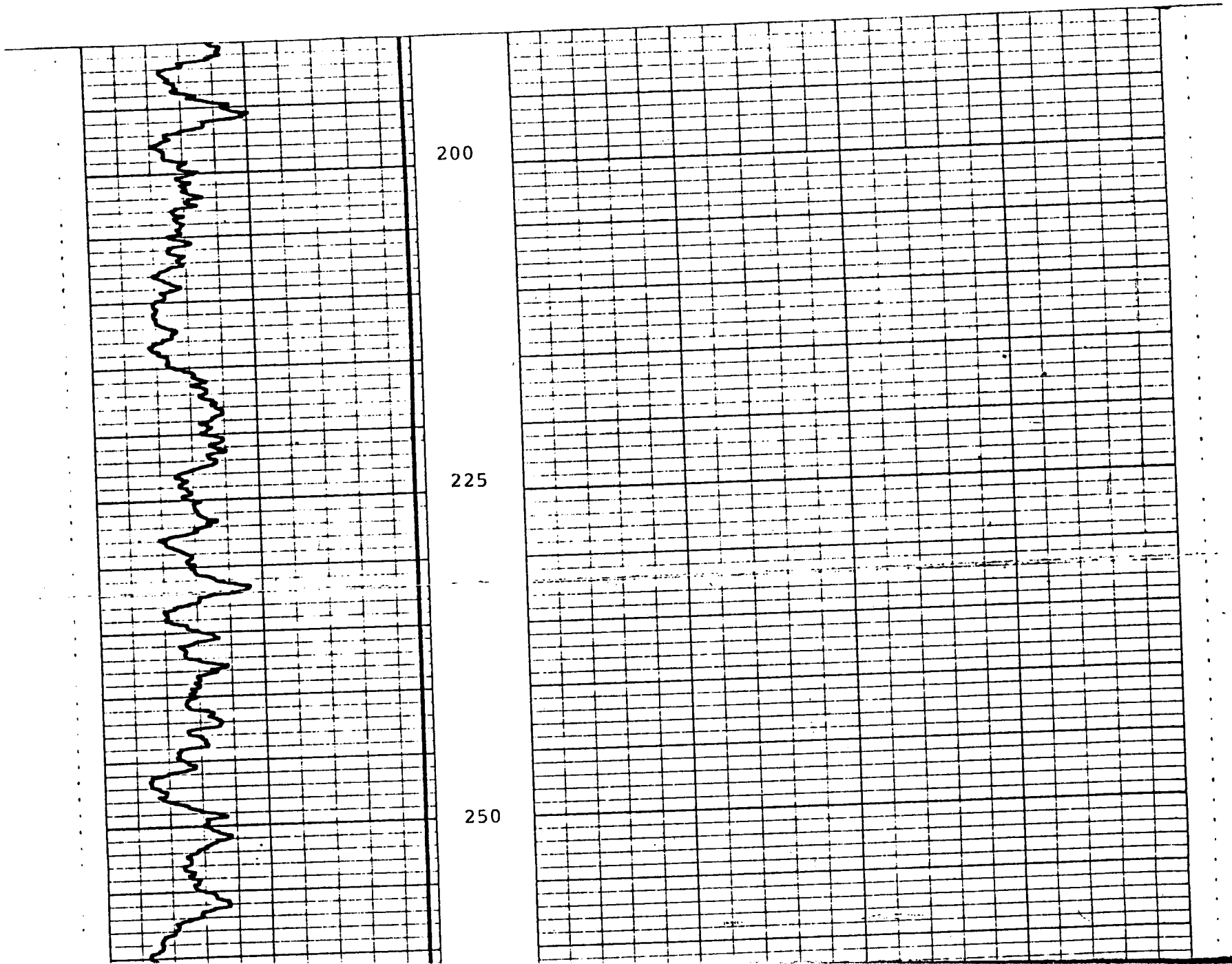
DH-7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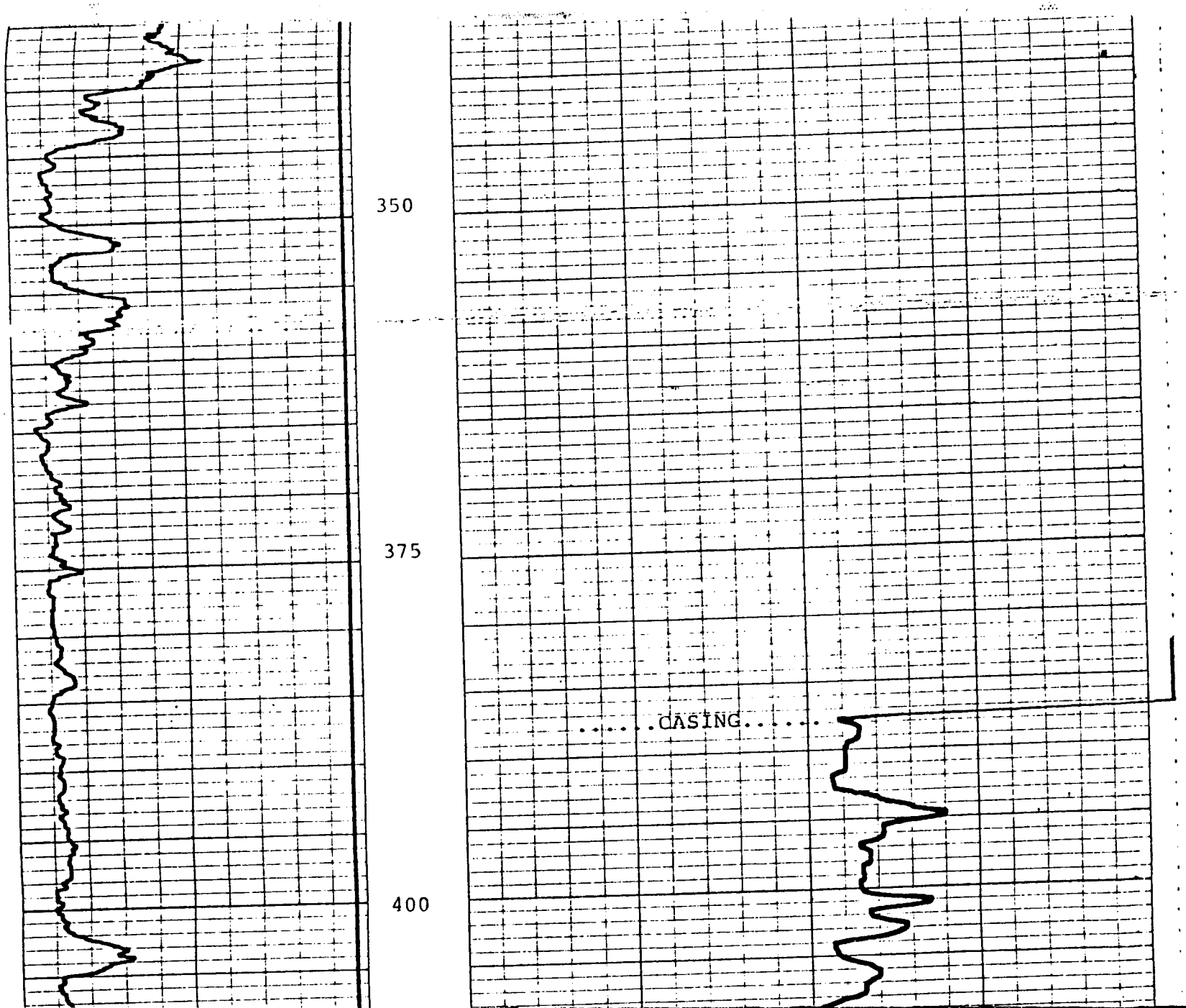
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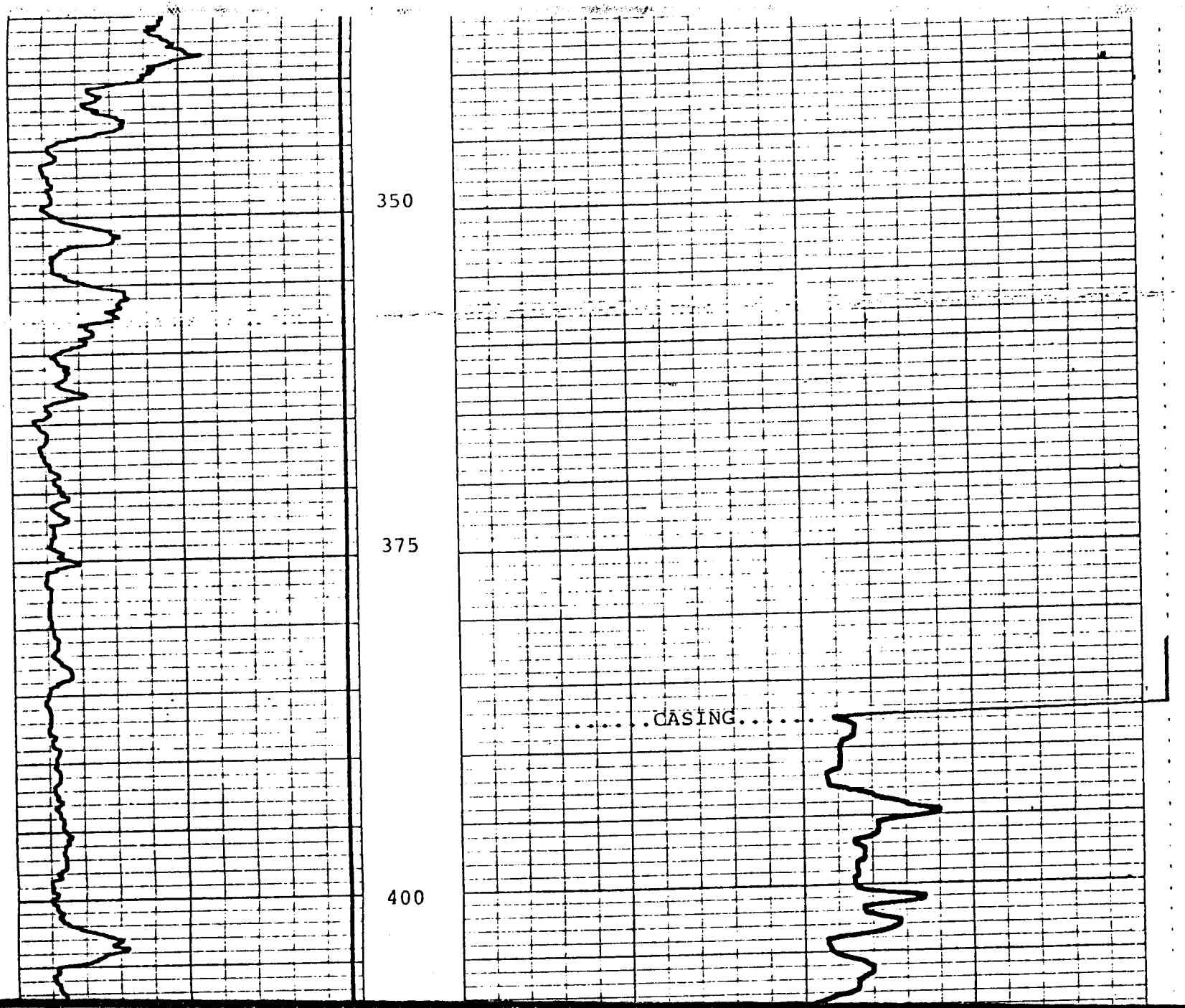
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