UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

# LITHOLOGY AND LITHIUM CONTENT OF SEDIMENTS DRILLED IN A TEST HOLE ON ALKALI FLAT (FRANKLIN LAKE), INYO COUNTY, CALIFORNIA

By

Michael P. Pantea

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## ABSTRACT

The U.S. Geological Survey drilled test holes on several playas in the California Desert Conservation Area to make an appraisal of leasable mineral resources. Data from Franklin Lake were obtained for critical evaluation of various hypotheses concerning the occurrence and distribution of lithium and for the possible identification of other nonpegmatic lithium resources.

Franklin Lake and Alkali Flat (AF-1) refer to the same locality. For uniformity, AF-1 is used to designate this hole and the accompanying samples. This report describes the lithology and lithium content of the sediments that were penetrated.

## ACKNOWLEDGMENTS

Drilling was completed by a reverse-circulation rotary drilling rig contracted by the U.S. Geological Survey, Menlo Park, California, under the supervision of J. Calzia (Calzia and others, 1978). Sample collection and field identification were done by Alan Wanek. Emission spectrographic analyses and atomic absorption spectrographic analyses for lithium were performed by Fred Lichte and B. F. Arbogast, respectively. Whole-rock and clay-mineral identification were determined by X-ray powder diffraction by J. D. Morgan and M. P. Pantea. Water analyses were performed by the U.S. Geological Survey laboratory in Denver, Colorado.

## INTRODUCTION

Alkali Flat (Franklin Lake) is a small playa about two miles (3.2 km) in diameter occupying the lowest point in the California-Nevada Ash Meadows Quadrangle (fig. 1). The playa is four miles (6.4 km) south-southeast of Death Valley Junction in Inyo County, California. The drill site (AF-1) is in the north-central part of the playa in the SW¼SE¼ sec. 31, T. 25 N., R. 6 E., San Bernardino meridian. The geology of the Ash Meadows 7½ Minute Quadrangle are described by Denny and Drewes (1965).

Drilling was done with a reverse circulation technique to minimize contamination of sediments and water samples. Lithology was described in the field and was supplemented with laboratory examination. Color classification was done on damp-to-wet samples using a rock-color chart (Goddard and others, 1948). Water samples were collected at the first aquifer having a significant flow, and at total depth. Temperature, pH of untreated samples, and specific gravity of filtered samples were recorded in the field.

Sixty-eight samples, one taken every five feet (1.5 m), were submitted for analysis of lithium. Samples were calcareous mud and mudstone with detrital quartz and feldspar, having calcitic or dolomitic cements (fig. 2). Samples from strata in the lower half of the hole have a greater proportion of clay, as indicated by the increased intensities of the 7 Å, 10 Å, and 14 Å peaks in the X-ray analysis.

All samples were analyzed for lithium by atomic absorption spectroscopy (fig. 2). Lithium values ranged from 58 to 810 parts per million (ppm) and have an average value of 387 ppm Li. Clay-mineral separations were done on 11 samples having 500 ppm Li or greater; all have expanding clay minerals in them (fig. 3). Samples AF1-140 (Alkali Flat) and AF1-210 contain a hectorite-like trioctahedral smectite (H. C. Starky, oral commun., 1980), these samples have 810 ppm Li and 580 ppm Li, respectively. Specific clay mineralogy of the other samples was not determined.

Four of the 11 samples were then analyzed by emission spectrographic methods (table 1). These samples contain 600-680 ppm Li. Samples AF1-250 was considerably higher in concentrations of Cu, Pb, and Zn than the other three.

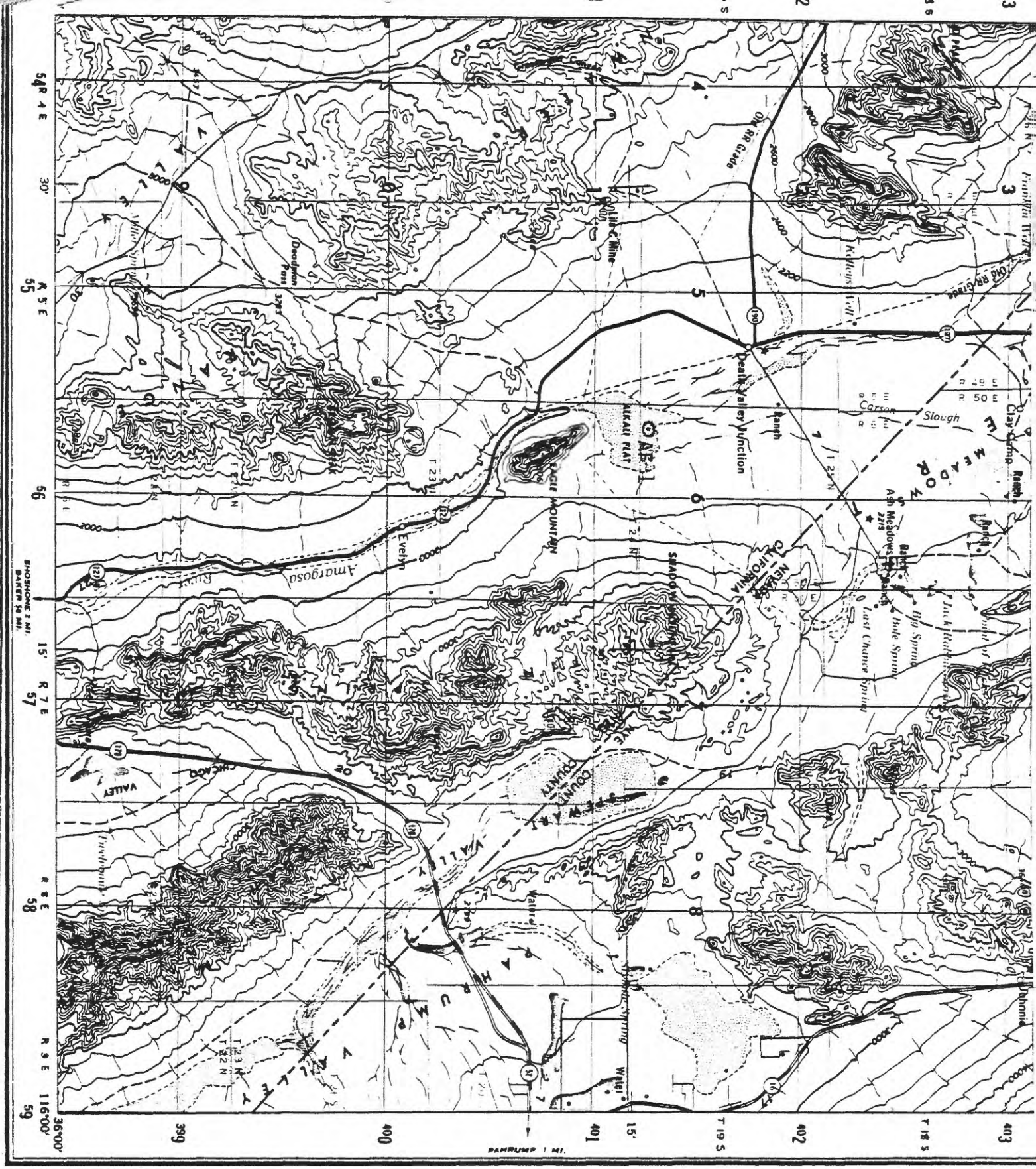



Figure 1.--Map showing location of drill site AF-1.

