MAP SHEET 1
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ECONOMIC GEOLOGY OF THE LONG VALLEY DIATOMACEOUS EARTH DEPOSIT, MONO COUNTY, CALIFORNIA

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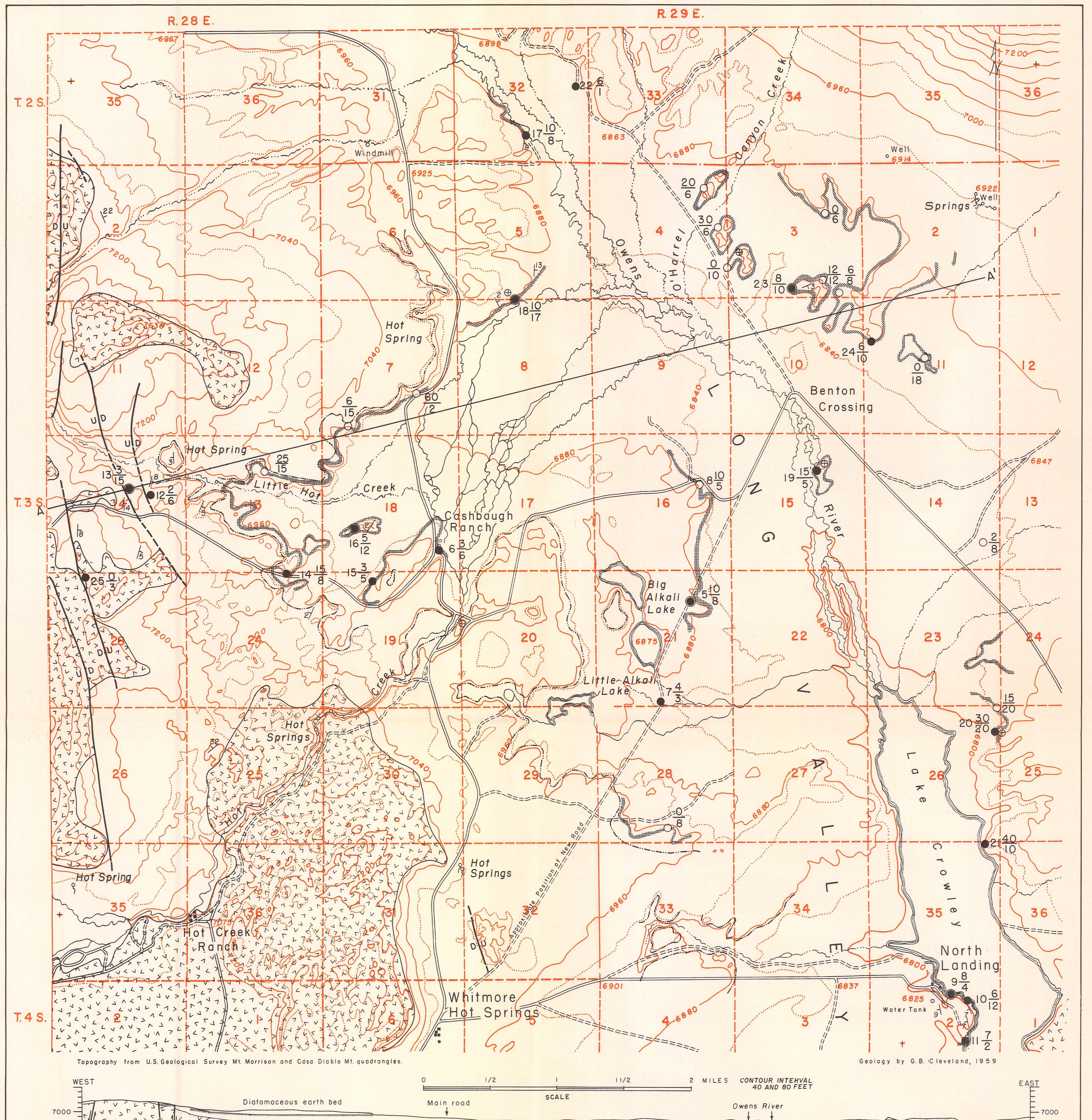


LEGEND

Pleistocene (Tahoe stage?)