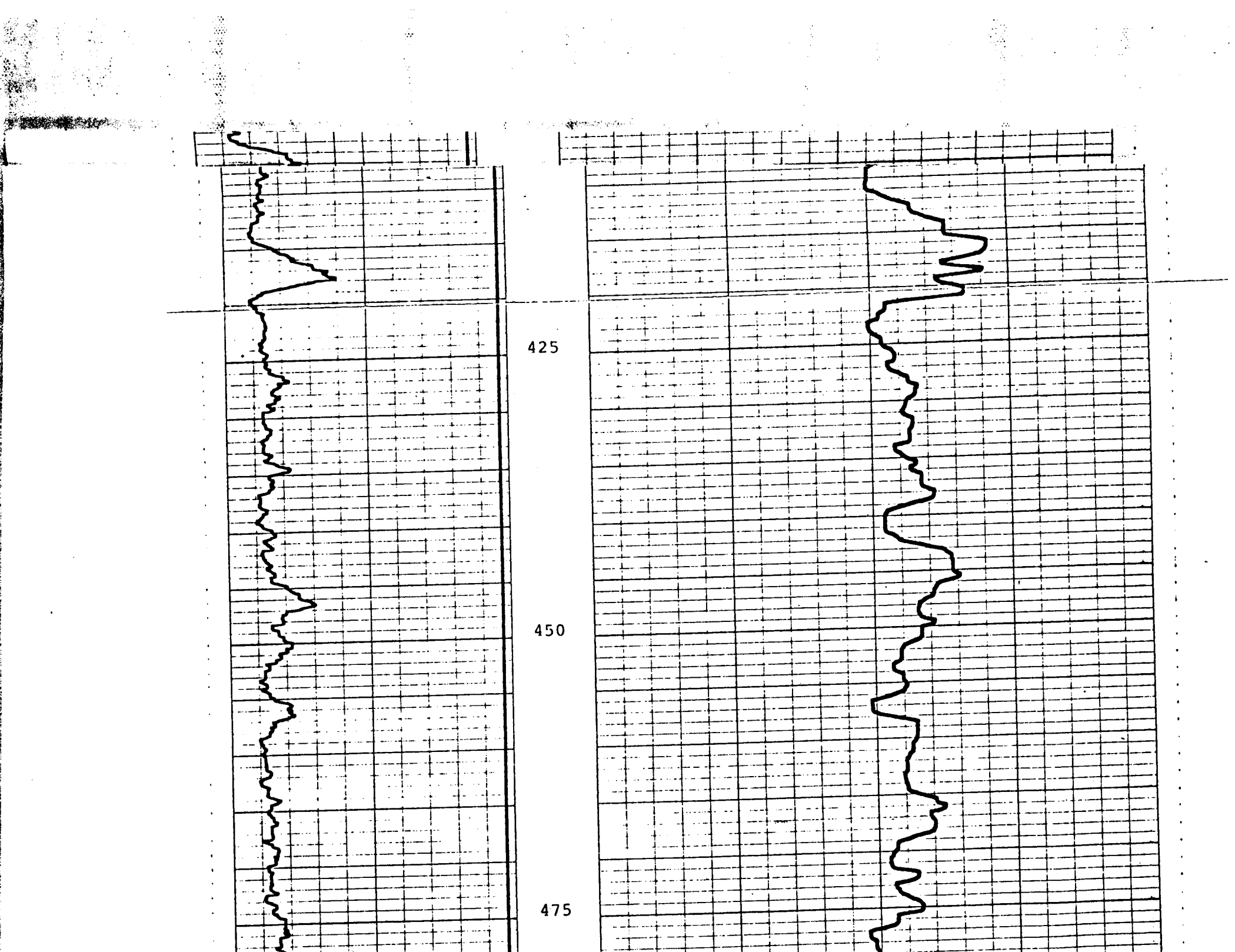
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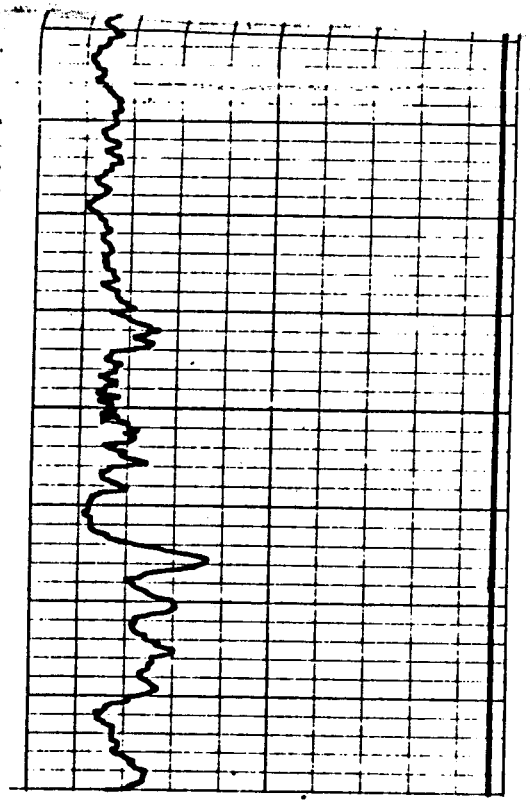

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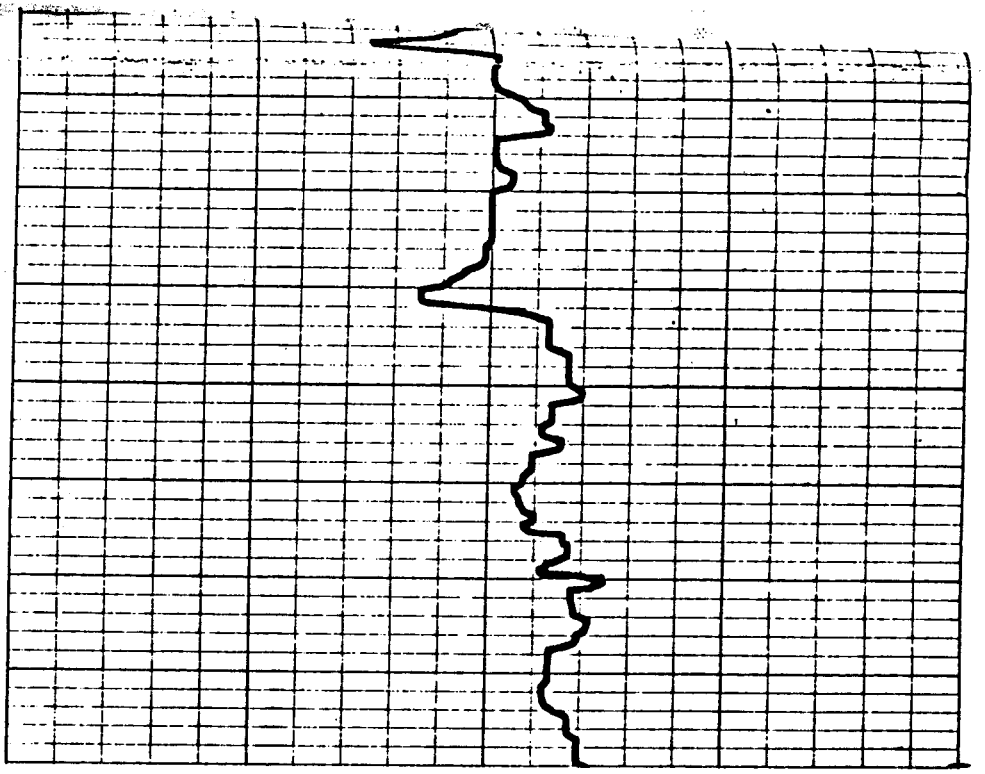

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