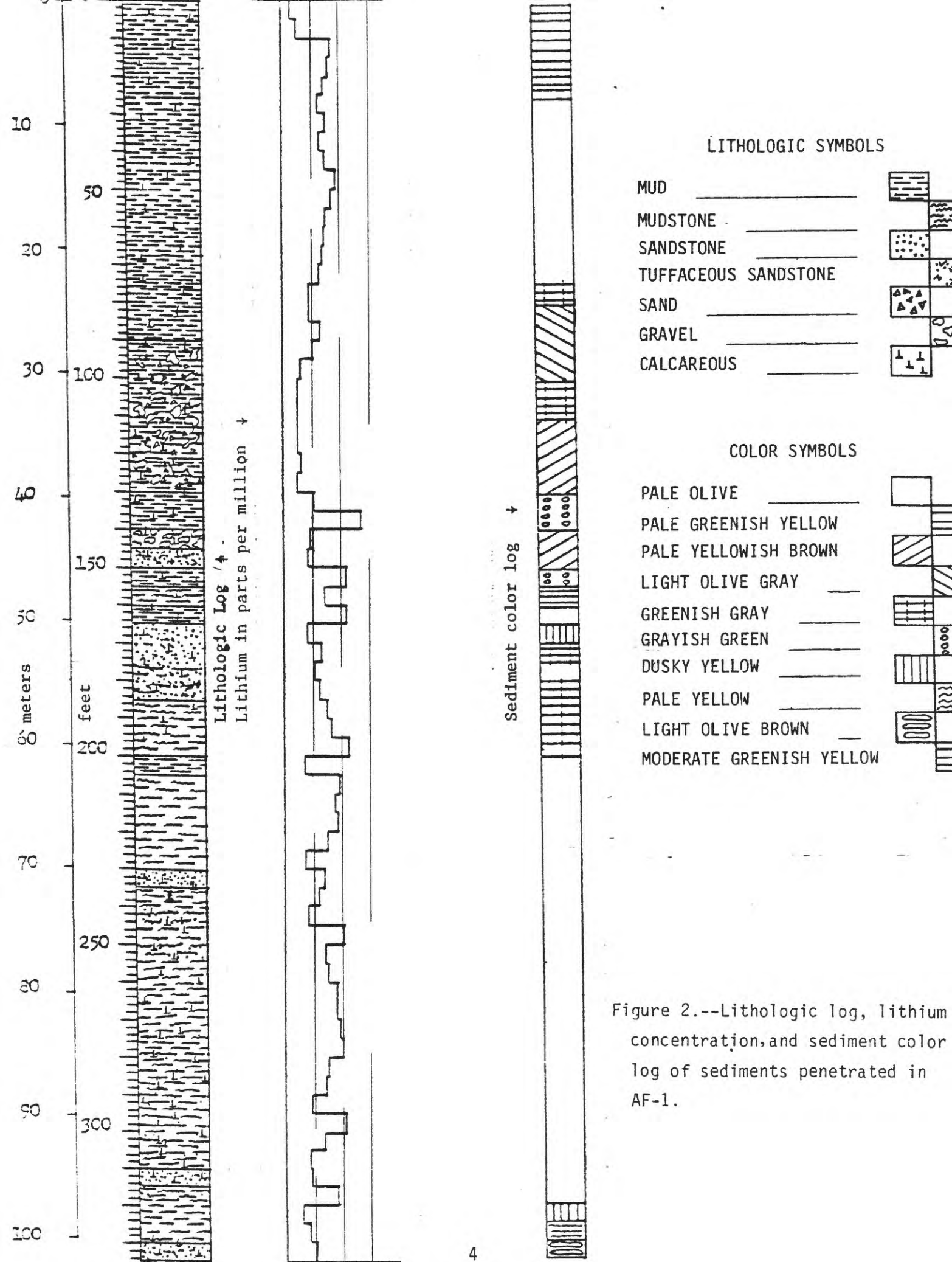



Figure 2.--Lithologic log, lithium concentration, and sediment color log of sediments penetrated in AF-1.

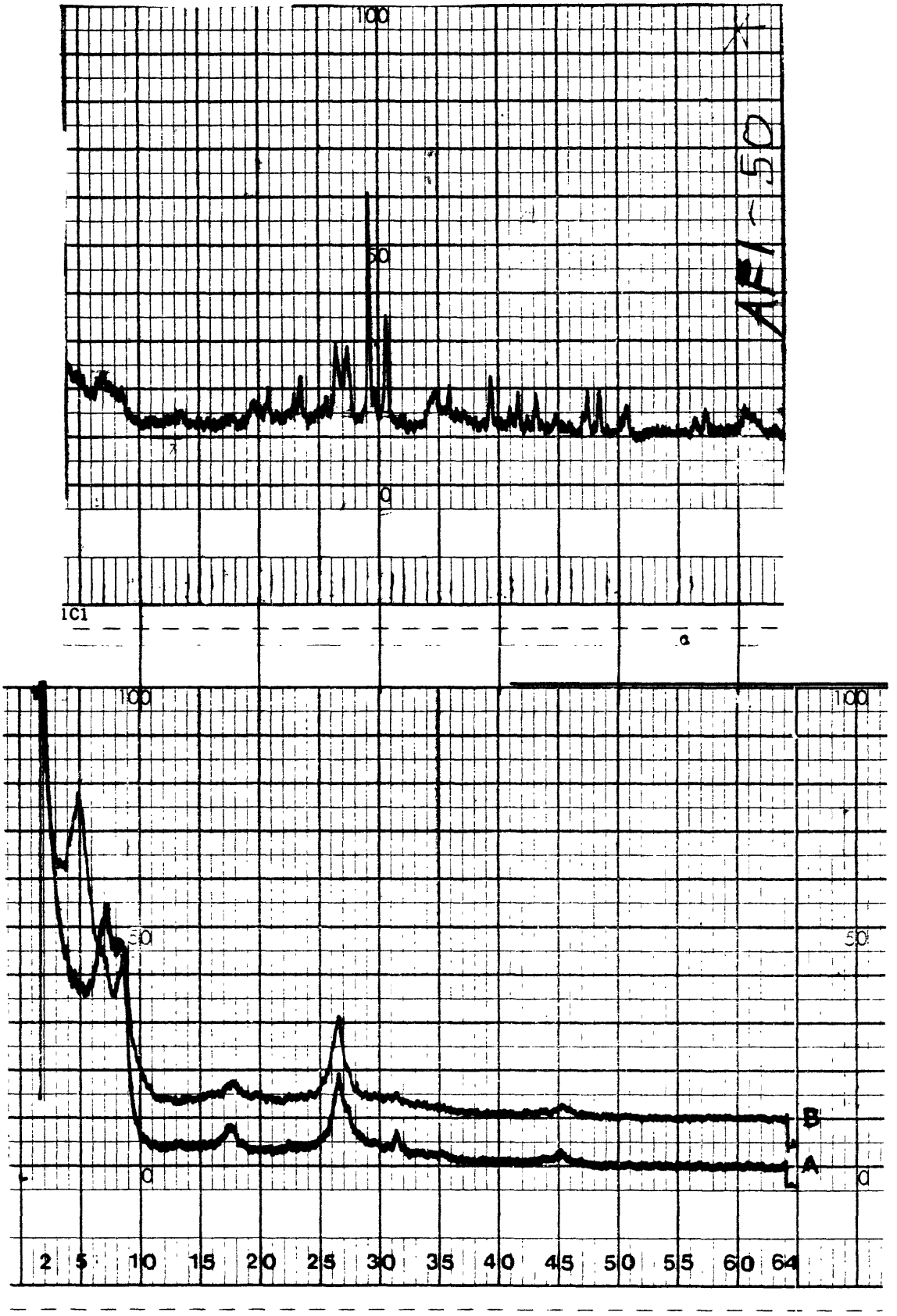
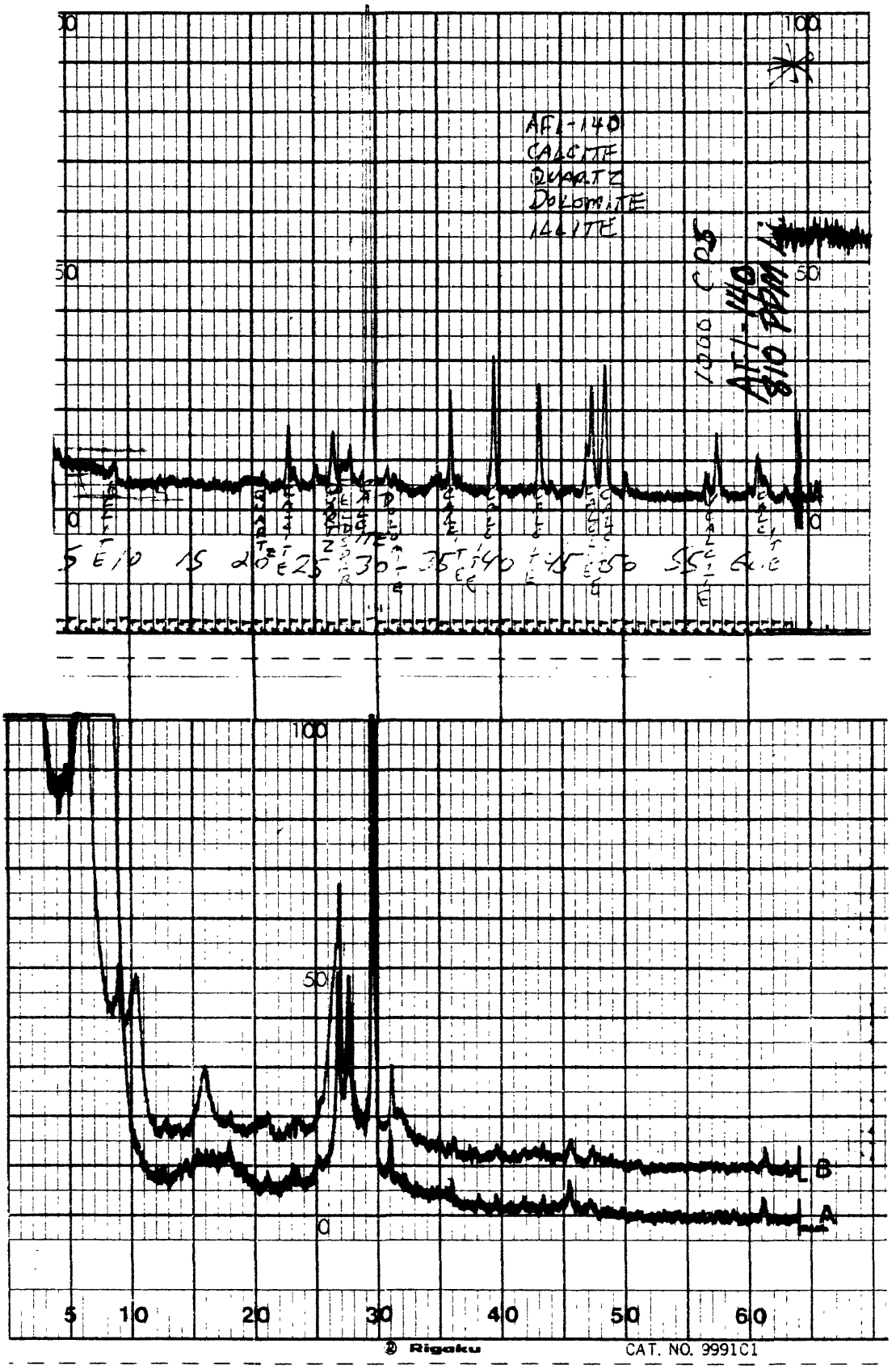



