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U.S. GEOLOGICAL SURVEY

Core OL-92 from Owens Lake, southeast California

George I. Smith and James L. Bischoff

Editors

U.S. Geological Survey, Menlo Park, California

Open-File Report 93-683

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George I. Smith and James L. Bischoff, Editors.
U. S. Geological Survey
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1.0 Introduction

George I. Smith
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An important element of the investigations supported by the USGS through its Global Change and Climate History ("GCH") Program is the record of past changes in precipitation in now-arid parts of the United States. More than a century of geologic investigations has revealed several lines of evidence indicating that major changes in precipitation and runoff occurred during Quaternary time throughout much of this region. Among the most convincing evidence was that indicating large changes in the sizes of lakes in the Great Basin. These basins are sometimes termed "nature's rain gages" because their levels primarily record precipitation amounts within their drainage areas, and their lake-level histories document major changes in this element of climate during the past. There is, however, an inadequate consensus about the sequences and ages of these ancient lakes as well as the quantitative meteorological significance of their fluctuations. Because changes in precipitation amounts were--and in the future, would be--among the most critical to various forms of life, the timing and intensities of these climatic changes pose important questions to earth and paleoclimate scientists. Among them:

- How did the timing of precipitation changes in mid-latitude regions compare with the timing of high-latitude glacial-interglacial cycles? Were their maximum-intensity stages in phase or out-of phase? Were their responses characterized by significant time lags or leads? How did the precipitation responses in the southwestern U.S. compare with the responses and their timing in other mid-latitude regions?
- What were the variations in the magnitudes of precipitation amounts? What meteorological phenomena controlled the limits of those variations?
- Were geologic processes at the earth's surface altered significantly by changes in precipitation and runoff? For example, what about the rates of sedimentation, erosion, soil-formation, or weathering?
- Can a climate balance exemplified by the 10-ky-long Holocene be identified during any part of the 1600-ky-long Pleistocene? Do we

have records that could prove or disprove the existence of such a climate balance during this period?

Milestone studies of these Pleistocene lake histories published prior to 1980 are summarized by Smith and Street-Perrott (1983), and subsequent studies are noted by Benson and others (1990). The late-Pleistocene and Holocene histories of some of the lakes discussed in these summaries have been determined in detail. Comparable information about earlier (ca. >150 ka) lake histories is more difficult to extract from geologic records, however, because most of the sediments and other evidence of former lakes have been destroyed by erosion or buried by younger deposits. This older segment of the continental record is important because we do not yet have enough areal coverage or geologic perspective on Pleistocene climates to reconstruct the one-or-more air-mass circulation patterns that accompanied such profound changes in global climates.

Records of many earlier Pleistocene-age lakes can be found, however, in deposits beneath the surfaces of modern lakes or playas, but core drilling is required to obtain them. A drilling program such as this, lasting several years, was envisioned by several of us affiliated with a GCH workshop in the Spring of 1990. Owens Lake, a closed basin in southeast California, was determined to be one of the promising sites because:

(1) Owens Lake, and the succession of downstream basins that were connected during wet ("pluvial") periods of the Pleistocene, represent a hydrologic configuration capable of recording a very wide range of precipitation extremes. In the geological past, it was the first in a series of Pleistocene lakes that at times extended south and east to Indian Wells, Searles, Panamint, and Death Valleys, the floors of which are now dominated by playa lakes (see Smith, 1993, Fig. 1). The number and depths of perennial lakes in that succession primarily reflected the amounts of precipitation falling in their collective basins, which primarily included the high eastern slopes of the southern Sierra Nevada which drain into the Owens River, but also the slopes of lower-elevation ranges that adjoin those lakes' basins. Variations in wind, relative humidity, temperature, and other climatic variables that influence evaporation rates were also factors in determining lake sizes, but changes in them were much less important than variations in precipitation (Smith, 1991). Published studies of exposed lacustrine outcrops, cores, and landforms have helped reconstruct the past histories of lakes in the downstream basins that were part of this formerly-extended drainage (Gilbert, 1875; Gale, 1914; Blackwelder, 1933; Smith, 1962; Hooke, 1972; Smith,1975; Smith, 1979; Smith and others, 1983; Smith, 1984); glacial, geomorphic, and botanical studies in these and adjoining areas provide additional criteria that help reconstruct past climates (Blackwelder, 1931; Sharp and Birman, 1963; Martin and Mehringer, 1965; Burke and Birkeland, 1983; Sharp, 1987). These and many other studies promised to provide constraints when interpreting the lacustrine record of Owens Lake because these areas were all part of the same climatic and hydrologic system, and their histories, or some modification of them, must end up in agreement.

(2) Owens Lake today lies in a well-known hydrologic setting. Its drainage area is one of the most thoroughly studied in the United States as a result of more than a century of measurements by scientists and engineers concerned with the water supply for the City of Los Angeles. The relation between modern precipitation and runoff, therefore, is well documented. For this reason, past relations between temperature, precipitation, evaporation, and runoff in the Owens River drainage can be estimated on the basis of a well-established foundation of numerical data.

• (3) Geophysical studies show that more than 1.8 km of low-density sediments underlie Owens Lake's surface (Pakiser and others, 1964), meaning that a long record of valley-filling sediments of late Cenozoic age is likely to be preserved. As these geophysical studies also show the bedrock surface beneath this part of the basin to be the deepest and broadest in southern Owens Valley, it is also a likely site for that deposition to have been in a lake.

• (4) Evidence that Owens Lake never dried during Pleistocene time enhanced it as a desirable drill site because perennial lakes commonly accumulate lacustrine records that appear both continuous and unaffected by subaerial erosion. The evidence and rationale pointing to a permanent Pleistocene lake is as follows: Cenozoic uplift of Sierran terrain near the north end of the Owens River drainage area elevated the range's crest to within about 1000 m of its present altitude by 3 Ma (Huber, 1981). Probably, therefore, most Sierran terrain in this region during Quaternary time (0 Ma to 1.6 Ma) was within about 500 m of its present elevation. It is difficult to reconstruct the meteorological consequences of this different topography. Crest elevations that were lower would have caused less orographic cooling of uplifted, east-moving air masses from the Pacific, and while this would have decreased the amount of moisture that precipitated along the Sierran crest, it would have allowed more moisture to reach areas east of the crest--and perhaps condense over other ranges that drained into the Owens River or one of its downstram basins However, studies of modern precipitation gradients in the Sierras show that areas 500 m lower than near-crest elevations receive nearly 90 percent as much precipitation as the higher terrain, implying that without the above-described effects, runoff near the beginning of Quaternary time would have still been nearly 90 percent that of the present--which represents a notably arid period (Baker, 1983). Between 1872 and 1905, when this arid-period river flow was further decreased about 75 percent by irrigation, as shown by the decrease in Owens Lake's surface area by this much during that period, Owens became a shallower--but still perennial--lake (Gale, 1914). This evidence of an ever-present perennial Owens Lake is further supported by the absence of salts below those deposited in the lake during the 1910's, as indicated by the 278.5-m-deep core record obtained in 1953 from Owens Lake (Smith and Pratt, 1957, p. 5-14).

The drilling project at Owens Lake commenced in April, 1991. This Open-File Report represents an effort to make available to other researchers our preliminary data collected during the first year of study following completion of the core-drilling phase. Nineteen data collections and preliminary interpretations are presented in the following sections. They are the work of fifteen first-authors and their several co-authors. Besides this introduction, their topics include a field log of the core (1 contribution), sedimentological analyses (1), clay-mineral identification (1), geochemical analyses (5), dating and age estimates of the cored sediments (4), and identifications of fossil materials (7).

Supplemental data are also included on the depths of various sample sets used by these investigators, and the depths in the core assigned to the tops of each "run" and "slug" (see next section for explanation of these two terms); these will enable future researchers to locate the horizons in the cores from which we took samples, and therefore accurately place new data, based on their samples, into the same stratigraphic order. Details about the location of the core site, drilling equipment and methods, sampling and curating procedures, and lithologic-description criteria are also presented in the following section.

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2.0 Field log of Core OL-92

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The 323-m-long core designated OL-92 was recovered between April 22 and June 9, 1992, from the south-central part of (now-dry) Owens Lake, Inyo County, California (fig. 1A). The drill site is approximately 140 m west and 420 m north of the southeast corner of Sec. 9, T. 18 S., R. 37 E. [M. D. B. M.] (fig. 1B). Permission to drill the core hole was obtained by the U.S. Geological Survey from the California State Lands Commission which has jurisdiction of State lands that include the surface of Owens Lake. The drill site and a large amount of land around it is leased by the State of California to the Lake Minerals Corp.; they permitted our group to use their roads and were helpful in numerous other ways.

Five other cores have been obtained from Owens Lake. The 278.5-m-long core obtained by the U. S. Geological Survey in 1953 (Smith and Pratt, 1957, p. 5-25) was from a site about 2 km NE of the OL-92 site (fig. 1B). Although that core represents approximately the same depth of lake fill as was anticipated from the 1992 coring effort, a new core was desired because only 66 percent of the section at the 1953 core site was recovered, and many techniques have been developed during the intervening years that improve our ability to date sediments, determine sediment and interstitial water chemistry, interpret the environmental significance of fossils, and reconstruct the environments of deposition. Four shorter cores that were recovered more recently from Owens Lake (Newton, 1991; Lund and others, 1991) were studied with the goal of reconstructing climatic events and magnetic excursions during the latest Pleistocene and Holocene.

Core recovery for Core OL-92 was better than 80 percent. Because of drilling technicalities, Core OL-92 is actually three cores from essentially-adjacent sites; Cores OL-92-1 and -2 were recovered from the surface of a man-made drill-pad (which was used as the "core-depth datum" throughout the project, even though actually 0.94 m above the dry-lake bed), and Core OL-92-3 was recovered a few meters east of the drill pad. The depths of their cored intervals overlap slightly. Core OL-92-1 extends from 5.49 m to 61.37 m below the pad surface (85 percent core recovery), and OL-92-2 extends from 61.26 m to 322.86 m below that surface(79 percent recovery). Core OL-92-3 extends from 0.94 m (depth of the lake surface below the drill pad) to 7.16 m (100 percent recovery).

The rotary drill rig used for Cores OL-92-1 and OL-92-2 recovered 3-in. (7.6 cm)-diameter cores with a core barrel equipped with a split-spoon liner. The coring-bit size was 4.88 in. (12.4 cm) outside diameter, and the PVC (polyvinyl chloride) casing (set in OL-92-2 to a depth of about 60 m) was 6-in. (15.2 cm) diameter. Maximum core length was 15 ft (4.6 m) but most runs were two-thirds or less that length. Drilling mud was a bentonite type. Core OL-92-3 was obtained using two techniques. The upper 2.58 m of sediments (below the drill pad elevation) consists of salts and well cemented oolites; they were sampled using a rotary, sawtooth-edged drill used by Lake Minerals Corp. to test the thickness or

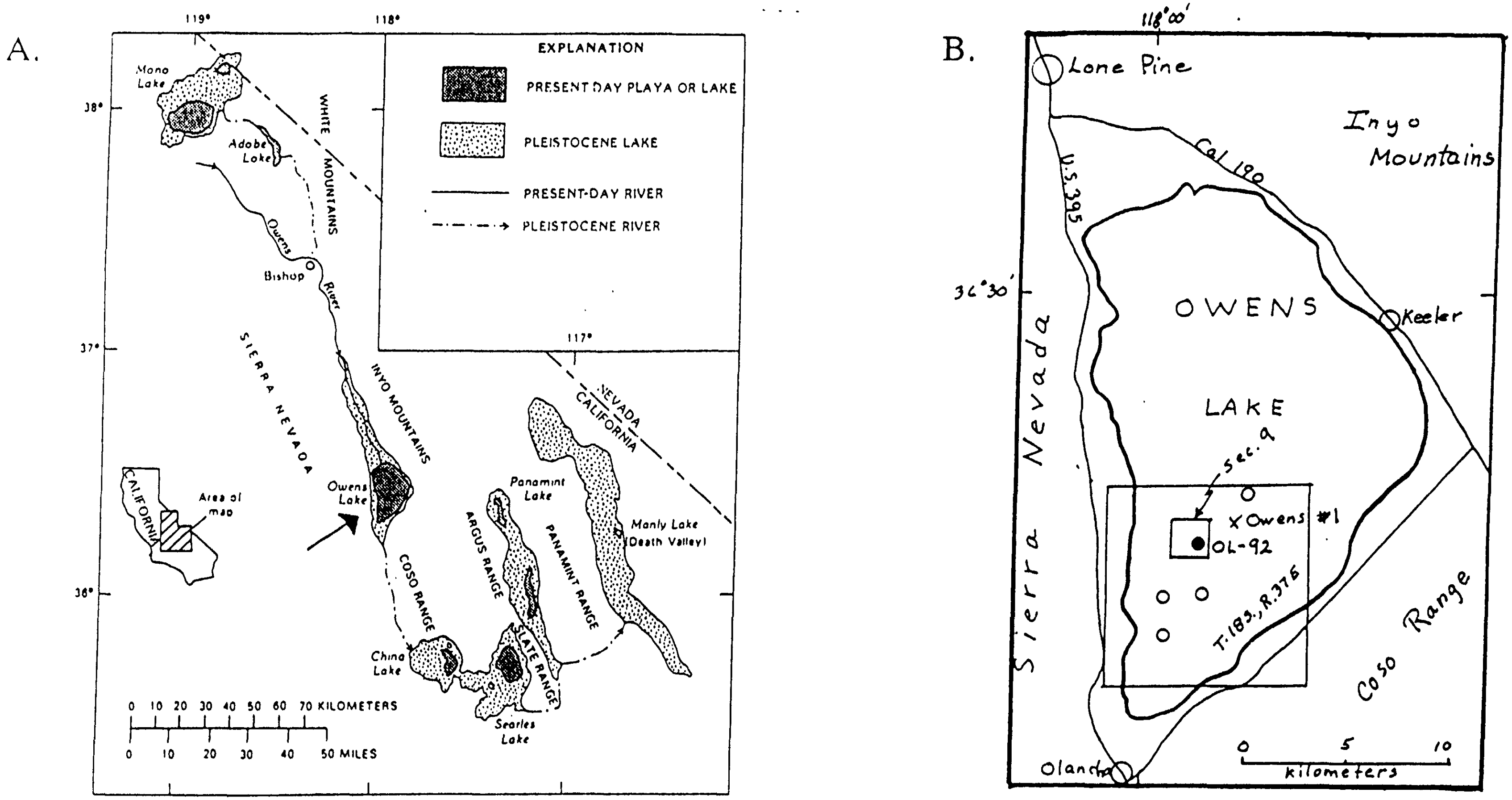
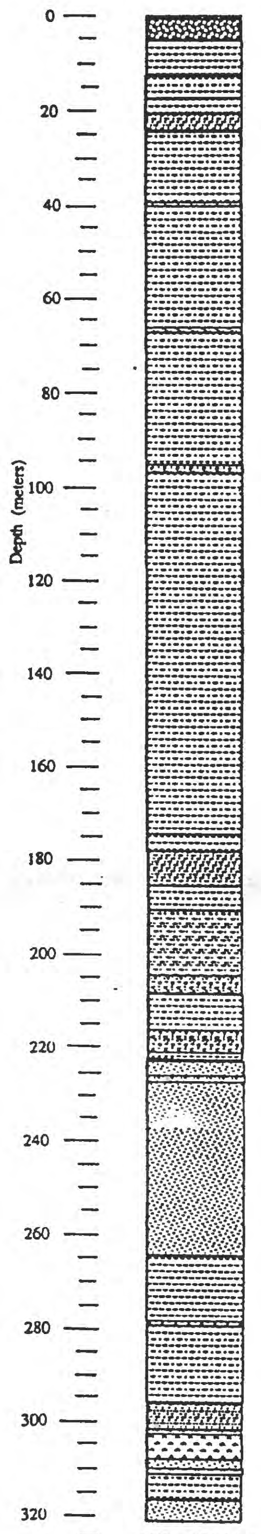
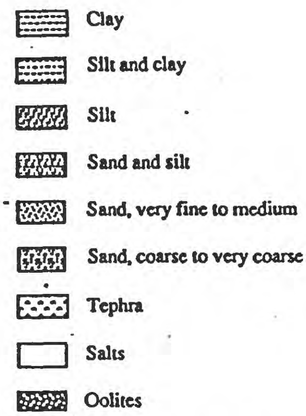


Figure 1. Maps showing location of core OL-92. (A) Location of Owens Lake (arrow) and other lakes hydrologically connected with it during pluvial periods of the Pleistocene. (B) Solid circle shows location of OL-92 on the surface of Owens Lake, in Sec. 9, T. 18 S., R. 37 E.; open circles show locations of cores described by Newton (1991, fig. 1-2); X shows location of Owens Drill Hole 1

OWENS LAKE DRILLING PROJECT

Core OL92





Generalized log of Core OL92

Depth (m)	Thickness (m)	Lithology
0-1.32	1.32	Salts
1.32-5.16	3.84	Oolites
5.16-12.83	7.67	Clay-sized sediment
12.83-17.15	4.32	Silt and clay
17.15-20.19	2.68	Clay
20.19-24.77	4.58	Silt
24.77-39.49	14.72	Silt and clay
39.49-40.00	.51	Sand, very fine
40.00-66.74	26.74	Silty clay
66.74-66.99	.25	Sand, fine to coarse
66.99-95.24	28.25	Silty clay
95.24-96.51	1.27	Sand, medium to very coarse, methane
96.51-174.16	78.65	Silty clay
174.16-178.03	3.87	Clay
178.03-184.82	6.79	Silty clay
184.82-190.63	5.81	Clay, silt, and sand
190.63-204.46	13.83	Silty clay
204.46-208.46	4.00	Sand, fine to very coarse
208.46-216.54	8.08	Silty clay
216.54-221.25	4.71	Sand, fine to very coarse
221.25-223.08	1.83	Clay and silt
223.08-227.51	4.43	Sand, fine to medium
227.51-227.67	.16	Sand, very coarse, and granules
227.67-266.22	38.55	Sand, mostly fine to medium, some silt
266.22-278.86	12.64	Clay, some silt
278.86-280.27	1.41	Sand, medium to very coarse
280.27-297.08	16.81	Clay and silt
297.08-302.94	5.86	Sand and silt
302.94-303.53	.59	Sand, medium to very coarse, some granules
303.53-309.14	5.61	Tephra, basal 0.6 m is primary fallout of Bishop Tuff ash, overlying 5 m is reworked ash and lapilli; two 0.3 m beds of silt and clay, 1/3 and 2/3 down
309.14-311.01	1.87	Sand, fine to medium, and silt
311.01-311.69	.68	Tephra
311.69-317.71	6.02	Clay and silt, some sand
317.71-322.86	5.15	Sand, very fine to medium, 8 cm of very coarse to granules a 319.88 m.

Fig. 2. Generalized graphic and written logs of core OL-92.

composition of near-surface layers. The remaining part of the oolite bed, which was nearly uncemented, and the soft, dark, clay-sized sediment beneath it, were sampled using a thick-walled, 3-in. diameter, 20-ft-long PVC pipe that was pushed down, using a large backhoe, through the bottom of the hole created by the rotary drill. While the PVC pipe was still a short distance above ground level, a cap was cemented on the top of the pipe and a chain was attached to it using a clove hitch. The tube was then pushed down to its maximum depth, a short distance into an excavated depression below lake surface, the attached chain enabling the backhoe to pull it back up

On recovery, the cores were carried a few meters, in one half of the split-spoon liner, to a 25-foot long, partially refrigerated, truck-type trailer where a 16-ft-long work table was set up along one side. On this table, the core was first transferred from the split-spoon liner into 3-in.-diameter PVC tubes that had been pre-sawn into 1.5-m lengths and longitudinally into halves. Core-top directions were indicated by arrows marked on the outside surfaces of each segment of PVC tubing. Using an improvised "cheese cutter" or a coping saw, the core was then split longitudinally into a "working" half and an "archive" half, and finally cut into 1.5-m-long (or less) segments that filled (or partially filled) the pre-cut PVC tubes.

The logs are based primarily on field observations of both core halves; the samples for chemical, isotopic, and sedimentary analyses, fossil identification, paleomagnetic study, and other investigations were mostly taken at the same time from the working half. Those samples were placed in rigid-plastic cube-shaped containers (for paleomagnetic study) or numbered glass bottles with air-tight "Polyseal" caps. After their positions were entered into the log, the samples were stored in the refrigerated section of the trailer. Both halves of the core were then wrapped in "Saran Wrap" to retard evaporation, and the working and archive halves were re-united. Plastic caps were placed over, and taped to, the ends of the re-united PVC tubes, holding the two halves together; additional tape was wrapped around this new unit in two or three intermediate places to make it more rigid. Labels were placed on the caps and also into each tube. The cores were then also put into the refrigerated end of the trailer which was separated from the working area by thick, floor-to-ceiling sheets of insulating material.

