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LITHOLOGIC LOG, LITHIUM CONTENT, AND MINERALOGY OF SEDIMENTS PENETRATED IN TEST BORING DRILLED IN EUREKA VALLEY, INYO COUNTY, CALIFORNIA

by
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INTRODUCTION

A test boring was drilled in a playa in Eureka Valley, Calif., by the U.S. Geological Survey in the spring of 1978. Work was done under the terms of a cooperative agreement between the U.S. Geological Survey and the U.S. Bureau of Land Management to evaluate the leasable mineral potential of various playas in the California Desert Planning area, as described in the environmental analysis (prepared by the U.S. Geological Survey, 1978). The purpose of this report is to describe the occurrence and distribution of lithium in the basin sediments as part of a program to identify additional domestic resources of nonpegmatite lithium (Vine, 1978). Interest in this playa stems from the fact that Eureka Valley is located in a region where other lithium resources have been identified. Lithium is recovered from subsurface brines at Clayton Valley, Nev., to the north and at Searles Lake, Calif., to the south. Eureka Valley is a closed topographic basin that has an arid climate, it thus provides suitable conditions for the entrapment of a brine and subsequent concentration of lithium by evaporation.

Development of new energy related uses for lithium in batteries for electric vehicle propulsion and for off-peak power storage by the utility industry (Chilenskas and others, 1977) may be aided by identification of a large domestic resource of lithium.

ACKNOWLEDGMENTS

Drilling was done under contract with Drilling Services, Inc., Tempe, Ariz., by the reverse-circulation rotary technique in order to minimize contamination and to facilitate recovery of both sediment and water samples. The drilling was performed under the general supervision of James P. Calzia, of the U.S. Geological Survey, Menlo Park, Calif. Alan Wanek collected sediment samples representative of each 5-ft (1.52-m) interval for lithium analysis and mineralogical studies. Lithium content of 68 rock samples and two water samples was analyzed by atomic absorption spectrometry by John Sharkey of the Geological Survey's Denver laboratory.

LOCATION

Eureka Valley is located in Inyo County, Calif., in the Sierra Nevada portion of the Basin and Range physiographic province (fig. 1). Eureka Valley occupies a narrow north-south-trending intermontane valley containing a dry lake or playa at its southern end that is less than 2 mi^2 (4.4 km^2) in area. It is separated from Death Valley by the Last Chance Range to the east and from Saline Valley by the Inyo Mountains to the west. In its central portion, Eureka Valley is of gentle relief, with broad alluvial fan slopes bordering the mountains. The lowest point on the playa is 2,980 ft (908.3 m) above sea level. The surrounding mountain peaks are as much as 7,500 ft (2,286 m) in elevation. The lowest pass from the valley at the east side is about 6,000 ft (1,829 m) in elevation. A highway extends from Big Pine on the west across the Inyo Mountains, Eureka Valley, and the Last Chance Range to the north end of Death Valley. In the vicinity of the drill site, the playa surface is a mixture of mud and silt. Vegetation is sparse, consisting primarily of creosote bush (U.S. Geological Survey, 1978). Topographic coverage of Eureka Valley is provided by the 15-minute Last Chance Range and Waucoba Spring quadrangles. The closest town to the area is Big Pine, about 48 miles (77 km) west of the valley. Eureka Valley land, including the drill site, is mostly public domain according to the environmental analysis report (U.S Geological Survey, 1978).