Figure 3.--X-ray Diffractometer traces from 11 samples which contain Li values greater than 500 ppm. The upper trace on each page is the whole-rock sample. The lower trace is from the clay-sized particle fraction; trace A is the air-dried sample, trace B is the ethylene glycol-saturated sample.

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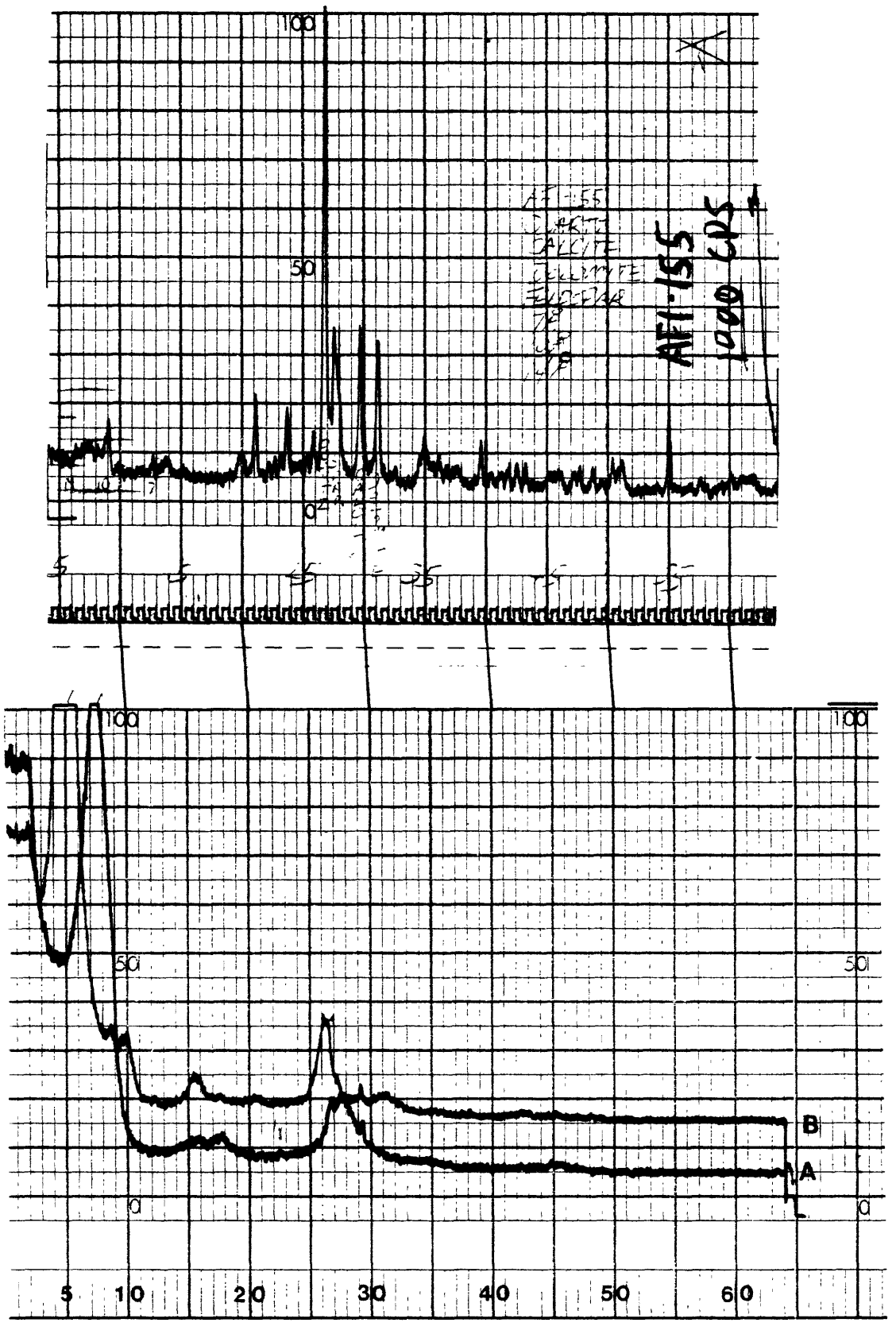