The field log was made primarily by visual inspection supplemented by hand-lens and binocular-microscope study. Wentworth's (1922) terminology and size limits for clastic rocks were followed. A petrographic microscope and index oils were available and used to confirm the isotropic character of suspected volcanic glass, but with no electricity, the instrument was found difficult to use without the built-in light from below. The numerical designations of the colors of the unoxidized and still-wet cores, included in the field log, are based on the numerical system used by the "Rock-color chart" that is distributed by the Geological Society of America (1991). Within a few days after logging, colors changed as the cores oxidized, and in the months since then, some have dried noticeably (even though they have been kept in closed tubes and refrigerated), changing both their "lightness" and "chroma" but rarely their "hue". The descriptive terms for the colors in the Rock-color chart are not included in the log because they do not lend themselves to numerical extrapolation of the present core colors back to the logged core colors or *vice versa*, and some of the color names suggested by the chart are so general that they would be equally appropriate for several nearby color chips in the Rock-color chart. The logs of these three cores are tabulated below (tables 1, 2, and 3). An abbreviated written log, and a graphic log based on it, are presented in figure 2.

Each core segment was logged in the field in terms of its "drive" number (which represented the times the empty core barrel had re-entered the core hole) and "slug" designation (the letter representing each 1.5- m-long core segment from that drive, with "A" at the top); starting and ending depths of each drive (in feet and inches) were based on the driller's log; they were later converted to meters to the nearest 0.01 m. Unrecovered core, logged as "No core", was arbitrarily placed at the base of each drive.

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Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
0.00	5.49	5.49	No core. [See log for Core OL-92-3.]
5.49	6.31	.82	**Clay-sized sediment**, massive, 5Y5/2.
6.31	7.01	.70	No core.
7.01	7.72	.71	**Clay-sized sediment**, possibly some silt, mostly massive, some color beds, 5Y5/2 to 5Y4/4.
7.72	7.73	.01	**Sand**, medium to very coarse, silty matrix, 5Y4/4.
7.73	8.51	.78	**Clay-sized sediment**, mottled, areas having different colors have dimensions ranging from 1-3 mm (worm borings?) , N6 (mottling) to N2 (matrix),.
8.51	8.53	.02	No core.
8.53	9.45	.92	**Clay-sized sediment and silt**, mixed, 5Y2-5/1-2; soft, probably cuttings, not core.
9.45	9.58	.13	**Silt**, massive, appears deformed 5Y5/2; basal contact concave downward over 5 cm.
9.58	10.74	1.16	**Clay**, mottled, bioturbated(?), locally poor bedding, 5Y6/1 to 5Y2/1.
10.74	10.97	.23	No core.
10.97	12.83	1.86	**Clay-sized sediment**, black, lumpy, lumps 5 to 20 mm across (glacial flour plus silt?), N3, some 5Y3/1; probably cuttings, not core.
12.83	13.37	.54	**Silt**, very fine, mottled, bioturbated(?), holes and tubes 3 to 5 mm wide (short dimension) 20 to 30 mm (long), N4-6.
13.37	14.02	.65	**Silt**, like above but stiffer (core broke into pieces), mottled, bioturbated(?), holes and tubes, tubes 3 to 5 mm wide, 20 to 30 mm long, N4 to N6.
14.02	16.55	2.53	**Clay**, very fine, lumpy, pods of greenish and black, lumps 1 to 5 cm long , some greenish fragments up to 17 cm long; may be cuttings, not core.

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
16.55	16.59	.04	**Silt and clay**, slightly mottled, mostly N6, some N4; could be volcanic ash.
16.59	17.15	.56	**Silt and clay**, mostly mottled, some faint bedding in lower half of interval, N3 (70%) to N6 (30%).
17.15	17.56	.41	**Clay**, soft, N3; possibly cuttings, not core.
17.56	17.66	.10	**Clay**, possibly some silt, very faint color bedding, N3 and N6 .
17.66	17.94	.28	**Clay**, some(?) silt, mottled, bioturbated, N5.
17.94	18.04	.10	**Clay**, some(?) silt, 5Y5/2, lens of tan-colored sediment near base.
18.04	18.38	.34	**Clay**, some(?) silt, when split, blocky fracture developed below 18.14 m but unfractured above, N5.
18.38	19.06	.68	**Clay**, some(?) silt, massive, 5Y5/2.
19.06	20.19	1.13	No core.
20.19	21.50	1.31	**Silt**, mostly massive, faint regular bedding near 21.00 m, discontinuous bedding between 21.24 and 21.28 m, 5Y5-6/2, zones of lighter colored beds near 20.56 m.
21.50	21.72	.22	No core.
21.72	22.07	.35	**Silt**, mostly massive, local faint bedding, 5Y4/4.
22.07	24.77	2.70	**Silt**, individual well rounded rock fragments (dropstones?), each 2 to 10 mm long, at 22.40, 23.16, and 23.43 m, faint color bedding, 5Y4-6/2 .
24.77	27.48	2.71	**Clay**, some(?) silt, mostly massive, mottled between 24.77 and 24.89 m, 25.61 and 25.72 m, and 25.97 and 26.15 m, poorly defined bedding between 24.89 and 24.91, 5Y4-6/2; basal contact gradational over 5 cm.
27.48	27.78	.30	**Clay**, some(?) silt, slightly mottled, possibly caused by bioturbation, N6.
27.78	30.86	3.08	No core.

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
30.86	31.31	.45	**Silt or marl**, massive though basal 15 cm breaks with horizontal partings, 5Y3-5/2.
31.31	31.47	.16	No core.
31.47	31.77	.30	**Silty clay**, mottled, borings(?) prominent, 5GY3-4/1; basal contact gradational.
31.77	32.66	.89	**Silty clay**, similar to above, but borings(?) less prominent, 5GY4-5/1; basal contact gradational.
32.66	32.97	.31	**Silty clay,** similar to interval between 31.47 and 31.77 m
32.97	33.65	.68	**Silty clay**, mottled, bioturbation(?) tubes characteristically 2 to 4 mm wide, 5GY3-4/1; sharp basal contact.
33.65	33.91	.26	**Silty clay**, mottled, bioturbation(?) tubes typically 3-6 mm wide, 5GY3-4/1.
33.91	34.46	.55	**Silty clay**, mottled, 5GY4/4, between 34.09 and 34.19 core is brittle and badly jumbled during extraction from barrel, 5GY4/3-5.
34.46	34.67	.21	**Silty clay**, weakly mottled, soft.
34.67	35.05	.38	**Silty clay**, mottled, bioturbated(?), tubes up to 10 mm wide, 5G4/3-4.
35.05	35.25	.20	**Silty clay**, mottled, bioturbated(?) tubes typically 1 to 5 mm wide, 5G4/3 to 5G4/4.
35.25	35.41	.16	**Silty clay**, mottled, bioturbated(?) areas up to 50 mm in both dimensions, 5G4/3-4.
35.41	35.97	.56	**Silty clay**, like above, but tubes mostly 1 to 2 mm x 5 to 10 mm, 5G4/3-4.
35.97	36.96	.99	**Silty clay**, massive, very dry, fractures into blocks, almost brittle; many ostracodes, some in "beds" one-shell deep, especially in basal 20 cm.
36.96	37.82	.86	**Clay**, some(?) silt, massive, mottled, 5GY3-5/1; soft, probably cuttings not core.

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
37.82	38.47	.65	**Silty clay**, massive, 5GY2/1, some irregular sub-horizontal areas of 5Y6/1.
38.47	39.49	1.02	**Silty clay**, massive, 5G1-3/1, some sub-vertical streaks, 1-2 mm wide, having a lighter green color.
39.49	39.93	.44	**Silt and sand**, very fine, mixed; at top, very fine sand, pure, well bedded, mottled: 90% 5Y6/2 and 10% 5GY2/1.
39.93	40.01	.08	No core.
40.01	40.18	.17	**Silty clay**, massive, 5GY4/1, soft ; probably cuttings not core.
40.18	40.43	.25	**Silty clay**, mostly massive, faint horizontal color beds, 5G4-6/1.
40.43	40.45	.02	**Silty clay**, massive, 5GY5/2.
40.45	40.87	.42	**Silty clay**, faint color bedding in upper half, massive in lower, 5GY5-6/1.
40.87	41.07	.20	**Silty clay**, faint color beds, 5GY3-5/1.
41.07	41.11	.04	**Sand**, very fine, faint color beds, 5Y5/2.
41.11	41.22	.11	**Silty clay**, faint color beds, 5Y5-6/2 .
41.22	41.27	.05	**Sand**, very fine, massive, 2GY2/1.
41.27	41.37	.10	**Silty clay**, faint color bedding, 5GY6/1.
41.37	41.38	.01	**Tephra**, impure, massive, 5Y2/1.
41.38	41.54	.16	**Silty clay**, faint color bedding, 5Y3-6/2.
41.54	42.26	.72	**Silty clay**, massive, 5G2/1.
42.26	42.51	.25	**Silty clay**, massive, 5GY4; ostracodes noted, tephra(?) at 42.36 m.
42.51	42.75	.24	**Silty clay**, massive, 5Y5/1.
42.75	42.97	.22	**Silty clay**, massive, 5GY2/1.
42.97	43.05	.08	No core.
43.05	43.09	.04	**Silty clay**, mottled, N4.

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
43.09	43.19	.10	**Silty clay**, mottled, 5GY3-5/1.
43.19	44.58	1.39	**Silty clay**, faint color beds, 1 to 2 cm thick, 5GY3-5/1; zone of bioturbation(?) near 44.00 m.
44.58	44.82	.24	**Silty clay**, faintly mottled, 5Y4/1.
44.82	46.10	1.28	**Silty clay**, massive, 5GY1-3/1.
46.10	46.37	.24	**Silty clay**, massive, 5Y4/1; soft, probably cuttings not core.
46.37	47.58	1.21	**Silty clay**, massive, 5G1-3/1, basal contact gradational over 2 to 3 cm.
47.58	47.62	.04	**Silt and sand**, very fine, dark fragments of biotite(?), faintly bedded, 5Y4/1.
47.62	48.00	.38	**Silty clay**, massive, 5GY2/1, many ostracodes.
48.00	48.02	.02	**Sand**, very fine, faintly bedded, slightly fissile, 5Y6/1; very abundant ostracodes.
48.02	49.15	1.13	No core.
49.15	49.24	.09	**Silty clay**, massive to mottled, 5Y-5GY4/1; probably cuttings, not core.
49.24	49.25	.01	**Sand**, very fine, 5Y6/1.
49.25	49.82	.57	**Silty clay**, color beds 5- to 10-mm thick, 10Y3-5/2; 2-mm thick ostracode coquina bed (N2) at 49.52 m, zone of ostracodes at 49.62 m.
49.82	49.97	.15	**Silty clay**, bedding irregular, mottled, colors vary from dark (5Y4/1) to light (10Y5/2); basal contact channel shaped.
49.97	50.10	.13	**Silty clay**, like 49.245 to 49.82 m.
50.10	50.38	.28	**Silty clay**, faint color beds, 10 to 20 mm thick, 5Y3/1; basal contact gradational.
50.38	50.64	.26	**Silty clay**, massive, 5Y4/4; ostracodes(?) present.

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
50.64	50.69	.05	**Tephra**, impure, massive upper half, laminated lower half, laminae 3 to 10 mm thick, N4-7; most similar to tephra layer in sediments beneath Walker Lake at depth of 79 m.
50.69	52.20	1.51	No core.
52.20	52.25	.05	**Tephra**, impure, very-fine-sand sized, well sorted, N3, basal contact in shape of channel; probably part of tephra unit above.
52.25	52.50	.25	**Silty clay**, very faint color bedding, 10Y4/2.
52.50	52.59	.09	**Silty clay**, massive to very faint color bedding, 5Y3/1-2.
52.59	52.91	.32	**Silty clay**, faint color bedding, beds 3-5 mm thick, 10Y3-6/2; several ostracode coquina beds (1 to 2 mm thick) between 52.60 and 52.66 m, coquina beds, 5Y6/2.
52.91	53.10	.19	**Sand**, very fine (or ostracodes ?), thin beds of similar thickness, 5Y6/2; basal contact gradational over 10 cm.
53.10	54.00	.90	**Silty clay**, thin color beds, 5Y-5/2, 1- to 2-mm thick beds of sand (tephra or ostracodes ?) at 53.46, 53.64, and 53.96 m.
54.00	54.87	.87	**Silty clay**, massive, 5Y3-52.
54.87	55.25	.38	**Silty clay**, faint to prominent color bedding, 5Y4-6/4.
55.25	55.30	.05	**Silty clay**, mottled, 5Y3-5/2; may be cuttings not core.
55.30	55.57	.27	**Silty clay**, very faint color bedding, average thickness 3 to 5 mm, 5Y5/2.
55.57	56.11	.54	**Silty clay**, very faint color bedding, 5Y4/4.
56.11	56.18	.07	**Silty clay**, prominent color bedding, 10% 5Y3/4 and 90% 5Y5/4.
56.18	56.27	.09	**Silty clay**, prominent color bedding (1-5 mm thick), 90% 5Y3/2 and 10% 5Y5/2 .

Table 1. Log of Core OL-92-1

From (meters)	To (meters)	Unit thickness (meters)	Description
56.27	58.35	2.08	**Silty clay**, upper 5 cm massive, remainder characterized by faint to prominent color beds (1 to 10 mm thick), 5Y4-6/2-4.
58.35	59.55	1.20	**Silty clay**, very faint color beds (10 to 20 mm thick), 5Y3-4/2.
59.55	59.79	.24	**Silty clay**, moderately prominent color bedding, 5Y4-5/2.
59.79	59.83	.04	**Silty clay**, bedding defined by color but some color changes cross bedding, 5Y3-5/2.
59.83	61.37	1.54	**Silty clay**, massive, 5Y2-4/2; ostracodes scattered throughout, concentrated between 61.27 and 61.37 m.

BASE OF CORE OL-92-1

Between 5.49 m and 61.37 m (total = 55.88 m), "no core" entries in log account for 8.50 m; thus, 85 percent of this interval was recovered as core (although some of it was suspected of being "cuttings, not core").

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
0.00	61.26	61.26	No core. [See logs of OL-92-1 and -3]
61.26	62.47	1.21	**Silty clay**, faint color beds, 5-10 mm thick, in upper 30 cm, massive below, 5Y2/1.
62.47	62.64	.17	**Clay**, moderately calcareous, trace of volcanic ash, faintly bedded, 5Y7/2.
62.64	63.16	.52	**Silty clay**, massive, 5Y2/1, basal contact gradational over 10 cm.
63.16	63.97	.81	**Silty clay**, mostly massive, 5Y-5GY4/1-2.
63.97	64.09	.12	**Silty clay**, laminar bedding, 5Y4/2.
64.09	64.14	.05	No core.
64.14	64.24	.10	**Silty clay**, like sediment between 63.97 and 64.09 m, basal contact gradational over 6 cm interval.
64.24	65.22	.02	**Silty clay**, massive, 5Y2/1.
65.22	65.25	.03	**Sand and silt**; two beds of fine to very fine sand, each 1-3 mm thick, separated by black silt, each bed massive, sands are 5Y4/4, silt is N2.
65.25	65.64	.39	**Silty clay**, massive, 5Y2/1.
65.64	66.28	.64	**Silty clay**, very faintly color bedded in upper two thirds, some tan sand or coarse silt in the lower third, 5Y3/2.
66.28	66.74	.46	**Silty clay** (70%), discrete beds of clay and clayey silt (30%) that average about 1 cm thick, bedding faintly but clearly defined.
66.74	66.99	.25	**Sand**, fine to coarse, average medium, many grains appear coated with carbonate, poorly sorted, faintly bedded in lower half, 5Y4-6/4.
66.99	67.19	.17	**Silty clay**, faintly color bedded, beds 5-10 mm thick, 5Y4-6/2.
67.19	67.23	.07	**Silty clay**, faintly color bedded, beds 5-10 mm thick, 5Y3-4/2.
67.23	67.31	.08	**Silty clay**, some fine to very fine sand, prominent bedding, some laminar, 5Y4-6/4.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
67.31	68.04	.73	**Silty clay**, some sand, between 67.40 and 68.14 m, 12 beds of very fine to medium sand, 0.3 to 3.0 cm thick, and separated by silty-clay beds having thicknesses ranging from 2 to 16 cm, appears possibly cyclical, silty clay 5Y3/2 (5GY3/1 between 67.62 and 67.78 m); 1-cm thick bed of sand at 67.72 m, 5Y5-6/4.
68.04	68.49	.45	**Silty clay**, faintly color bedded, 5GY3-4/1.
68.49	69.71	1.32	**Silty clay**, possibly 5% silt beds in lower half, faint color bedding, each 0.5 to 10 cm thick, 5GY4-5/1.
69.71	69.95	.24	**Silty clay**, prominent color bedding, beds typically 0.2-1.0 cm thick, 10YR5/4, 5-10Y4-5/2, 5GY4/1.
69.95	70.46	.51	**Silty clay**, faint color beds, 5Y3-5/2.
70.46	70.72	.26	**Silty clay**, color bedded, beds 0.5 to 1.0 cm thick, 5-10Y3-5/2.
70.72	70.92	.20	**Silty clay**, very faint beds (color), 5GY3/1; possible tephra, 0.5 mm thick, at 70.86 m.
70.92	71.82	.90	**Silty clay and clayey silt**, bedding distinct, caused by changes in color and sediment size, 5Y-5GY4-6/1.
71.82	71.92	.10	**Silty clay**, massive, 5GY2/1.
71.92	71.94	.02	**Sand**, very fine, exceptionally micaceous, 5Y4/1.
71.94	73.25	1.31	**Silty clay**, massive in upper third, slightly bedded in lower two thirds, 5GY2/1 (upper), 5Y4/4 to 5GY2/1 (lower); cross-cutting vein(?) of white or gray minerals at 72.27 m, carbonate-rich layer (possibly containing tephra) at 72.98 m.
73.25	73.51	.26	No core.
73.51	74.36	.85	**Siltly clay**, distinct color beds, 0.1 to 1.0 cm thick, 5GY2/1 (upper half) grading down to 5Y-5GY4/1; tephra(?), 1 to 2 mm thick, at 74.27 m.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
74.36	74.38	.02	**Limestone**, impure, possibly containing tephra, forms highly indurated zone, massive, numerous diatoms, 5Y6/1; core fragmented during removal from core barrel.
74.38	74.42	.04	No core.
74.42	74.47	.05	**Limestone**, impure, highly indurated, weakly bedded, 5Y6/1.
74.47	74.83	.36	**Silty clay**, weakly color bedded, 0.2 to 1.0 cm thick, beds more widely spaced in middle of unit, mostly 5-10Y5-6/2-4.
74.83	75.04	.21	**Silty clay**, weakly-defined color beds, average 5-10 mm thick, 5GY4-5/1.
75.04	75.22	.18	**Silty clay**, weakly defined color beds, average 0.5 to 1.0 cm thick, 5GY2-4/1.
75.22	75.55	.33	**Silty clay**, massive, 5GY2-4/1.
75.55	76.22	.67	**Silty clay**, slightly mottled, 5GY2-4/1.
76.22	76.51	.29	**Silty clay**, very faint color bedding, 5B4/1.
76.51	76.56	.05	No core.
76.56	85.64	9.08	**Silty clay**, massive, 5GY4-5/1; 1- to 2-cm-thick beds of diatom-rich marl at 79.98, 81.46, 81.76 to 81.84 m, 84.52, and 84.56 m; normal fault between 83.31 and 83.61 m, dips about 70°, offsets 5-mm-thick sand bed more than 20 cm (it does not reappear in core, so not caused by coring pressures].
85.64	85.75	.11	No core.
85.75	85.94	.19	**Silty clay**, like sediments between 82.65 and 85.64 m, basal contact gradational over 15-cm zone.
85.94	88.75	22.81	**Silty clay**, weakly color bedded, beds 0.3-2.0 cm thick, 5GY3-5/1; many beds consist of a dark layer (with sharp upper contact) that grades down into a lighter layer of about-equal thickness; bioturbation(?) structures throughout, especially between 86.33 and 86.49 m; discontinuities that dip about 20° seen at 87.61 and 88.36 m.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
88.75	91.76	3.01	**Silty clay**, variegated (bioturbated?), tube structures up to 7 cm x 1 cm, 80% 5GY5/1, 20% 5GY3/1; possibly slump but probably core.
91.76	91.80	.04	No core.
91.80	93.09	1.29	**Silty clay**, perhaps 1% silt or very fine sand, color beds are 1-3 cm thick, bioturbated(?), 50% 5GY4/1, 50% 5G2/5.
93.09	93.41	.32	**Silty clay**, bioturbated(?), 20% 5GY2/1, 80% 5GY3/1.
93.41	94.30	.89	**Silty clay,** disseminated grains of silt or very fine sand that have a glassy luster, extremely turbated, almost no recognizable beds, 70% 5Y2/1, 30% 5GY2/1.
94.30	94.84	.54	**Silty clay**, like above, slightly turbated, faint color bedding, mostly 5Y2/1, some slightly lighter.
94.84	94.90	.06	**Clay** and **silt** (90%), and **very fine sand** (10%), mottled, 5Y2/1.
94.90	94.95	.05	**Silty clay**, mottled, 5Y2-4/1.
94.95	95.06	.11	**Clay** and **silt**, like that at 94.84 to 94.90 m.
95.06	95.24	.18	**Silty clay** grading down to interbedded **clay and sand**, very fine to medium, bedding caused by grain-size variation, 5Y2/1.
95.24	95.52	.28	**Sand**, medium to coarse, some clay fragments (up to 10 x 15 mm), sand is granitic, well to fairly-well sorted, sub-angular to sub-rounded, dark clay matrix (5-10%), very faint bedding, coarsest sand in lower half, 5Y2/1; unit contained methane under high pressure.
95.52	96.06	.54	No core.
96.06	96.17	.11	**Sand**, fine to coarse, silty matrix, sand angular to sub-rounded, well sorted, granitic source, irregular subhorizontal streaks of lighter beds of silty clay, sand is massive, 5Y-GY2-4/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
96.17	96.42	.25	**Sand**, medium to coarse, angular to sub-angular, well sorted, granitic, 5% black organic-rich (?) matrix, massive, same size range throughout, 5Y2/1.
96.42	96.51	.09	**Sand**, medium to very coarse, angular, granitic, many quartz grains, massive, 5Y2/1, many grains N7-N8.
96.51	96.68	.17	**Silty clay**, dark, mottled, bioturbated(?), lighter "borings" up to 10 x 70 mm, 5Y-GY2/1.
96.68	96.84	.16	**Silty clay**, similar to above but "borings" smaller (up to 2 x 20 mm).
96.84	97.84	1.00	No core.
97.84	98.52	.68	**Silty clay**, like core between 96.68 and 96.84 m.
98.52	100.76	2.24	**Silty clay**, disseminated sand grains, zones of semi-indurated sand at 98.57, 98.74 and 98.90 m, patch (2 x 10 mm) of orange (10YR5/4) sandstone(?) or fossil wood(?) at 100.01 m, very faint color banding, 0.5 to 1.5 cm thick, N1 to 5G-5GY1-3/1; basal contact gradational over 5 cm.
100.76	100.84	.08	**Silty clay**, 1 x 3 mm zones of gray (N3-5) sediment (10%) in darker sediment; core damaged during extraction.
100.84	100.89	.05	No core.
100.89	100.96	.07	**Silty clay**, like sediment between 98.52 and 100.76 m.
100.96	101.04	.08	**Silty clay**, color bedding moderately prominent, 5Y2-5/1.
101.04	101.07	.03	**Clay and sand**, very fine, well sorted, in prominent beds 1 to 2 mm thick, 5Y6-7/1.
101.07	101.36	.29	**Silty clay**, numerous very fine sand layers 1 to 2 mm thick, both discontinuous and continuous, uniform color bedding (3 to 15 mm thick) fairly prominent, 5GY2-4/1; sand beds appear rhythmic, commonly about 1 cm apart.

