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OCCURRENCE OF DIATOMACEOUS EARTH NEAR KENAI, ALASKA

by

George Plafker

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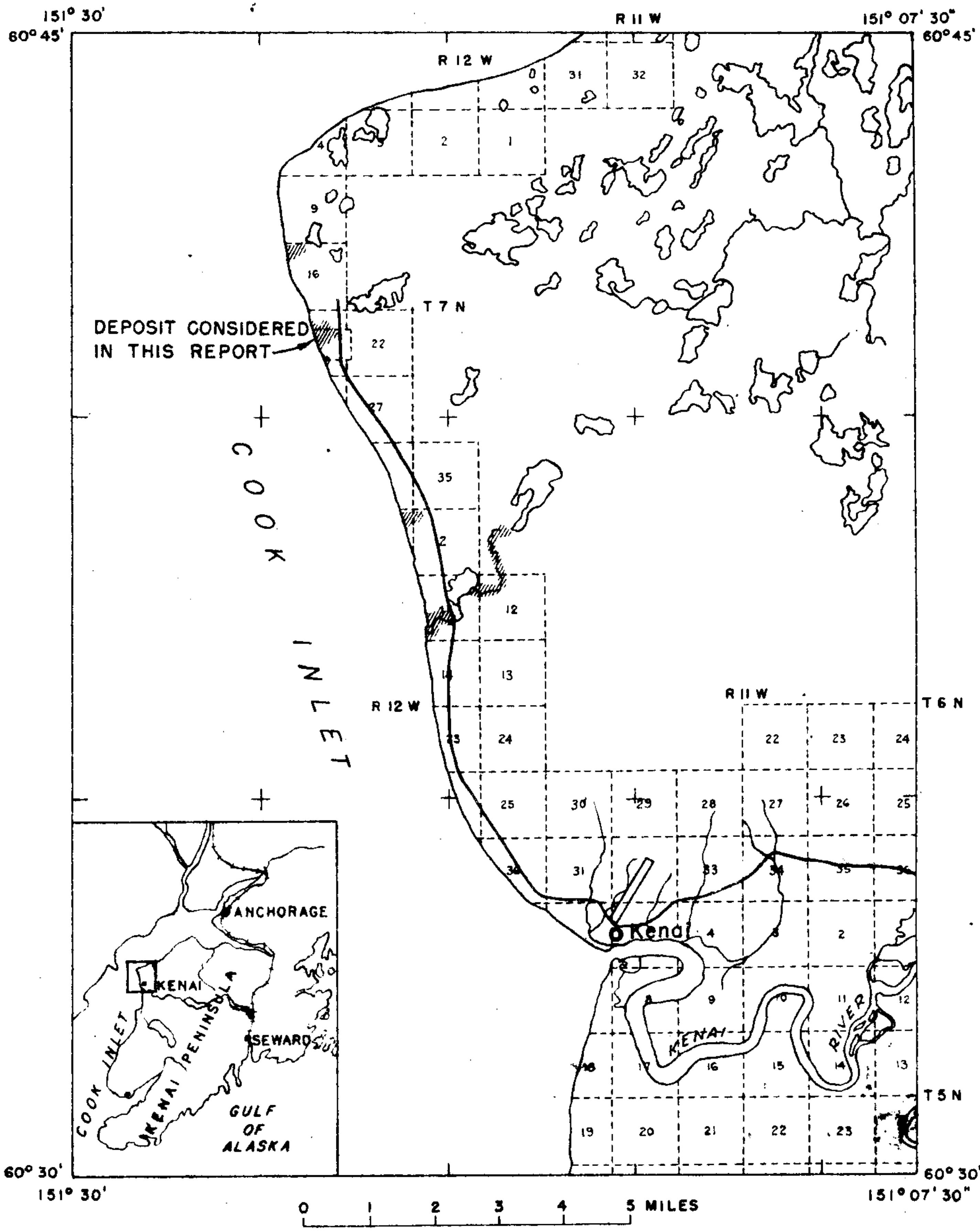

Figure 1: Index map of the Kenai area showing location of diatomaceous earth deposits (hachured).

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Abstract

Diatomaceous earth _/ occurs in post-glacial lake deposits exposed

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_/ Diatomaceous earth is an unconsolidated earthy deposit formed by accumulation of the minute siliceous tests (skeletons) of diatoms, a type of algae. Diatomaceous earth is sometimes referred to as diatomite.

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along the shore of Cook Inlet north of the village of Kenai, Alaska.