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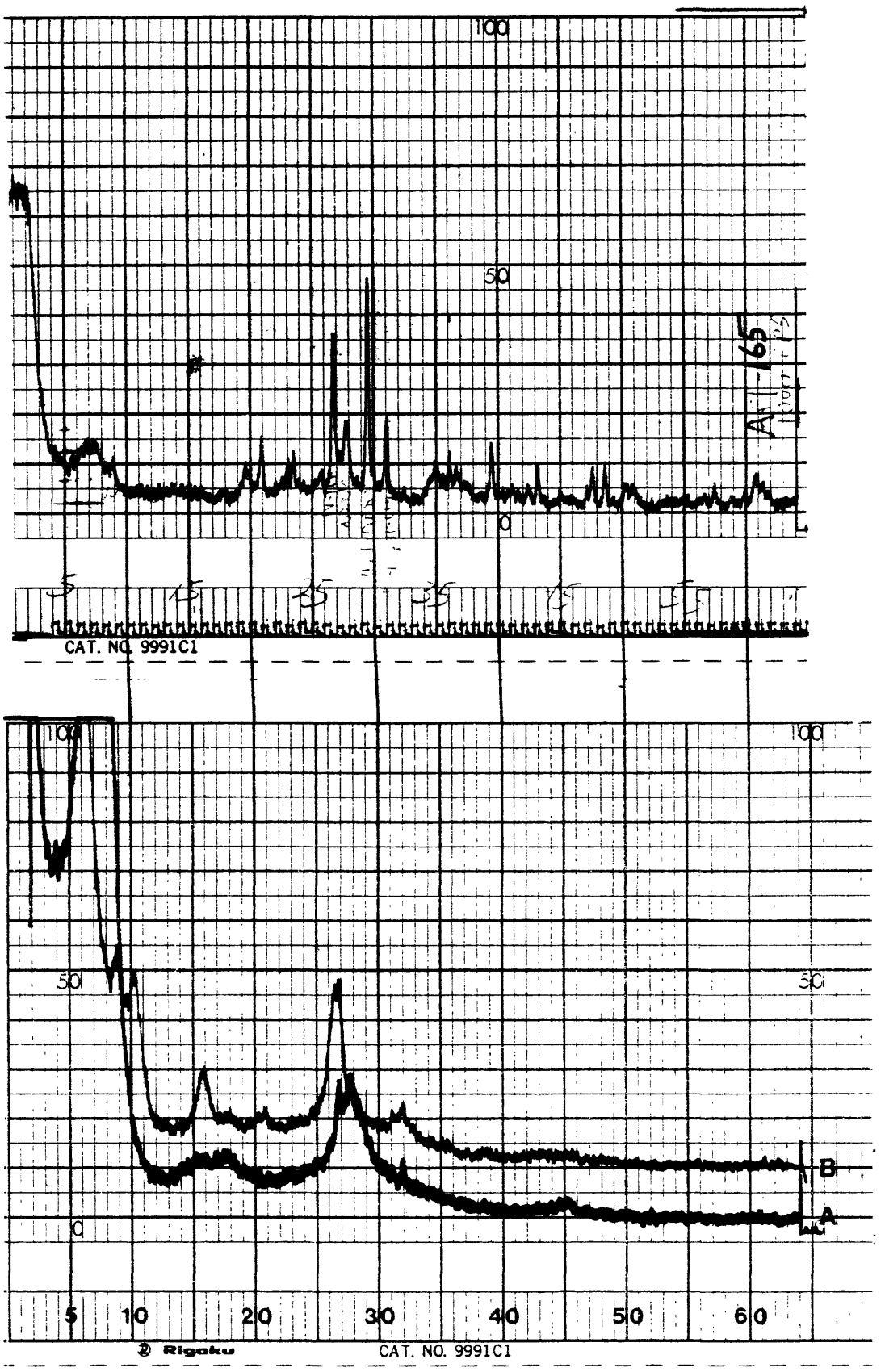


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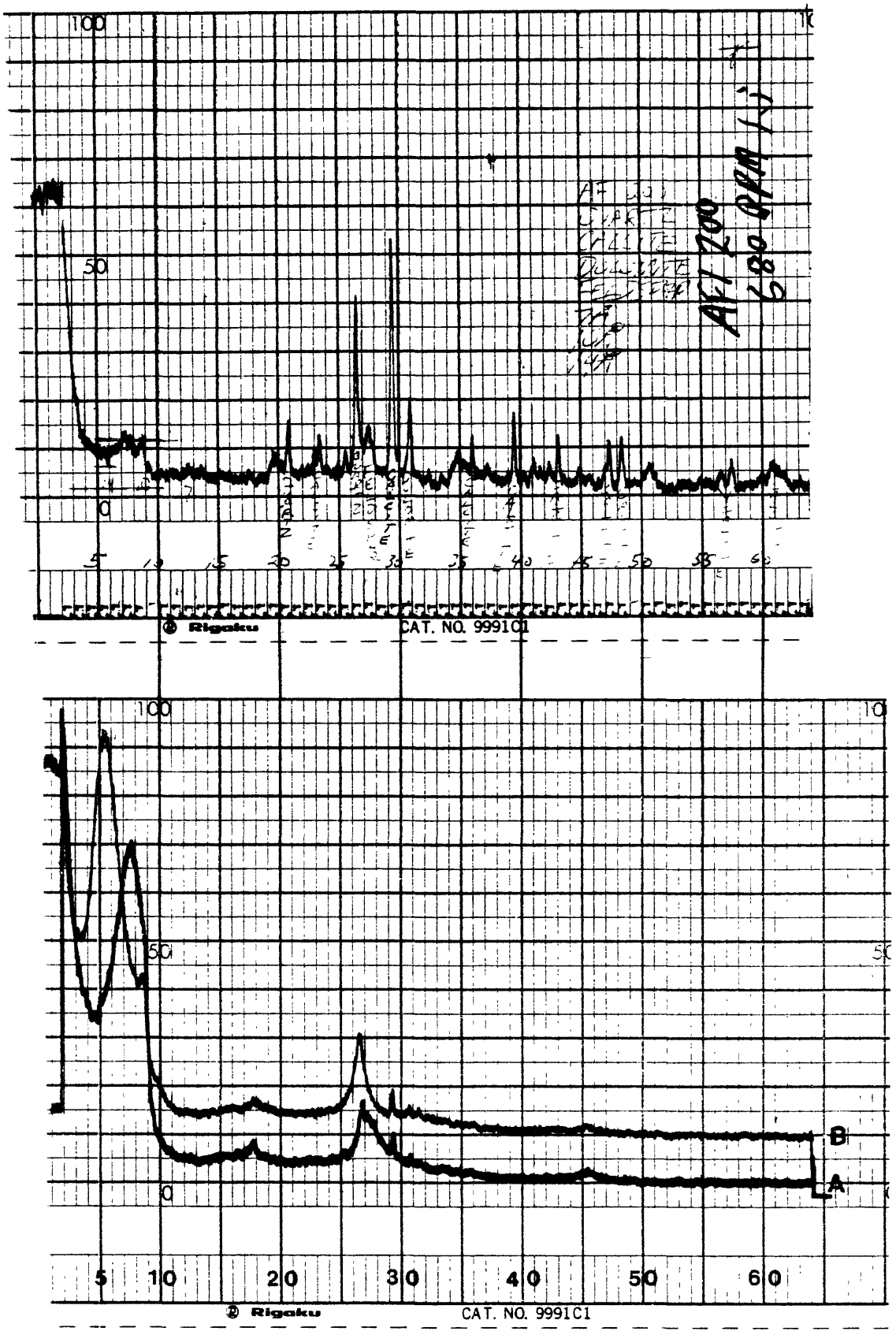