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Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
101.36	101.41	.05	**Silt and clay**, very fine, well bedded due to variations in grain size, 5Y5/2.
101.41	101.89	.48	**Silty clay**, faint color bedding (5 to 15 mm average thickness), and prominent thin sand beds (0.5 to 1.0 mm thick, spaced about 5 cm apart), silty clay is 5GY5/2, sand is 5Y7/1, colors darkens below 101.75 m.
101.89	102.37	.48	**Silt clay**, micaceous, numerous disseminated sand grains, massive, 5Y2/1.
102.37	102.65	.28	**Silty clay**, disseminated fine and medium sand grains, 3-cm-thick bed of very fine sand at 102.54 m, massive, 5Y-5GY2/1.
102.65	102.73	.08	**Clay**, about 10% silt and very fine sand, disseminated grains of fine and medium sand, very well bedded, silt 5Y2/1, sand 5Y6/1.
102.73	102.86	.13	**Silty clay**, many disseminated grains of sand faintly bedded, 5Y2-3/1.
102.86	102.90	.04	**Silt**, some clay and possibly very fine sand, well bedded due to grain size variation, 10Y5/2.
102.90	103.17	.27	**Silty clay**, discontinuous beds (2 mm thick) of very fine sand, mottled, 10Y4-6/2.
103.17	103.42	.25	**Clay, silt, and sand**, very fine, massive in upper and lower quarters, laminated in middle, (laminae less than 1 mm thick), light part is very fine sand, dark is clay or silt.
103.42	103.79	.37	**Silty clay**, 1- to 4-mm-thick beds of very fine sand are both continuous and discontinuous, bedding shown by sand beds and color changes in silt, 10Y6/2 to 5GY2/1, 3-cm darker zone near middle.
103.79	107.06	3.27	No core.
107.06	107.18	.18	**Clay and silt**, some beds of very fine sand, color bedding 2 to 5 mm thick, mostly 5GY3-5/2, light beds (5Y6/4) are very fine sand.
107.18	107.22	.04	**Clay and silt**, like above but darker (10Y3/2).
107.22	107.23	.01	**Sand**, fine to medium, 5Y7/4.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
107.23	107.31	.08	**Clay and silt**, some sand, like 107.18 to 107.22 m.
107.31	107.40	.09	**Silt and clay**, a 1 cm thick bed of fine to very fine sand at 107.34 m, very faint color bedding, 10Y4/2.
107.40	109.46	.06	No core.
109.46	110.26	.80	**Silty clay**, 3 to 6 mm thick beds of very fine sand at 109.58, 109.86, 109.93, and 110.06 m, silty clay is nearly massive, slightly mottled, 5G3-5/1.
110.26	111.06	.80	**Silty clay**, micaceous, 0.5 to 1.0 cm thick beds of very fine sand at 110.38, 110.41, 110.52, 110.58, 110.61, 110.64, 110.77 and 111.05 m, bedding defined by sand layers, otherwise by color, silty clay is 5Y-5GY4/2-4, sand is 5GY4/1.
111.06	111.33	.27	**Silty clay**, micaceous, faint color bedding, 5Y3-5/4.
111.33	112.37	1.04	**Silty clay**, beds of silt and very fine sand at 111.54 and 111.75 m, faint color beds, 5GY3-5/1.
112.37	112.40	.03	**Silt and sand**, very fine, as alternating beds having about equal thickness (5 mm), 5GY4/1.
112.40	112.58	.18	**Silty clay**, like that between 111.33 and 112.37 m.
112.58	112.59	.01	**Silt and sand**, very fine, 5G3/1.
112.59	112.84	.25	**Silt and sand**, very fine (upper and lower third), 5GY5/4, and **silty clay** (middle third), 5GY4/1, faint bedding defined by very fine sand beds and colors.
112.84	113.44	.60	**Silt and sand**, very fine, like that between 112.59 and 112.84 m.
113.44	113.79	.35	**Silty clay**, very few silt and very fine sand beds except near 113.73 m, nearly massive except where very fine sand beds are found, 5GY4/1.

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[U. S. Geological Survey Open-File Report 93-683]

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Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
113.79	113.83	.04	**Silty clay**, trace of very fine sand, nearly massive, 5GY2/1.
113.83	114.59	.76	**Silty clay**, like sediment between 113.44 and 113.79 m.
114.59	114.60	.01	**Silt**, disseminated grains of medium to coarse sand, nearly massive, 5Y4/6; numerous ostracodes.
114.60	115.24	.64	No core.
115.24	115.43	.19	**Silty clay**, some silt or very fine sand, faintly bedded, beds 1-5 mm, 5Y4-6/2.
115.43	116.21	.78	**Silty clay**, 1-cm-thick beds of silt or very fine sand at 115.46, 115.73, and 115.80 m, coarser beds well defined, finer beds weakly defined by color unless mottled, 5GY4-6/1; clastic dike composed of silt, between 115.98 and 116.10 m, dips about 70° from horizontal, 3 to 5 cm thick; bubbles, 2 to 4 mm diameter, of methane(?) forming on freshly-exposed surface.
116.21	116.85	.65	**Silty clay**, no sand or silt layers, faint color beds, slightly mottled 5GY5/1-2.
116.85	117.30	.40	**Silty clay**, some very fine sand, well bedded by colors and very fine sand layers that are 0.5 to 5 mm thick, in places rhythmically bedded, mostly 5GY4/1, between 117.21 and 117.24 m; disturbed zone between 117.07 and 117.12 m is the base of a clastic dike, 2 to 3 mm wide, that extends vertically up to 116.68 m .
117.30	117.51	.21	**Silty clay**, very faint color bedding in upper half, contorted bedding in lower half, 5GY4-5/1.
117.51	117.73	.22	**Silty clay**, like that between 116.85 and 117.30 m but contains about 5% very fine sand, bedding defined by both color change and sand beds that are 1 to 5 mm thick, some beds tilted, 5GY4/1.
117.73	119.25	1.52	**Silt and clay**, like sediments between 116.85 and 117.30 m; concentrations of very fine sand beds having thicknesses ranging from 5 to 11

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From (meters)	To (meters)	Unit thickness (meters)	Description
			cm at 118.03, 118.36, 118.72, and 119.06 m, silt and clay 5GY4-6/1, sand layers 5Y6/1 to N8; between 118.22 and 118.31 m, a 45° "fault" truncates beds but they can not be matched across fault.
119.25	119.98	.73	**Silty clay** and an estimated 30% very fine sand or silt, as discrete beds, sand beds well bedded, silty clay beds faintly color bedded, 5GY4-5/1; at 119.96 m, a 1-cm-thick bed of very fine sand, color bedded, N4 grading upward to N6.
119.98	120.21	.23	**Silty clay and sand**, very fine, as beds, like unit above put perhaps 40% very fine sand or silt, 5Y4/4 to 5GY5/1; at 120.19 m, a 1-cm bed of sand containing a few shards of glass.
120.21	120.84	.63	**Silty clay**, some (?) very fine sand, faintly bedded, 5GY4/1.
120.84	122.30	1.46	**Silty clay**, like above, silty or sandy zones between 121.05 and 121.16, 121.55 and 121.65, and 122.23 and 122.24 m.
122.30	123.84	1.54	**Silty clay**, scattered zones containing more silt and very fine sand, bedding shown by 0.5-mm-thick) layers of silt and very fine sand that commonly are about 1 cm apart (examples near depths of 122.57, 122.97, 123.20, 123.61, and 123.71 m), 5GY5-7/1.
123.84	125.68	1.84	**Silty clay**, like unit above, though fewer very fine sand beds, massive.
125.68	126.08	.40	**Silt**, some very fine sand, 5Y5/4 grading down to 10Y4/2; very sharp basal contact.
126.08	126.57	.49	**Silty clay**, grading down to silt and sand, very fine, in lower third, 10Y6/2 to 5GY4/1.
126.57	129.67	3.10	**Silty clay**, bedding faint, colors alternate between green (5GY4-6/1) and orange (5Y5/1); between 128.18 and 129.33 m, several subvertical wavy, darker colored lines (1 mm wide), and clastic dikes (2 mm wide); the dikes start abruptly at about 129.23 and 129.38 m, and thin upward.

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From (meters)	To (meters)	Unit thickness (meters)	Description
129.67	130.76	1.09	**Silty clay**, 10% beds of silt and very fine sand, bedding, caused by silt and sand layers is moderately distinct; many zones where silt or sand layers 5 to 15 mm apart, some beds due to color changes but most of unit is variegated, 5GY5/1 to 5Y5/4.
130.76	131.14	.38	**Silty clay and sand**, very fine, in beds 1 to 3 mm thick, 5 to 20 mm apart, flat, 10Y4/2.
131.14	131.17	.03	**Silty clay**, massive, 5GY5/1.
131.17	131.18	.01	**Tephra and sand**, very fine to fine, coarser in upper half, well sorted and bedded, very hard, N4; tephra are small, clear, and commonly in shape of a triangle, diamond, or rectangle.
131.18	134.26	3.08	**Silty clay**, unit includes at least 14 distinct sand beds, 2 to 15 mm thick, elsewhere, faint color beds have gradational contracts, 5GY5/2, some 5Y5/2.
134.26	134.45	.19	**Silty clay**, sand layers average about 0.5 mm thick, 3 to 10 mm apart, a 5 mm layer at 134.39 m, 5GY5/2, some 5Y5/2.
134.45	134.65	.20	**Silty clay**, like above, but no sand.
134.65	135.06	.41	**Silty clay and sand**, fine, like that between 134.26 and 134.45 m.
135.06	135.10	.04	**Silty clay**, like that between 134.45 and 134.65 m.
135.10	135.20	.10	**Silty clay**, massive, 5GY5/1.
135.20	135.22	.02	**Silt**, very fine sand, faint color bedding, 5Y5/4
135.22	136.08	.86	**Silty clay**, mostly very faint color bedding, but discrete beds of silt to very coarse sand 0.5 to 1.0 mm thick, make distinct beds, commonly as rhythmic sequences of two or three beds about 1 cm apart.
136.08	136.22	.14	**Silty clay**, mottled, darker colors make 1 to 2-mm-wide "veins" (no change in sediment size), 5-10Y3-4/2.

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From (meters)	To (meters)	Unit thickness (meters)	Description
136.22	136.46	.24	**Silty clay**, cut by lighter colored clastic "dikes" and "sills", 2 to 10 mm wide and about 200 mm high, 5Y3-5/2.
136.46	136.74	.28	**Silty clay**, massive, 5Y4/4; lower contact gradational.
136.74	137.38	.64	**Silty clay**, some silt and very fine sand layers that are 1 to 2 m thick, silty clay is slightly mottled, 5GY6/1 to 5Y5/2.
137.38	137.55	.17	**Silty clay**, very little silt, mottled, 5Y4/2-4.
137.55	137.89	.34	**Silty clay**, some silt, 5GY6/1 with some 5Y5/2.
137.89	138.21	.32	**Silty clay**, like above but more distinct beds of silt and very fine sand, 5GY6/1.
138.21	138.80	.59	**Silty clay**, several silt partings 1 to 2 cm apart, 5Y5/2; lower quarter more brittle, fractured into blocks when removed from core barrel.
138.80	139.04	.24	No core.
139.04	139.23	.19	**Silty clay**, some silt in upper third of unit, faint bedding caused by both color changes and silt layers, 5GY6/1, some 5Y4/4.
139.23	139.64	.41	**Silty clay**, moderately distinct bedding, some beds of silt to very fine sand, 10Y4/2.
139.64	140.03	.39	**Silty clay and clayey silt**, beds and discontinuous zones of sand, 1 to 3 mm thick, make prominent beds, distance between sand bed ranges from 5 to 15 mm, 5GY3-5/1, sand beds N6-7; lower contact wavy (2 cm amplitude, 4 cm wave length).
140.03	140.83	.80	**Silty clay**, massive, 5GY5/1.
140.83	141.46	.63	**Silty clay**, like that between 139.64 and 140.03 m, but more silt and very fine sand in upper quarter of this unit.
141.46	141.82	.36	**Silty clay**, like that between 140.03 and 140.83.
141.82	141.86	.04	Silty or **sandy clay**, disseminated fine to very fine sand, 5G4/1.
141.86	141.89	.03	Silty or **sandy clay**, like above, 5Y4/4.

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From (meters)	To (meters)	Unit thickness (meters)	Description
141.89	142.02	.13	**Silty** or **sandy clay,** like that between 141.82 and 141.86.
142.09	142.57	.48	**Silty or sandy clay**, like that between 41.89 and 142.09 m, 1-mm thick beds of silt and very fine sand more common in upper quarter of this unit, subvertical "veins" of darker colors, 1 to 15 mm across, otherwise massive, 5G4/1, with insides of "veins" 5G3/1.
142.57	142.89	.32	**Silty clay**, disseminated biotite flakes, 2-mm layer of very fine sand at 142.83 m, massive, 5-10Y4/4.
142.89	143.08	.19	**Silty clay**, disseminated silt and very fine sand grains, massive except for vertical color "veins", 5Y4/4.
143.08	143.25	.17	**Silty clay**, with 1- to 3-mm-wide clumps of very fine sand between 143.11 and 143.25 m, massive except for vertical color "veins", 5Y4/4.
143.25	143.61	.36	**Silty clay**, some beds of silt and very fine sand, "veins" defined by colors, unit mostly 5GY5/1, "veins" 5Y4/3.
143.61	144.83	1.22	**Silty clay**, disseminated silt and very fine sand, 5-10Y4-5/1-2; one color "vein" extends from 144.07 m to 143.63 m which is 5Y4/4, another extends from 144.83 m to 144.61 m which is 5GY4/1.
144.83	145.24	.41	**Silty clay**, sparse very fine sand, 5-10Y4-6/1-2; several vertical color "veins", a 10-cm long "vein" at base in cut by a 45° fault.
145.24	146.74	1.50	**Silty clay**, no conspicuous silt or sand layers, mottled, 5Y-5GY5/1; three vertical to sub-horizontal color "veins" 1 to 2 mm wide are 5G4/4.
146.74	146.92	.18	**Silty clay**, like above but no color "veins", 5Y-5GY5/1.

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From (meters)	To (meters)	Unit thickness (meters)	Description
146.92	147.68	.76	**Silty clay**, mostly massive, 5Y3-5/4 grading down to 5Y4/6; clastic dike, 5 to 15 mm wide, extends from base to top of unit, its boundaries are very sharp, a 2-mm-thick bed of fine sand, 12 cm up from base, is offset 2 mm by dike; basal 5 cm is ostracode coquina.
147.68	147.81	.13	**Silt and clay**, silt is both disseminated and in thin beds, 5-10Y4/2.
147.81	148.84	1.03	**Silty clay**, with fine to very fine sand beds and pods that are 2 to 10 mm in diameter, sand beds mostly 1 to 3 mm thick, silty clay is mostly massive, some color beds, 10Y4/2, thicker sand beds are 5Y4/2.
148.84	149.47	.63	**Silty clay**, numerous 1- to 3-mm thick beds of fine to very fine sand, massive except for sand beds, 5GY4/1.
149.47	149.55	.08	**Silty clay**, massive, some sand pods (not beds), 5G4/1.
149.55	149.87	.32	**Silty clay**, massive, a few sand pods near 149.65 m, 5GY5/1.
149.87	150.93	1.06	**Silty clay**, a 3-mm-thick bed of very fine sand at 149.91 m, mostly massive, some sand pods near 150.03 and 150.48 m, upper half of unit is 5GY5/1, lower half is 5G5/1; at 150.24 m is a pebble 12 mm long.
150.93	151.88	.95	No core.
151.88	153.41	1.53	**Silty clay**, two 2-mm granules noted, several thin silt-free zones, massive, 5G5/1.
153.41	155.25	1.84	**Silty clay**, variable disseminated silt and very fine sand, massive to faintly mottled, 5GY5/1; basal contact sharp but wavy.
155.25	155.33	.08	**Silt and sand**, very fine , some clay, very hard, both color and grain-size bedding, 5Y5/2 to 5GY5/1.
155.33	155.74	.41	**Silty clay**, like that between 154.51 and 155.25 m, 5GY5/1.
155.74	157.01	1.27	**Silty clay**, faint color beds, 5 to 15 mm thick, 5Y-5GY4-5/1-4.