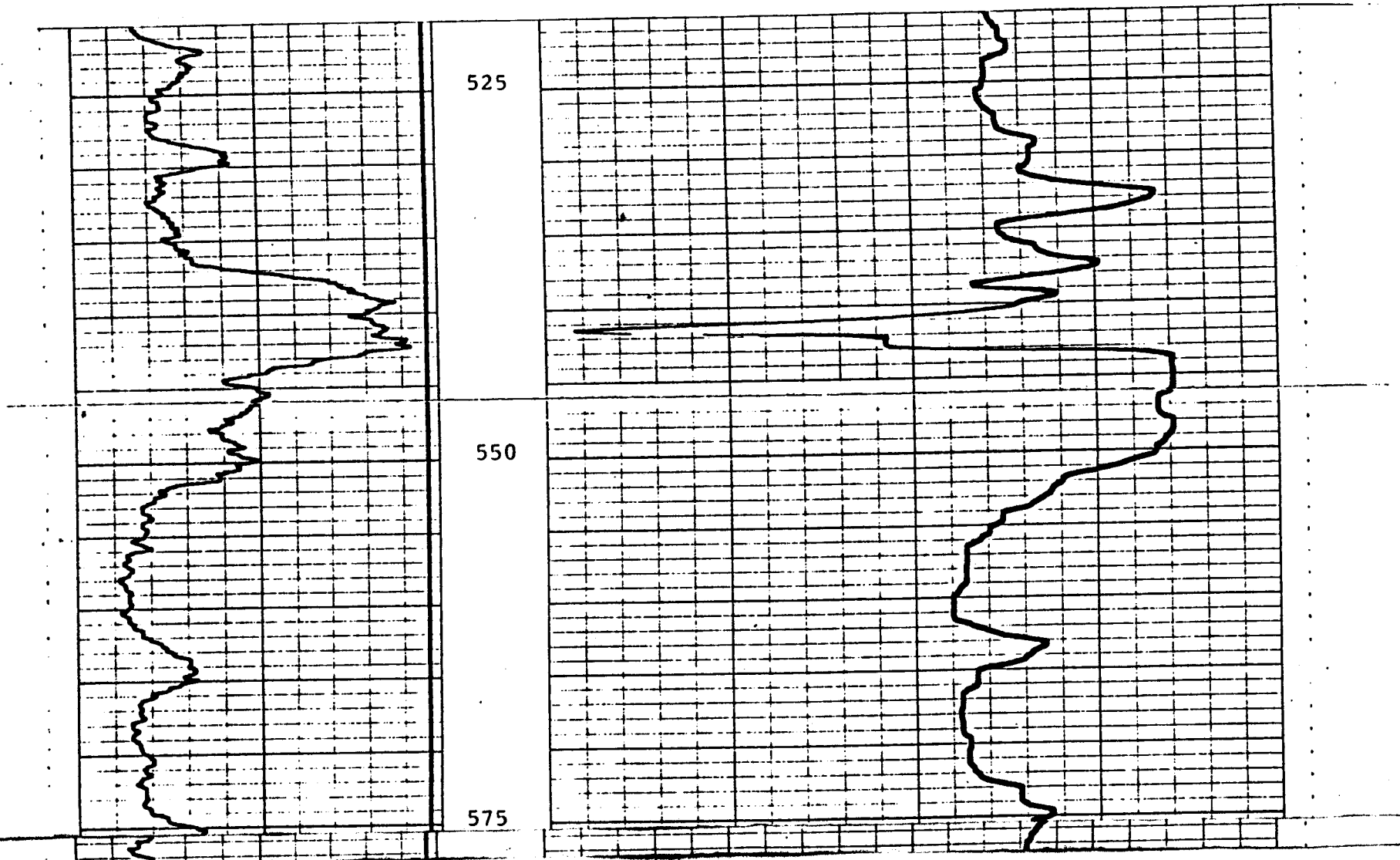
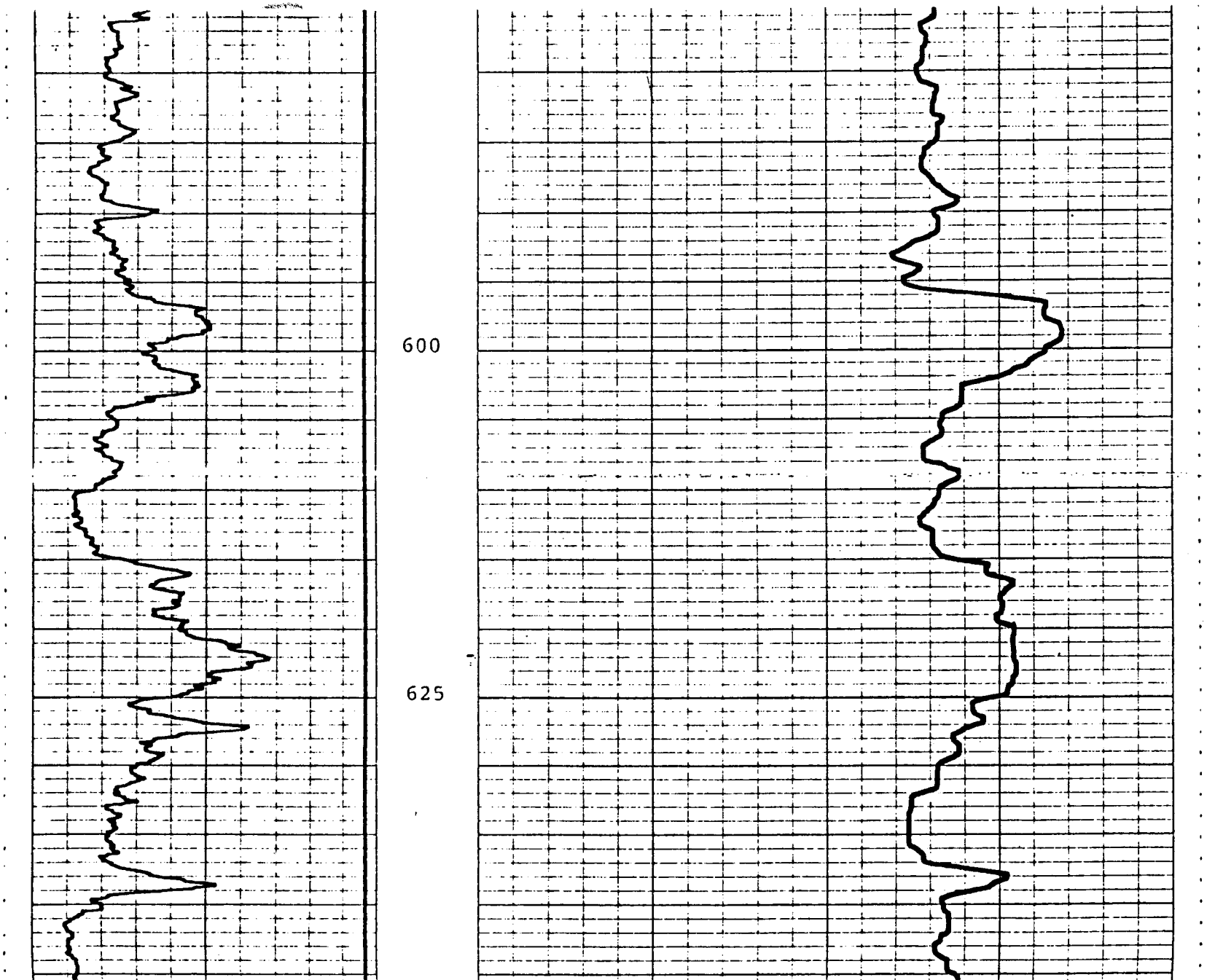
OIL, GAS & MINING

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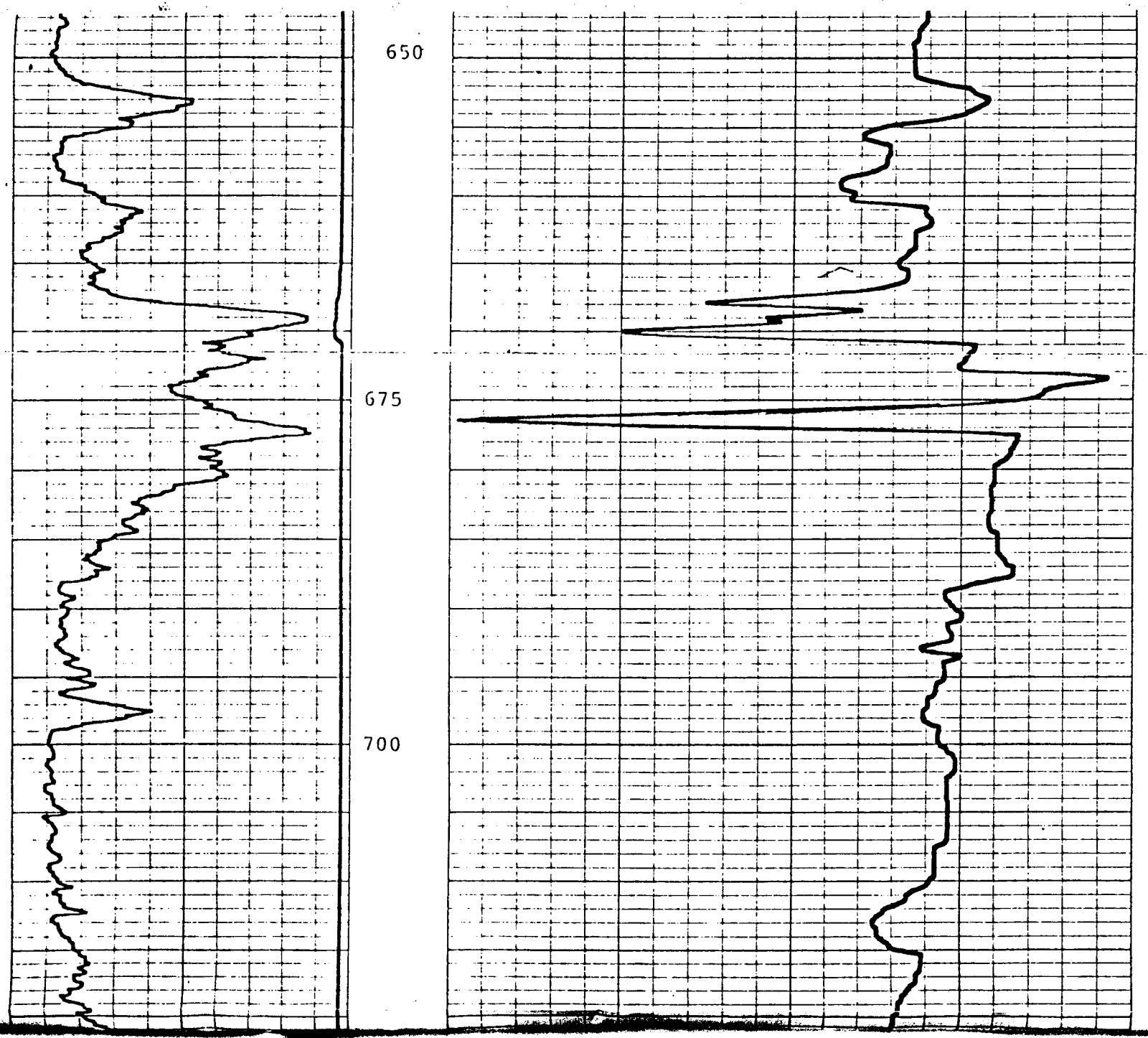
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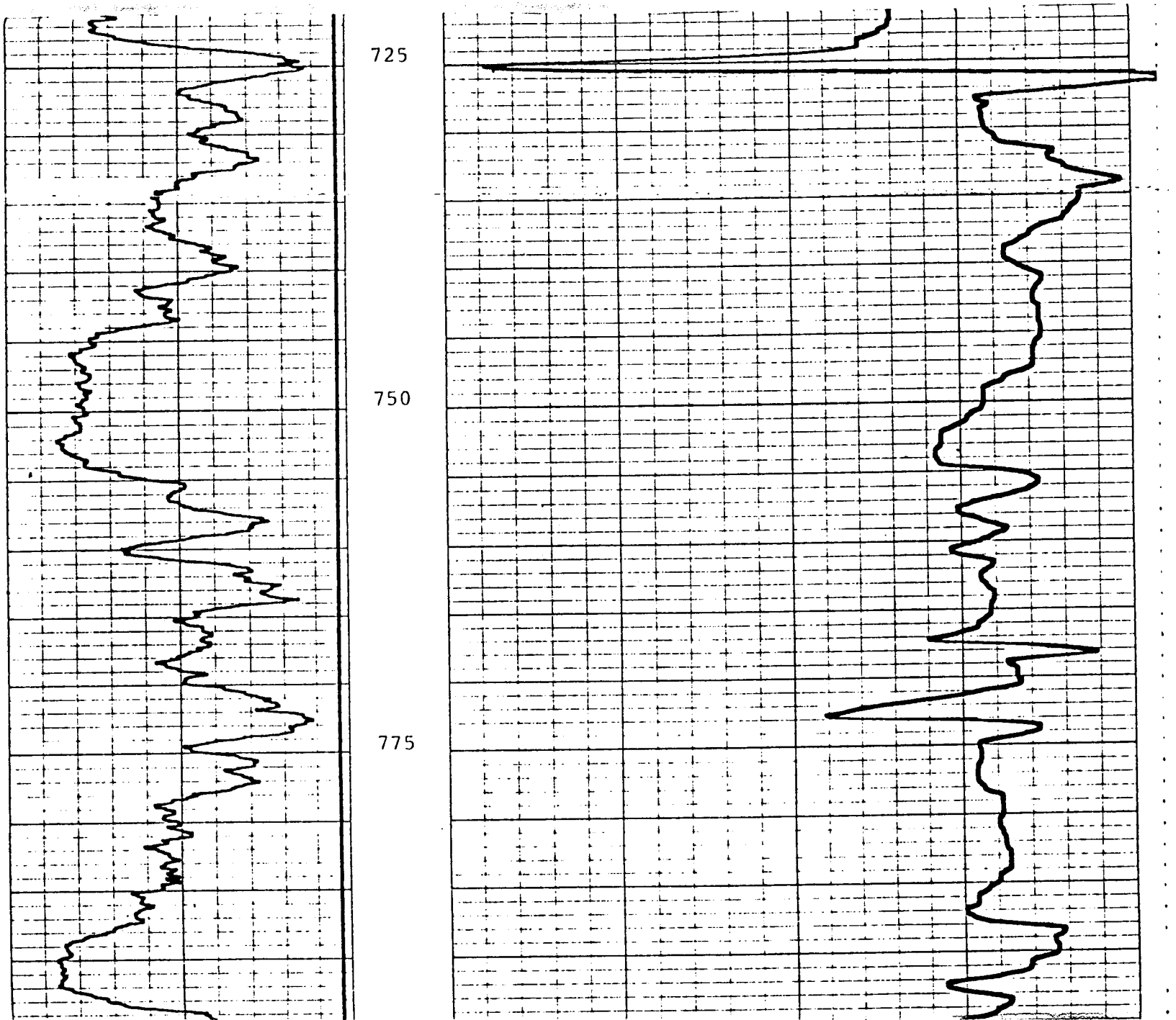