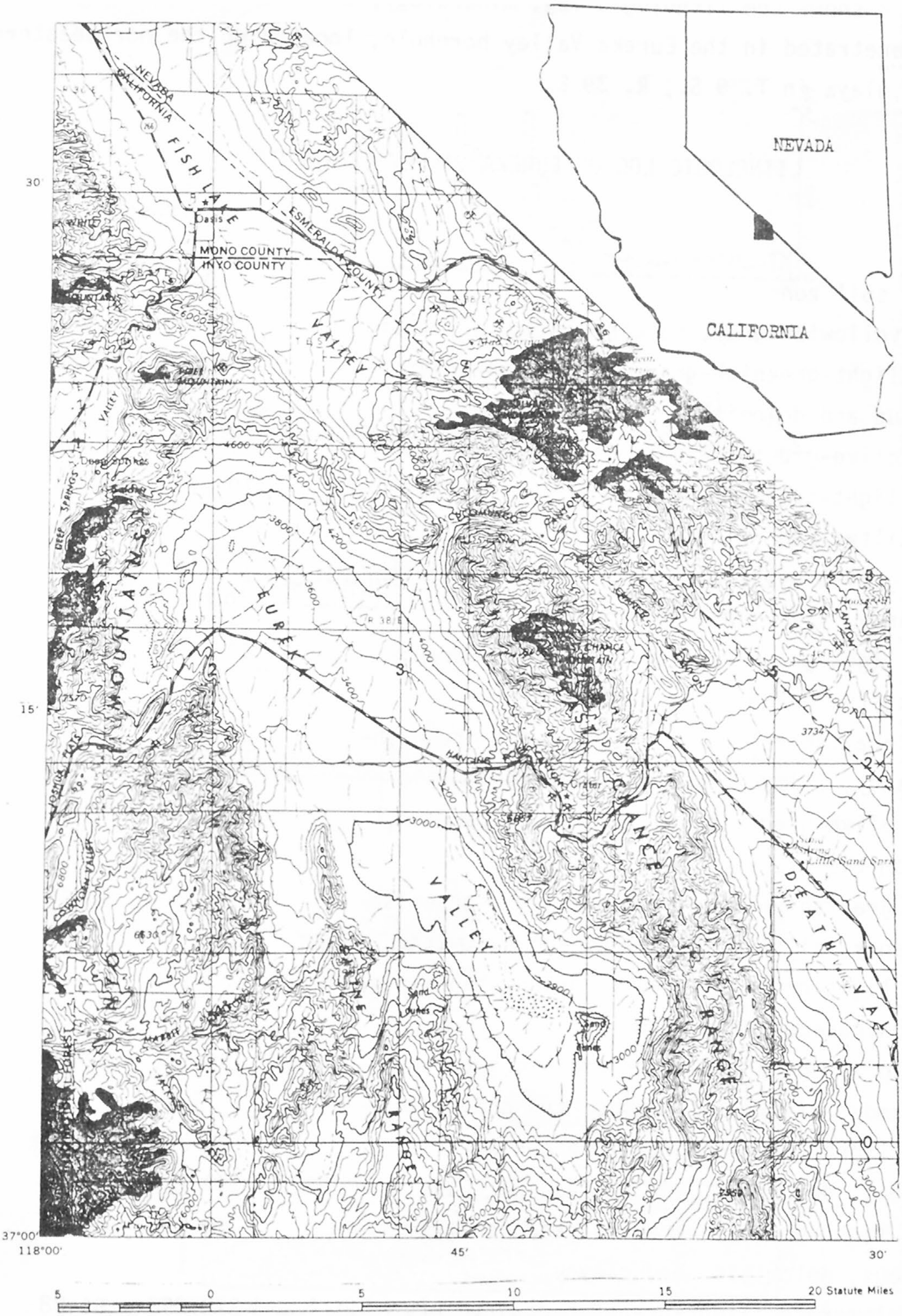


Figure 1.--Index map of east-central California, showing the playa (dotted) in Eureka Valley.

DRILLING RESULTS

Figure 2 shows the lithologic log, mineralogy, and lithium content of the sediments penetrated in the Eureka Valley borehole, located on the northeastern edge of the playa in T. 9 S., R. 39 E.