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From (meters)	To (meters)	Unit thickness (meters)	Description
157.01	157.29	.28	**Silty clay**, some(?) very fine sand in upper half, grades down to fine or medium sand, faintly bedded, 5Y4-5/2.
157.29	157.35	.06	No core.
157.35	158.51	1.16	**Silty clay**, a few silt- to-medium-sand beds, mostly massive except for coarser beds, 5GY5/1.
158.51	162.69	4.18	No core.
162.69	162.81	.12	**Silty clay**, massive, 5GY5/1; basal contact gradational.
162.81	163.11	.30	**Silty clay**, several 3-mm-thick beds of fine to medium sand, well bedded where sand zones occur, silty clay is massive and 5GY5/1, sand is 5Y4/1; near base is a 7-cm-high rounded "intrusion" of sand containing discrete 1 to 2 mm pods of N6 fine sand.
163.11	163.30	.19	**Sand**, fine to very fine, very hard (beds not bent down at core edge), 5Y4-5/2-4.
163.30	163.44	.14	**Silty clay**, several 1-mm-thick beds of sand, zone of dark, very fine sand near base, 5GY5/1.
163.44	163.53	.09	**Silty clay**, disseminated sand grains, silty clay is massive, 15-mm-thick bed of dark sand is well bedded, 5Y3-4/4.
163.53	164.04	.51	**Clay**, with some beds of silt and sand, sand in beds (1 to 10 mm thick) and pods (1 to 3 mm across), massive except for sand beds, 5GY3-4/1.
164.04	164.28	.24	**Silty clay**, almost no sand, massive, 5GY4/1.
164.28	164.49	.21	**Silty clay**, many disseminated grains of fine to very fine sand and white carbonate pods, massive, 5Y-GY4/1.
164.49	164.73	.24	**Silty clay**, like above, 5Y4-5/2.
164.73	164.82	.09	**Silty clay**, like that between 164.04 and 164.28 m.
164.82	166.74	1.92	No core.

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From (meters)	To (meters)	Unit thickness (meters)	Description
166.74	166.89	.15	**Silty clay**, massive, 5GY5/1.
166.89	167.22	.33	**Silty clay** containing disseminated very fine sand, several white carbonate pods, several beds of medium to fine sand, silt is massive, sand is fairly well sorted silty clay is 5GY5-6/2, sand is 10Y4/2; near middle of unit is a 40-mm-wide pod of fairly well sorted fine to medium sand.
167.22	167.26	.04	**Silty clay**, like unit above, massive, 5Y3/4.
167.26	168.63	1.37	**Silty clay**, beds and pods of very fine sand in upper quarter of unit, no sand seen in remaining part of unit, essentially massive, 5GY5/1, sand is N7.
168.63	171.42	2.79	No core.
171.42	171.64	.22	**Silty clay**, massive, 5GY4/1.
171.64	171.73	.09	No core.
171.73	173.68	1.95	**Silty clay**, small amount of disseminated silt or very fine sand fragments having glassy luster (quartz or mica ?), massive, 5G4/1; two vertical color "veins", 25 and 10 cm long, are 5GY3/1.
173.68	173.82	.14	**Silt or very fine sand**, a 3-cm-thick very hard layer at base, could be a tuff or carbonate-cemented zone, 5Y5/2; sediments are from core-catcher, stored in bag.
173.82	174.16	.34	No core.
174.16	175.53	1.37	**Clay**, with 1 to 5% silt or very fine sand, mostly massive, very faintly mottled between 174.81 and 175.28 m, faintly color bedded below 5GY5/1.
175.53	176.30	.77	No core.
176.30	178.03	1.73	**Clay**, like core segment described above, massive, 5GY5/1.
178.03	178.74	.71	No core.

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From (meters)	To (meters)	Unit thickness (meters)	Description
178.74	181.32	2.58	**Silty clay**, about 2% disseminated very fine sand, massive, 5GY5/1.
181.32	181.79	.47	No core.
181.79	183.18	1.39	**Silty clay**, like next core unit above.
183.18	184.68	1.50	**Silty clay**, like unit above, massive except for 2-mm-wide vertical color veins between 184.06 and 194.20 m which are darker, 5GY5/1.
184.68	184.82	.14	**Silty clay**, containing very fine and medium sand as disseminated grains, not beds, massive, 5GY5/1.
184.82	184.84	.02	**Silt and sand**, fine, much mica, sharp upper contact, 5Y6/1.
184.84	185.94	1.10	**Clay, silt, and sand**, very fine, some disseminated grains of coarse and very coarse sand or granules, massive, 5GY6/1.
185.94	186.57	.63	**Clay and silt**, similar to above but fewer sand grains and coarse fragments, massive, 5GY6/1.
186.57	186.66	.09	**Clay, silt, and sand**, very fine, like sediments between 185.84 and 185.94 m.
186.66	186.95	.29	**Silty clay**, 2-cm-thick very fine sand layer in upper part, faint color bedding lower half. 5GY5/2 grading down to 5Y6/1-2.
186.95	187.27	.32	**Clay, silt, and sand**, very fine, massive, 5Y6/1-2.
187.27	187.44	.17	**Silt**, some very fine to fine sand, faint color bedding, 10Y4/2.
187.44	187.70	.26	**Silt**, some beds of very fine to fine sand, otherwise massive, 5GY4/1
187.70	187.85	.15	**Silt and sand**, very fine to fine, 0- to 3- mm bed of black sand in lower half, 5GY4/1.
187.85	187.88	.05	**Sand**, coarse, well sorted, little matrix, faint bedding caused by variations in sand size, 10Y4/2.

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From (meters)	To (meters)	Unit thickness (meters)	Description
187.88	189.07	1.19	**Clay, silt, and sand**, very fine, noted 10 prominent sand beds, each 2 to 5-mm-thick, scattered throughout interval, sand beds are 5G4/1 to N4, clay and silt are 5G4/1.
189.07	189.12	.05	**Sand**, medium to fine, well sorted, 5G2/1.
189.12	189.48	.36	**Silty sand**, very fine, some clay, very calcareous, slightly mottled, faint bedding in basal 6 cm, N7 at top grading down to 5GY4/1.
189.48	189.49	.01	**Sand**, very fine, very well sorted and bedded, 5Y6-8/2.
189.49	190.38	.89	**Silty clay** (80%) **and sand** (20%), very fine to fine, pods (not beds) of well sorted fine sand in upper third of unit, several 5-mm-thick beds of slightly coarser sand found in lower two-thirds of unit, sand is 5Y4/2, silty clay is 5GY4-5/1.
190.38	190.51	.13	**Sand**, fine to very fine, massive, 5Y4/1.
190.51	190.53	.02	**Silty clay**, some sand, massive, 5Y4/1.
190.53	190.63	.01	**Sand**, fine to medium, fair sorting, sub-angular fragments, massive, 5GY4-5/1.
190.63	191.61	.98	**Silty clay**, some very fine sand, alternating with 17 beds, 3 to 30 mm thick, of fine to very coarse sand, silty clay is massive, sand is faintly bedded, 5GY4-6/1.
191.61	192.16	.55	**Silty clay** and **clayey silt**, very little sand, massive, 5Y-5YR4/1 grading down to 5GY4/1.
192.16	193.05	.89	**Silty clay**, some fine sand beds, like sediments between 190.63 and 191.61 m.
193.05	193.98	.93	**Silty clay and clayey silt**, like sediments between 191.61 and 192.16 m except some thin sand layers in lower part of unit.
193.98	194.63	.65	**Silt**, some clay, about 2% very fine to medium sand, disseminated, massive, 5G4-5/1.

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From (meters)	To (meters)	Unit thickness (meters)	Description
194.63	194.81	.18	**Silt and clay**, a few thin very fine sand beds, basal beds very calcareous, mottled, 5GY4-5/1 grading down to 5Y6-7/1 at base; basal contact is a color change that is sharp but has irregular shape over a zone 3 cm deep.
194.81	195.49	.68	**Silt and clay**, a few 1-mm-thick beds of very fine sand, calcareous, 5Y5/1; mollusk-coquina bed at 195.14 m.
195.49	196.56	1.07	**Clay and silt**, small amounts of very fine to medium sand, massive, mottled, colors define zones that change downward in the following sequence: 5Y5/1, 5GY6/1, 5Y5-5GY5/1, 5Y6/2, and 5Y-5GY5/1.
196.56	196.64	.08	**Silt and clay**, mottled, 5GY5/1.
196.64	196.74	.10	**Silt and sand**, very fine, faint color bedding, 1 to 3 cm thick, 5Y4-6/2-4.
196.74	196.81	.07	**Clay and silt**, mottled, 5GY5/1.
196.81	197.01	.20	**Silt**, some clay, beds of very fine sand, very calcareous, mottled, 5Y4-5/2.
197.01	197.64	.63	**Silt**, some(?) clay, like unit above but includes several irregular black (N2) pods that have dimensions up to 5 mm x 10 mm.
197.64	198.37	.73	**Clay and silt**, a few beds of very fine to fine sand (1-2 mm thick), mottled, 10Y5/2 (85%) and 5GY2/1 (15%); ostracodes abundant in sandy layers.
198.37	198.64	.27	**Clay and silt**, calcareous, very few irregular dark splotches up to 2 mm wide, 10Y6/2.
198.64	198.96	.32	**Clay and silt**, like sediments between 197.64 and 198.37 m.
198.96	199.15	.19	**Clay and silt**, like unit above except for colors which are 10Y6/2 to 5Y6/4.
199.15	200.65	1.50	**Silt and clay**, lighter colored areas very calcareous, numerous thin partings of very fine to medium sand, colors mostly 5-10Y4/2, zones of 10Y6/2.

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From (meters)	To (meters)	Unit thickness (meters)	Description
200.65	201.60	.95	**Clay and silt**, about 10 fine sand beds, 1 to 4 mm thick, otherwise massive, 5GY5/1 at top, grades down to 5Y5/2.
201.60	203.10	1.50	**Silt and clay,** fine to very fine, sand beds constitute less than 1%, calcareous, mottled to faint bedding, color beds average about 1 cm thick, predominantly 10Y4-5/2 and 5Y4-5/4.
203.10	203.30	.20	**Clay and silt**, mottled, faint color bedding, one black zone near base, mostly 5Y4/4 to 10Y4/2.
203.30	203.43	.13	**Clay and silt**, some fine to very fine sand partings, 5Y5/4, some 5Y3-4/2.
203.43	203.72	.29	**Silt and clay**, like sediment between 201.60 and 203.10 m.
203.72	204.27	.55	**Silt and clay**, like above, but many sand partings, color changes to 5-10Y4/2.
204.27	206.17	1.90	No core.
206.17	206.78	.66	**Sand**, coarse to very coarse, fairly well sorted, subangular to subround, appears to be granitic in origin, massive, 5Y5/1, grains, lighter, probably dark clay mixed with sand.
206.78	207.09	.31	No core.
207.09	207.53	.44	**Sand**, fine to medium, slightly calcareous, much mica(?) and quartz, massive, 5GY4/1.
207.53	207.93	.40	**Sand**, fine, some medium, intermixed silt, 1-cm-thick bed of clean fine sand at 207.58 m, cm-thick pod of clean fine sand 5 cm lower, massive except where beds of sand occur, 5GY4/1.
207.93	207.99	.06	**Sand**, very coarse (95%), some smaller grains, massive, 5GY4/1.
207.99	208.04	.05	**Sand**, medium (95%), one 3-mm long sand fragment, little matrix, massive, 5GY4/1.
208.04	208.46	.42	**Sand**, fine, like sediment between 207.53 and 207.93.