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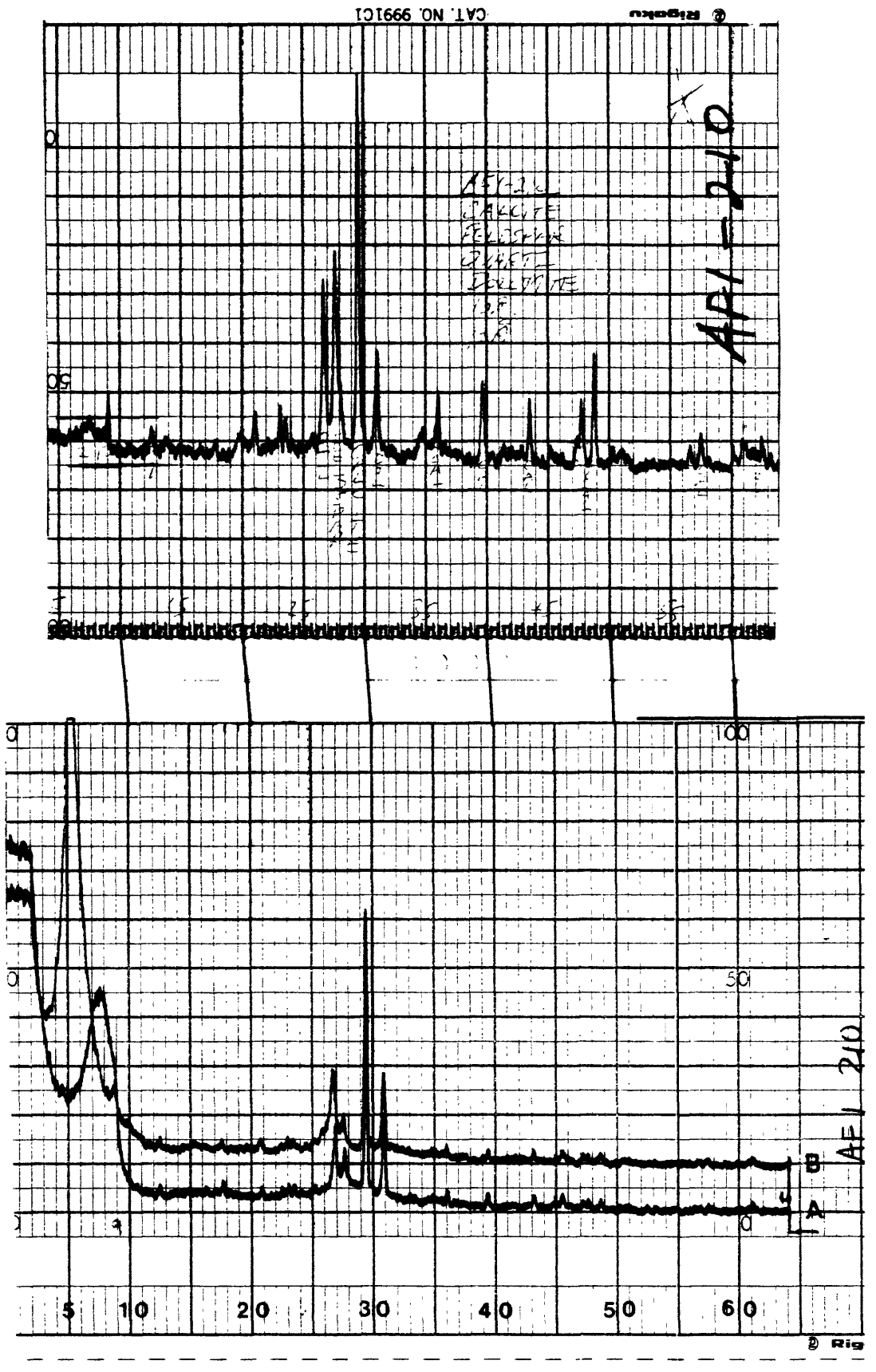


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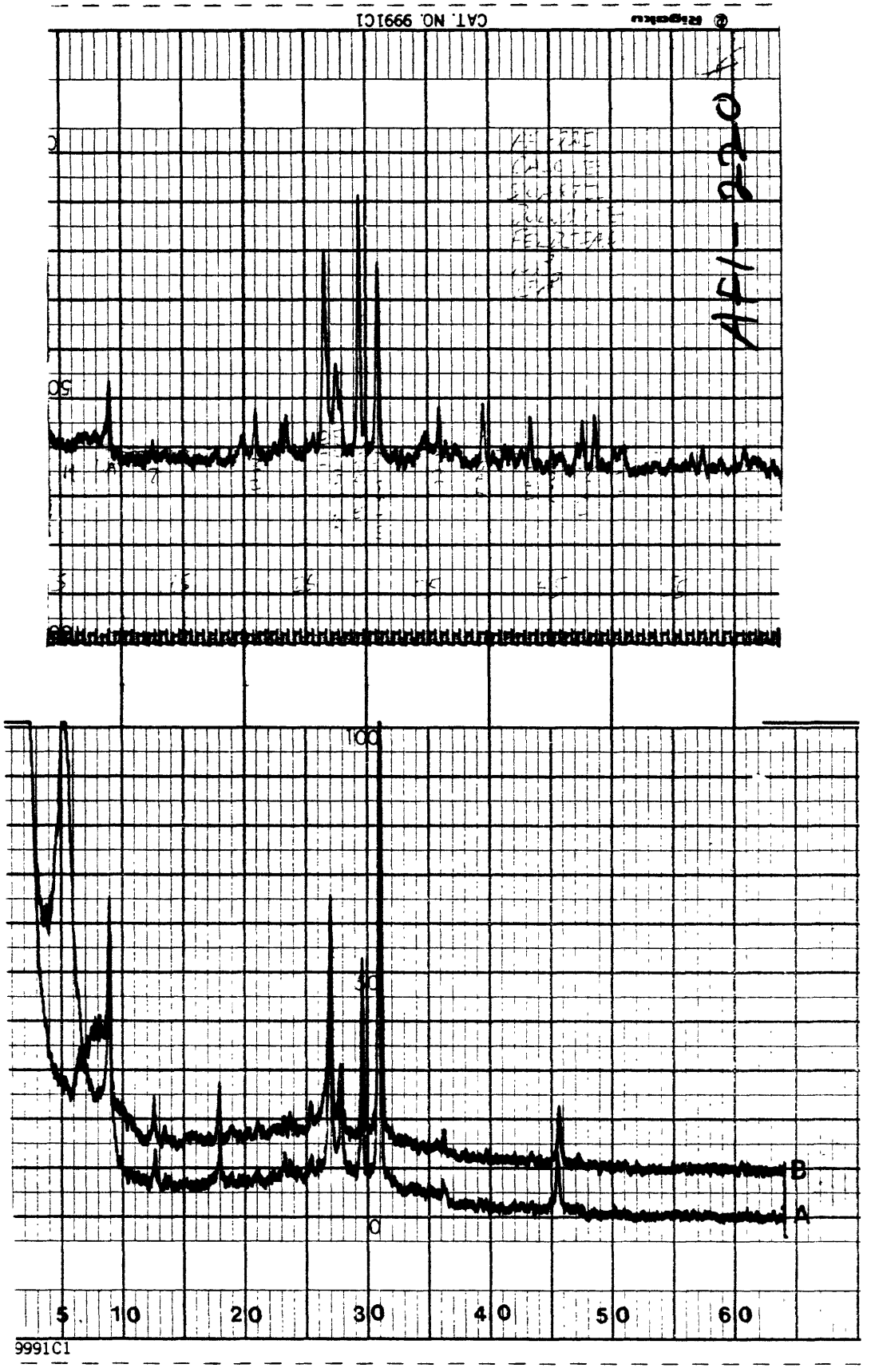