LITHOLOGIC LOG OF EUREKA VALLEY SEDIMENTS

	Depth ft	Depth m
Brown silt; soil zone	0-20	0-6
Claystone, yellowish-gray; calcareous and dolomitic	20-30	6-9
Claystone, light-greenish-gray to greenish-gray; calcareous and dolomitic	30-90	9-27
Claystone, olive-green; calcareous and dolomitic	90-105	27-32
Claystone, light-greenish-gray to greenish-gray; sandy, silty, and dolomitic	105-110	32-34
Claystone, grayish-yellow-green and light-greenish-gray; sandy, silty, and dolomitic	110-115	34-35
Claystone, light-greenish-gray to greenish-gray; sandy, silty, calcareous, and dolomitic	115-125	35-38
Claystone, grayish-yellow-green and light-greenish-gray; sandy, silty, calcareous, and dolomitic	125-130	38-40
Claystone, olive green; silty, sandy, calcareous, and dolomitic	130-145	40-44
Claystone, grayish-yellow-green and light-greenish-gray; sandy, silty, calcareous, and dolomitic	145-150	44-46
Claystone, light-greenish-gray to greenish-gray; sandy, silty, calcareous, and dolomitic	150-188	46-57
Claystone, grayish-yellow-green and light greenish-gray; sandy, silty, calcareous, and dolomitic	188-195	57-59
Claystone, light-greenish-gray to greenish-gray; calcareous, dolomitic, and tuffaceous	195-210	59-64
Sandstone, light-greenish-gray to greenish-gray; calcareous, dolomitic, and clayey	210-275	64-84
Pebble conglomerate, light-greenish-gray to greenish-gray; calcareous, dolomitic, and clayey	275-290	84-88
Sandstone, light-greenish-gray to greenish-gray; dolomitic, calcareous, and clayey	290-340	88-104