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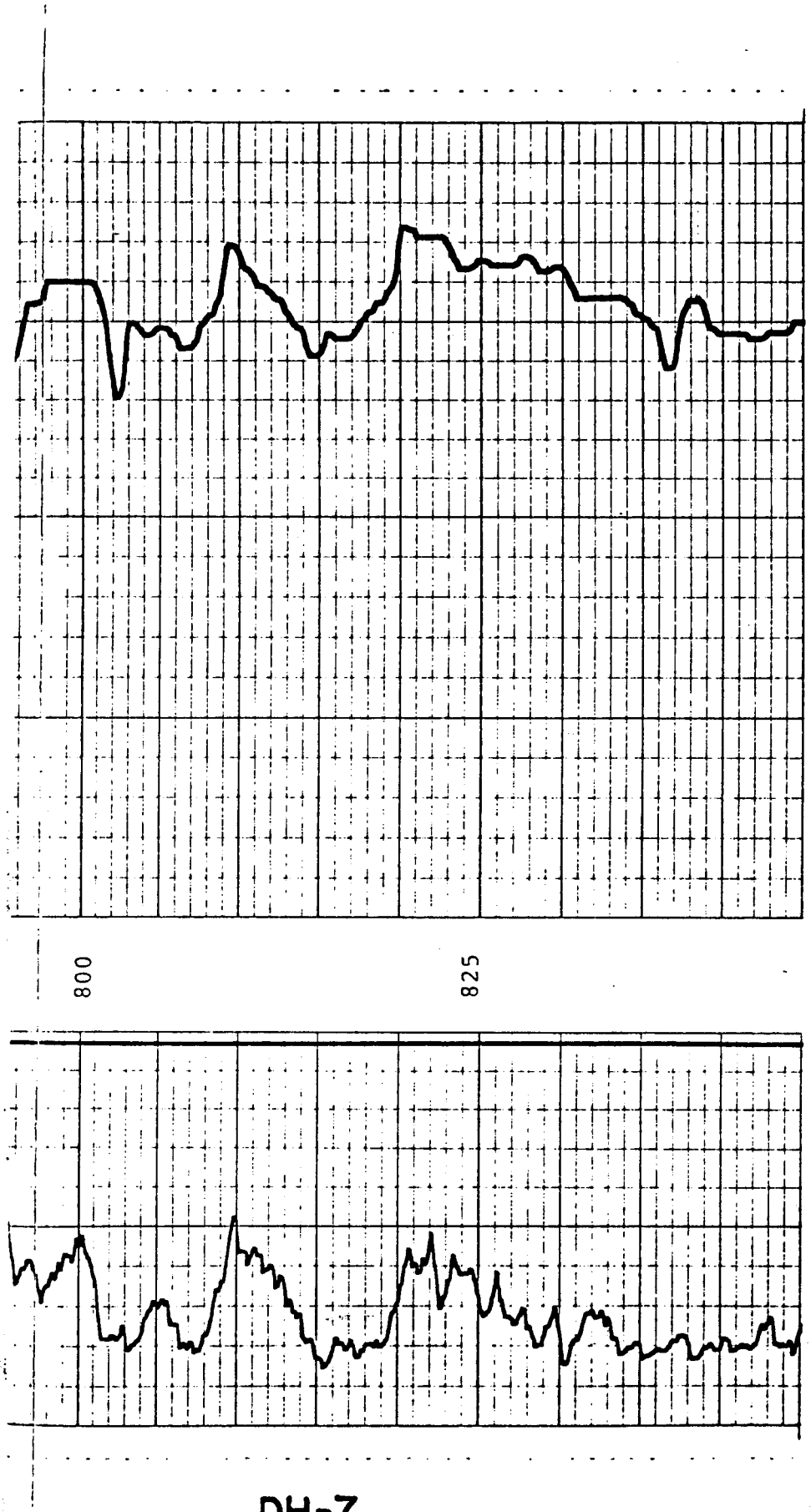
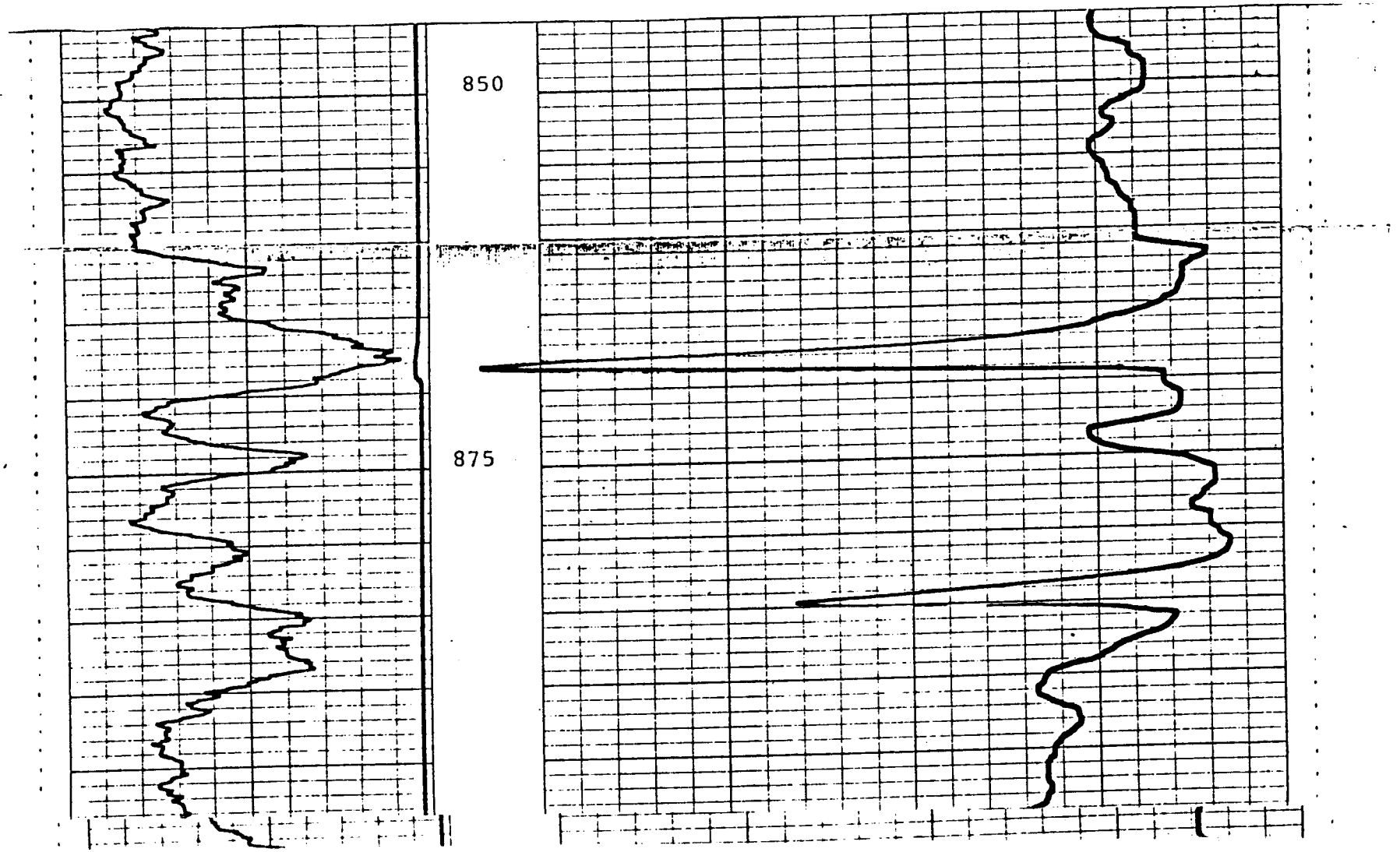


DH-7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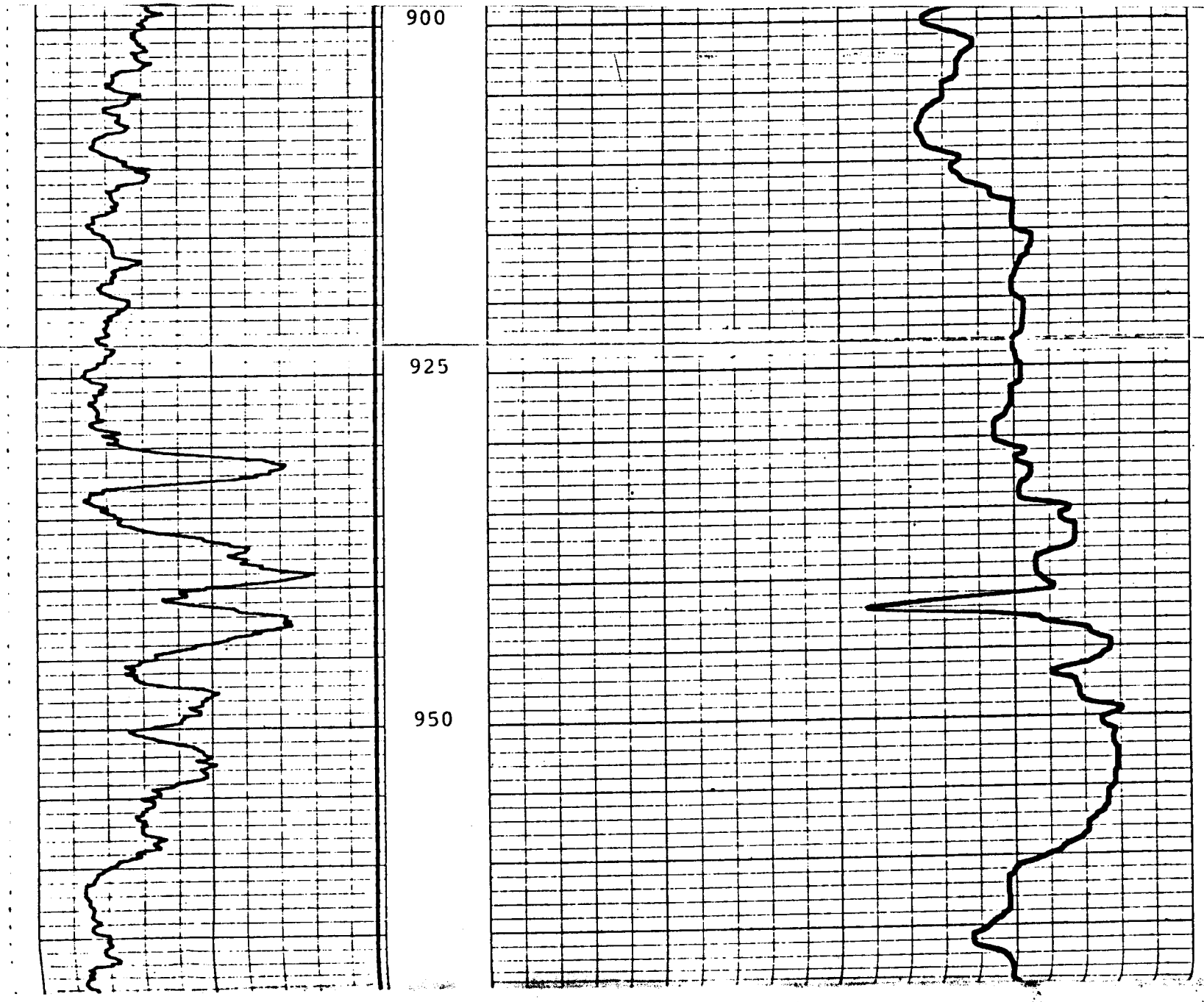