The largest and purest of these deposits was mapped and sampled in detail. The diatomaceous earth attains a maximum thickness of 12 feet, with the dried material averaging between 65 and 75 percent diatoms by weight.

The deposit mapped contains about 200,000 cubic yards of diatomaceous earth which is readily accessible, and is favorably situated with regard to transportation by sea and road.

Introduction

As a part of the U. S. Geological Survey's program of exploration for construction materials in Alaska, diatomaceous earth exposed in four post-glacial lake deposits along the shore of Cook Inlet from 6 to 12 miles north of the village of Kenai (fig. 1) were examined. The deposit described in this report is the only one considered to be of sufficient extent and purity to be of possible economic interest. This deposit is 10¼ miles north of Kenai in sec. 21, T. 7N., R.12W. Anchorage, the largest city in Alaska, is 65 miles to the northeast by sea and 172 miles by an all weather road.

The climate of the Kenai area is characterized by cool summers and mild winters for the latitude. The following table compiled from the records of the U. S. Weather Bureau shows average monthly temperatures at Kenai over a period of 18 years, and average precipitation for a period of 22 years.

Table 1.

Average monthly temperature and precipitation at Kenai

Month		Temperature	Precipitation
January		11.5	0.77
February		17.4	0.78
March		23.7	0.86
April		32.5	0.78
May		43.3	0.80
June		49.4	0.76
July		53.6	2.22
August		53.3	3.10
September		46.3	3.17
October		34.5	2.08
November		21.2	1.62
December		13.2	1.07
	Yearly totals	33.4	20.63

Since the beginning of World War II Alaska has experienced a construction boom so that today the construction industry in Alaska now monetarily outranks both mining and fishing. However, all of the raw materials for construction, other than natural aggregates and some lumber, are imported, with attendant increased costs of freight and handling charges. In view of the rigorous climate in Alaska, it is particularly desirable to develop sources of lightweight and insulative building materials such as diatomaceous earth, haydite, perlite, and pumice. These materials not only serve as thermal insulation, but, because of their relatively light weight, also reduce the amount of costly framing required for large structures.

The deposits shown on figure 1 were described briefly in an unpublished administrative report by Thor N. V. Karlstrom of the U. S. Geological Survey in November, 1951. The present investigation was made between July 26 and August 9, 1952, during which time all the deposits shown on figure 1 were mapped and sampled. The largest deposit was mapped in detail (see pl. 1) by plane table (scale 1:2,400; contour interval 10 feet). Twenty sections, clearly exposed along the sea cliff, were examined and measured. In addition, 25 hand auger holes shown on plate 1 were drilled throughout the deposit to determine the thickness of the diatomaceous earth.

The author wishes to thank Mr. Ted Meining of Kenai for the many courtesies extended during the course of field work, and Dr. G. Dallas Hanna of the California Academy of Sciences who kindly identified the diatoms occurring the deposit.

Geology

The diatomaceous earth is the youngest deposit in a sequence of post-glacial lacustrine sediments with a maximum aggregate thickness of 18 feet. These sediments were deposited on the surface of a glacial outwash plain in one or more small lakes which were subsequently drained and are now exposed in cross section in the sea cliff along the east shore of Cook Inlet.

Glacial outwash.-- The entire area shown in figure 1 is underlain by glacial outwash of unknown thickness. Maximum local relief on the surface of the outwash is 75 feet, with numerous shallow depressions occupied by lakes and peat bogs. The outwash is generally well stratified, consisting predominantly of tan to brown, subrounded, pebble-and-cobble conglomerate with a silty sand matrix. Where the outwash is close to the surface in this area it characteristically supports a moderately dense growth of brush and trees (fig. 2).

Older lake sediments.-- Deposited on the glacial outwash is a sequence of fine-grained, dark, thinly laminated clay, silt, and sand up to 13 feet in thickness (fig. 3). The older lake sediments consist predominantly of brown or gray to black silt, clayey silt, and sandy silt containing a considerable amount of organic matter. Interstratified with, and grading into the silty sediments, are subordinate amounts of very fine to medium-grained brown sand or pebbly sand and minor dark-brown clay. Individual units average less than 6 inches in thickness and are not persistent laterally. Where the poorly-drained older lake sediments are exposed at the surface, they support a sparse growth of trees.