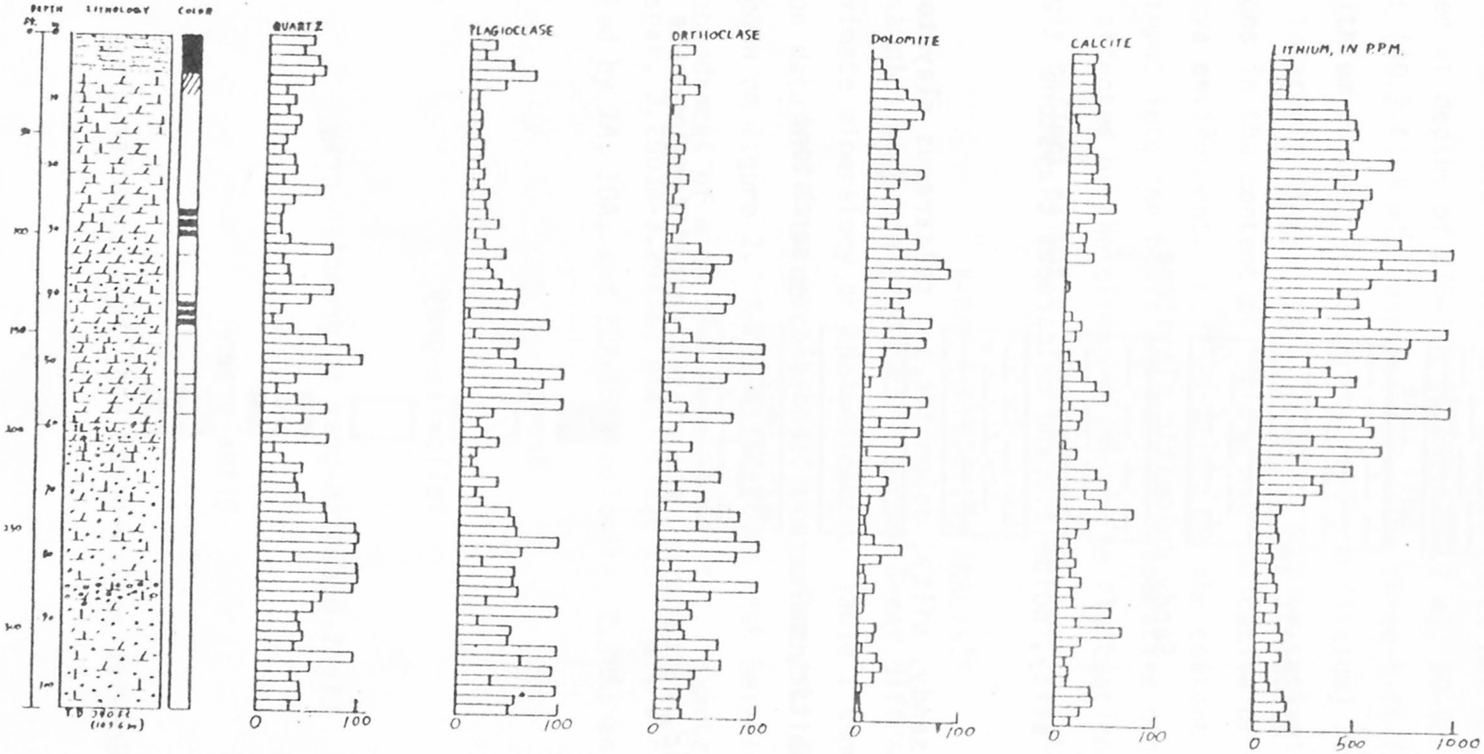
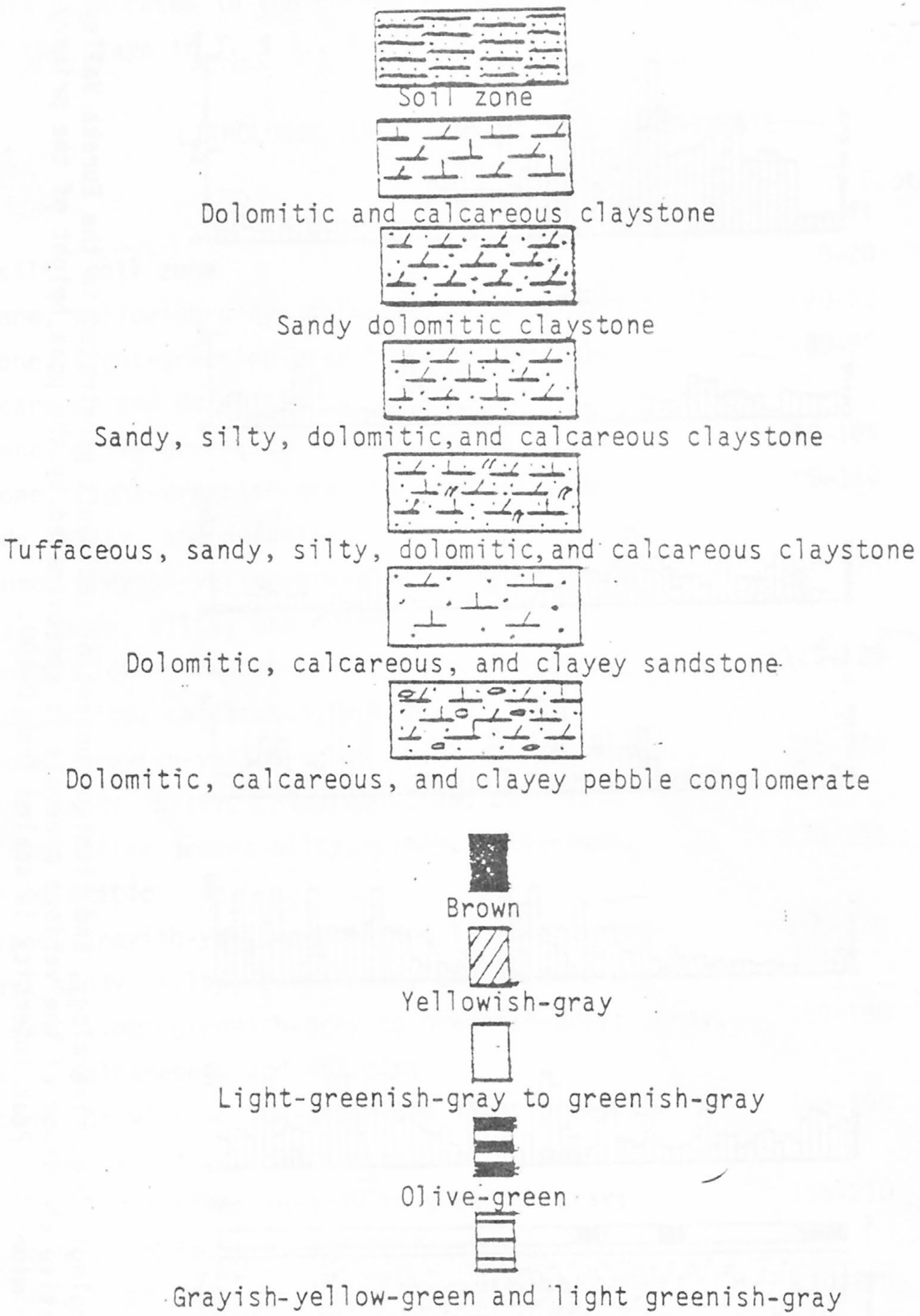