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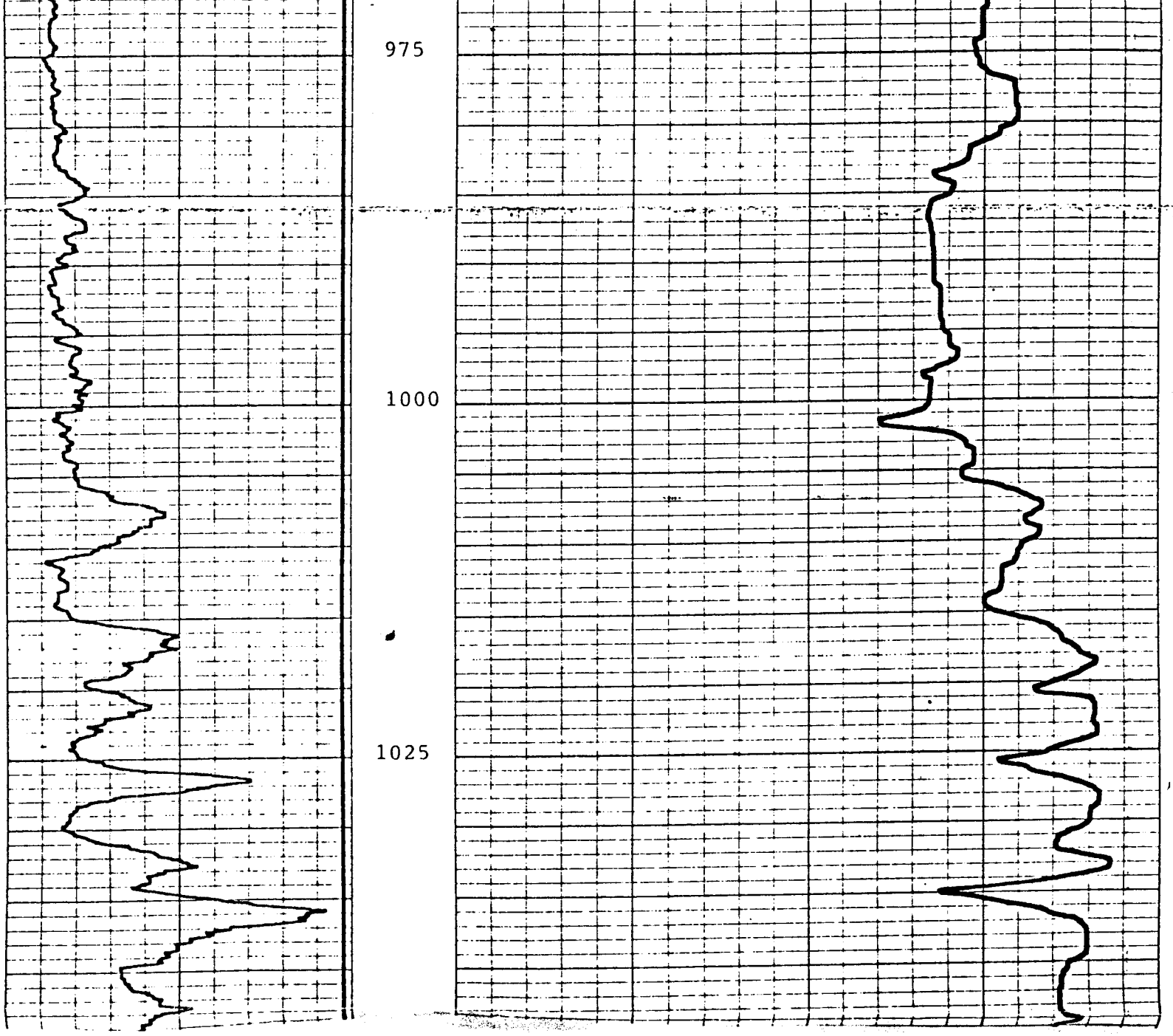
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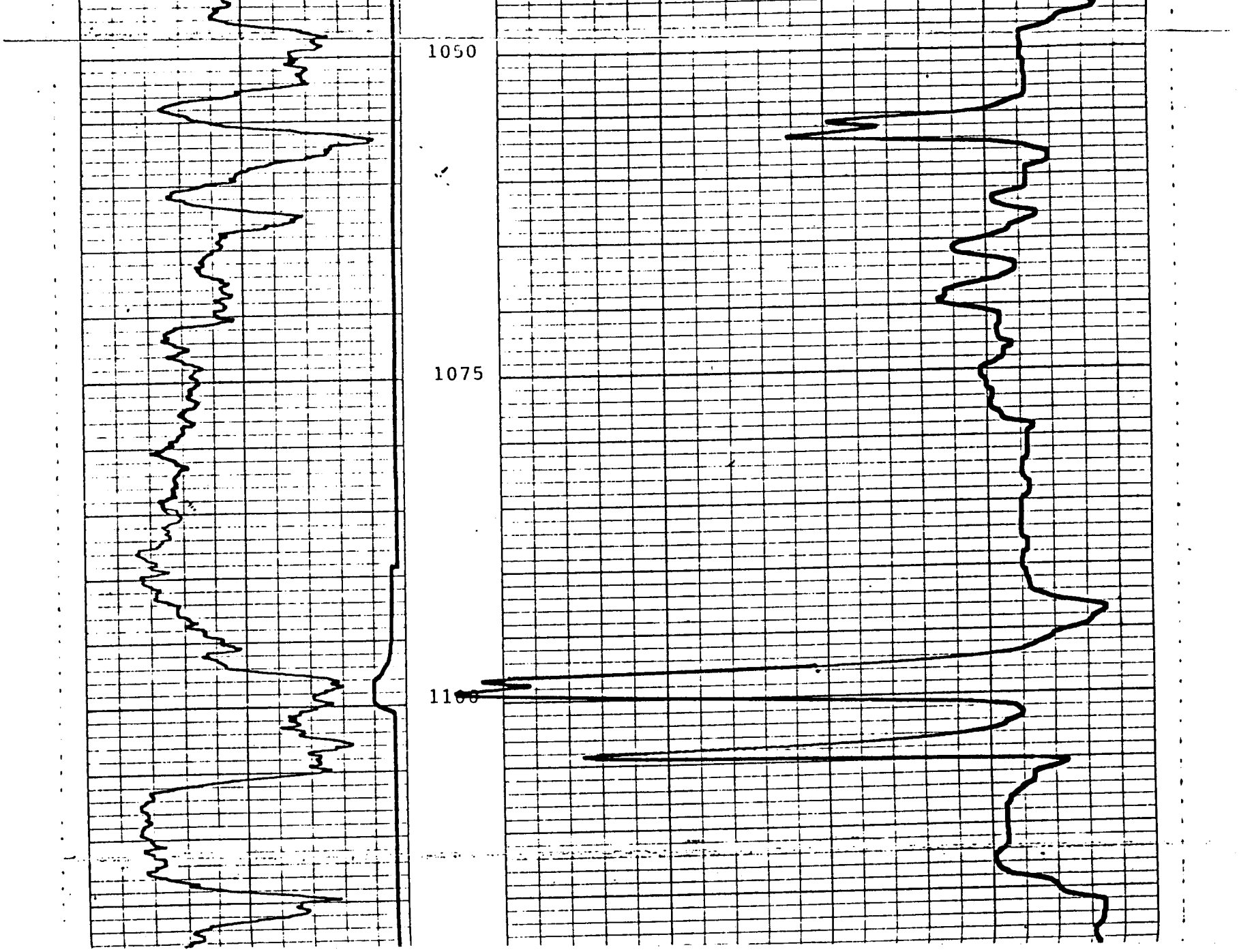
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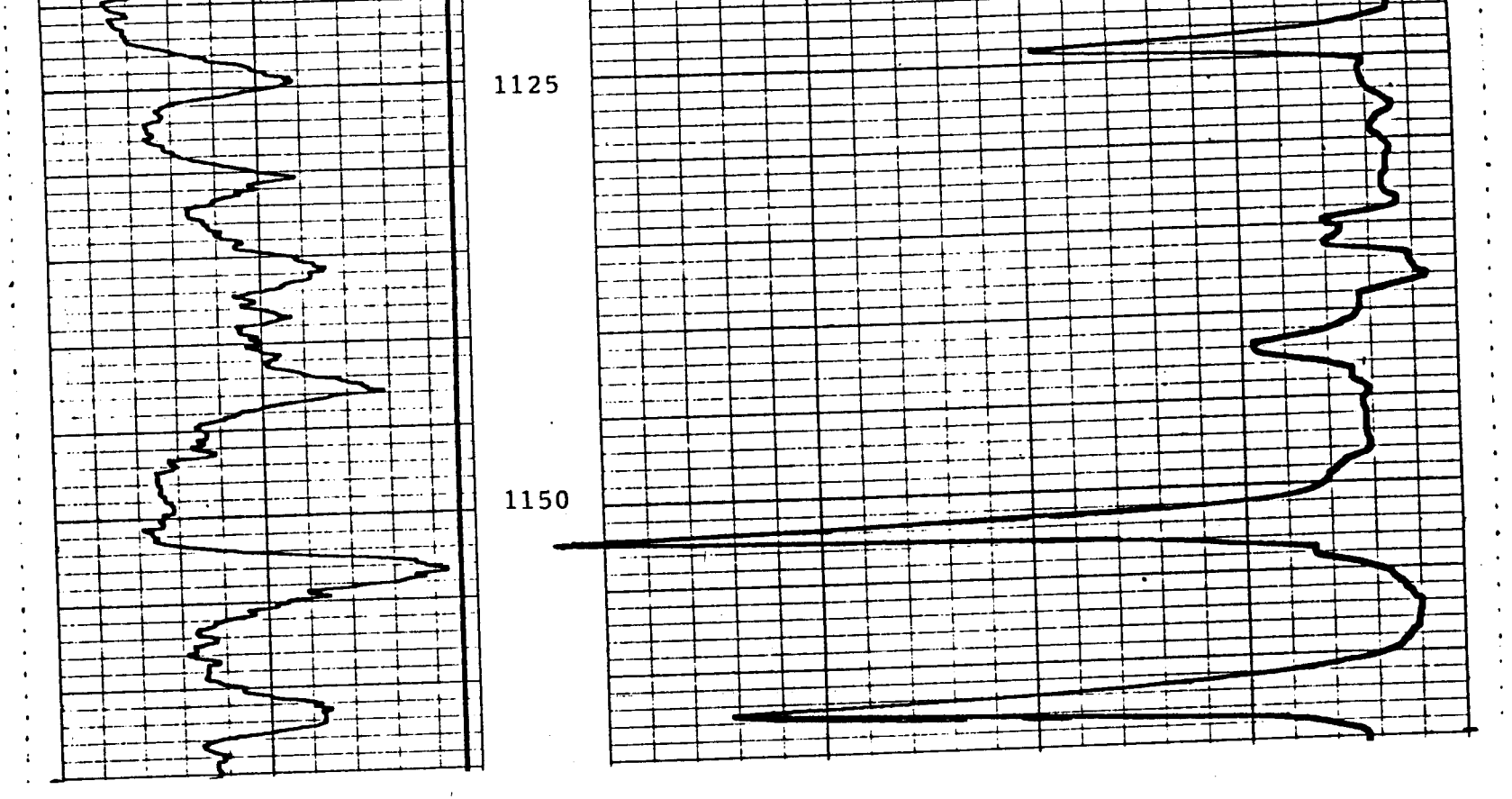