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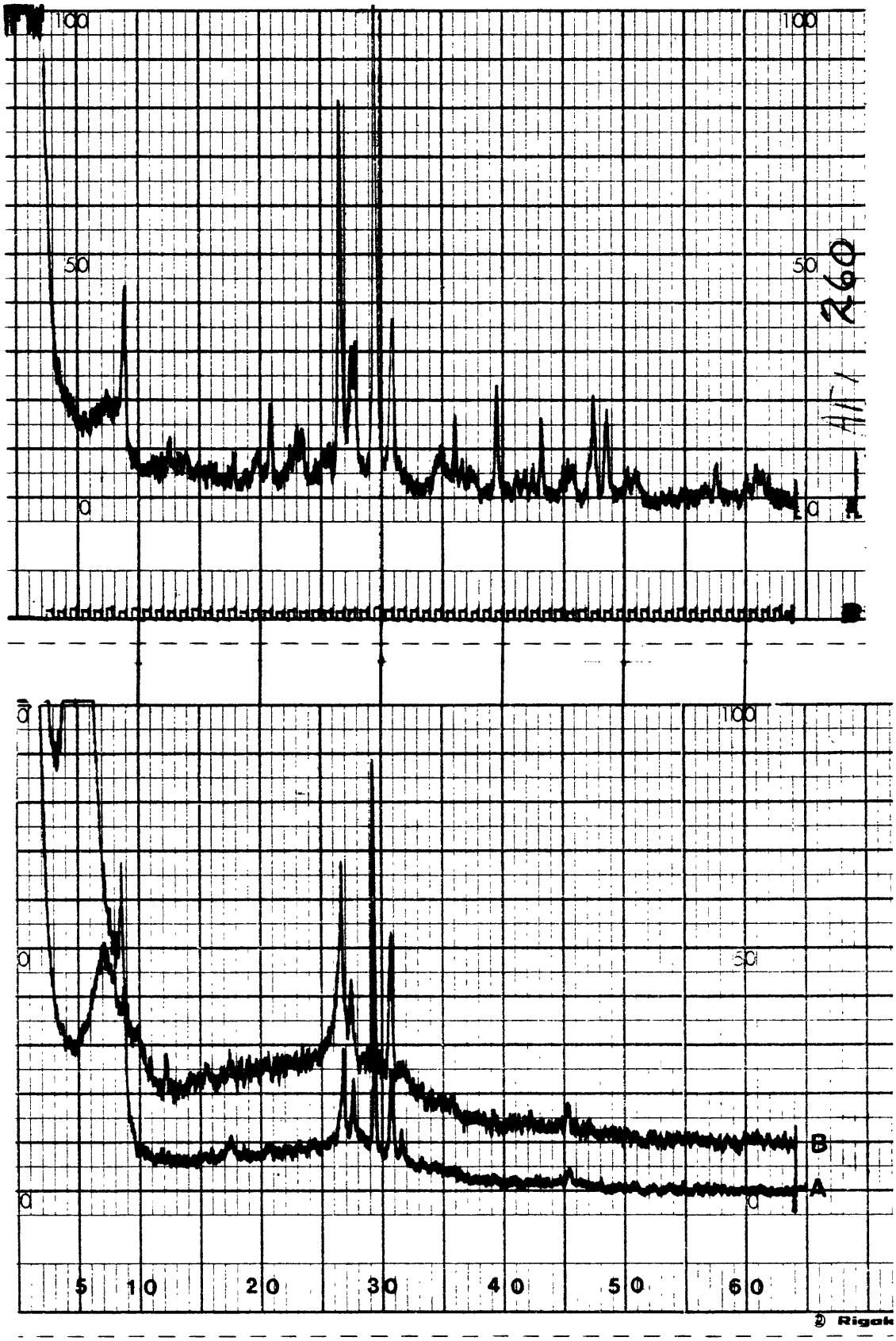


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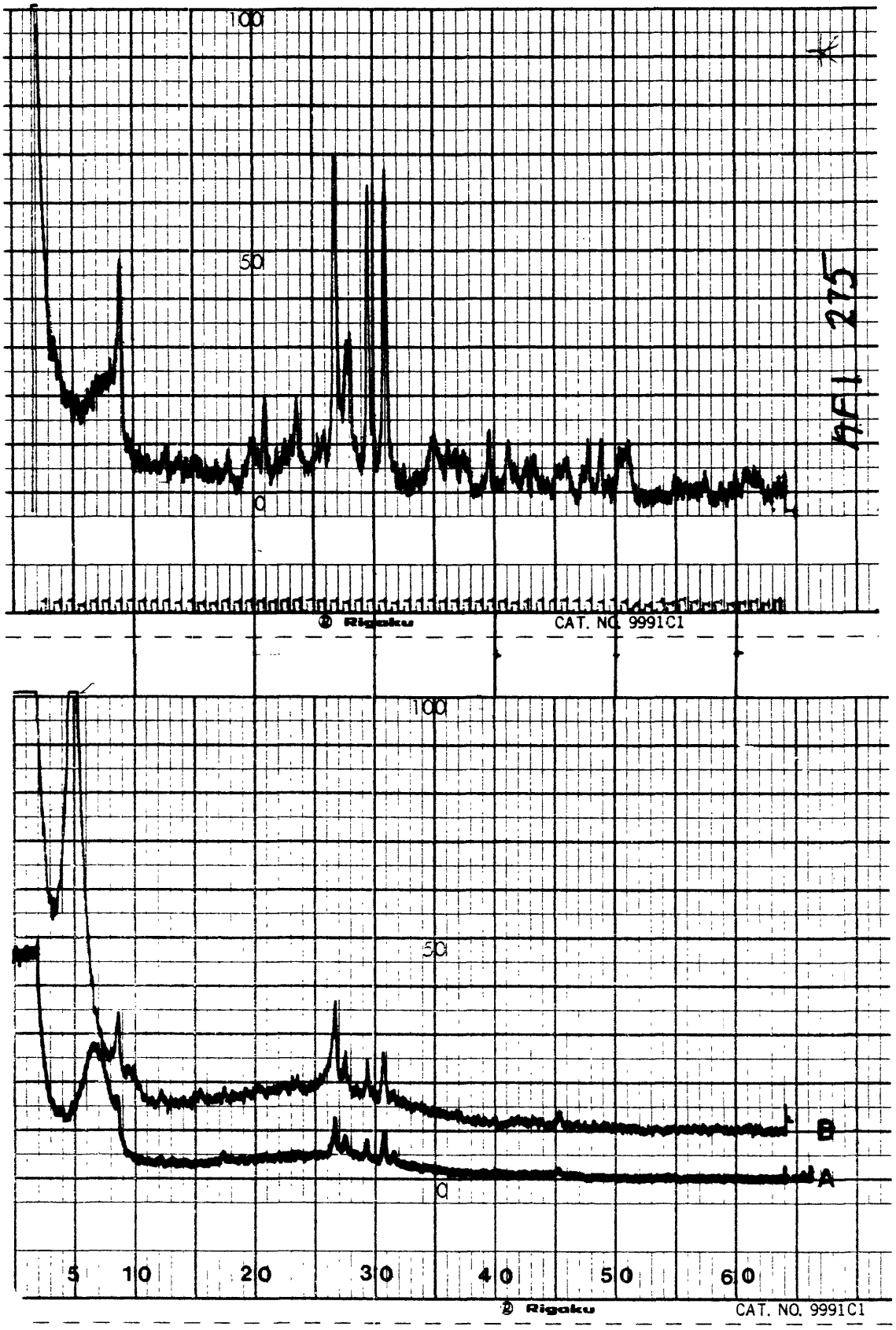