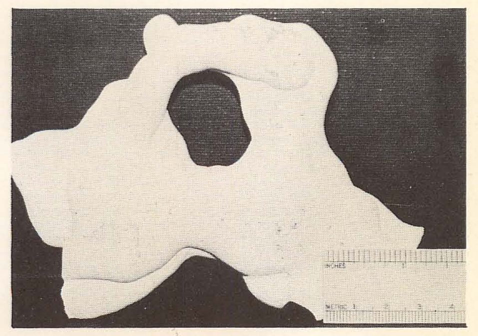
- Diatomaceous earth bed
- resistant sandstone bed in the lacustrine deposits.
- Lacustrine deposits diatomaceous tuff, sandstone and diatomaceous earth, also includes alluvium and surficial volcanic ash.

Pliocene?

- Pre-lacustrine rocks largely rhyolite flows and tuff breccia

SYMBOLS

- Sample number 5 6/8 thickness of overburden / exposed thickness of diatomaceous earth.
- Exposed thickness of diatomaceous earth and overburden recorded.
- Microscopic examination made
- Microscopic examination made and industrial properties determined
- Strike and dip of beds
- Flat lying beds



Left, typical platy chert concretion common in main diatomaceous earth in section 18. Below, exposure of diatomaceous earth showing biscuit-like weathering.

Table 1. Industrial properties of the Long Valley diatomaceous earth

Properties[1]	Sample number[2] 5	9	13	16	18	23
Chemical analysis						
SiO_2	79.46	77.16	74.86	78.76	75.28	79.37
Al_2O_3	8.58	5.78	10.48	2.32	12.62	10.14
$FeO+Fe_2O_3$	0.88	2.24	1.44	1.84	1.76	1.44
CaO	0.79	2.04	0.80	3.19	0.85	0.41
MgO	0.97	1.19	1.27	0.97	0.92	0.75
P_2O_5	0.35	0.47	0.38	0.30	0.43	0.39
Brightness (G.E. eq.)						
Crude	-	50.0	79.0	71.5	57.0	52.5
Flux Calcined	70.00	-	81.5	-	-	-
Moisture (%)						
Crude	6.4	5.5	15.8	7.2	5.5	8.4
Oven dry	-	3.1	-	1.5	2.5	2.9
Particle size						
30μ	-	26.0	-	7.0	13.0	9.0
150 mesh	-	-	5.6	-	-	-
325 mesh	-	33.2	-	25.6	19.2	35.2
Cake density (lbs./ft.^{3})						
Natural	-	-	29.5	-	-	-
Flux Calcined	21.8	-	22.8	-	-	-
Flow rate "index"[3]						
Natural (index 1)	-	-	33	-	-	-
Flux Calcined (index 7)	109	-	103	-	-	-

[1] Chemical analyses made by Twinimg Laboratories, Fresno; all other test data through the courtesy of the Great Lakes Carbon Company, Walteria Laboratory, Los Angeles.
[2] Sample localities shown on Plate 1.
[3] "Index" equated to commercial products of Johns-Manville Company and Great Lakes Carbon Company. The flow rate properties tabulated fall within the limits of these products: Johns-Manville Company Celite—"Filtercel", Index 1; "Hyflo", 7. Great Lakes Carbon Company Dicalite—"Superaid", Index 1; "Speedplus", 7.

ABSTRACT

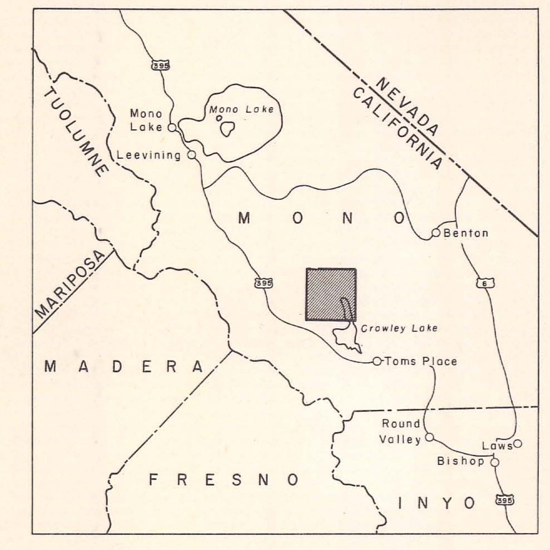
Poorly exposed beds of impure diatomaceous earth occur in Long Valley, southwestern Mono County, in the middle part of a lacustrine sequence of late Pleistocene (?) age. The beds crop out, below thin cover, in numerous places over an area of about 50 square miles. Most of the diatomite occurs in a single bed, which ranges in thickness from a few feet to about 20 feet. The rest is in one or more thinner beds. The diatomite is composed principally of skeletons of the genus Stephanodiscus, but a large part of the deposit is contaminated with volcanic ash and calcium carbonate. The deposit is undeveloped, but the properties of the material sampled suggest that it may be suitable as a low-grade filteraid, as a filler in paper, or for other uses for which relatively low-grade material is satisfactory. The deposit contains minimum reserves of about 7 million tons of easily recoverable diatomaceous earth.