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208.46	208.61	.15	No core.
208.61	209.86	1.25	**Silt and clay**, numerous thin beds of silt or very fine sand, moderately well bedded due to sediment-size changes, 5GY5/1.
209.86	211.55	1.69	**Silty clay**, rare thin beds of silt or very fine sand, massive except for thin silt beds, 5GY5/1.
211.55	211.58	.03	**Sand**, very fine, very weakly bedded, 5Y5/1.
211.58	211.61	.03	**Silty clay**, very weakly bedded, 5GY5/1.
211.61	211.91	.30	No core.
211.91	213.34	1.43	**Silt and clay**, partings of very fine sand, massive except for sand partings, 3GY4/1.
213.34	214.77	1.43	**Silt and clay**, numerous very fine sand laminae (1 to 3 mm thick) and beds, bed of black (N2) sand, massive except for sand laminae and beds, 5GY4-5/1.
214.77	214.86	.09	**Silt to sand**, very fine, massive, 5GY5/1.
214.86	215.20	.34	**Clay, silt, and sand**, very fine, massive, 5GY5/1.
215.20	215.47	.27	**Clay and silt**, massive, 5GY5/1.
215.47	215.78	.31	**Silt and sand**, very fine, beds of fine sand, 5GY5/1.
215.78	216.54	.76	**Silt**, some clay, about 10 very fine sand beds, massive elsewhere, 5GY5/1.
216.54	216.75	.21	**Sand**, coarse to very coarse, some clay, mottled, N2-N6 (sand) and 5Y4/1 (clay); probably cuttings, not core.
216.75	217.34	.59	**Sand**, coarse to very coarse, some medium sand, fair to good sorting, grains sub-angular to sub-round; quartz and feldspar common, 10% dark minerals, massive, N3-N7 (clay contamination causes darker colors.)
217.34	219.73	2.39	No core.
219.73	219.75	.02	**Silt and sand**, very fine, massive, 5GY5/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
219.75	220.89	1.14	**Silt and clay**, some very fine sand partings, massive except for sand partings, 5GY5/4.
220.89	220.90	.01	**Sand**, very fine to fine, well sorted, sub-angular to sub-round, quartz, massive, N4.
220.90	221.25	.35	**Silt and sand**, very fine, grades down into very fine to medium sand in lower half, massive, mostly 5GY5/1, but between 220.93 and 221.16 m, a subvertical color contact separates 5GY5/1 from a lesser amount of 5GY6/1 silt and sand.
221.25	221.72	.41	**Clay and silt** , very little fine sand as partings, massive, 5GY5/1
221.72	223.08	1.36	**Clay and silt**, 5% very fine sand as numerous discrete thin beds, otherwise massive, 5GY4-5/1.
223.08	223.22	.14	**Silt and sand**, very fine, some clay beds, 5Y5/2.
223.22	223.24	.02	**Silt and sand**, very fine, like sediments between 221.72 and 223.08 m.
223.24	224.09	.85	**Silt and clay**, partings of very fine sand, 5GY5/1 changing gradually near middle of interval to 5Y6/1; basal contact gradational over 5 cm interval.
224.09	224.14	.05	**Silt and clay**, massive, 5GY5/1.
224.14	224.17	.03	**Tephra**, very fine grained, not calcareous, slightly gritty feel, mottled, N5-N7, darker color near base; major component identified as Dibekulewe ash bed.
224.17	224.46	.29	**Silt and sand**, very fine, some clay, massive, 5GY5/1.
224.46	224.61	.15	**Silt and sand**, very fine, some clay, massive, 5GY4/2.
224.61	226.37	1.76	**Silt**, some clay and very fine sand, massive except for partings of very fine sand, 5Y4/2.
226.37	226.45	.08	**Sand**, fine to medium, bedding defined by changes in sand sizes, 5Y5/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
226.45	226.50	.05	**Sand**, medium to very coarse, 5Y2/1.
226.50	226.69	.19	**Sand**, medium to very coarse, 5Y3/1.
226.69	226.88	.19	**Sand**, fine to very coarse, average near medium 5GY4/1.
226.88	226.95	.07	**Sand**, coarse grading down to medium and fine, massive, 5GY4/1.
226.95	227.02	.07	**Sand**, fine grading down to coarse, average near medium, very faintly bedded, 5GY4/1.
227.02	227.26	.24	**Silt to sand**, fine, average very fine, 5GY5/1.
227.26	227.36	.10	**Sand**, medium, well sorted, quartzose, sub-angular to sub-round, massive, 5GY5-6/1.
227.36	227.51	.15	No core.
227.51	227.67	.16	**Granules and sand**, average very coarse, granules range up to 4 mm long, one granule of basalt cinder is 20 mm long, massive, 10G4/2; the most poorly sorted sediment seen down to this level in core.
227.67	227.77	.10	**Sand**, coarse to very coarse, fairly well sorted, massive, 5GY4/1.
227.77	227.82	.05	**Silt to sand**, very coarse, some clay, massive, 5G4/2.
227.82	229.82	2.00	No core.
229.82	229.98	.16	**Sand**, medium to very coarse, scattered granules up to 8 mm long, quartzose, poorly sorted, sub-angular to sub-rounded, massive, 5G4/1.
229.98	233.03	.05	No core.
233.03	233.45	.42	**Sand**, medium to fine, well sorted, one 2-mm well rounded grain, finer grains angular to sub-angular, quartzose, very faint bedding, 5G5/1.
233.45	233.68	.23	**Sand**, medium, well sorted, sub-angular to sub-rounded, quartzose, massive, 5GY4/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
233.68	233.78	.10	**Sand**, fine to very fine, 3- to 5-cm-thick beds of fine clean sand at 233.70 and and 233.74 m, otherwise massive, 5GY4/1.
233.78	233.91	.13	**Sand**, like sediment between 233.45 and 233.68 m.
233.91	234.21	.30	No core.
234.21	234.47	.26	**Sand**, medium, well sorted, sub-angular, quartzose, massive, 5GY4/1.
234.47	234.66	.19	**Sand**, fine, otherwise same as above.
234.66	234.81	.15	**Silt**, some very fine to medium sand, massive, 5G5/1.
234.81	235.10	.29	**Sand**, medium, massive, 5GY3/1.
235.10	235.11	.01	**Sand**, medium to fine, quartzose, massive, 5GY3/1.
235.11	235.72	.61	**Silt to sand**, fine, massive, very hard, 5G5/1.
235.72	235.75	.03	**Sand**, fine, well sorted, quartzose, wavy lower contact over thickness of 3 cm, 5GY4/1.
235.75	235.87	.12	**Silt to sand**, very fine, massive, 5GY4/1.
235.87	235.88	.01	**Sand**, fine, massive, 5GY4/1.
235.88	235.95	.07	**Silt to sand**, very fine, massive, 5GY4/1.
235.95	236.45	.50	No core.
236.45	236.85	.40	**Sand**, fine to medium, some very fine sand and silt, pods of coarse sand, massive with some partings, 5G5/1; lower contact gradational over 5 cm.
236.85	237.02	.17	**Silt and sand**, very fine, massive, 5G6/1; lower contact gradational over 5 cm.
237.02	237.11	.09	**Sand**, like sediment between 236.45 and 236.85 m.
237.11	237.18	.07	**Silt and sand**, very fine, massive with some partings, 5G6/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
237.18	237.38	.20	**Sand**, medium, quartz rich, well sorted, sub-angular, massive, 5GY5/1.
237.38	237.69	.31	**Sand**, medium, some very fine sand and silt, pods of coarse sand, well sorted, massive with some partings, 5GY5/1.
237.69	238.08	.39	**Sand**, coarse, 2-cm bed of very coarse sand at 237.76 m, well sorted, sub-angular, massive, 5GY5/1; basal contact gradational over 6 cm.
238.08	238.40	.32	**Silt**, intermixed fine to very coarse sand grading down to fine to medium sand, upper part poorly sorted, lower part well sorted, massive, 5GY5/1.
238.40	238.56	.16	**Silt to sand**, mostly fine, coarser in lower half, massive, 5GY5/1.
238.56	238.67	.11	**Sand**, medium, notably free of fine matrix, massive, 5GY5/1.
238.67	238.88	.21	**Silt to sand**, fine, massive, very hard, 5GY5/1.
238.88	239.80	.92	No core.
239.80	240.12	.32	**Silt**, grading down to silty medium sand in basal 3 cm, massive, 5GY5/1.
240.12	240.37	.25	**Sand**, medium, 2% larger fragments of biotite, well sorted, sub-angular, massive, 5GY5/1.
240.37	240.50	.13	**Sand**, fine, otherwise like above unit.
240.50	240.78	.28	**Silt**, like that between 239.80 and 240.12 m, grades down into fine sand in basal 3 cm, massive, 5GY5/1.
240.78	240.96	.18	**Sand**, medium, well sorted, sub-angular, quartzose, massive, 5GY5/1; basal contact gradational over 4 cm.
240.96	241.23	.27	**Silt**, like sediment between 239.80 and 240.12 m.
241.23	241.42	.19	**Sand**, medium, like sediment between 240.78 and 240.96 m.
241.42	244.45	3.03	No core.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
244.45	244.70	.25	**Sandy silt**, grading down to **fine to very fine sand**, well sorted, sub-angular, massive 5G5/1 grading down to 5GY-10Y4/1-2.
244.70	245.05	.35	**Sand**, fine to medium , otherwise like above unit, massive, 5Y-5GY4-5/1-2; basal contact gradational over 3 cm.
245.05	245.38	.33	**Sand**, fine to very fine, grading down into fine to medium sand, includes much silt, sand well sorted, sub-angular, unit mottled in upper third, massive in lower part, 5Y5/2 to 5GY5/1 in mottled part, 5GY5/1 in massive part.
245.38	245.64	.26	**Sand**, coarse in middle third, medium in remaining thirds, well sorted, sub-angular, massive, 5GY5/1.
245.64	245.76	.12	**Sandy silt**, 1-2 mm-thick partings of very fine sand, faintly bedded, 5GY5/1, 1 cm of 5Y2/1 at base.
245.76	246.00	.24	**Sand**, medium grading down to fine and very fine, massive, 5GY6/1 grading down to 5GY4/1.
246.00	246.11	.11	**Sand**, medium to very coarse, sub-angular, moderately well sorted, massive, 5GY5/1.
246.11	246.26	.15	**Sand**, like that between 245.76 and 246.00 m.
246.26	247.32	1.06	No core.
247.32	247.58	.26	**Silt and sand**, very fine to fine, calcareous, unit is massive, 5G5/1; three large concretions(?), up to 50 mm in long dimensions; concretion lithology on fresh surfaces is similar to enclosing sediment but very hard.
247.58	247.77	.19	**Sandy silt**, grading down to **very fine to fine sand**, 5-cm bed of sand near middle of unit is "cleaner" than rest of unit, massive, 5G4/1 to 5GY5/1 for "cleaner" sand.
247.77	250.37	2.60	No core.
250.37	250.48	.11	**Sand**, fine to medium, fair sorting, massive, 5GY5/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
250.48	250.71	.23	**Silt and sand,** fine to medium, more silty in lower part, massive to faintly bedded, 5GY5-6/1; basal contact dips over 4 cm range.
250.71	250.87	.16	**Sand**, fine to medium, well sorted, subangular, quartzose, faint horizontal bedding planes, mostly 5GY5/1, 5GY6/1 near base.
250.87	250.88	.01	**Silt and sand**, very fine, "clean", 5GY4/1.
250.88	251.52	.64	**Silt and sand,** fine to medium, fair sorting, massive, 5-cm bed of subangular fine to medium sand near 251.38 m is "clean" and well sorted, 5Y4/1 to 5GY5/1.
251.52	251.67	.15	**Sand**, medium, "clean", sub-angular, very well sorted, massive, 5GY4/1.
251.67	252.50	.83	No core.
252.50	253.17	.67	**Sand**, medium to coarse, angular to sub-angular, uniformly quartzose, well sorted, massive, N6 to 5GY6/1.
253.17	253.18	.01	**Silt and sand**, very fine, massive, 5GY4/1.
253.18	253.47	.29	**Silt and sand**, very fine to medium, faintly bedded, 5G4/1.
253.47	253.60	.13	**Sand**, very fine to medium , well sorted, 5GY3/1; gradational lower contact .
253.60	254.00	.40	**Sand**, very fine to medium, averages fine, well sorted, some silt in matrix, quartzose, very faintly bedded in upper part, 5Y3-4/1.
254.00	255.04	1.04	**Sand**, very fine to medium, averages fine, grades down to silt and sand, fine to very fine, unit massive, 5GY4-5/1.
255.04	255.17	.13	**Sand**, fine to coarse, average medium, quartzose, sub-angular, massive, 5GY4/1.
255.17	255.32	.15	**Silt and sand**, very fine to fine, massive, 5GY4/1.
255.32	255.51	.19	**Sand**, very fine to medium, average fine, quartzose, massive, 5GY4/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
255.51	255.58	.07	**Silt** , 5% very fine to medium sand, massive, 5GY4/1.
255.58	261.95	6.37	No core.
261.95	262.28	.33	**Sand**, fine to medium, a few fragments up to 4 mm long, clean, fairly well sorted, quartzose, sub-angular, massive, 5GY4/1.
262.28	262.30	.02	**Sand**, medium to coarse, massive, 5GY4/1.
262.30	265.98	3.68	No core.
265.98	266.10	.12	**Clay and silt**, mixed, probably slump not core.
266.10	266.12	.02	**Sand**, fine to medium, well sorted, quartzose, fairly "clean", massive, 5GY5/1.
266.12	266.22	.10	**Silt and sand**, very fine, 1-cm silty clay bed at 266.19 m, otherwise massive, 5GY5/1.
266.22	266.32	.10	**Clay and silt**, 1% very fine sand, mottled, 5GY3-5/2.
266.32	266.78	.46	**Silt and clay**, 3% very fine or fine sand as dispersed grains, diatom-rich layer at 266.43 m, faintly bedded to mottled, N2-3, some beds of 5Y3/1.
266.78	267.06	.28	**Clay**, 1 to 2% dispersed very fine to fine sand grains, massive and dense, breaks with conchoidal fracture, N2.
267.06	267.48	.42	**Clay**, 1 to 2 % dispersed very fine to fine sand grains, 4-cm zone near 268.14 m contains up to 5% dispersed grains, some silty beds, color beds average about 1 to 2 cm thick, some zones mottled, N2 to 5Y5/1.
267.48	267.66	.18	**Clay, silt, and sand**, very fine, averages silt, faint color beds and strongly mottled zones, 5Y3-4/2, N2 locally.
267.66	267.76	.10	**Clay, silt, and sand**, very fine, massive, N2.
267.76	268.24	.48	**Clay, silt, and sand**, very fine, averages silt, some clay-free zones, massive to very faintly bedded, 5Y4/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
268.24	268.32	.08	**Clay**, 1 to 2% dispersed grains of fine to very fine sand grains, massive, dense, N2.
268.32	269.88	.56	No core.
269.88	272.38	2.50	**Clay**, some silt, 1 to 3% dispersed grains of very fine to medium sand, some grains appear well rounded but most are sub-angular, mostly mottled, some faint color beds, fractures with conchoidal surface that has a "waxy" luster, N2 (5GY4/1 when partly dry) and 5Y4-5/2; ostracodes and diatoms visible.
272.38	272.44	.06	**Silt and sand**, very fine, cemented to rock-like hardness by carbonate, massive, 5GY4/1.
272.44	272.45	.01	**Clay and silt**, massive, 5GY4/1.
272.45	272.61	.16	**Silt**, 2% dispersed grains of very fine to medium sand, massive, 5G4/1.
272.61	275.55	2.94	No core.
275.55	276.05	.50	**Clay (and silt?)**, disseminated fine to medium sand, massive, 5GY4/1, some (near top) N5.
276.05	276.17	.12	**Clay**, possibly some silt, disseminated fine to medium sand, mottled (bioturbated?), 5GY4/1 (matrix) and 5Y5/1 ("tubes").
276.17	276.70	.53	**Clay**, possibly some silt, like sediments between 275.55 and 276.05 m; basal contact gradational over 20 to 30 cm.
276.70	276.88	.18	**Clay**, like above, but occasional thin zones of fine to medium sand, some as near-horizontal (but commonly discontinuous) "beds", and some as clastic dikes, generally massive, 5GY4-5/1.
276.88	277.66	.78	**Clay**, 2% disseminated fragments of fine-sand-sized grains of quartz(?), massive, 5GY4/1; near 276.95 m, a 2-cm wide, irregularly shaped pod of fine to medium sand, 10YR3/2.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
277.66	277.80	.14	**Clay**, some silt, much is faintly bedded but some zones are massive, abundant biotite, 5G5/1 to 5GY5/1; 0.5 to 1.0 mm-thick lenticular beds and clastic dikes of very fine to fine, dark (N3) sand, beds are horizontal to sub-horizontal, dikes cut bedding, basal 4 cm has dike, up to 2 cm thick, of poorly sorted fine to very coarse sand.
277.80	278.86	1.06	**Clay**, some silt, with fine to medium sand as isolated grains, mostly angular flakes of bronze-colored flat mineral (oxybiotite or glass?) up to 1 mm long, parallel to bedding planes, 1- to 3-cm-thick beds of fine sand between 278.50 and 278.70 m; massive in upper part, sand beds in lower part, 5GY4-6/1.
278.86	278.89	.03	**Sandstone**, fine to very coarse sand, possibly some tephra, very well indurated, not calcareous, poorly sorted, notable amounts of mica(?) on some bedding surfaces, sediment from granitic terrain, bedding caused by grain size or composition changes, beds 2 to 10 cm thick, N5-7 (dry).
278.89	279.33	.44	**Sand**, medium to very coarse, poorly sorted, sub-angular to sub-round, quartzose, some clay or silt in matrix, silt bed near 279.04 m, massive to faint bedding, N5-5Y-GY5/1, silt layer is 5Y5/1.
279.33	279.66	.33	**Clay , silt, and sand**, fine, thin beds of fine to medium sand, faintly bedded , 5GY5/1.
279.66	279.71	.05	**Sand**, very fine to medium, well sorted, moderately distinct bedding, 5Y4/1.
279.71	279.72	.01	**Clay, silt, and sand**, very fine, massive, 5GY5/1.
279.72	279.80	.08	**Sand**, very fine to medium, well sorted, distinct bedding, 5Y4/1.
279.80	279.90	.10	**Sand**, medium to very coarse, sub-rounded, poorly sorted, distinct bedding, 5Y4/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
279.90	280.25	.35	**Sand**, fine to medium, alternating with **silty sand**, grading down to **clay and silt** containing a few beds of very fine to fine sand, moderately well bedded, 5GY4-5/1.
280.25	280.27	.02	**Silt to sand,** fine, mica flakes as large as 1 mm on bedding planes, massive, 5GY6/1.
280.27	282.74	2.47	No core.
282.74	282.81	.07	**Sand and clay**, mixed, probably cuttings not core.
282.81	283.21	.40	**Clay and silt**, 30% very fine to fine sand, beds and blocky zones of of coarse grains, 5GY4-5/1; a 6-cm-high clastic dike composed of fine to very fine sand near base.
283.21	286.94	3.73	**Clay and silt**, numerous beds of very fine to fine sand, average spacing between beds 1 to 3 cm (but variable), average thickness of sand beds is between 1 and 5 mm, 10Y4-5/2 (sand grains, N3-5), grading down to 5Y4-5/1-2, basal 15 cm is 10YR4-5/2-4.
286.94	287.89	.95	**Clayey silt**, 5% very fine sand, faint color bedding, mottled in places, upper part is 10YR5/2, some beds of 10YR3/2, gradual color change downward to 10YR4/2.
287.89	288.65	.76	**Silt and sand**, very fine, several thin slightly mottled, several darker beds, upper part is 10YR4/2 , gradual color change downward to 5Y4/2-4.
288.65	289.17	.52	**Clay and silt**, some very fine sand, faint color bedding, 5Y3-5/2 to 10Y4/2.
289.17	289.58	.41	**Clay and silt**, some zones of silt and very fine sand, faint color bedding, 5Y-5GY5/2.
289.58	289.97	.39	**Clay and silt**, some silt and very fine sand, faintly bedded, 5Y5/1 to 5GY5/1.
289.97	290.95	.98	**Clayey silt**, 5 to 20% very fine to fine sand, between 290.23 and 290.31 m, some crystals up to 1 mm long, massive, 5GY4-5/1; basal 25 cm has faint laminar bedding, slightly calcareous.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
290.95	291.52	.57	No core.
291.52	293.59	2.07	**Clay and silt**, some disseminated very fine to medium sand, partings of very fine sand to medium sand are well sorted, some are very "clean", fair bedding due to partings but massive between partings, 5GY4-5/1; at 292.52 m is a subrounded granitic pebble 5 mm long (dropstone?).
293.59	294.70	1.11	No core.
294.70	295.21	.51	**Clay**, 5% silt, trace of disseminated very fine sand, beds of silt to fine sand, massive, 5GY4/1.
295.21	295.65	.44	**Clay and silt**, trace of disseminated very fine sand, very faint bedding, 5GY4/1.
295.65	295.91	.26	**Silt and clay**, some intermixed very fine sand, beds of very fine to fine sand, very faint color bedding, 5Y4/1; basal contact gradational over 1 cm.
295.91	295.95	.04	**Sand**, very fine to medium (some tephra shards?), massive, 5Y4/1.
295.95	296.00	.05	**Tephra**, impure, gradational over 3 cm, massive, 5Y6/1.
296.00	296.06	.06	**Tephra**, pure, massive, sharp contact, N7-5Y6/1; sharp basal contact; chemically similar to unnamed tuff in Borrego Badlands (S. Calif.).
296.06	297.42	1.36	**Clay and silt**, possibly some very fine sand, some pods and streaks of fine to medium "clean" sandy, faintly color bedded, 10YR3-4/2, grades down to massive to mottled and 5Y3-4/2-4 in basal 35 cm.
297.42	297.56	.14	**Silt and sand**, very fine, grading down to sand, fine to medium, faintly color bedded, 5YR3-5/1.
297.56	297.66	.10	**Silt and sand**, very fine, disseminated white fibrous mineral, very hard, faintly color bedded, 5YR2/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
297.66	297.74	.08	**Silt and sand**, very fine to medium, disseminated white mineral, very hard, faintly color bedded, 5YR3/1
297.74	297.92	.18	**Clayey silt and sand**, fine, as alternating beds of each (70% clayey silt), unit well bedded, 5YR2-3/4-5.
297.92	298.25	.33	**Clay, silt , and sand**, fine to medium, grading down to sand, fine to medium, with some clay and silt, bedding caused by sediment-size changes; average bed thickness 1 to 2 cm, 5YR3-4/1-2 grades down to 5Y4-5/1.
298.25	301.79	3.54	**Sand**, medium to coarse, noted 5 zones of very coarse sand, grains sub-angular to sub-round, fairly well sorted, quartzose, very faintly bedded, N6 to 5Y5/5-6.
301.79	301.88	.09	**Silt and sand**, very fine to medium, faint bedding due to sediment-size change, 5Y4/1.
301.88	301.95	.07	**Sand**, fine to medium, well sorted, quartzose, massive, 5Y6/1.
301.95	302.01	.06	**Silt and sand**, very fine to fine, 1-1 to 3-mm-long crystals of curved, fibrous, white mineral (gypsum?), very faintly bedded, 5Y4/1.
302.01	302.94	.93	**Clayey silt**, beds (30%) of silt and fine sand, local pods and discontinuous beds (horizontal to sub-horizontal) of very fine to fine sand which are 5Y2/1, bedding caused by sediment size change, 5GY4/1 grading down to 10YR3-5/2-4.
302.94	303.30	.36	**Sand and granules**, upper third is fine to medium sand, middle third is very coarse sand and granules (centered at 303.11 m), lower third is very fine to medium sand, faintly bedded, coarser fractions very poorly sorted, mostly 5Y-10YR5-6/1-2, two 2-cm-thick zones of 5Y6/1 near base.
303.30	303.53	.23	**Sand**, fine to medium, well sorted, sub-angular, some silt (and clay?).

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
303.53	303.88	.35	**Tephra**, impure(?), fragments are fine- to medium-sand size, massive, 5Y6/1 to N6.
303.88	305.04	1.16	**Tephra**, fragment sizes like unit above, numerous 1-cm-thick beds of greenish impure (silt and clay) ash, well bedded to laminated, pure ash is N7 to 5Y5-6/1 (one 6-cm zone near 304.9 m is N8), greenish impure beds are 5Y4-5/1.
305.04	305.15	.11	**Tephra**, impure, faint to distinct bedding (but not laminated), 5Y5-7/1.
305.15	305.25	.10	**Tephra**, like above, massive to very poorly bedded, 5Y6-8/1.
305.25	305.37	.12	**Tephra**, like that between 305.04 and 305.15 m.
305.37	305.39	.02	**Tephra**, relatively pure, massive, 5Y6-8/1.
305.39	305.70	.31	**Silt, clay, and sand**, very fine, with numerous continuous to discontinuous beds (1 to 2 mm thick) of **tephra**, well bedded, 5Y5-6/1, tephra is N6-8.
305.70	305.71	.01	**Wood(?)** or **Fe oxide(?)**, massive, hard, 5YR4-5/4-6.
305.71	305.79	.08	**Tephra**, as a jumbled mixture of yellowish to light pink (5%) lapilli(?), in a matrix of fine to medium sand, massive, average color about 5Y6/1 .
305.79	306.99	1.20	**Tephra**, as pebble- , granule- , and very coarse sand-sized fragments, rounded, one white fragment 30 mm long, most 10 mm or less, tephra are (5R8/2) and matrix is (N8), grades downward to very-fine- to medium-sand-sized fragments of same material, 1% dark minerals, massive, 5YR7/1 grading downward to 5Y7/1.
306.99	307.06	.07	**Tephra**, like upper half of overlying unit.
307.06	307.33	.27	**Clay and silt**, some very fine sand, some sand- and granule-sized grains of pink or white tephra, massive, 5Y7/1.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
307.33	307.44	.11	**Clay and silt**, some very fine sand, a 12-mm-long rounded fragment of pink (5YR8/4) pumice, massive, 5GY6/1.
307.44	307.48	.04	**Tephra**, fine, with scattered pumice granules.
307.48	308.32	.84	**Tephra**, as silt to very fine sand-sized fragments, locally laminated, 5Y7/1 grading down to 5Y6/1.
308.32	308.53	.21	**Tephra**, reworked primary fallout, as sand- , granule- , and small-pebble-sized pumice fragments, rounded, in finer matrix, massive, fragments both (5Y7/1) and (5R8/2); little contamination from detritus.
308.53	309.14	.61	**Tephra**, like that above, but as fine- to medium-sand-sized fragments.
309.14	309.39	.25	**Silt and sand**, very fine, flakes of biotite to 2 mm across, some silt partings, faint bedding caused by silt layers, 10Y5/2.
309.39	309.44	.05	**Sand**, fine to medium, many dark mineral fragments, massive.
309.44	309.49	.05	**Silt and sand**, very fine, like sediments between 309.14 and 309.39 m.
309.49	310.18	.69	No core.
310.18	310.24	.06	**Silt**, faintly color bedded, 5GY4/1.
310.24	310.27	.03	**Sand**, medium, massive, N4; mollusks common.
310.27	310.36	.09	**Silt**, partings of very fine sand, fairly well bedded, 5G4/1.
310.36	310.55	.19	**Sand**, fine to medium, grading down to medium sand in middle, then to fine sand and silty clay at base, faintly bedded, 5Y4-6/1.
310.55	310.71	.16	**Silty clay**, silt partings in upper and lower thirds faintly bedded where silt is present, color bedded in middle, 5Y6/2.
310.71	310.74	.03	**Sand**, fine to medium, well sorted, massive, N5; a 5-mm thick fragment of wood(?) near middle which is 5YR3-4/2-6.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
310.74	311.01	.27	**Silty clay**, some very fine sand, two darker fine to medium sand zones near 310.93 m, faintly color bedded, 5Y5-6/2, sands are N5.
311.01	311.18	.17	**Tephra**, thin beds of medium- to very-coarse-sand-sized tephra alternating with beds of fine- to very-fine-sand-sized tephra, some beds poorly sorted, bedding good, defined by color and grain-size change, N5-7 to 5Y6/1.
311.18	311.38	.20	**Tephra**, medium- to coarse-sand-sized grains of tephra, very faintly bedded, N6 to N7.
311.38	311.67	.29	**Tephra**, composed of silt-sized fragments, massive, mostly N7, upper 6 cm is 5Y6/1.
311.67	311.69	.02	**Tephra**, fine, N6; basal contact very sharp.
311.69	311.86	.17	**Sand**, two sequences of equal thickness, each composed of coarse to very coarse sand grading down to fine to medium sand, grains are about half silicate crystals and half tephra, well sorted, N6-8.
311.86	313.19	1.33	**Clay and silt**, some very fine sand, five darker beds of fine to coarse sand, 1 to 6 cm thick, evenly distributed throughout unit, otherwise massive, 5GY5/1 in upper two thirds grading down to 5GY6/1; near 312.52 m, several pebbles noted (largest, 17 mm in long dimension); fragment of wood(?), 7 mm long, at 312.15 m.
313.19	314.45	.26	No core.
314.45	315.92	1.47	**Clay and silt**, beds and partings of very fine to medium sand, coarse-sand-sized mica flakes common, massive to very faint bedding, 5GY5-6/1; many ostracodes at top of unit.
315.92	317.34	1.42	**Silt**, partings of very fine to medium sand and larger biotite flakes, at 317.25 m a 1-cm-thick bed of fine to coarse sand, calcareous, massive, harder than unit above, 5GY5-6/1; at 317.25 m, numerous ostracode and mollusk shells noted.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
317.34	317.62	.28	**Sand**, medium to coarse, many mollusk fragments (especially at 317.38 m), faintly bedded, N4-6 but 5Y4-6/1 where shells abundant.
317.62	317.66	.04	**Clay, silt, and sand**, a mixture of overlying and underlying sediments, massive, N4-5Y5/1.
317.66	317.71	.05	**Clay and silt**, some very fine to fine sand, mottled, 5Y7/2.
317.71	317.76	.05	**Sand, silt, and clay**, like unit between 317.62 to 317.66 m but more sand, N4-6; basal contact gradational over 3 cm.
317.76	317.89	.13	**Sand**, fine to medium, clean, well sorted, sub-angular, massive, upper third is 5Y4/1, middle third is 5Y2/1, and lower third is 5GY3/1, color changes do not follow bedding.
317.89	318.11	.22	No core.
318.11	318.28	.17	**Sand**, fine, angular, very well sorted, 90% quartz, massive, 5G3/1.
318.28	318.64	.36	**Sand**, medium to fine, angular, very well sorted, 90% quartz, massive, 5G4/1; basal contact gradational over 5 cm.
318.64	318.94	.30	**Sand**, very fine, angular, very well sorted, grades down near middle of unit to silt, massive, 5G-5GY4/1; basal contact gradational over 2 cm.
318.94	319.02	.08	**Sand**, fine, angular, moderately well sorted, quartz, unit composed of two distinct beds, mostly 5GY4/1, basal 1 cm is 5G6/1.
319.02	319.56	.54	**Clay and silt**, massive, mostly 5G4/1 but 8-cm-thick zone of 5Y3/2 near 319.30 m.
319.56	319.63	.07	**Clay**, 2 to 3-mm-thick partings of silt(?), 5YR2-3/1-2.
319.63	319.84	.21	**Clay**, massive, 10YR2/2; shrinks upon drying.
319.84	319.92	.08	**Granules and sand**, coarse, sub-angular, very poorly sorted, massive, N3.