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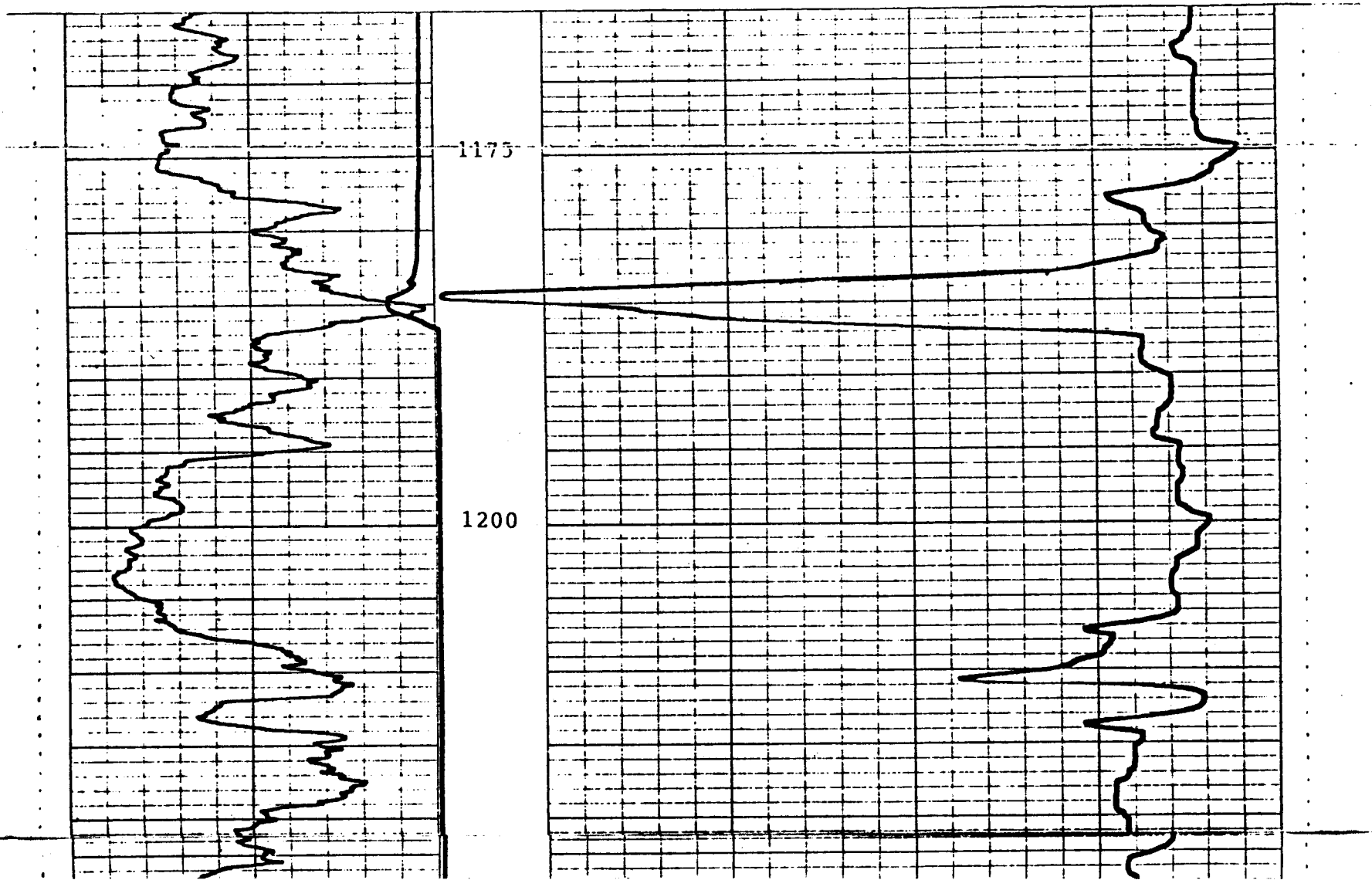

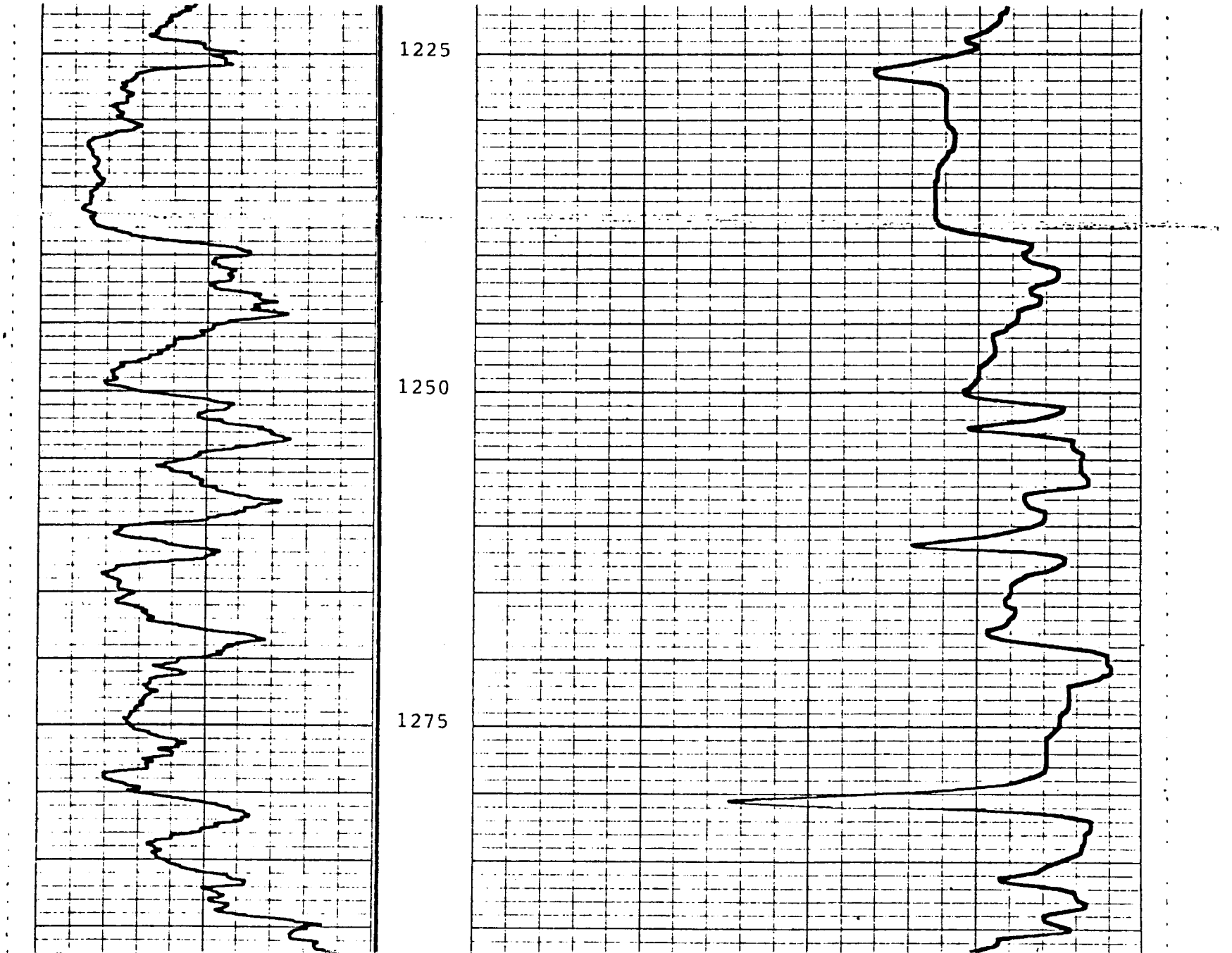
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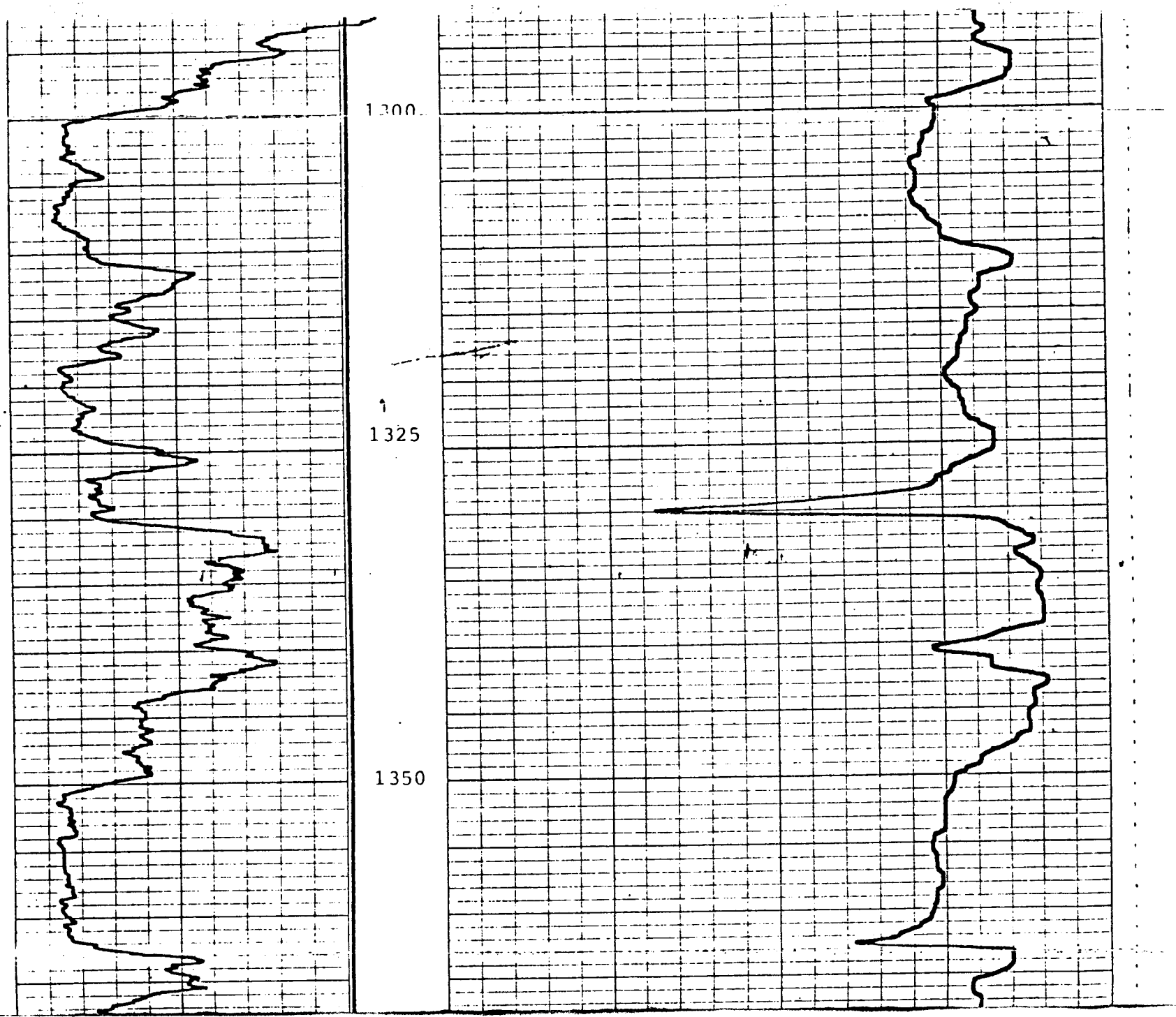
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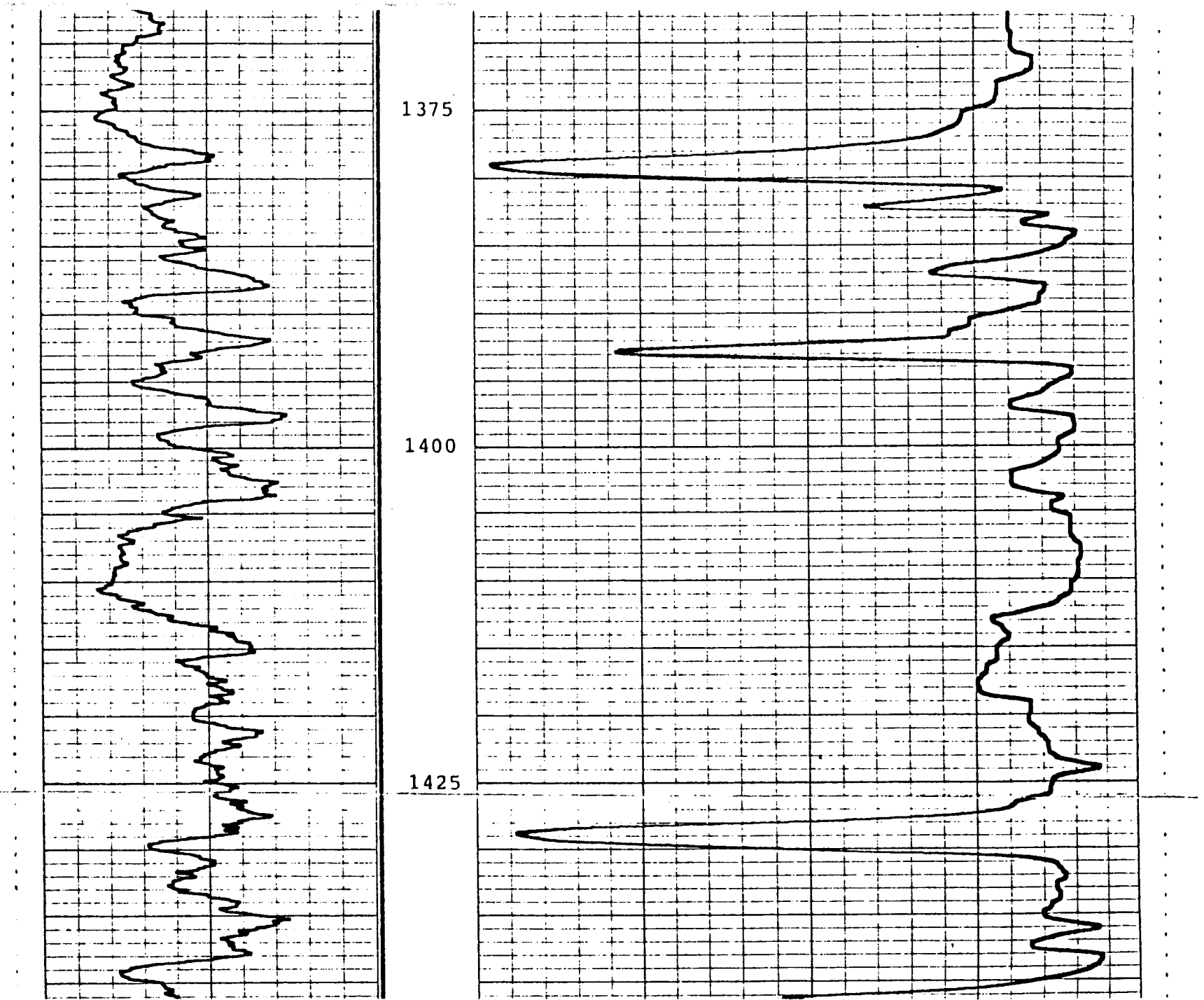