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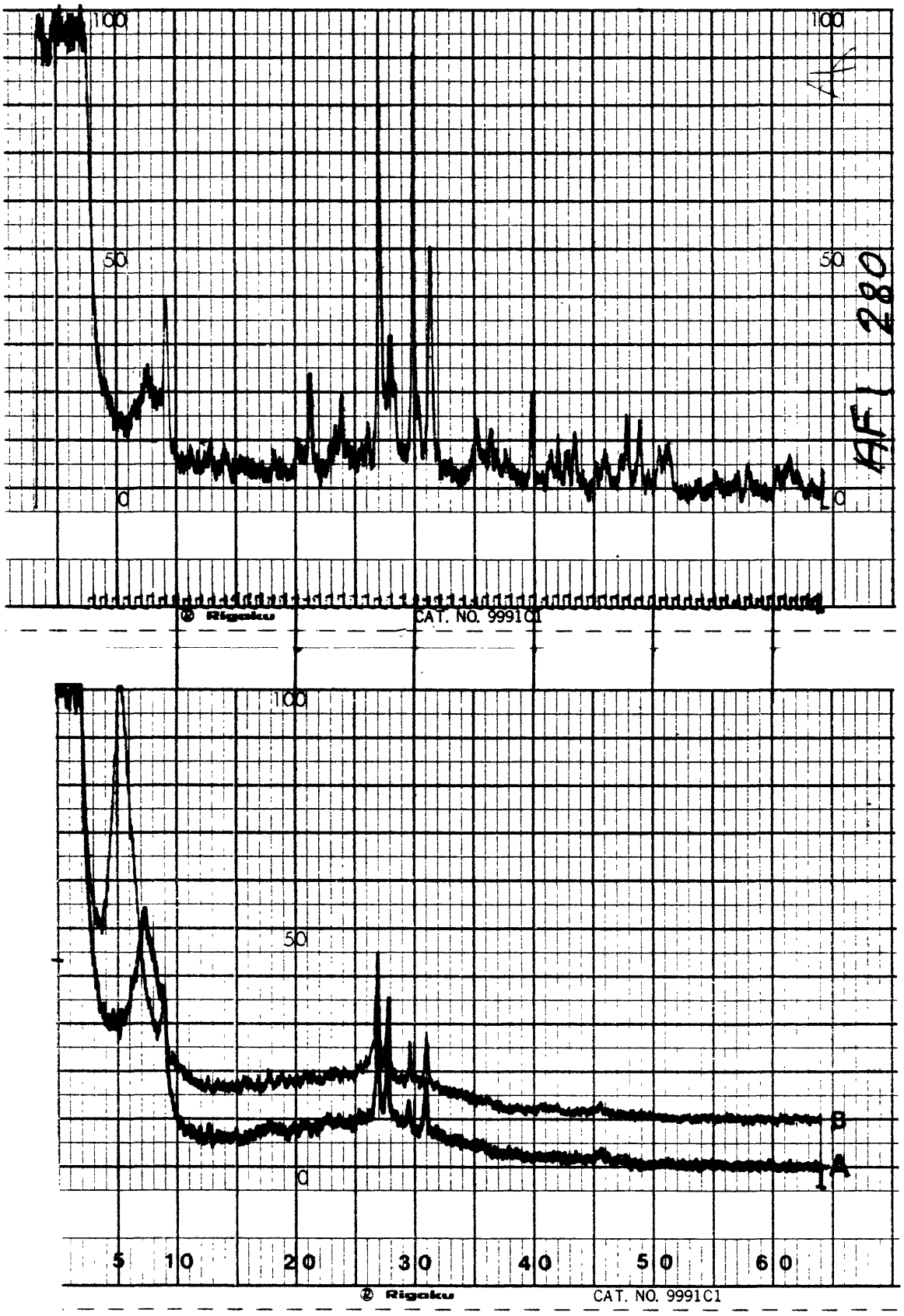


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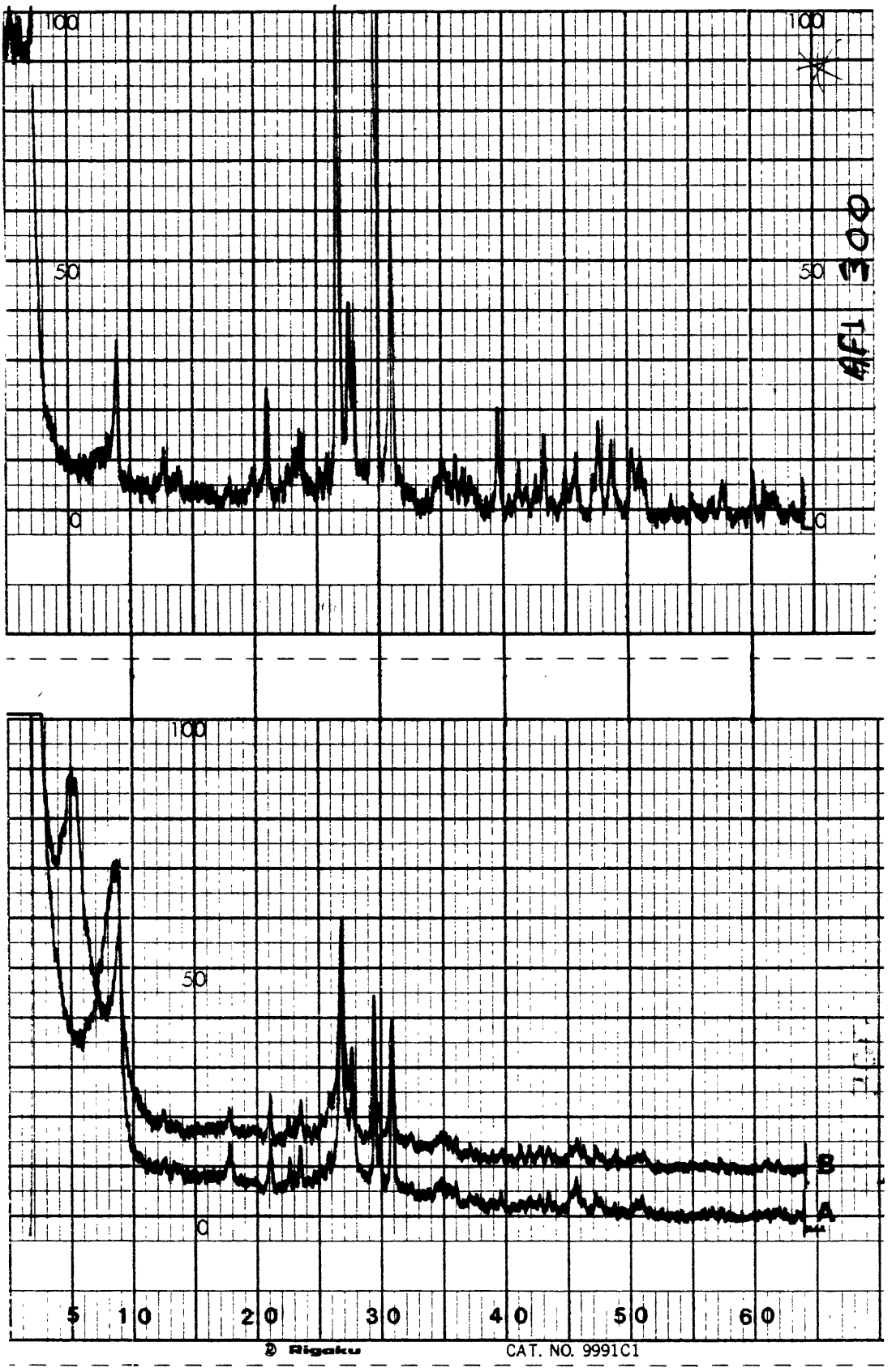


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Table 1.--Emission spectrographic analysis by Fred Lichte of selected samples from Alkali Flat (Franklin Lake).