Table 2. Log of Core OL-92-2

From (meters)	To (meters)	Unit thickness (meters)	Description
319.92	319.96	.04	**Sand**, fine to medium, angular, well sorted, faintly bedded, beds 1 cm apart caused by 1- to 2-grain-thick layers of medium sand, 5Y3/2.
319.96	320.04	.08	**Tephra**, medium-sand-sized fragments, angular, moderately well sorted, thinly bedded, beds distinguished by grain size and color, N4.
320.04	320.15	.11	**Sand**, mostly medium, scattered grains of fine to very coarse sand and granules, micaceous, angular, poorly sorted, massive, N3.
320.15	320.74	.59	**Sand**, medium grading down to coarse, scattered coarse grains throughout, occasional scoria granules, moderately well sorted, angular, massive or very faintly bedded, N5 grading down to N3.
320.74	321.03	.29	No core.
321.03	321.15	.14	**Sand**, very coarse, angular to sub-angular, a few are well rounded, moderately well sorted, some near granule sizes, massive, N5.
321.15	321.19	.04	**Sand**, medium, some very fine, well sorted, sub-angular, massive, N5.
321.19	321.68	.49	**Sand**, very coarse, angular, moderately sorted, massive, N4.
321.68	322.03	.35	**Sand**, medium and well sorted in top and bottom thirds, coarse and poorly sorted coarse in middle third, well bedded, N6.
322.03	322.14	.11	**Sand**, mostly coarse but some very fine, angular, moderately well sorted, mostly quartz, massive, N6.
322.14	322.43	.29	**Sand**, fine, very well sorted, angular, massive, N6-7.
322.43	322.86	.43	No core.

BOTTOM OF CORE 0L-92-2

Between 61.26 m and 322.86 m (total cored thickness = 261.60 m), "no core" entries in log account for 54.71 m; thus, 79 percent of this interval was recovered as core (although some of it was suspected of being "cuttings, not core").

Table 3. Log of Core OL-92-3[1]

From (meters)	To (meters)	Unit thickness (meters)	Description
0.00	0.94	0.94	**Artificial fill**; top of this unit is "lake-surface level" at the drill site where cores OL92-1 and OL92-2 were recovered.
0.94	1.32	.38	**Salts**, mostly well bedded halite, trona, and burkeite; salts are result of completion of the Los Angeles Aqueduct which led to desiccation of Owens Lake in about 1921; maximum thickness of salts elsewhere on lake surface is about 2.75 m .
1.32	3.52	2.20	**Oolites**, granule to coarse-sand sized, well rounded, massive to faintly bedded, 5Y6-8/1; oolites are rounded to subrounded, fine- to coarse-sand-sized grains composed apparently of calcite and aragonite; this unit is very hard where oolites are cemented together[2].
3.52	4.12	.60	**Oolites and sand**[3], medium to very coarse, massive, unconsolidated, 5Y7/4; XRD of sample from 3.67 m shows (calcite ≈ gaylussite) > (halite ≈ aragonite).
4.12	4.64	.52	**Oolites and sand**, medium to coarse, well rounded, massive, unconsolidated, 5Y7/2; basal contact very irregular; XRD of samples from 4.17 m and 4.57 m show (calcite ≈ gaylussite) > (halite ≈ aragonite).
4.64	4.72	.08	**Oolitic sand**, fine- to medium-sand sized, and darker silt to fine sand, as contorted irregular masses, unconsolidated, 5Y5/2 (sand) to 5YR5/2 or N5 (silt).
4.72	4.87	.15	**Oolitic sand**, very fine- to medium-sand sized, fairly well bedded, unconsolidated, 5Y4-5/2; a 3-cm bed of very-coarse-sand-sized oolites at 4.80 m; sharp basal contact.
4.87	4.90	.03	**Silt and oolitic sand**, fine to medium, massive, 5-10R2/2; gradational lower contact.
4.90	5.12	.22	**Oolites**, very-fine- to medium-sand sized, fairly well bedded, 5Y4-5/2; XRD of sample from 5.07 m shows (calcite) > (aragonite ≈ halite), but no gaylussite.

Table 3. Log of Core OL-92-3[1]

From (meters)	To (meters)	Unit thickness (meters)	Description
5.12	5.16	.04	**Oolite sand and silicate sand**, medium to very coarse, more indurated than material above and below, contrasting colors create contorted patterns, 5YR3/4, 5YR8/1, and 10Y4/2.
5.16	5.60	.44	**Clay-sized sediment**, 3% euhedral, bladed salt crystals[4], randomly distributed and oriented, massive, 5Y2/1.
5.60	5.64	.04	**Clay-sized sediment**, some silt and very fine sand, salt crystals not noted, fair bedding, 10Y3/2.
5.64	5.79	.15	**Clay-sized sediment**, 3% salt crystals, like those described above, faintly mottled, 5GY2/1; basal contact gradational.
5.79	6.07	.28	**Clay-sized sediment**, like unit above but virtually no salt crystals, basal contact gradational; a few salt crystals noted at 5.96 m.
6.07	6.16	.09	**Clay-sized sediment**, mottled, 5Y3/4.
6.16	6.36	.20	**Clay-sized sediment**, mottled, 5Y3-4/2, darker at base; basal contact undulates over 3-cm range.
6.36	6.75	.39	**Clay-sized sediment**, about 1% disseminated very-fine- to fine-sand grains that have a glassy-luster, 5Y4/2.
6.75	7.16	.41	**Clay-sized sediment**, disseminated grains of sand, like unit above, 5Y2-3/2.

BASE OF CORE OL-92-3

Footnotes for Core OL-92-3

1. All listed depths are converted to "drill-pad datum depths" which are 0.94 m above lake surface.

2. From 0.94 m to 3.52 m, core was recovered as cuttings or short segments that were logged but not saved; from 3.52 m to 7.16 m, core recovery was 100 percent, all of which was logged and archived.

3. X-ray diffraction and thin section study of oolite samples reveal a significant percentage of the saline mineral gaylussite ($Na_2CO_3 \cdot CaCO_3 \cdot 5H_2O$). In thin section, the outer edges of many oolites are coated with relatively large, high-birefringence crystals that we think are probably gaylussite; similar crystals are also found attached to cavities inside the oolites. We interpret this phase to be one that formed early in the 20th century, when the Owens River was diverted into the Los Angeles Aqueduct causing Owens Lake to desiccate, producing a brine that had a sufficiently high density to displace the original interstitial fluids and replace it with brines having the composition and salinity that would crystallize gaylussite.

4. At room temperature, these salt crystals dehydrated to white powder that XRD tests showed to be mostly thenardite (Na_2SO_4), but tests with acid show that they also contained some carbonate mineral; the "white powder" was probably a mixture derived from the dehydration of mirabilite ($Na_2SO_4 \cdot 10H_2O$) and natron ($Na_2CO_3 \cdot 10H_2O$) that crystallized from the interstitial brines after the cores were first brought to the surface and refrigerated.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Sediment Size Analyses of the Owens Lake Core

by

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Abstract

Sedimentary analyses of a 323-m core from Owens Lake, southeastern California, show variations on many different time scales. Grain size analysis was determined on point samples taken at 2 to 3 m intervals down the core. In addition, sand plus gravel, silt, and clay percentages were measured on 3.5-m-long channel samples to supplement point sample grain size data. The upper 195 m of sediment consist of interbedded fine silts and clays. The lower 128 m, however, comprise interbedded silts and fine sands. Fluctuations in mean grain size of sediments in the top 200 m of the core correlate well with variations in carbonate content of channel samples.

Introduction

Owens Lake is the first in a chain of lakes lying to the east of the Sierra Nevada. The lake, which lies at the southern end of the topographically closed Owens Valley, receives runoff primarily from the Sierra Nevada via the Owens River and its tributaries. During "pluvial" (high ratio of precipitation to evaporation) periods, Owens Lake exceeded the confines of the southern Owens Valley and spilled over a sill into the China and Searles Lake basins (Smith, 1984). During drier periods, the lake shrank and remained nearer to or at levels lower than the spillover sill. In this paper, we report results of grain size analyses conducted on sediments from a 323-m-long core of Owens Lake which reflect the variations in pluvial-interpluvial climate in the Sierra Nevada.

Sample Types

Two types of samples were taken from the Owens Lake core for sedimentary analyses. "Point samples," which represent about 2 to 3 cm of core length, were collected at the drill site at 1 to 2 m spacings down the core. These samples comprise about 60 g of bulk sediment and have been used to determine water content, pore water chemistry, organic carbon and carbonate content, and grain size; grain size is reported here. "Channel samples" were produced in the laboratory and represent integrated ribbons of sediment, each spanning 3.5 m of core and comprising about 50 g of sediment. Organic carbon/carbonate, grain size, clay mineralogy and bulk chemical analyses have been performed on these samples; grain size is reported here.

Methods

Grain Size Analysis--Point Samples

About 10 g of each point sample were placed in a beaker with 100 ml of deionized water. The samples were lightly disaggregated with a glass stirring rod. To remove carbonate and organic material, 150 ml of Morgan's solution (1 L solution of deionized water, acetic acid, and sodium acetate, containing 27 ml of glacial acetic acid buffered to pH 5 with 82 g of sodium acetate) and 20 ml of 30 wt.% H_2O_2 were added (Note: we have assumed that fine grained carbonates were chemically precipitated in the lake rather than detrital in nature. In order to assure complete disaggregation of detrital clastics, then, it was necessary to remove any binding cements). Morgan's solution was used in place of dilute HCl because it is considered less damaging to clay minerals (Mark Johnsson, personal communication), and the clay-sized fractions of some grain size samples were collected for X-ray diffraction analysis. Samples sat in this solution for two days and were stirred once every 8 to 12 hrs. Heating to 150 °C for 2 to 4 hours removed excess H_2O_2. Samples were centrifuged for 30 minutes at 5000 rpm and the supernate discarded. The remaining sediment was wet sieved to separate gravel, sand, and silt plus clay fractions. U.S. standard sieves of 20 and 230 mesh (equivalent to -1 and 4 Φ grain sizes) were used in the sieving process. The clay and silt fraction of each sample was collected in a 1000 ml graduated cylinder. Sands and gravels were poured into evaporating dishes and dried in an oven at 60 °C.

Dried gravels (-2 to -1 Φ) were weighed and then sieved at 0.5 Φ intervals to determine their grain size distributions. Sands (-1 to 4 Φ) were weighed and then split to arrive at 0.1 to 0.5 g representative subsamples. These subsamples were introduced into specially-constructed settling tubes owned by the U.S. Geological Survey Pacific Marine Geology Branch. Each settling tube consists of a 2 m long section of PVC pipe closed at one end and mounted vertically into a metal scaffold. The pipe is filled with water to a level resulting in a grain fall height of 205 cm. Near the base of each tube, a small plastic disk is suspended from a metal rod connected to a strain gauge. Sand grains are spread onto a wetted plate which is lowered into the PVC pipe, initiating settling. As settling proceeds, grains are deposited onto the plastic disk displacing the metal rod downward. The resulting strain gauge voltage signal is recorded on a chart recorder which plots voltage versus time. A suite of calibration standards allows the conversion of these voltages to grain sizes. Further descriptions of the settling tube can be found in Galehouse (1971), Cook (1969), and in Felix (1969). Sand grain sizes were determined at 0.5 Φ intervals by this method.

To prevent flocculation, 5 ml of 5% sodium hexa-metaphosphate ("calgon") dispersant solution were added to each clay and silt solution (<4 Φ) and the graduated cylinders filled to 1000 ml with deionized water. Each solution was agitated for two minutes, then allowed to settle for 20 seconds, after which 20 ml were removed with a pipette submerged to 20 cm depth (as described by Folk, 1968). To determine the weight of silt and clay in each sample, the 20 ml aliquot was placed in a previously weighed aluminum dish and allowed to dry for two days in an oven heated to 40 °C. After drying, the resulting mass value was multiplied by 50 to derive the total mass of silt and clay held in the graduated cylinder. Each solution was re-agitated for two minutes and another 20 ml sample drawn off after 20 seconds at 20 cm depth. The resulting aliquots were introduced into a Cimax Inc. Model TSS8005-H Hydrophotometer at the U.S. Geological Survey Pacific Marine Geology Branch.

The hydrophotometer uses both Stokes' Law of settling and the Beer-Lambert Law to calculate grain sizes of sediments in suspension. The instrument consists of a series of 12-cm-long tubes bored into a transparent slab of plexiglass. The tubes have windows near their bases on each side of the slab. Suspended sediment is introduced into each cell until all are filled to a known height (we used a grain-fall height of 8 cm). A light beam is shined through the windows of each tube into a detector on the other side of the plexiglass slab, and the light transmittance through the suspended sediment is calculated by a microprocessor. Light transmission is measured at specified time intervals determined by Stokes' Law which states that:

$$V = \frac{g(\Delta p)\, d^2}{18n}$$

where d is the particle diameter, g is the acceleration due to gravity, Δp is the difference in density between a sedimentary grain and the liquid in which it is suspended, n is the viscosity of the liquid, and V is the velocity at which the grain is falling (Jordan, Fryer and Hemmen, 1971). Given that the fall height of the grains is known, the settling time can be calculated by dividing the fall height by the velocity at which the grain is settling. In this way, the hydrophotometer can measure light transmittance at those times when each successive grain size class has fully settled out of suspension. Conversion of light transmittance values to weight percents of individual grain size classes results from the Beer-Lambert Law:

$$\ln\frac{I_0}{I_n} = \alpha c L \sum_{d_0}^{d_1} K_x\, N_x dx^2$$

where I_0 is the intensity of the beam emanating from the light source, I_n is the intensity of the beam transmitted through the sample cell and hitting the detector, α is a constant related to grain shape, c is the concentration of particles of size dx in grams per cubic centimeter, L is the length that the light beam traverses through the sample cell, K_x is an empirically derived constant dependent on grain size, and N_x is the number of particles, per gram of sample, of size dx (Jordan, Fryer and Hemmen, 1971; and Simmons, 1959). Using this technique, grain sizes were determined at 0.5 Φ intervals. For a further explanation of hydrophotometers and the theory behind them, see Jordan, Fryer and Hemmen (1971), and Simmons (1959). Because of the rather lengthy nature of grain size analyses, only a few replicate measurements have been produced as of yet. These analyses indicate an average precision of about +/- 0.25 Φ. Torresan (1987) has determined a precision of about +/- 0.5 Φ for the hydrophotometer used in these analyses.

Grain Size Analysis--SDSZ program

The U.S. Geological Survey computer program SDSZ, written by Graig McHendrie, welds the sieve, hydrophotometer and settling tube data sets into one cumulative grain size curve on which the program calculates statistical parameters such as mean and median grain size, sorting, skewness, and kurtosis. The information necessary to construct the cumulative curve consists of the weight fraction of each grain size class, i.e. the weights of gravel, sand, and silt plus clay in each sample, and the size distribution of each grain size class (as determined by sieving, settling tube or hydrophotometer). The program employs the graphical statistic equations developed by Folk and Ward (1957), Inman (1962), and Trask (1930) and was used to analyze the Owens Lake core point-sample grain size data. The statistical equations used by the program follow:

Folk and Ward (1957) statistics:

$$\text{Mean} = \frac{\phi_{16} + \phi_{50} + \phi_{84}}{3}$$

$$\text{Median} = \phi_{50}$$

$$\text{Sorting} = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_{05}}{6.6}$$

$$\text{Skewness} = \frac{\phi_{16} + \phi_{84} - (2*\phi_{50})}{2*(\phi_{84} - \phi_{16})} + \frac{\phi_{05} + \phi_{95} - (2*\phi_{50})}{2*(\phi_{95} - \phi_{05})}$$

$$\text{Kurtosis} = \frac{\phi_{95} - \phi_{05}}{2.44*(\phi_{75} - \phi_{25})}$$

where Φ_{16} refers to the Φ grain size at the sixteenth percentile on the cumulative grain size curve, etc., and * symbolizes multiplication.

Inman (1962) statistics

$$\text{Mean} = \frac{\phi_{16} + \phi_{84}}{2}$$

$$\text{Median} = \phi_{50}$$

$$\text{Sorting} = \frac{\phi_{84} - \phi_{16}}{2}$$

$$\text{Skewness}_1 = \frac{\text{Mean - Median}}{\text{Sorting}}$$

$$\text{Skewness}_2 = \frac{\frac{\phi_{05} + \phi_{95}}{2} - \text{Median}}{\text{Sorting}}$$

$$\text{Kurtosis} = \frac{\frac{\phi_{95} - \phi_{05}}{2} - \text{Sorting}}{\text{Sorting}}$$

Trask (1930) statistics

$$\text{Mean} = \frac{mm_{25} + mm_{75}}{2}$$

$$\text{Median} = mm_{50}$$

$$\text{Sorting} = \sqrt{\frac{mm_{25}}{mm_{75}}}$$

$$\text{Skewness} = \frac{mm_{25} * mm_{75}}{\text{Median}^2}$$

$$\text{Kurtosis} = \frac{mm_{75} - mm_{25}}{2*(\ mm_{90} - mm_{10})}$$

In plotting our data (see results section), we have chosen to use the Folk and Ward (1957) statistics because they take the "tails" of the grain size distribution into account (however, we have converted the Φ units they use into µm). According to these workers, sorting values from 1.00 to 2.00 Φ units are classified as poorly sorted. Skewness values between -0.10 and +0.10 are defined as symmetrical while skewness values between +0.10 and +0.30 are positively skewed. A positive skewness implies that samples are weighted toward fine grains while negative skewness implies a weighting toward coarse grains. Kurtosis is a ratio of the degree of sorting of the central part of a grain size distribution to the sorting of the extreme ends of the distribution and can also be thought of as the "peakedness" of a grain size distribution. Values of 1.11-1.50 are classified as "leptokurtic" meaning the central part of the distribution is better sorted than the ends. Values between 1.50 and 3.00 are considered "very leptokurtic" implying that the central part of the distribution is extremely well sorted compared to the ends.

Sand, Silt and Clay Contents--Channel Samples

Sand plus gravel, silt, and clay contents were determined on ninety-one 3.5 m long channel samples. Ten-gram splits were subjected to the same chemical treatments used on the point samples. Sand and gravel were separated from silt and clay by wet sieving with a sieve of U.S. standard mesh size 20 (-1 Φ). The sands and gravels were collected together in evaporating dishes and weighed after drying. Silts and clays were collected in 1000 ml graduated cylinders. A scaled-down pipette analysis was used to determine concentrations of coarse silt, fine silt and clay in each sample (Galehouse, 1971): twenty milliliter aliquots were removed at various time intervals based on the grain size of interest and the temperature of the solution. These aliquots were dried and weighed and their weights multiplied by 50 to estimate the weight of sample in each size fraction.