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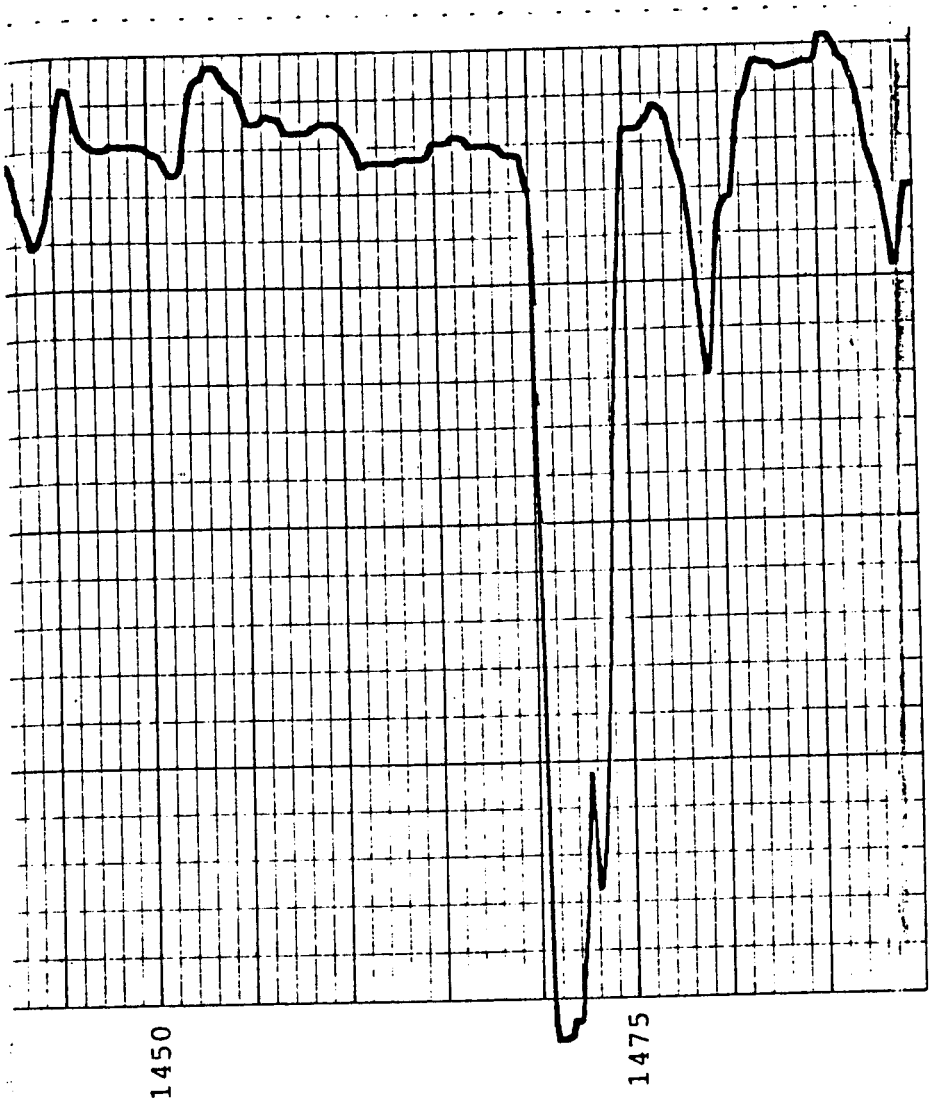

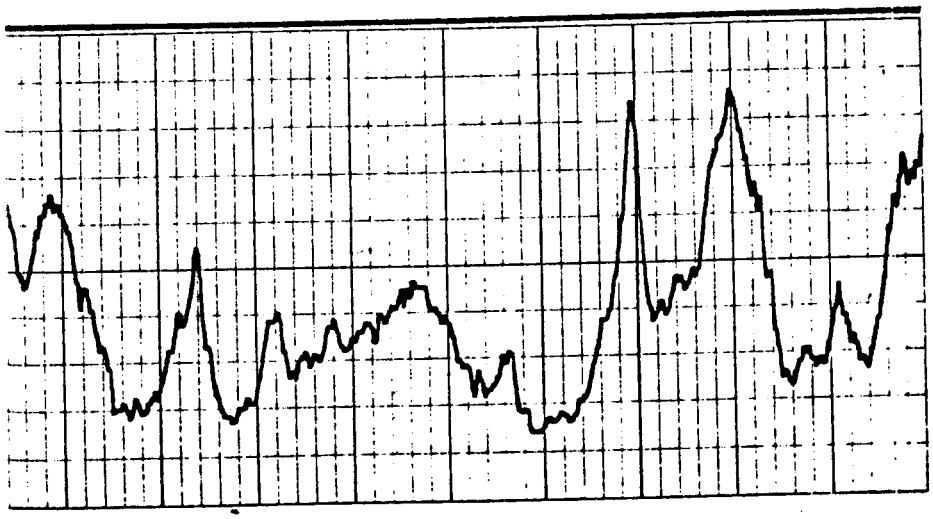

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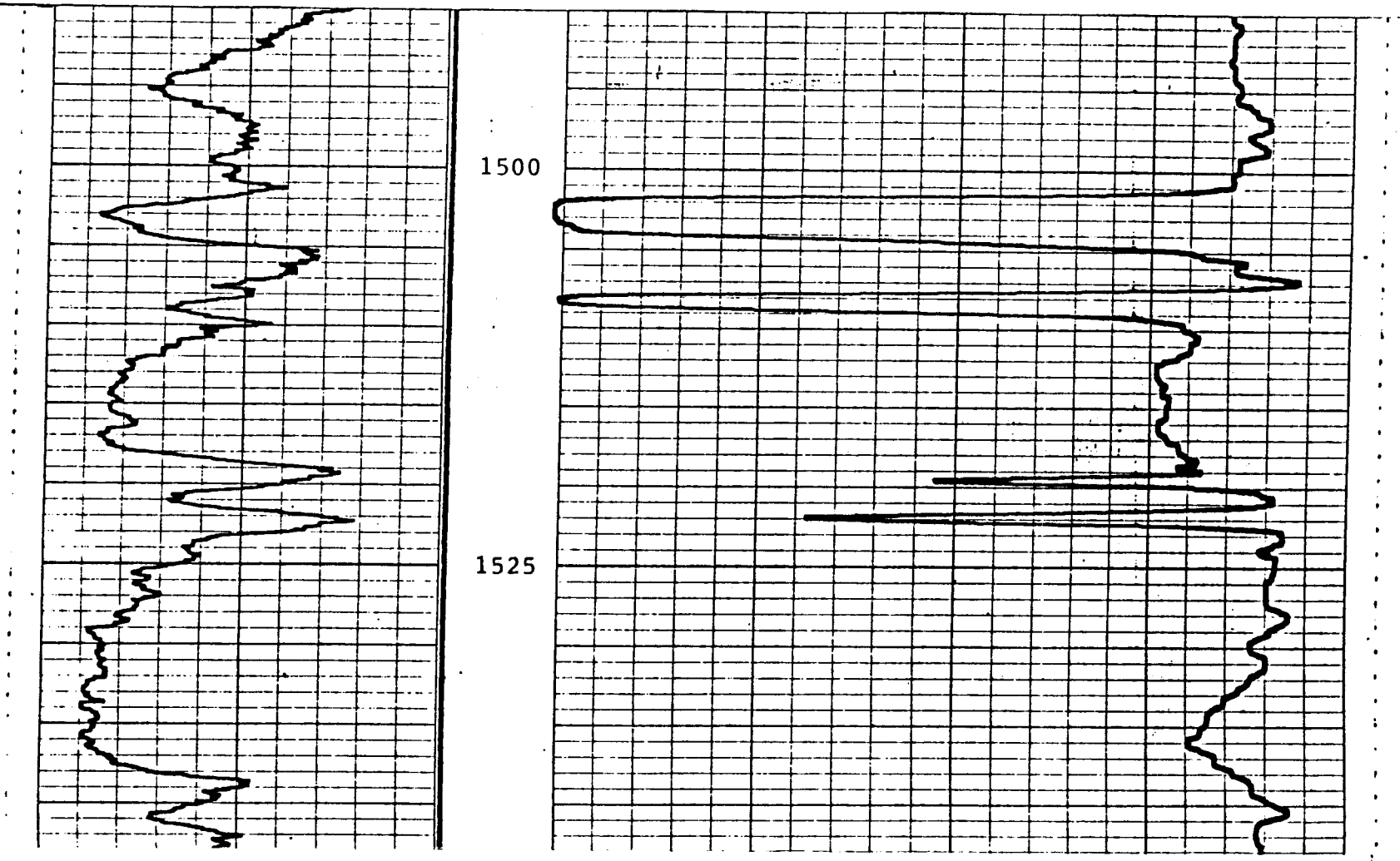
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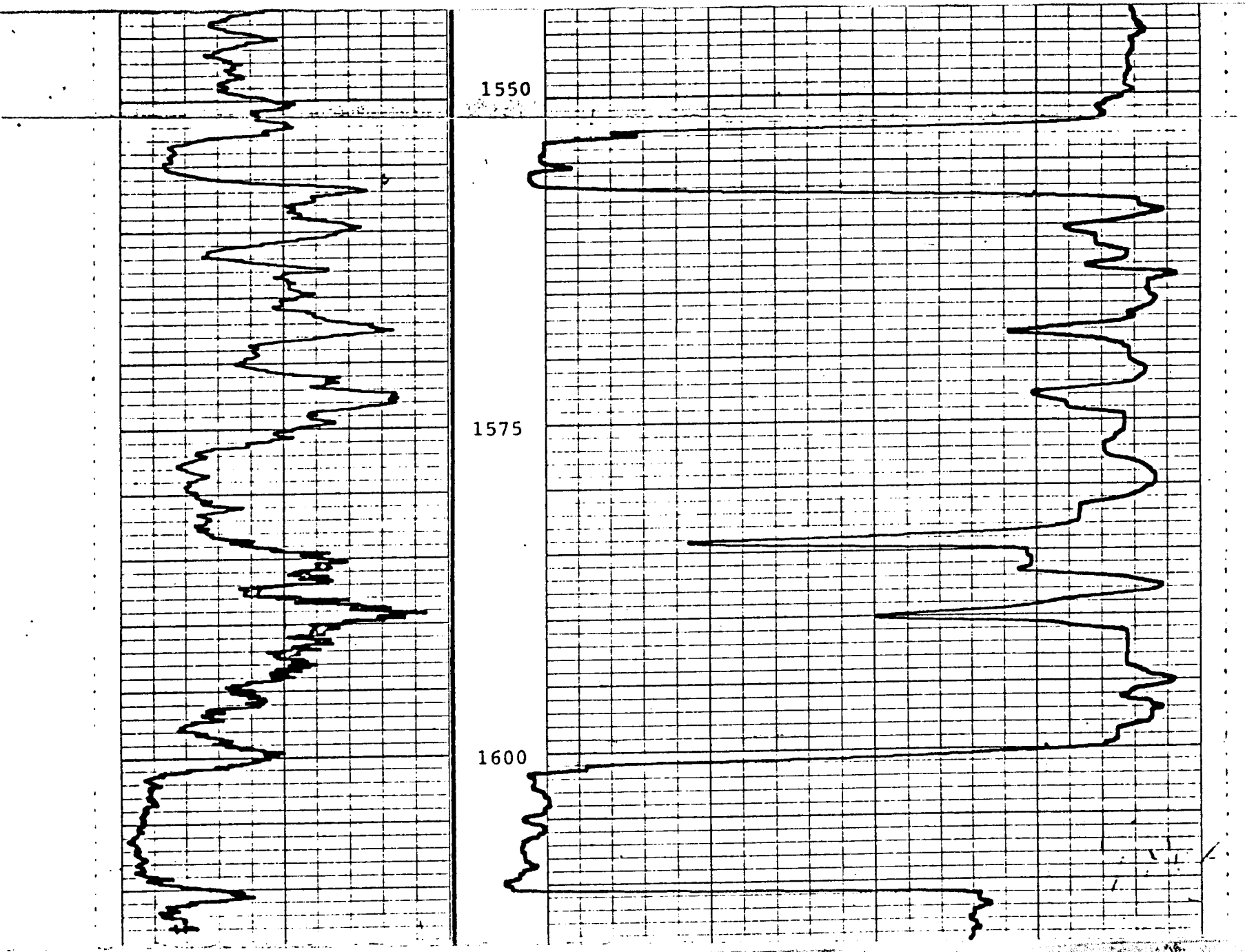