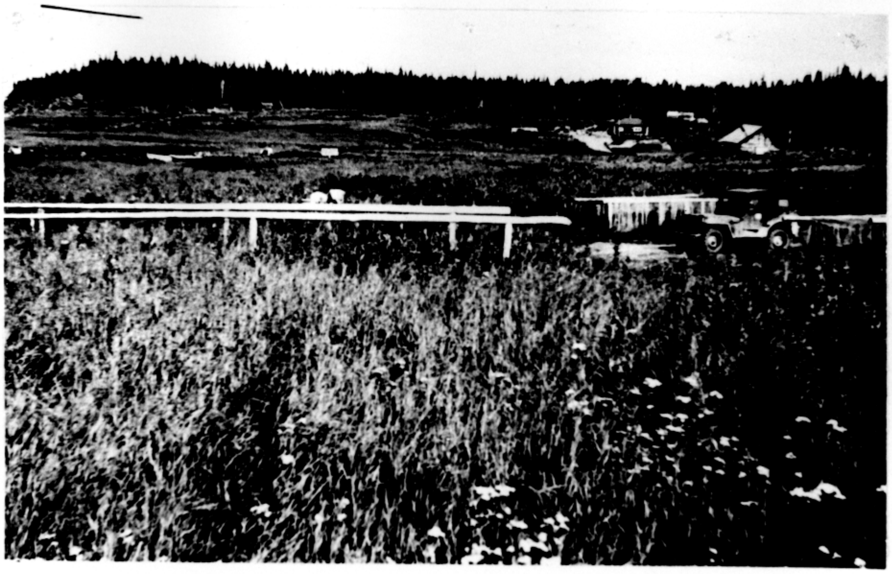

Fig. 2. View looking north from near south end of meadow underlain by diatomaceous earth. Trees in background mark approximate contact of diatomaceous earth with glacial outwash.

Fig. 3. Road cut in sea cliff exposing 12 feet of diatomaceous earth (white) underlain by 3 feet of older lake deposits (black) and glacial outwash (gray). The base of the cut is mantled with talus.

Diatomaceous earth.-- A surficial layer of diatomaceous earth mantles the older lake sediments as shown in figure 3. The thickness of this deposit is extremely variable due to the irregular configuration of the lake floor on which the diatoms were deposited, and to stripping after the lake was drained and exposed to erosion. Throughout most of the deposit the diatomaceous earth averages between 2 and 6 feet thick, and, near the southern margin of the deposit, attains a maximum thickness of 12 feet. The contact of the diatomaceous earth with the underlying sediments is abrupt with only local perceptible downward gradation into the older lake sediments.

Except for a thin veneer of air-dried material exposed along the sea cliff, the diatomaceous earth is saturated with as much as 1½ times its weight of water. When wet, the diatomaceous earth is mottled drab brown to green in color, fetid in odor, and jelly-like in consistency. In contrast, the dried material is massive, very light weight, chalk white to light buff, and friable. Although the diatomaceous earth is extremely homogeneous in appearance and composition, a faint varve-like banding is locally discernible in moist samples.

Between 65 and 75 percent by weight of the dried diatomaceous earth consists of Recent fresh water diatom tests ranging in size from .023 to .004 mm. (fig. 4). Genera identified in the deposit are as follows:

Genera of diatoms identified in the diatomaceous earth

Abundant Forms	Less Abundant Forms
Stephanodiscus	Fragillaria
Melosira	Navicula
Cymbella	Pinnularia
	Gomphonema
	Epithemia
	Tetracyclus
	Cyclotella
	Synedra

The remainder of the diatomaceous earth is composed of approximately 13 percent organic matter, minor amounts of siliceous sponge spicules approximately .3 mm. long and from 10 to 20 percent wind-deposited silt and clay less than .025 mm. maximum diameter. The chemical composition of a representative sample of diatomaceous earth analyzed by the Bureau of Mines is shown in table 2.

Table 2

Chemical analysis of diatomaceous earth

Composition		Percent
SiO_2		71.02
Al_2O_3		6.96
Fe_2O_3		3.84
TiO_2		0.37
Others		4.14
Ignition loss		13.69
	Total	100.02