Results

Grain-size analysis of point samples defines two distinct depositional regimes (figure 1). With the exception of a coarse grained oolite layer at the top of the core, mean grain size fluctuates between 5 and 15 µm (clay- to silt-sized material) between 7 and 195 m in depth. In contrast, between 195 m and the base of the core at 323 m, mean grain size fluctuates between 10 µm (medium fine silt) and 50-100 µm (coarse silt to fine sand). Sand plus gravel, silt, and clay contents (measured as weight percents) of 3.5 m long channel samples broadly mimic the point sample trends, with fine silts and clays predominating from the top of the core to 190 m depth and then changing to coarser grained material between 190 and 323 m depth (figure 2). Clay content (figure 3) of the channel samples varies widely from less than 10 weight percent to nearly 80 weight percent. A closer look at the top 200 m of the core reveals periodicity in mean grain size with depth in the point sample record (figure 4). Comparison of the mean grain size versus depth curve to the channel sample carbonate content versus depth curve reveals great similarities in trends (figure 5). For example, lows in carbonate content are matched with very fine mean grain sizes, while highs in carbonate content correspond to coarser grain sizes.

Table 1 lists mean grain size, sorting, skewness, and kurtosis for the top 195 m of the core (excluding the very coarse oolite layer at the top) and the bottom 128 m of the core. The difference in depositional style between these two core sections is evident in the mean grain size and skewness parameters, while the sorting and kurtosis are much the same in the two sections.

Table 1: Grain size parameters for the top 195 m of the core and the bottom 128 m (Folk and Ward, 1957, statistical parameters).

Statistical Parameter	top 195 m	bottom 128 m
mean grain size (Φ)	7.40 +/- 0.79	5.73 +/- 1.56
mean sorting (Φ)	1.80 +/- 0.43	1.90 +/- 0.52
mean skewness	0.16 +/- 0.14	0.04 +/- 0.25
mean kurtosis	1.53 +/- 0.39	1.41 +/- 0.60

In the Owens Lake core, all sediments fall into the poorly sorted category whether they are the fine grained sediments in the top of the core or the coarser grained sediments of the lower core. Those sediments in the top 195 m of the core are positively skewed implying a weighting toward fine grains. Sediments in the bottom 128 m show a basically normal grain size distribution. Both sections of the core are leptokurtic.

Discussion

A particularly striking feature in the Owens Lake core is the change from sediments composed largely of interbedded sands and silts in the lower third of the core to sediments consisting primarily of silt and clay in the upper two-thirds. It is possible that the lower, sandy section of the core represents a shallow lake present in a drier climate. On the other hand, it is also possible that the change in depositional style at 195 m occurred as the result of tectonic factors, namely valley deepening or uplift of the spillover sill with respect to the surface of the lake, rather than from climate change. At this point, we do not have enough information to determine the nature of the depositional change. Grain size statistics collected to date show little difference between the sediments from 0 to 195 m and those from 195 to 323 m.

Like the channel- and point-sample carbonate records, the mean grain size record in the top 200 m of the core exhibits oscillation in deposition. Mean grain size may reflect variations in lake level, with coarse-grained materials deposited during times of lake lowstands, when the shore of Owens Lake more closely approached our core site, and fine-grained sediments deposited during highstands, when the shoreline was at a greater distance from the core site.

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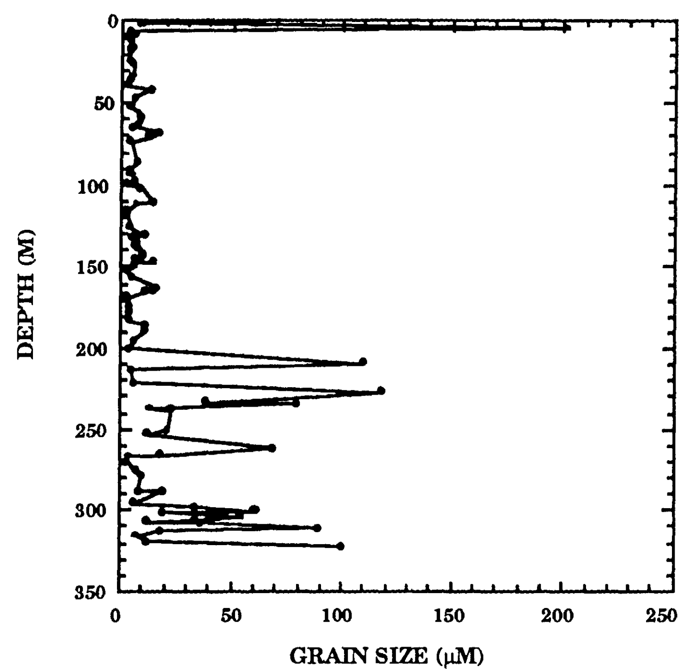

Figure 1- Mean grain size of point samples (in micrometers) versus depth (in meters). Note the change in depositional style at 195 m from interbedded silts and clays at the top of the core to interbedded sands and silts at the base. Mean grain size was calculated using Folk and Ward's (1957) statistics and then converted to μm.

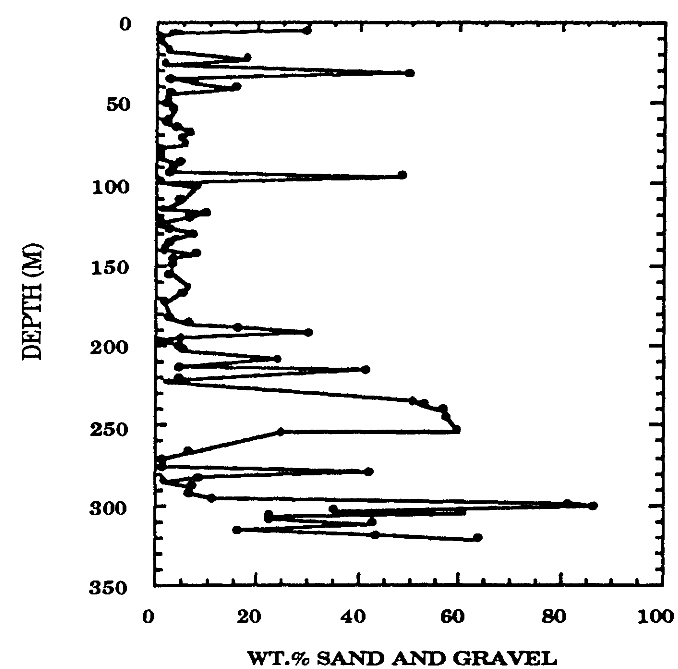

Figure 2 - Sand plus gravel content of channel samples (in weight percent) versus depth (in meters). Note the change in depositional style at 190 m depth from samples with little sand and gravel at the top of the core to samples with high quantities of sand and gravel at the base of the core.

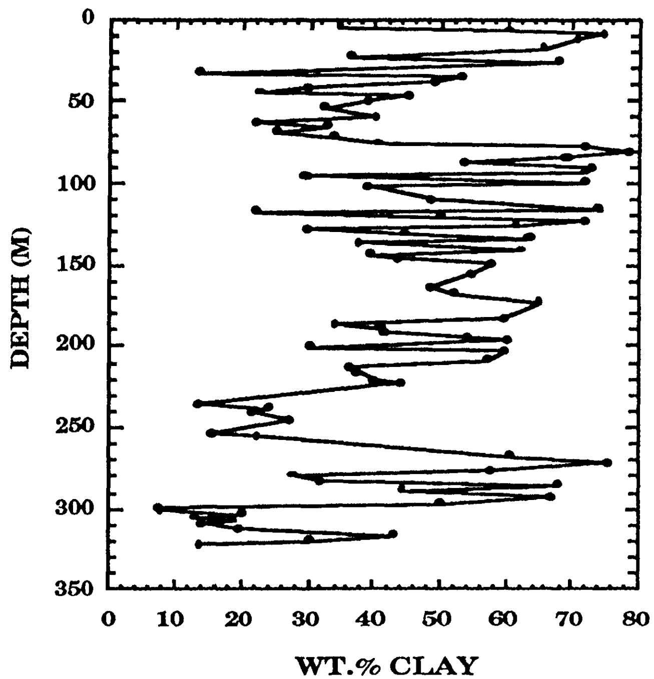

Figure 3 - Clay content (in weight percent) versus depth (in meters). Note the great variability.

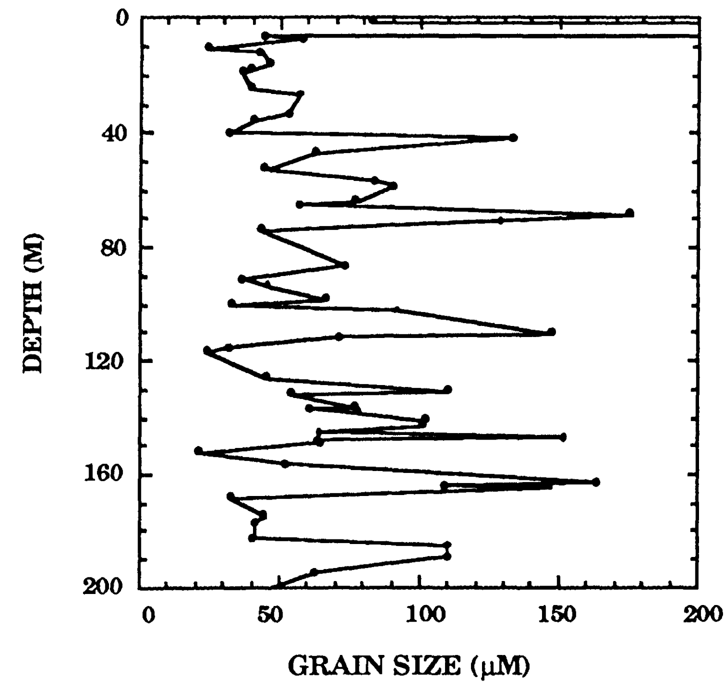

Figure 4 - Closer look at the top two hundred meters of the core. Plotted is mean grain size (in µm) versus depth (in m). Note the apparent periodicity in deposition.

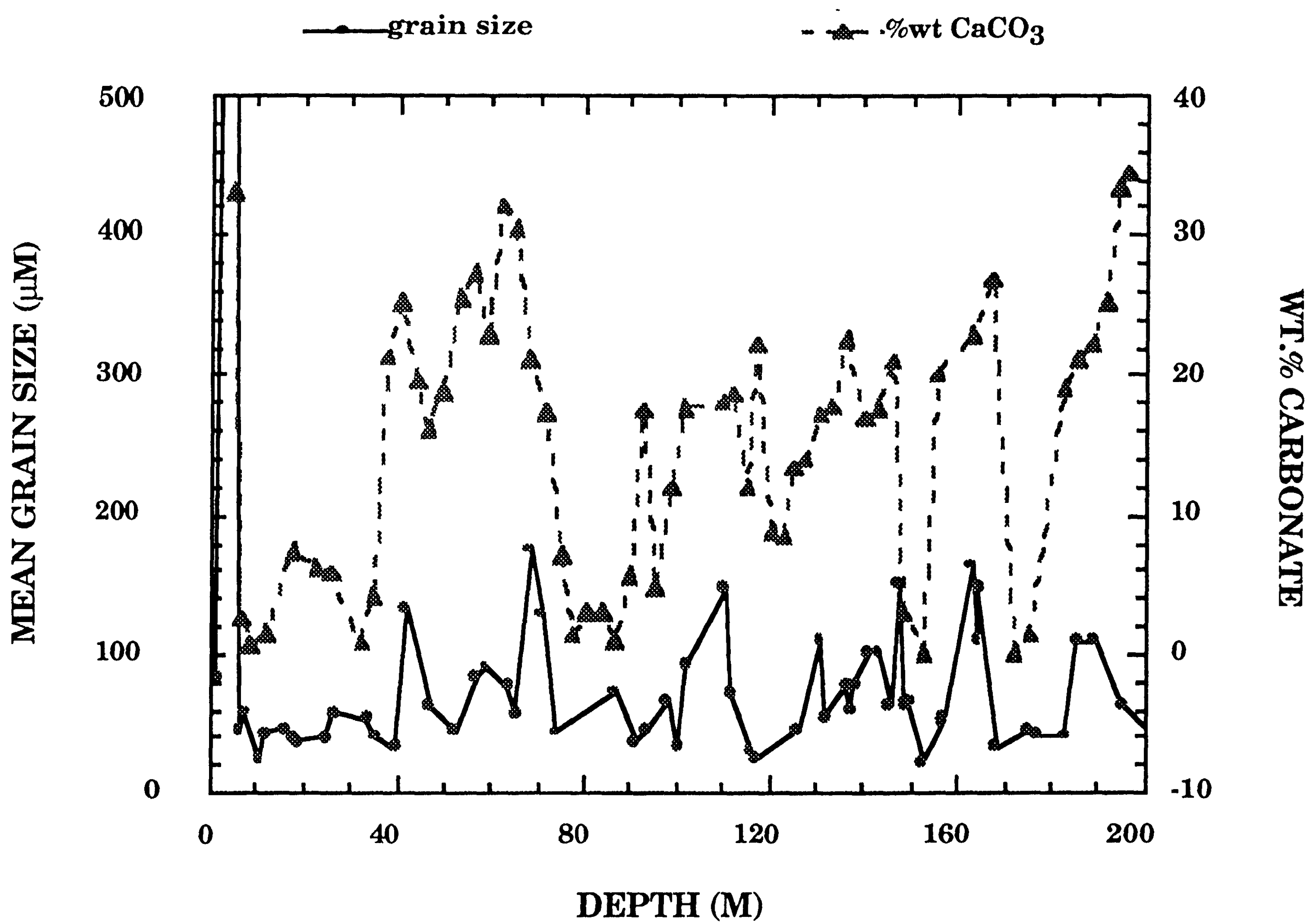

Figure 5 - Mean grain size (in μm) and carbonate content (in wt.%) versus depth, top 200 meters. Note the close correspondence between the two curves--mean grain size is coarsest when carbonate content is highest. Conversely, mean grain size is finest during periods of little or no carbonate deposition.

Appendix

Table 1 - Raw point sample grain size data in the format accepted by the program SDSZ. The first four columns, -2.0 Φ through -0.5 Φ, are gravel weights in grams. The next twelve columns, -1.0 Φ through 4.5 Φ, are cumulative percentages of sands measured with a settling tube. The remaining 11 columns, 4.5 Φ through 14 Φ, are light transmission values determined by hydrophotometer on silt and clay samples. Some overlaps in grain size between different methods exists resulting in the two values each for -1.0 Φ, -0.5 Φ, and 4.5 Φ.

sample #	-2.0 Φ	-1.5 Φ	-1.0 Φ	-0.5 Φ	-1.0 Φ	-0.5 Φ	0 Φ	0.5 Φ	1.0 Φ	1.5 Φ	2.0 Φ	2.5 Φ	3.0 Φ	3.5 Φ	4.0 Φ	4.5 Φ	4.5 Φ	5.0 Φ	5.5 Φ	6.0 Φ	6.5 Φ	7.0 Φ	7.5 Φ	8.0 Φ	8.5 Φ	9.0 Φ	14.0 Φ
463	0	0	0	0	0	0	0	0	0	9	20	27	38	67	96	100	1.89	2.14	5.6	14.82	17.09	12.69	16.37	9.49	6.17	6.29	7.45
466	0.08	0	0.05	0.05	0	0	0	11	27	55	67	78	83	91	99	100	17.72	16.34	10.65	9.75	8.5	7.48	8.89	6.34	5.79	4.95	3.59
200	0	0	0	0	0	0	0	0	0	0	4	9	16	53	94	100	3.46	2.4	1.16	0.58	0.21	10.98	28.36	10.03	14.85	11.85	16.12
201	0	0	0	0	0	0	0	0	0	0	0	0	0	37	95	100	4.6	3.09	1.11	0.28	9.32	15.88	16.47	17.58	9.58	9.24	12.85
204	0	0	0	0	0	0	0	0	0	1	4	14	37	62	91	100	6.28	3.93	1.61	2.14	1.43	1.01	1.34	16.25	15.19	17.9	32.92
205	0	0	0	0	0	0	0	0	0	0	0	40	62	80	100	100	2.48	2.04	0.15	0.25	2.67	13.98	23.87	13.08	11.02	14.42	16.04
208	0	0	0	0	0	0	0	0	0	0	0	5	16	47	91	100	3.13	1.49	0.97	0	0.28	13.98	23.33	17.05	11.63	14.17	13.97
211	0	0	0	0	0	0	0	0	2	4	8	11	22	63	95	100	4.86	0.97	1.41	0.67	0.7	8.020	21.29	13.74	10.56	18.24	19.54
213	0	0	0	0	0	0	0	0	0	0	0	4	21	61	95	100	3.18	1.56	1.09	0.69	0.47	10.35	14.16	20.46	13.75	14.01	20.28
216	0	0	0	0	0	0	0	0	1	3	7	13	34	75	96	100	3.75	2.33	2.01	0.45	0.59	9.5	20.98	9.55	12.32	13.79	24.73
218	0	0	0	0	0	0	0	0	0	6	11	16	24	54	76	100	2.64	0.87	0.75	0.47	7.37	17.94	25.63	12.21	11.36	8.98	11.78
221	0	0	0	0	0	0	20	23	26	26	30	42	58	74	90	100	2.74	1.61	0.45	0.69	5.4	15.3	25.43	11.22	13.29	11.76	12.11
223	0	0	0	0	0	0	0	0	1	4	7	12	37	71	98	100	6.17	2.44	0.64	0.41	7.18	10.09	17.81	8.48	12.63	11.62	22.53
226	0	0	0	0	0	0	0	0	0	2	9	26	52	90	100	100	4.76	2.8	3.92	1.76	9.23	5.9	12.08	9.86	10.75	12.23	26.71
228	0	0	0	0	0	0	0	0	0	0	0	0	8	25	64	100	1.72	9.51	20.63	18.29	12.9	9.4	8.27	5.75	4.94	3.79	4.8
231	0	0	0	0	0	0	0	0	3	7	13	26	43	73	91	100	1.18	0.89	0.33	0.56	14.88	20.47	23.51	15.77	7.86	7.67	6.88
233	0	0	0	0	0	0	0	0	0	0	0	7	18	49	78	100	1.93	2.3	0.84	0.83	6.64	11.71	18.73	16.41	12.13	11.87	16.61
236	0	0	0	0	0	0	0	0	0	0	0	3	17	51	92	100	1.17	0.66	7.55	16.08	17.14	14.67	12.47	9.6	6.44	7.05	7.17
238	0	0	0	0	0	0	0	0	0	1	3	9	25	50	84	100	2.38	1.61	1.06	12.3	11.94	22.85	31.61	6.72	3.37	2.79	3.37
243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.82	1.07	1.27	14.28	19.25	15	18.46	10.01	6.530	5.790	6.520
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.78	1.26	0.61	0.38	9.12	22.86	22.36	12.54	9.46	9.65	7.98
248	0	0	0	0	0	0	0	0	0	0	0	0	7	30	84	100	5.25	19.43	21.75	13.89	11.38	7.02	5.96	5.12	3.04	3.25	3.91
250	0	0	0	0	0	0	0	0	0	0	0	0	4	51	96	100	0.75	9.56	21.15	17.47	12.88	9.63	9.43	7.35	3.72	4.2	3.86
253	0	0	0	0	0	0	0	0	0	1	3	12	28	67	98	100	3.17	0.92	0.17	1.01	3.64	13.13	14.44	20.08	12.9	14.64	15.9
260	0	0	0	0	0	0	3	5	8	9	14	26	41	63	95	100	2.66	1.57	5.47	8.78	10.93	12.83	15.87	9.2	10.78	11.55	10.36
263	0	0	0	0	0	0	0	0	0	0	0	10	31	63	90	100	9.42	5.45	2.11	1.06	0.72	3.02	9.82	10.36	8.39	17.44	32.21
265	0	0	0	0	0	0	6	7	11	18	22	29	45	76	95	100	2.07	2.24	0.82	0.8	0.58	8.93	27.18	16.67	14.35	11.69	14.67
268	0	0	0	0	0	0	0	0	0	1	5	18	40	67	92	100	31.96	0.57	0.8	6.24	6.12	8.73	8.76	10.28	7.4	5.91	13.23
270	0	0	0	0	0	0	0	0	0	0	0	0	23	63	93	100	8.09	1.96	2.59	3.26	5.25	7.14	5.22	12.45	10.26	13.67	30.11
273	0	0	0	0	0	0	0	0	1.5	4	11	24	41	63	90	100	3.33	3.88	16.77	14.98	9.9	11.55	7.27	7.14	8.45	8.58	8.15
278	0	0	0	0	0	0	0	0	0	0	0	0	0	20	69	100	4.03	12.69	11.65	18.37	9.92	11.15	12.23	4.35	5.89	5.26	4.46
278	0	0	0	0	0	0	0	0	0	0	0	0	0	20	69	100	4.03	12.69	11.65	11.34	7.37	7.88	5.02	4.65	3.56	2.71	3.89
280	0	0	0	0	0	0	0	0	4	9	12	22	43	72	91	100	2.92	0.31	2.91	13.64	9.91	11.44	14.6	17.34	8.23	10.09	8.61
283	0	0	0	0	0	0	0	0	1	3	12	23	53	80	98	100	9.89	4.45	3.19	1.42	1.25	0.98	2.64	12.8	10.14	16.17	37.07
285	0	0	0	0	0	0	0	0	0	0	0	10	31	62	93	100	4.64	2.12	1.49	0.96	1.27	1.64	10.56	17.66	13.27	15.6	30.79
285	0	0	0	0	0	0	0	0	0	0	3	15	27	60	93	100	4.64	2.12	1.49	0.96	1.27	1.64	10.56	17.66	13.27	15.6	30.79
293	0	0	0	0	0	0	0	5	11	16	20	26	37	58	92	100	3.44	1.91	0.92	0.25	1.29	16.12	18.07	19.46	10.37	11.66	16.51
298	0	0	0	0	0	0	0	0	5	7	10	16	35	70	92	100	2.45	6.01	15.19	18.44	11.83	8.02	12.85	8.41	4.65	6.78	5.37
300	0	0	0	0	0	0	0	0	0	1	3	8	24	56	89	100	3.15	2.37	0.88	0.57	0.68	5.67	15.78	10.16	15.32	13.79	31.63
305	0	0	0	0	0	0	0	0	0	0	2	10	28	50	90	100	1.96	1.56	0.52	12.19	20.13	17.73	18.45	7.63	5	6.95	7.88
308	0	0	0.01	0	0	0	0	7	8	14	18	28	43	65	92	100	1.37	0.86	0.62	4.16	17.95	16.01	17.57	11.15	9.07	8.61	12.63
310	0	0	0	0	0	0	0	0	1	2	4	11	25	54	92	100	2.16	2.68	10.8	10.41	9.8	12.11	16.63	8.69	7.52	7.14	12.06
313	0	0	0	0	0	0	0	0	6	13	18	26	36	66	87	100	2.88	1.23	12.27	7.16	15.92	26.93	12.01	7.31	2.21	4.49	7.59
315	0	0	0	0	0	0	0	0	0	0	15	8	27	75	96	100	1	0.81	14.31	11.77	12.55	15.73	15.16	9.44	6.42	6.1	6.71
318	0	0	0	0	0	0	0	0	0	0	0	2	19	44	84	100	1.79	1.47	0.5	0.8	16.15	20.28	21.19	17.12	5.9	5.25	9.55
320	0	0	0	0	0	0	0	0	0	0	2	8	23	53	92	100	2.48	15.89	17.46	15.65	12.95	11.03	8.6	5.25	3.66	4.12	2.91
322	0	0	0	0	0	0	0	0	0	0	3	16	38	75	96	100	2.15	1.77	1.25	11.39	10.52	12.57	12.95	13.67	10.13	9.44	14.16
323	0	0	0.162	0	0.5	1	1.5	6	9	18	31	48	63	75	91	100	2.15	3.16	·1.01	8.85	12.26	19.84	22.91	5.03	1.96	8.07	14.76
325	0	0	0	0	0	0	0	0	5	8	17	27	45	79	100	0	5.91	3.16	1.06	1.41	0.62	1.77	14.72	12.23	7.4	21.22	30.5
325	0	0	0	0	0	0	0	0	3	10	16	29	51	78	100	0	3.42	4.08	1.23	0.45	0.72	0.48	13.64	14.82	8.25	20.44	32.47
328	0	0	0	0	0	0	0	11	15	17	19	28	43	66	98	100	2.13	1.56	0.86	0.62	12.37	10.58	16.65	13.14	15.81	12.14	14.14
328	0	0	0	0	0	0	0	0	0.5	3	7	16	33	56	88	100	2.13	1.56	0.86	0.62	12.37	10.58	16.65	13.14	15.81	12.14	14.14
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13.4	19.69	15.2	9.81	9.46	7.27	7.75	5.13	4.39	4.91	2.99
332	0	0	0	0	0	0	0	1	3	6	11	23	42	68	93	100	2.07	0.48	19.91	14.99	12.79	12.58	14.62	7.81	4.89	3.81	6.05
333	0	0	0	0	0	0	0	2	2	5	9	21	41	59	92	100	10.4	12.06	12.75	9.17	10.47	8.15	14.08	5.56	5.89	5.33	6.14
335	0	0	0	0	0	0	0	0	15	25	41	50	66	86	98	100	6.48	3.42	1.98	0.81	6.66	9.5	13.29	10.58	13.84	5.45	27.99
338	0	0	0	0	0	0	4	16	31	41	47	54	65	78	97	100	6.86	1.24	0.45	0.31	1.25	27.87	11.1	14.54	6.28	11.37	18.73
340	0	0.04	0	0	0	1	6	11	16	29	39	51	64	80	97	100	7.58	2.41	0.97	4.57	2.55	12.42	10.07	14.84	3.45	16.36	24.78
343	0	0	0	0	0	0	0	5	8	11	16	23	33	49	84	100	3.39	2.11	1.54	0.95	2.14	16.8	18.72	12.14	8.89	14.22	19.1
345	0	0	0.028	0	0	0	0	0	2	2	3	5	10	37	83	100	0.7	5.21	10.25	17.18	14.35	10.1	17.96	6.54	6.94	3.4	7.37
348	0	0	0.034	0.008	0	0	0	2	6	13	24	38	54	67	83	100	8.17	7.87	13.69	14.58	6.21	9.62	8.81	6.31	7.69	8.08	8.97