GEOLOGIC SETTING

The distribution of lacustrine deposits along the Owens Valley trough in Mono and Inyo Counties has long been recognized as indicating the previous existence of a group of lakes that occupied local depressions during Pleistocene time (Miller, 1946; Blackwelder, 1954). In some places the lacustrine units contain both diatomaceous strata and layers of volcanic ash, thus indicating that diatoms flourished concurrently with Pleistocene volcanism (Russell, 1889; p. 307; Knopf, 1918, p. 50; Mayo, 1934; Rinehart and Ross, 1957; Smith and Pratt, 1957, p. 1; Cleveland, 1958). As diatoms have a siliceous skeletal framework, or frustule, their abundance in the lacustrine deposits can be partly attributable to the availability of silica through decomposition of ash in water. Moreover, the growth of diatoms also is promoted by relatively low temperatures, which inhibit the development of acid-forming bacteria and permits the water to absorb relatively greater quantities of carbon dioxide and oxygen (Conger, 1942). Therefore, the relatively cool Pleistocene climate also favored the deposition of diatomaceous strata.

The thickest and most widespread of the diatomaceous deposits found to date in the Owens Valley region occurs in Long Valley, which is in southwestern Mono County about 20 miles south of Mono Lake and about 30 miles northwest of Bishop. The valley lies between low volcanic hills near the front of the Sierra Nevada on the west, and the Benton Range on the east. It is a broad, relatively flat depression which rises gently to abrupt mountain fronts on nearly all sides. The valley is about 15 miles long in a northwest direction and about 10 miles wide. Its floor averages about 6800 feet in elevation. Owens River flows through the center of the valley to Lake Crowley reservoir near the southern end.

Long Valley is a structural as well as topographic basin and has existed at least from mid-Pleistocene time and possibly since Pliocene time (Gilbert, 1938, p. 1860; Rinehart and Ross, 1957). Geophysical studies made by Pakiser and Kane (1956, p. 1724) suggest that the basin contains 12,000 feet of Cenozoic rocks of which about 200 feet of Pleistocene lacustrine deposits are exposed at the surface.



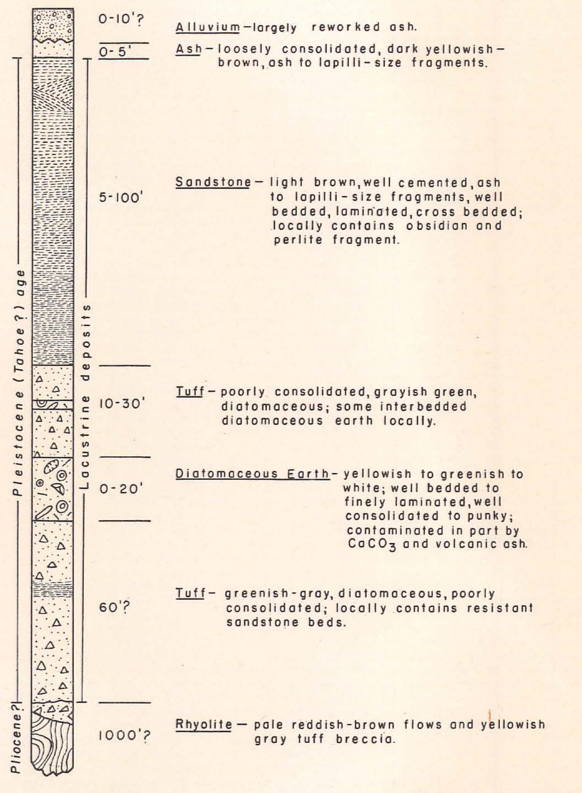
Russell (1883, p. 234) first reported evidence of an ancient lake in Long Valley, and Woods (1924), Mayo (1934), Gale (unpublished manuscript) and Rinehart and Ross (1957) described the basin and the occurrence of lacustrine rocks. The lake once covered an area of at least 80 square miles (Rinehart and Ross, 1957).