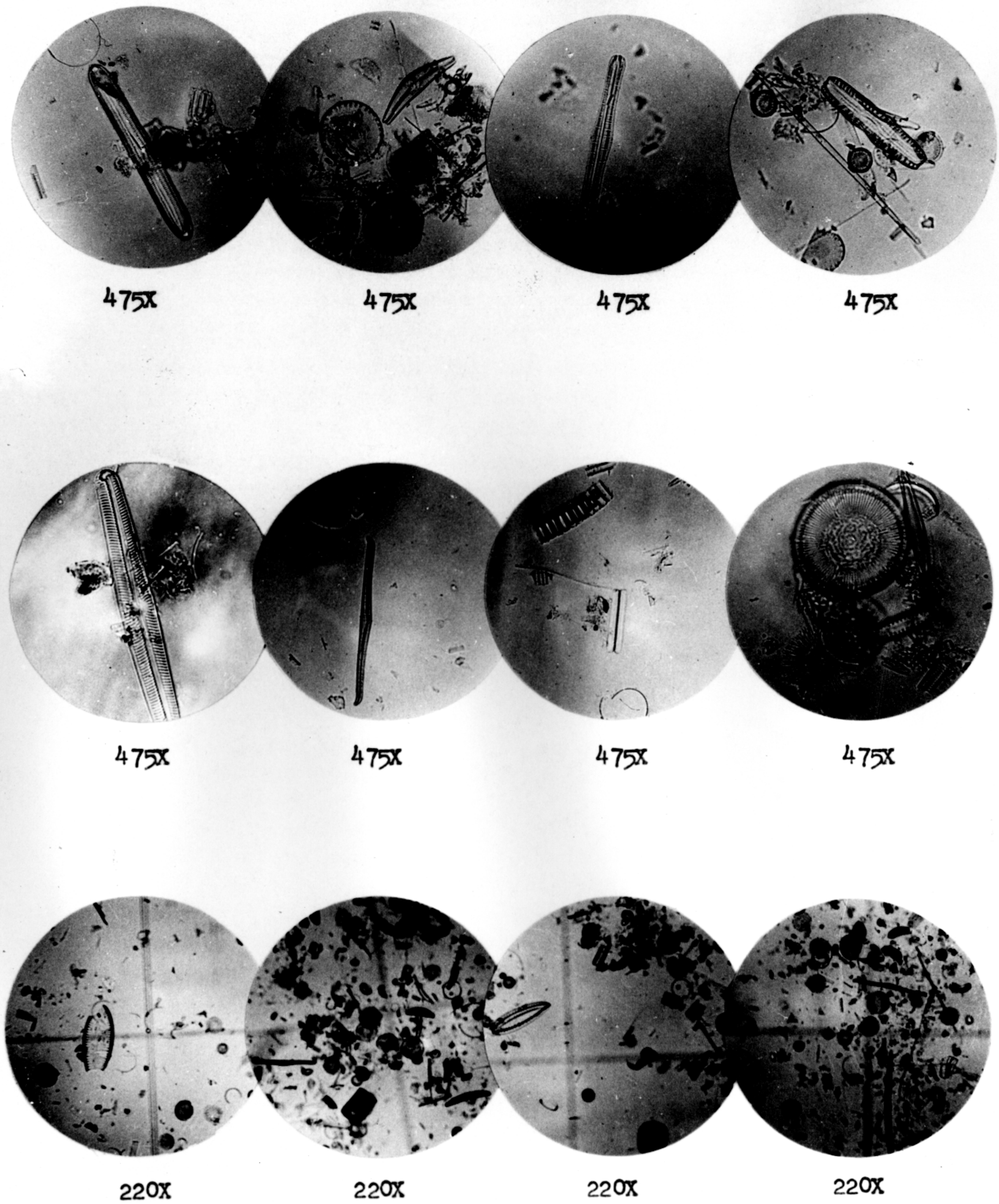

Fig. 1. Photomicrographs of diatoms from deposit described.

Areas underlain by diatomaceous earth are mantled by hummocky mounds of weeds and grasses (fig. 2). Within the root zone, which is generally less than 2 feet thick, the diatomaceous earth is stained to a rust color, due to oxidation of iron contained in the impurities.

Talus and beach deposits.--All but the highest section of the steep sea cliff shown in plate 1 is mantled with loose outwash gravel and blocks of lake sediments that have slumped from the cliff (see fig. 3). The beach deposits and road fill consist of loose, rounded sand and gravel derived from the glacial outwash.

Origin of the diatomaceous earth.--According to carbon 14 dating by Karlstrom (Péwé and others, 1953) the outwash underlying this area was deposited between 8,000 and 14,000 years ago during the Naptowne glaciation by meltwater streams from a glacier whose southern margin was approximately 6 miles north of the diatomaceous earth deposit. The depression in which the diatomaceous earth occurs was probably formed by melting away of a mass of ice that was buried or partly buried in outwash. Subsequently, the depression was filled with water and the older lake deposits consisting of laminated clay, silt, and sand which underlie the diatomaceous earth, were carried into the lake by streams and to a lesser extent by wind. After accumulation of as much as 13 feet of older lake sediments, deposition abruptly ceased and the lake water cleared. The accumulation of diatoms followed and continued without interruption until the sea cliff along Cook Inlet cut into and drained the lake, leaving the deposit exposed as we see it now.