Figure 2.--Lithologic log, mineralogy, and lithium content of sediments penetrated in the Eureka Valley borehole. Relative abundance of the various minerals is approximated by the peak height of the primary peak for each mineral. Peak intensity is scaled from 0-100.

Lithology


Soil zone
Dolomitic and calcareous claystone
Sandy dolomitic claystone
Sandy, silty, dolomitic,and calcareous claystone
Tuffaceous, sandy, silty, dolomitic,and calcareous claystone
Dolomitic, calcareous, and clayey sandstone
Dolomitic, calcareous, and clayey pebble conglomerate
Brown
Yellowish-gray
Light-greenish-gray to greenish-gray
Olive-green
Grayish-yellow-green and light greenish-gray

LITHIUM ANALYSIS

Drill-core sediments were analyzed for lithium by atomic absorption. Maximum lithium values of 945, 930, and 920 parts per million (ppm) were encountered at depths of 170-175 ft (52.6-54.2 m), 90-95 ft (27.9-29.4 m), and 130-135 ft (40.2-41.8 m), respectively. The three 5-ft (1.52-m) sections of highest lithium content (greater than 900 ppm lithium) are separated by two 35 ft (11-m) intervals of sediments lower in lithium content. The rhythmic fluctuations in the content of lithium are indicative of geochemical changes in the playa environment. Factors affecting the content include rate of detrital input into the basin and rate of evaporative concentration, both of which are affected by the climate. Thus, the fluctuation in lithium content may strongly reflect climatic fluctuations (Brenner-Tourtelot and Glanzman, 1977).

X-RAY DIFFRACTION ANALYSIS

All samples were analyzed by whole-rock X-ray diffraction to determine the approximate mineralogy of the sediments. Table 1 shows the specific X-ray diffraction data and lithium content of the sediments. Tabulation of this data is shown on figure 2. X-ray diffraction peak heights used to determine relative abundances of minerals, were as follows: quartz, 3.3491A; potassium-rich feldspar, 3.2503A-3.2413A; plagioclase feldspar, 3.2143A-3.1807A, clays as reflected by 7A, 10A, and 12A-15A; dolomite, 2.98A; and calcite, 3.04 A.

Table 1.--SPECIFIC X-RAY DATA AND LITHIUM CONTENT OF EUREKA VALLEY SEDIMENTS. PRIMARY PEAK HEIGHT INTENSITY FOR MINERALS IS MEASURED ON A SCALE FROM 0-100. (Leaders (--) indicates none present; tr, trace)