Lacustrine units are distributed over the entire floor of the valley, but in the central part, the Owens River has eroded away the upper part of the section along a strip one to five miles wide and about 8 miles long. Throughout most of this area the river has cut down below the known diatomaceous earth beds and eroded them away. The lacustrine deposits are generally undisturbed except near the margins of the basin where they are in fault contact with older rocks (Rinehart and Ross, 1957). In general, they dip ½° toward the center of the basin, although locally they are slightly warped.

The lacustrine rocks consist mainly of poorly consolidated water-laid tuff and diatomaceous tuff; impure diatomaceous earth; and well consolidated sandstone. These rocks show a wide range in thickness from place to place in the basin. The sandstone occurs only on the west side of the valley where it forms a thick resistant rock above the diatomaceous earth. Overlying the lacustrine rocks is a deposit of loosely consolidated ash that ranges in thickness from a few inches to several feet. Alluvium covers the central part of Long Valley but nearly everywhere else it covers low-lying areas topographically below the exposures of the main diatomaceous earth bed.

The lacustrine rocks of Long Valley were tentatively correlated with the Tahoe glacial stage by Rinehart and Ross (1957); this is the next to youngest of the four Sierran glacial stages (McGee, Sherwin, Tahoe and Tioga) recognized by Blackwelder (1931).

The nature of the diatom flora suggests that the lake was relatively shallow and somewhat alkaline. The diatom genera *Epithemia* and *Cymbella* were common in most samples examined and are bottom dwelling forms indicative of shallow water. The abundance of diatoms belonging to the genera *Surirella*, *Campylodiscus*, *Epithemia* and *Stephanodiscus* indicates that ancient Long Valley lake was somewhat brackish at the time that the diatomaceous earth was being formed.



COMPOSITE COLUMNAR SECTION

DIATOMACEOUS EARTH

In Long Valley, the exposures of diatomaceous earth are confined to an area of about 50 square miles. The diatomaceous earth occurs in the middle part of the lacustrine section and mostly in a single bed. This main bed ranges in exposed thickness from a few feet to about 20 feet, but averages between 10 and 15 feet. In a few places, thinner beds 3 feet or less thick are exposed. The main bed is poorly exposed and crops out only where slopes are oversteepened; especially below the sandstone cap rock on the west side of the valley and at some places along the shore of Lake Crowley. The bed appears to have once covered the entire basin and probably extends from outcrops on the west side of the valley, westward below a thin cover to the margin of the basin, and correspondingly eastward, from outcrops on the east side of the valley.

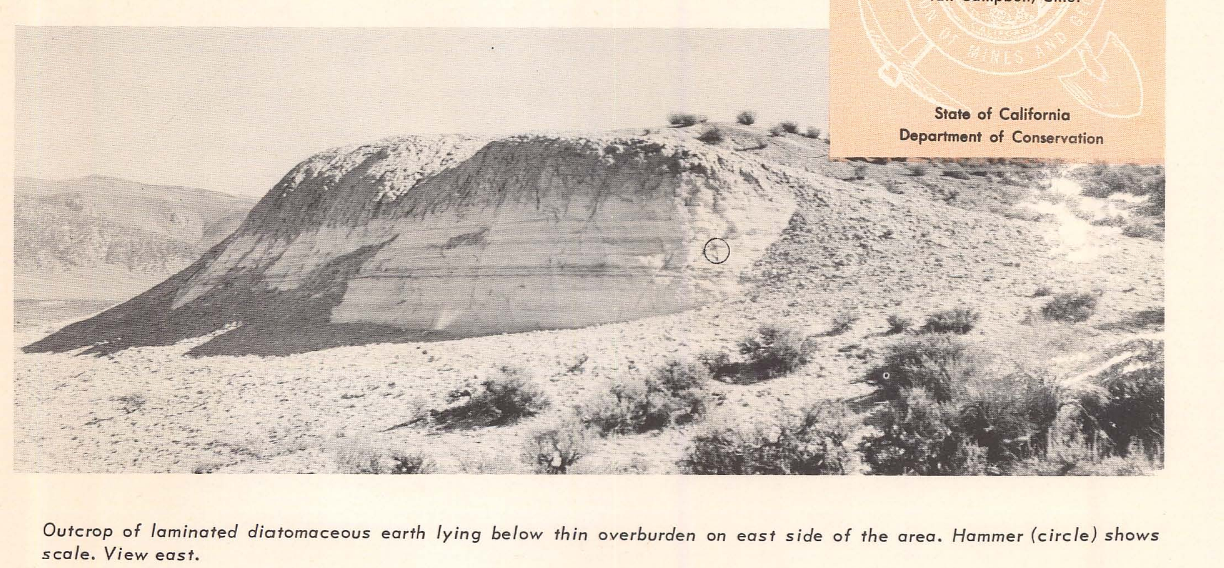
The diatomaceous earth is generally well bedded and commonly thinly laminated. Where it is exposed on level surfaces it forms a biscuit-like pavement. It is a pale yellowish- to greenish-gray to white, well consolidated to punky and of low apparent specific gravity. Most of the main bed is contaminated with volcanic ash. The ash occurs as relatively thin beds intercalated with the diatomaceous earth and as minute fragments with it. There are all gradations from diatomaceous earth with a few percent of volcanic ash to nearly pure ash with widely scattered diatoms. Most of the samples collected appeared to contain 25 percent or more of ash. In section 18 the main bed contains numerous light colored platy concretions of chert. These are generally less than one inch thick and are several inches long. They lie with their long dimension parallel to the bedding. At several localities the diatomaceous earth is contaminated with calcium carbonate.