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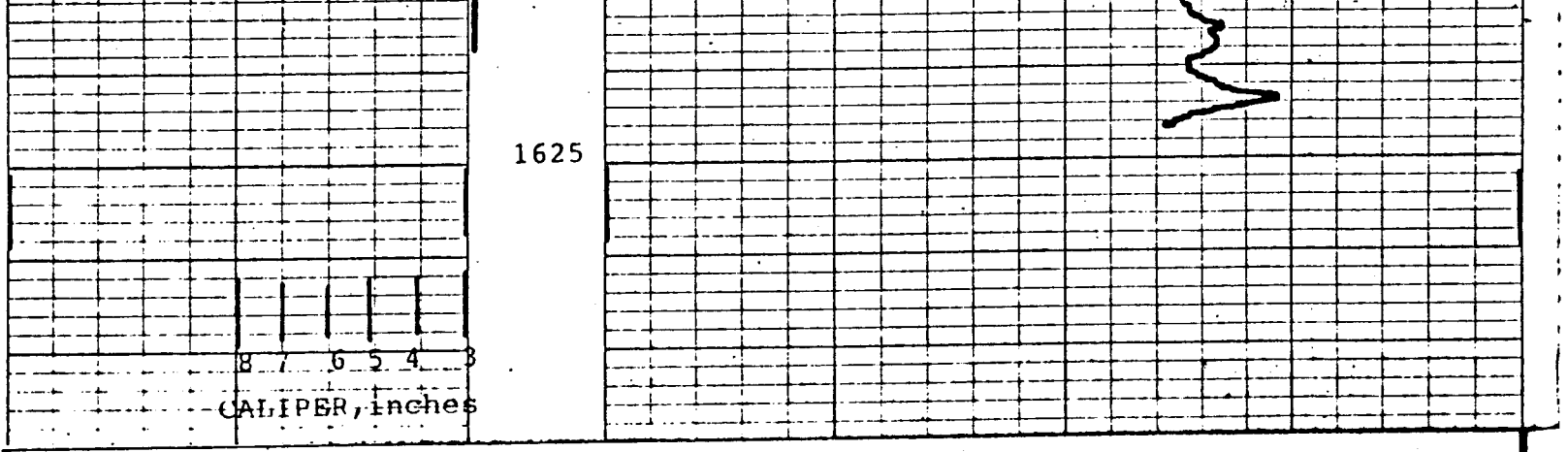

0 API 200	1":10'	1.3 g/cc 2.8
GAMMA RAY	DEPTH	DENSITY

BPB

BOREHOLE 7

CLIENT COAL SYSTEMS INC/NEICO

AREA Tie Fork, Utah

COUNTRY USA

MY 95160 R