| FIELD # | | AFI-200 | AFL-250 | AFI 280 | AFI 300 |
|---|---|---|---|---|---|
| SAMPLE | | D-214399 | D-214400 | D-214401 | D-214402 |
| SPECTRUM | | 19 | 1 | 21 | 22 |
| SI | % | 19 | 19 | 18 | 22 |
| AL | % | 2.7 | 1.9 | 3.1 | 4.3 |
| FE | % | 1.4 | 2.0 | 1.6 | 2.5 |
| MG | % | 4.0 | 5.1 | 2.7 | 3.9 |
| CA | % | 0.69 | 1.8 | 0.44 | 0.62 |
| NA | % | 1.4 | > 0.46 | 0.53 | 0.51 |
| K | % | 3.6 | 2.3 | 3.6 | 4.3 |
| TI | % | 0.11 | 0.092 | 0.13 | 0.22 |
| P | % | < 0.46 | < 0.46 | < 0.46 | < 0.46 |
| MN | % | 0.026 | 0.023 | 0.023 | 0.028 |
| AG | PPM | < 0.46 | 1.3 | < 0.46 | < 0.46 |
| AS | PPM | < 220 | < 220 | < 220 | < 220 |
| AU | PPM | < 4.6 | < 4.6 | < 4.6 | < 4.6 |
| B | PPM | 290 | 460 | 300 | 430 |
| BA | PPM | 78 | 69 | 76 | 150 |
| BE | PPM | 1.3 | 1.3 | 1.4 | 2.0 |
| BI | PPM | < 10 | < 10 | < 10 | < 10 |
| CD | PPM | < 10 | < 10 | < 10 | 15 |
| CE | PPM | < 46 | 55 | < 46 | 71 |
| CO | PPM | 7.9 | 13 | 8.5 | 14 |
| CR | PPM | 19 | 22 | 25 | 43 |
| CU | PPM | 48 | > .2200 | 62 | 40 |
| DY | PPM | < 10 | < 10 | < 10 | < 10 |
| ER | PPM | < 4.6 | < 4.6 | < 4.6 | < 4.6 |
| EU | PPM | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| GA | PPM | 10 | 8.6 | 15 | 23 |
| GD | PPM | < 10 | < 10 | < 10 | < 10 |
| GE | PPM | 3.4 | 2.1 | 2.8 | 6.0 |
| HF | PPM | < 100 | < 100 | < 100 | < 100 |
| HO | PPM | < 10 | < 10 | < 10 | < 10 |
| IN | PPM | < 50 | < 50 | < 50 | < 50 |
| IR | PPM | < 46 | < 46 | < 46 | < 46 |
| LA | PPM | 12 | 33 | 17 | 30 |
| LI | PPM | 1100 | 1100 | 890 | 1100 |
| LU | PPM | < 10 | < 10 | < 10 | < 10 |

Table 1.--Emission spectrographic analysis by Fred Lichte of selected samples from Alkali Flat (Franklin Lake).--Continued

| FIELD # | AFI-200 | AFL-250 | AFI 280 | AFI 300 |
|---|---|---|---|---|
| SAMPLE | D-214399 | D-214400 | D-214401 | D-214402 |
| SPECTRUM | 19 | 1 | 21 | 22 |
| MN PPM | 260 | 230 | 230 | 280 |
| MO PPM | 1.6 | 2.1 | 1.3 | 2.6 |
| NB PPM | 5.7 | 7.0 | 8.0 | 14 |
| ND PPM | < 46 | < 46 | < 46 | < 46 |
| NI PPM | 19 | 34 | 21 | 30 |
| OS PPM | < 22 | < 22 | < 22 | < 22 |
| PB PPM | 24 | 120 | 37 | 56 |
| PD PPM | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| PR PPM | < 68 | < 68 | < 68 | < 60 |
| PT PPM | < 10 | < 10 | < 10 | < 10 |
| RE PPM | < 46 | < 46 | < 46 | < 46 |
| RH PPM | < 2.2 | < 2.2 | < 2.2 | < 2.2 |
| RU PPM | < 10 | < 10 | < 10 | < 10 |
| SB PPM | < 46 | < 46 | < 46 | < 46 |
| SC PPM | 4.7 | 5.6 | 4.8 | 7.9 |
| SM PPM | < 46 | < 46 | < 46 | < 46 |
| SN PPM | 7.3 | 31 | 28 | 16 |
| SR PPM | 96 | 82 | 34 | 50 |
| TA PPM | < 500 | < 500 | < 500 | < 500 |
| TB PPM | < 46 | < 46 | < 46 | < 46 |
| TH PPM | < 220 | < 220 | < 220 | < 220 |
| TL PPM | < 4.6 | < 4.6 | < 4.6 | < 4.6 |
| TM PPM | < 4.6 | < 4.6 | < 4.6 | < 4.6 |
| U PPM | < 320 | < 320 | < 320 | < 320 |
| V PPM | 42 | 60 | 43 | 65 |
| W PPM | < 46 | < 46 | < 46 | < 46 |
| Y PPM | 9.8 | 11 | 9.3 | 12 |
| YB PPM | 0.62 | 1.0 | 0.65 | 1.2 |
| ZN PPM | 220 | 9.0000 | 240 | 410 |
| ZR PPM | 51 | 64 | 58 | 79 |
| MAJORS RECALCULATED AS OXIDES | | | | |
| SIO2 % | 41 | 41 | 39 | 47 |
| AL2O3 % | 5.1 | 3.6 | 5.9 | 8.1 |
| FE2O3 % | 2.0 | 2.9 | 2.3 | 3.6 |
| MGO % | 6.6 | 8.5 | 4.5 | 6.5 |
| CAO % | 0.97 | 2.5 | 0.62 | 0.87 |
| NA2O % | 1.9 | > 0.62 | 0.71 | 0.69 |
| K2O % | 4.3 | 2.8 | 4.3 | 5.2 |
| TIO2 % | 0.18 | 0.15 | 0.22 | 0.37 |
| P2O5 % | < 1.1 | < 1.1 | < 1.1 | < 1.1 |
| MNO % | 0.034 | 0.030 | 0.030 | 0.036 |

Water analyses are listed in table 2.

Lithium values seem to vary with sample composition. Low values correspond with sandy or gravelly sediments, whereas higher lithium values are in mudstones, argillaceous sandstones, and calcareous mudstones and sandstones. The amount of calcium in the coarse sediments seem to have no effect on the lithium concentration. Higher lithium values are in sediments varying in color from pale olive to light greenish yellow, (fig. 2) this particular correlation has been noted before (Vine and others, 1979).

Table 2.--Analyses of water samples from Alkali Flat, (Franklin Lake), Inyo County, California. California desert conservation area.

| Test Well number | Date of collection | Depth of water sample (ft) | Water temperature (°C) | pH lab | pH field | Specific gravity | Specific conductance (microhms/cm at 25°C) | Percent sodium | SAR (sodium absorption rate) |
|---|---|---|---|---|---|---|---|---|---|
| FL-1-1 | 6/11/78 | 135 | 27 | 9.0 | 9.2 | 1.020 | 12,600 | 95 | 203 |
| FL-1-2 | 6/11/78 | 335 | 23 | 9.4 | -- | 1.015 | 8,578 | 97 | 247 |

Results in mg/L

| Test Well number | Silica ($SiO_2$) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Phosphorus (P) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Total Nitrate ($NO_2$+$NO_3$) | Iodide (I) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FL-1-1 | 13 | 4.3 | 2.8 | 2,200 | 160 | 0.53 | 1,300 | 1,400 | 20 | .00 | .25 |
| FL-1-2 | 15 | 2.4 | 2.2 | 2,200 | 91 | 1.20 | 1,300 | 920 | 25 | .05 | .40 |

Results in mg/L

| Test Well number | Bicarbonate $(HCO_3)^+$ | Manganese (Mn) | Iron (FE) | Boron (B) | Lithium (Li) | Strontium (Sr) | Uranium (U) | Solids, residue on evaporation at 180°C (TDS) | Total Alkalinity Calcium Carbonate ($CaCO_3$) | Total hardness | Percent Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FL-1-1 | 2,220 | .010 | .050 | 48.000 | .110 | .240 | .046 | 6,380 | 1,820 | 23 | -1.83 |
| FL-1-2 | 2,457 | .020 | .350 | 60.000 | .150 | .200 | .029 | 6,040 | 2,080 | 15 | +1.25 |

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Vine, J. D., Asher-Bolinder, Sigrid, Morgan, J. D., and Higgins, B., 1979, Lithologic log and lithium content of sediments penetrated in a test boring drilled on Wilcox Playa, Cochise County, Arizona: U.S. Geological Survey Open-File Report 79-397, 16 p.