The diatom flora consists of at least 14 genera of which only *Epithemia*, *Cymbella*, *Cocconeis*, *Surirella*, *Campylodiscus* and *Stephanodiscus* are abundant. *Stephanodiscus*, a disc-shaped form, comprise more than 50 percent of the volume of 13 of the 21 samples examined. A few fresh water sponge spicules were noted in several samples. The diatom assemblages reported from each locality are similar and such differences as were detected may be partly attributable to the difficulty in selecting representative samples.

Although the Long Valley deposit is undeveloped, the diatomite possesses properties that may be suitable for some industrial uses; these properties are given in Table 1. The material has a relatively high cake density but fairly high flow rate characteristics, and possibly it would make an acceptable filteraid according to present standards. The high natural brightness of some samples suggests that the material might be of use as a paper filler if the coarse particle sizes were removed. It may possibly be used as a fertilizer conditioner; in heat and sound insulation; as a bulk filler; and with proper size classification and pH control, as an insecticide carrier.

The estimated reserves of diatomaceous earth in the Long Valley deposit were calculated from areas enclosed by continuous outcrop or from areas of partial closure. Where there was partial closure, the area underlain by diatomaceous earth was determined arbitrarily by connecting the extremities of the outcrop trace with a straight line. No estimates were made for material lying below the sandstone because this stratum would offer a serious obstacle to open-pit mining. The total area underlain by diatomaceous earth within the limits indicated above, is slightly more than two square miles. Based on an average thickness of 10 feet, the volume of material present is about 21 million cubic yards. Assuming an apparent specific gravity of 0.4 for dry diatomaceous earth, the deposit contains minimum reserves of more than 7 million tons. This includes all grades of material from diatomaceous earth to diatomaceous tuff. The reserves of the entire deposit, which can only be inferred from the geologic evidence, suggest a total several times that given, although most of them would lie below the sandstone. The thickness of overburden in areas where the reserves were calculated is generally less than 20 feet, however locally it is as much as 40 feet or more, and in some places has been entirely eroded away.

As the filteraid use constitutes by far the largest market for diatomite, the advent of large-scale mining of the diatomite in Long Valley will probably depend upon its suitability for this use. Diatomaceous earth that is initially unsuitable for this purpose or the part rejected during the processing of filteraid-grade material, is used for filler, thermal insulation, or in one of 300 other applications. Material suited to only one or a few minor uses has a highly restricted market. Potential consumers expect to buy a variety of grades of material from a single source and also expect to receive laboratory and engineering assistance. Furthermore, the processing of diatomaceous earth is a highly technical and difficult procedure. However, in California besides the large commercial deposits at Lompoc, Santa Barbara County, and elsewhere, relatively small, low grade deposits have been mined and the material sold for use in lightweight aggregate, absorptive compounds, heat insulation products, soil conditioners and as a source of silica.



Outcrop of laminated diatomaceous earth lying below thin overburden on east side of the area. Hammer (circle) shows scale. View east.