Field No.	Li (ppm)	Quartz	Plagioclase	Orthoclase	Dolomite	Calcite	7A	10A	14A
EK-0	95	44.0	25.0	23.0	--	23.0	8.0	24.0	4.0
EK-5	73	33.0	14.0	--	9.0	20.0	5.0	8.0	3.0
EK-10	71	50.0	41.0	9.0	13.0	22.0	7.0	13.0	3.0
EK-15	72	56.0	65.0	12.0	23.0	22.0	6.0	16.0	2.0
EK-20	362	44.0	34.0	29.0	34.0	23.0	6.0	13.0	3.0
EK-25	370	18.0	8.0	12.0	47.0	27.0	--	7.0	--
EK-30	425	28.0	8.0	2.0	51.0	4.0	6.0	27.0	3.0
EK-35	436	20.0	12.0	--	37.0	7.0	3.0	13.0	tr
EK-40	385	33.0	12.0	--	23.0	22.0	4.0	18.0	4.0
EK-45	390	29.0	9.0	8.0	22.0	20.0	5.0	16.0	--
EK-50	620	20.0	13.0	13.0	27.0	27.0	5.0	12.0	--
EK-55	435	15.0	13.0	10.0	27.0	28.0	5.0	12.0	tr
EK-60	330	28.0	10.0	--	53.0	21.0	3.0	21.0	--
EK-65	510	30.0	15.0	20.0	30.0	40.0	4.0	18.0	tr
EK-70	470	16.0	10.0	7.0	19.0	40.0	--	10.0	--
EK-75	460	56.0	21.0	4.0	30.0	47.0	tr	14.0	3.0
EK-80	440	28.0	17.0	16.0	30.0	25.0	4.0	15.0	--
EK-85	415	17.0	20.0	15.0	16.0	10.0	5.0	16.0	4.0
EK-90	660	14.0	31.0	11.0	39.0	20.0	4.0	11.0	tr
EK-95	930	15.0	7.0	5.0	50.0	17.0	4.0	11.0	--
EK-100	570	23.0	19.0	33.0	32.0	27.0	4.0	10.0	--

Field No.	Li (ppm)	Quartz	Plagioclase	Orthoclase	Dolomite	Calcite	7A	10A	14A
EK-105	850	68.0	40.0	66.0	75.0	--	tr	10.0	3.0
EK-110	525	18.0	22.0	48.0	81.0	--	3.0	16.0	tr
EK-115	365	23.0	27.0	45.0	22.0	3.0	tr	10.0	tr
EK-120	420	25.0	37.0	8.0	41.0	--	6.0	20.0	tr
EK-125	278	69.0	55.0	70.0	25.0	--	5.0	14.0	--
EK-130	532	37.0	53.0	60.0	37.0	8.0	4.0	10.0	3.0
EK-135	920	18.0	6.0	5.0	65.0	17.0	--	7.0	--
EK-140	735	9.0	86.0	15.0	20.0	11.0	4.0	11.0	--
EK-145	718	30.0	10.0	28.0	60.0	--	--	8.0	--
EK-150	240	62.0	55.0	100.0	20.0	6.0	--	10.0	--
EK-155	335	86.0	35.0	32.0	18.0	15.0	--	11.0	tr
EK-160	476	100.0	41.0	100.0	16.0	18.0	4.0	7.0	3.0
EK-165	360	65.0	100.0	63.0	7.0	33.0	6.0	29.0	--
EK-170	272	32.0	80.0	--	tr	46.0	4.0	20.0	tr
EK-175	945	15.0	7.0	7.0	63.0	8.0	tr	5.0	tr
EK-180	511	35.0	100.0	23.0	46.0	20.0	2.0	7.0	tr
EK-185	576	65.0	30.0	70.0	15.0	18.0	tr	10.0	--
EK-190	261	41.0	16.0	15.0	56.0	--	5.0	20.0	4.0
EK-195	606	18.0	20.0	--	40.0	3.0	3.0	16.0	--
EK-200	184	68.0	37.0	30.0	4.0	16.0	11.0	3.0	--
EK-205	464	12.0	16.0	12.0	48.0	--	4.0	tr	tr
EK-210	264	23.0	10.0	14.0	16.0	37.0	9.0	10.0	--
EK-215	315	42.0	17.0	60.0	27.0	45.0	3.0	13.0	3.0
EK-220	255	34.0	38.0	16.0	24.0	23.0	3.0	27.0	2.0