It is unlikely that "normal" geologic processes such as retreat of the glacier to the north or post-glacial uplift and warping could have been responsible for the abrupt change in conditions that cut off the supply of clastic sediments and favored relatively pure accumulation of diatoms. More probably the change in environment was related to the presence of a beaver dam that now blocks the old intake near the east side of this deposit (pl. 1) and to other beaver-dammed streams in this area. Construction of a beaver dam upstream from the former lake provided a settling basin in which all but the very finest particles were deposited, thereby cutting off the supply of clastic sediments to downstream areas. The resulting clear lake water was an ideal environment for diatoms to accumulate in vast numbers owing to the following factors: 1) a plentiful supply of silica (the basic constituent of the potential sediments), mainly in the form of finely divided siliceous rock flour from the surrounding glacial deposits and possibly in part from the wind-deposited volcanic ash derived from the chain of active volcanoes to the west and southwest; 2) low temperature, which inhibits bacterial activity, and increases the capacity of water to absorb both oxygen and carbon dioxide, thereby favoring diatom growth; 3) adequate illumination, which is essential for the growth of these plants (Conger, 1942). The above conditions must have been rigidly maintained over a considerable period of time for the minute diatoms to have accumulated to the extent shown in this deposit.

Undoubtedly similar environmental conditions prevailed in some of the numerous inland lakes in this same general area, and it is highly probable that prospecting might uncover additional deposits of diatomaceous earth.

Factors Affecting Development

Diatom tests consist of hydrous silicon dioxide containing between 96 and 97 percent of SiO_2 and between 3 and 4 percent of combined water, which can be driven off at temperatures between 500° and 800° C. Melting point of the silica is over 1,400° C. The diatom skeletons are chemically stable, being soluble only in hydrofluoric acid and caustic alkalies.

The silica of diatoms has a true specific gravity about the same as opal, or 2.1 to 2.2. Individual tests are extremely porous, however, so the apparent density of solid dried diatomaceous earth ranges from 0.2 - 0.5, and the apparent density of loose, powdered material is between 0.12 and 0.23.

From the physical and chemical properties, it is apparent that the distinguishing characteristics of a material consisting largely of diatom tests are high porosity, low apparent density, chemical inertness, and stability over a wide range of temperatures. It is suitable, therefore, for use as a filter media, filler, and as an insulative and building material. Minor amounts of diatomaceous earth are also used in the chemical, abrasives, fertilizer, and many other industries.

The diatomaceous earth in this deposit would probably be suitable for use as an insulator and construction material, but is not sufficiently pure for most of the other uses enumerated above.

For additional information on the uses and processing of diatomaceous earth the reader is referred to the following publications:

Bowles, Oliver, 1943, Industrial Insulation with Mineral Products: U. S. Bur. Mines Inf. Circ. 7263, December.

Eardley-Wilmot, V. L., 1928, Diatomite, its occurrence, preparation, and uses: Canada Dept. of Mines, Mines Branch, no. 691.

Friberg, W. R., 1953, Woodfibre diatomite concrete: Univ. of Idaho Coll. Agr. Ext. Bull. 179, October.

Mielenz, R. C., 1950, Materials for pozzolan: U. S. Bur. Recl. Rept. No. Pet.-90B, June.

The diatomaceous earth could be readily excavated by employing bulldozers, power shovels or scrapers. Only a thin mat of vegetation must be removed to expose the deposit. Quarrying operations would probably be hampered during the winter by sub-freezing temperatures and snowfall. The material could be loaded directly on barges at the beach during periods of favorable tides and weather, or could be trucked to Kenai where docking facilities are available.

A minimum calculated volume of diatomaceous earth in this deposit, based on the exposed section along the sea cliff and on the auger holes, is 210,000 cubic yards. Using the average apparent specific gravity of 0.4, the solid dried material weighs 25 pounds per cubic foot, or 0.337 ton per cubic yard. The minimum calculated reserves based on these figures would be approximately 70,000 tons of solid dried diatomaceous earth.

Literature Cited

Conger, P. S., 1942, Accumulation of Diatomaceous Deposits: Jour. Sedimentary Petrology, vol. 12, no. 2, August.

Péwé, T. L. and others, 1953, Multiple Glaciation in Alaska: U. S. Geol. Survey Circ. 289.

Weather Bureau, U. S. Dept. of Commerce, 1950: Annual Summary 1952.