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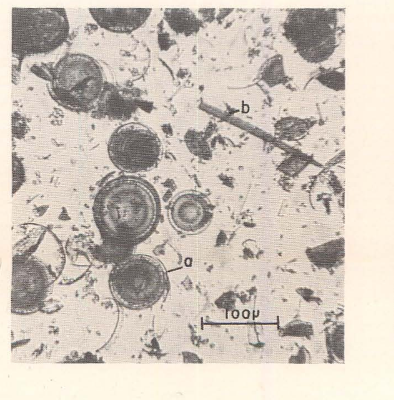
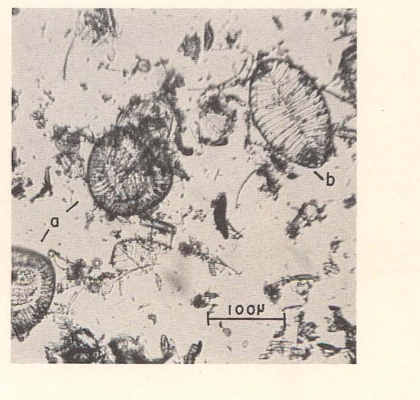
Table 2. Properties of the Long Valley diatomaceous earth.

Loc. no.[1]	Impurities[2] Volcanic ash (percent)	Impurities[2] $CaCO_3$	Color[3]	Diatom genera Dominant	Diatom genera Present
5	25-50		White	Cymbella Epithemia	Cocconeis, Fragilaria, Melosira, Navicula, (Sponge spicules)
6	25-50		White	Cocconeis Stephanodiscus	Campylodiscus, Cymbella, Epithemia, Melosira, Rhoicosphenia
7	50-75		Very light gray	Stephanodiscus	Cocconeis, Cymbella, Epithemia, Rhoicosphenia, (Sponge spicules)
8	25-50		White	Cocconeis Epithemia	Cymbella, Fragilaria, Stephanodiscus
9	0-25		Yellowish-gray	Epithemia	Fragilaria, Rhapolodia, Stephanodiscus
10	50-75		Yellowish-gray	Stephanodiscus	Cymbella, Epithemia, Fragilaria, Pleurosigma, Surirella
11	75-100		Pale greenish yellow	Cocconeis	Cymbella, Epithemia, Fragilaria
12	25-50		White	Stephanodiscus	Cocconeis, (Sponge spicules)
13	25-50		White	Cocconeis Epithemia	Cymbella, Rhoicosphenia, Stephanodiscus
14	75-100		Very light gray	Stephanodiscus	Cocconeis, Cyclotella, Cymbella, Epithemia, Fragilaria, Melosira, Surirella
15	0-25	x	Yellowish-gray	Cocconeis	Cymbella, Epithemia, Rhoicosphenia, Stephanodiscus
16	0-25	x	White	Campylodiscus Surirella	Cocconeis, Cymbella, Epithemia, Rhoicosphenia, Sticodiscus (?)
17	50-75		Very light gray	Stephanodiscus	Cocconeis, Fragilaria, Melosira, (Sponge spicules)
18	25-50		Very light gray	Stephanodiscus	Campylodiscus, Cocconeis, Epithemia, Fragilaria, Melosira, Rhapolodia, (Sponge spicules)
19	0-25	x	Very light gray	Stephanodiscus	Cymbella, Epithemia
20	25-50	x	White	Stephanodiscus	Cymbella
21	25-50	x	Very light gray	Stephanodiscus	Epithemia
22	50-75		Very light gray	Stephanodiscus	Fragilaria, Melosira
23	0-25		White	Stephanodiscus	Epithemia, (Sponge spicules)
24	0-25		White	Stephanodiscus	Cocconeis, Cymbella, Epithemia, Fragilaria, (Sponge spicules)
25	25-50		White	Stephanodiscus	Campylodiscus, Cocconeis, Epithemia, Fragilaria, Rhoicosphenia

[1] Sample localities shown on map.
[2] Proportion of volcanic ash estimated from strewn slides under the microscope. Presence of $CaCO_3$ indicated by effervescence after treatment with .2N HCl.
[3] Color designation according to Rock-Color Chart Committee (1948).

Left, photomicrograph of diatoms in sample from locality 9; (a) Stephanodiscus and (b) Epithemia. Center, photomicrograph of diatom genera occurring at locality 23; (a) Stephanodiscus and (b) fresh-water sponge spicules. Right, photomicrograph of diatoms in sample from locality 16; (a) Campylodiscus and (b) Surirella.