Field No.	Li (ppm)	Quartz	Plagioclase	Orthoclase	Dolomite	Calcite	7A	10A	14A
EK-225	111	37.0	15.0	43.0	10.0	41.0	5.0	13.0	tr
EK-230	85	44.0	21.0	5.0	8.0	75.0	3.0	8.0	--
EK-235	94	65.0	50.0	80.0	5.0	30.0	7.0	11.0	--
EK-240	106	68.0	56.0	38.0	7.0	18.0	6.0	16.0	tr
EK-245	64	96.0	58.0	76.0	14.0	11.0	5.0	15.0	--
EK-250	73	100.0	100.0	100.0	41.0	12.0	6.0	18.0	--
EK-255	66	96.0	62.0	77.0	22.0	17.0	4.0	11.0	--
EK-260	80	35.0	22.0	11.0	5.0	13.0	3.0	7.0	tr
EK-265	103	99.0	57.0	36.0	7.0	23.0	5.0	18.0	2.0
EK-270	49	100.0	55.0	100.0	15.0	14.0	6.0	14.0	3.0
EK-275	103	95.0	60.0	52.0	4.0	15.0	6.0	14.0	--
EK-280	46	64.0	28.0	30.0	5.0	53.0	5.0	12.0	--
EK-285	120	54.0	100.0	36.0	--	20.0	5.0	15.0	tr
EK-290	137	39.0	20.0	22.0	19.0	65.0	6.0	10.0	--
EK-295	77	42.0	53.0	27.0	17.0	25.0	7.0	14.0	--
EK-300	134	46.0	50.0	60.0	3.0	17.0	7.0	13.0	tr
EK-305	62	37.0	100.0	50.0	20.0	8.0	6.0	10.0	--
EK-310	60	97.0	63.0	64.0	24.0	13.0	4.0	10.0	--
EK-315	68	53.0	95.0	39.0	18.0	12.0	4.0	9.0	--
EK-320	150	35.0	33.0	34.0	6.0	36.0	8.0	8.0	3.0
EK-325	165	43.0	100.0	25.0	3.0	37.0	6.0	9.0	--
EK-330	130	44.0	59.0	24.0	4.0	24.0	7.0	8.0	--
EK-335	185	34.0	54.0	27.0	7.0	15.0	6.0	3.0	--

In examining figure 2, various relationships can be observed between the distribution of lithium and the mineralogy of the playa sediments. Lithium content is directly related to the abundance of dolomite and inversely related to the abundance of quartz and feldspar. Dolomite and calcite are also approximately inversely related to one another.

WATER ANALYSIS

Two water samples were collected and submitted for analysis, as shown here:

Depth		Temperature		Lithium	Chloride	Li/Cl ratio
ft	m	°F	°C	mg/L	mg/L	
115	35	80.6	27	0.04	280	0.00014
335	102	84.2	29	0.02	180	0.00011

The lithium and chloride values are quite low in comparison to the subsurface waters encountered in other playas. Moreover, the ratio, Li/Cl, is also low. These water data contrast with the anomalous average lithium content of 484 ppm for the sediments in the 200-ft (61.9-m) interval from 15 to 215 ft (4.6-97.5 m). The high concentration of lithium in the sediments in comparison to that in the water suggests an effective mechanism for the adsorption of lithium by the sediments.

CLAY MINERALOGY

Clay mineral separations were made on three samples selected for their high lithium content. Identification of the clay minerals was attempted using standard clay-mineral identification techniques (Hauff, P. L., Starkey, H. C., and Blackman, Paul D., written communication, 1974). Both samples contain a 10A micaceous mineral recognizable when observed with a petrographic microscope. Both samples also contain a 14A clay mineral that expands to nearly 18A upon glycolation and collapses to 10A upon heating the clay at temperatures of 400 and 550 C. An unoriented cellulose mount shows a 060 D-spacing near 1.52A characteristic of a trioctahedral smectite (Starkey and Mountjoy, 1973). Interpretation of the X-ray diffractogram pattern would indicate the existence of a 10A-14A mixed-layer clay. It appears that most of the lithium is held in the trioctahedral smectite and that some may be present in the micas (Levinson, 1953).

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