Table 1 - Raw point sample grain size data in the format accepted by the program SDSZ. The first four columns, -2.0 Φ through -0.5 Φ, are gravel weights in grams. The next twelve columns, -1.0 Φ through 4.5 Φ, are cumulative percentages of sands measured with a settling tube. The remaining 11 columns, 4.5 Φ through 14 Φ, are light transmission values determined by hydrophotometer on silt and clay samples. Some overlaps in grain size between different methods exists resulting in the two values each for -1.0 Φ, -0.5 Φ, and 4.5 Φ.

sample #	-2.0 Φ	-1.5 Φ	-1.0 Φ	-0.5 Φ	-1.0 Φ	-0.5 Φ	0 Φ	0.5 Φ	1.0 Φ	1.5 Φ	2.0 Φ	2.5 Φ	3.0 Φ	3.5 Φ	4.0 Φ	4.5 Φ	4.5 Φ	5.0 Φ	5.5 Φ	6.0 Φ	6.5 Φ	7.0 Φ	7.5 Φ	8.0 Φ	8.5 Φ	9.0 Φ	14.0
353	0	0	0	0	0	0	0	3	9	14	19	24	32	51	83	100	3.35	1.4	0.67	0.47	10.13	16.27	31.01	8.94	10.05	7.08	10.63
358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.1	2.09	0.37	0.57	0.4	14.64	16.58	20.11	14.3	11.89	14.95
358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.37	1.9	0.91	0.25	0.42	13.29	16.72	21.86	16.4	13.58	14.3
363	0	0	0	0	0	0	0	6	9	12	15	18	26	63	97	100	3.81	2.39	1.88	0.29	0.92	14.83	19.1	15.35	12.75	8.44	20.24
365	0	0	0	0	0	0	0	2	5	11	23	47	73	94	100	0	6.8	2.83	1.37	0.84	0.61	1.67	12.21	10.05	19.67	15.58	28.73
370	0	0	0.019	0	0	0	0	6	16	27	34	42	50	62	87	100	1.56	1.81	1.33	0.83	1.16	32.63	32.08	8.36	3.55	6.66	10.03
375	0.132	0	0	0	0	0	8	19	28	40	53	66	76	91	99	100	16.23	19.02	15.83	12.45	7.38	6.25	8.57	4.87	2.98	3.53	2.89
378	0	0	0	0	0	0	0	0	1	8	23	45	61	80	94	100	8.47	19.26	22.22	14.59	9.18	6.28	10.22	2.42	3.35	1.53	2.48
380	0	0	0	0	0	0	0	1	4	15	27	39	53	83	95	100	21.59	25.52	16.06	12.17	7.46	5.03	6.98	1.62	1.69	0.92	0.96
383	0	0	0	0	0	0	0	0	0	1	3	9	22	62	88	100	14.36	8.1	14.36	8.04	9.75	10.43	12.48	7.91	6.81	4.18	3.58
385	0	0	0.049	0.026	0	0	5	10	15	22	33	50	71	91	100	0	2.38	4.05	11.76	12.06	8.87	10.82	19.13	8.24	9.44	7.95	5.3
392	0	0	0.027	0	0	0	0	0	0	0	13	32	56	80	97	100	0.27	1.35	8.05	10.12	12.65	24.09	16.94	6.91	4.32	6.73	8.57
395	0	0.034	0	0	0	0	0	0	1	5	17	34	54	78	96	100	3.91	1.16	0.95	0.85	12.11	16.93	13.35	13.75	11.19	11.91	13.89
398	0	0	0.01	0	0	0	0	0	1	3	9	23	48	82	95	100	12.19	24.3	15.77	13.85	8.42	6.9	9.08	3.19	1.96	2.3	2.04
400	0	0	0	0	0	0	0	0	3	8	15	24	36	66	96	100	0.72	9.79	13.52	18.09	13.27	17.71	13.71	3.91	2.53	2.58	4.17
402	0	0	0	0	0	0	0	3	11	22	33	46	60	78	95	100	10.07	3.16	1.06	0.39	0.95	7.82	14.74	15.81	4.6	13.81	27.59
405	0	0	0	0	0	0	0	1.5	11	21	26	34	48	72	92	100	6.41	2.59	2.46	0.86	0.86	9.76	14.28	11.09	10.38	15.4	25.91
407	0	0	0.021	0	0	0	3	15	27	33	37	42	50	72	95	100	0.5	1.68	1.88	14.03	10.95	17.88	22.24	7.99	5.82	6.97	10.06
409	0	0	0	0	0	0	0	0	1	4	7	17	41	76	94	100	0.33	1.7	0.82	0.44	15.96	15.38	17.09	15.83	10.17	9.79	12.49
418	0	0	0	0	0	0	0	0	0	0	1.5	17	67	89	99	100	6.6	1.2	0.43	0.3	0.88	5.71	23.08	17.08	12.84	14.99	16.89
419	0	0	0	0	0	0	0	0	1	2	3	4	29	69	91	100	11.14	1.05	2.72	15.32	10.6	9.7	16.26	9.85	5.17	10.25	7.94
423	0	0	0	0.012	0	0	0	0	22	25	32	54	68	84	96	100	1.25	1.05	0.5	2.24	13.17	17.23	23.98	15.31	5.91	9.04	10.32
426	0	0	0.013	0	0	0	0	1	5	6	7	11	34	73	96	100	29.33	12.51	7.05	9.22	5.09	8.39	7.72	6.68	3.32	4.29	6.4
430	0	0	0	0	0	0	0	0	0	0	5	19	45	81	99	100	12.49	14.02	19.59	13.72	12.2	8.08	6.81	5.6	2.9	2.65	1.94
431	0	0	0	0	0	0	0	0	1.5	2	4	12	34	71	93	100	4.62	14.63	12.97	10.27	11.25	10.62	16.29	6.88	3.82	2.91	5.74
436	0	0	0	0	0	0	0	0	0	0	1	8	25	63	93	100	20.77	28.58	15.07	11.11	7.42	4.95	4.82	3.63	1.6	1.32	0.73
438	0	0.06	0.04	0.03	0	0	0	3	5	8	13	25	35	49	73	100	11.84	30.3	17.74	14.48	8.27	5.74	4.79	2.98	1.73	1.36	0.77
441	0	0	0	0	0	0	0	0	9	9	13	22	39	77	100	0	3.53	9.59	9.11	13.66	15.51	17.16	14.59	7.24	5.11	2.47	2.03
443	0.084	0.018	0.034	0.051	0	0	0	2	5	7	14	24	39	62	95	100	23.63	25.57	16.78	11.75	6.94	5.23	4.48	2.95	1.19	0.96	0.52
446	0	0	0.02	0	0	0	0	0	0.5	1	1	8	57	85	97	100	6.06	25.91	16.28	10.94	9.91	8.69	7.66	5.85	2.77	3.49	2.44
448	0	0	0.019	0.007	0	0	0	4	14	23	34	48	63	86	98	100	5.78	21.4	20.16	16.82	10.6	7.89	6.02	5.42	2.16	2.18	1.57
451	0	0	0.032	0.006	7	7	11.5	12	14	16	16	18	29	66	94	100	1.65	4.66	19.1	15.83	10.92	10.9	14.66	4.57	3.98	7.1	6.63
453	0	0	0	0	0	0	0	8	14	16	16	20	28	55	94	100	2.02	2.13	4	15.05	14.33	15.15	15.64	9.53	7.26	7.81	7.08
458	0	0.075	0.137	0.016	0	0	0	11	27	55	67	78	83	91	99	100	3.29	0.58	0.14	0.24	5.67	17.22	16.11	20.37	9.63	11.53	15.22
462	0	0	0.037	0	0	0	0	3	7	14	23	45	68	92	100	0	8.89	25.82	18.93	13.05	8.57	7.57	7.51	3.87	2.02	2.36	1.41

Table 2 - Mass of gravel, sand, and silt plus clay used in each point sample grain size analysis.

sample #	depth (m)	wt. gravel (g)	wt. sand (g)	wt. silt + clay (g)	total mass	wt.% gravel	wt.% sand	wt.% silt + clay
463	0.7	0	0.21	6.8	7.01	0	2.9957	97.004
466	3.15	0.18	5.78	1.4187	7.3787	2.4395	78.334	19.227
200	6.09	0	0.11	6.5	6.61	0	1.6641	98.336
201	7.48	0	0.23	6.1	6.33	0	3.6335	96.367
204	10.49	0	0.04	8.1	8.14	0	0.4914	99.509
205	11.92	0	0.09	4.9	4.99	0	1.8036	98.196
208	16.06	0	0.07	4.62	4.69	0	1.4925	98.507
211	17.94	0	0.34	6.5	6.84	0	4.9708	95.029
213	18.7	0	0.16	5.3	5.46	0	2.9304	97.07
216	24.61	0	0.56	6.5	7.06	0	7.932	92.068
218	26.46	0	0.3	7.3	7.6	0	3.9474	96.053
221	33.59	0	0.24	8.9	9.14	0	2.6258	97.374
223	35.56	0	0.14	4.9	5.04	0	2.7778	97.222
226	39.85	0	0.09	5.7	5.79	0	1.5544	98.446
228	41.72	0	0.23	5.3	5.53	0	4.1591	95.841
231	46.99	0	0.14	5.7	5.84	0	2.3973	97.603
233	52.37	0	0.05	5.6	5.65	0	0.88496	99.115
236	56.65	0	0.15	5.3	5.45	0	2.7523	97.248
238	58.8	0	0.15	7.447	7.597	0	1.9745	98.026
243	63.48	0	0.03	4.9	4.93	0	0.60852	99.391
245	65.23	0	0	6.44	6.44	0	0	100
248	68.35	0	0.44	5.7	6.14	0	7.1661	92.834
250	70.78	0	0.05	8	8.05	0	0.62112	99.379
253	73.79	0	0.18	6.1	6.28	0	2.8662	97.134
260	86.61	0	0.68	7.825	8.505	0	7.9953	92.005
263	91.26	0	0.12	7.3	7.42	0	1.6173	98.383
265	93.78	0	0.25	6.1	6.35	0	3.937	96.063
268	98.18	0	0.13	8.1	8.23	0	1.5796	98.42
270	100.18	0	0.08	7.2	7.28	0	1.0989	98.901
273	102.18	0	0.26	6.8593	7.1193	0	3.652	96.348
278	110.4	0	0.07	6.9	6.97	0	1.0043	98.996
280	111.65	0	0.42	4.6	5.02	0	8.3665	91.633
283	115.78	0	0.03	7.3	7.33	0	0.40928	99.591
285	117	0	0.22	6.4	6.62	0	3.3233	96.677
293	126.22	0	0.2	7.2	7.4	0	2.7027	97.297
298	130.78	0	0.16	5.8	5.96	0	2.6846	97.315
300	131.77	0	0.87	6.5	7.37	0	11.805	88.195
305	136.24	0	0.23	7.4379	7.6679	0	2.9995	97
308	137.18	0.01	0.3	7.6129	7.9229	0.12622	3.7865	96.087
310	138.31	0	0.32	6.0726	6.3926	0	5.0058	94.994
313	141.27	0	0.15	7.5047	7.6547	0	1.9596	98.04
315	143.01	0	0.66	5.8029	6.4629	0	10.212	89.788
318	145.55	0	0.13	6.3029	6.4329	0	2.0209	97.979
320	147.27	0	0.29	6.3643	6.6543	0	4.3581	95.642
322	148.47	0	0.42	8.9	9.32	0	4.5064	95.494
323	149.23	0.0162	0.28	8.1997	8.4959	0.19068	3.2957	96.514
325	152.32	0	0.04	7.3879	7.4279	0	0.53851	99.461
325	152.32	0	0.05	7.5497	7.5997	0	0.65792	99.342
328	156.74	0	0.26	7.505	7.765	0	3.3484	96.652
328	156.74	0	0.26	7.505	7.765	0	3.3484	96.652
330	162.92	0	0	7.0843	7.0843	0	0	100
332	164.19	0	0.34	9.7979	10.138	0	3.3538	96.646
333	164.54	0	0.72	5.7429	6.4629	0	11.141	88.859
335	168.28	0	0.14	5.7	5.84	0	2.3973	97.603
338	174.83	0	0.19	8.0147	8.2047	0	2.3157	97.684
340	177.08	0.04	0.15	7.9129	8.1029	0.49365	1.8512	97.655
343	182.95	0	0.26	7.7097	7.9697	0	3.2624	96.738
345	185.36	0.0278	0.64	6.8397	7.5075	0.3703	8.5248	91.105
348	189.25	0.05	0.25	6.1779	6.4779	0.77186	3.8593	95.369
353	195.09	0	0.46	6.8897	7.3497	0	6.2588	93.741
358	200.92	0	0.24	6.9	7.14	0	3.3613	96.639
363	209.04	0	0.83	10.02	10.85	0	7.6498	92.35
365	213.07	0	0.92	7.6047	8.5247	0	10.792	89.208
370	221.41	0.019	0.62	6.1497	6.7887	0.27988	9.1328	90.587
375	227.3	0.1316	5.92	3.1447	9.1963	1.431	64.374	34.195
378	233.51	0	3.09	5.8347	8.9247	0	34.623	65.377
380	234.89	0	5.4	3.6297	9.0297	0	59.803	40.197
383	237.53	0	0.23	6.6797	6.9097	0	3.3287	96.671
385	238.46	0.0757	2.9	6.3347	9.3104	0.81307	31.148	68.039
392	250.9	0.0268	3.12	6.0347	9.1815	0.29189	33.981	65.727
395	253.17	0.0345	2.44	7.555	10.03	0.34399	24.328	75.328
398	262.07	0.01	5.65	3.1479	8.8079	0.11353	64.147	35.74
400	266.12	0	1.38	7.2197	8.5997	0	16.047	83.953
402	266.97	0	0.09	8.1497	8.2397	0	1.0923	98.908
405	270.86	0	0.24	8.5179	8.7579	0	2.7404	97.26
407	276	0.0206	0.31	8.0579	8.3885	0.24557	3.6955	96.059
409	278.36	0	1.26	6.3137	7.5737	0	16.637	83.363
418	288.14	0	0.85	5.3537	6.2037	0	13.702	86.299
419	288.89	0	2.39	4.7687	7.1587	0	33.386	66.614
423	295.46	0.0118	0.25	6.5829	6.8447	0.1724	3.6525	96.175
426	297.99	0.0132	3.04	5.0829	8.1361	0.16224	37.364	62.473
430	300.75	0	5.27	3.2187	8.4887	0	62.083	37.917
431	301.83	0	1.74	6.8529	8.5929	0	20.249	79.751
436	304.01	0	4.79	4.0187	8.8087	0	54.378	45.622
438	305.98	0.13	2.16	5.6137	7.9037	1.6448	27.329	71.026
441	307.11	0	0.07	7.4429	7.5129	0	0.93173	99.068
443	308.36	0.14	1.66	6.0387	7.8387	1.786	21.177	77.037
448	311.21	0.0261	5.65	2.9837	8.6598	0.30139	65.244	34.455
451	312.83	0.0382	1.4	5.8979	7.3361	0.52071	19.084	80.396
453	315.58	0	0.5	8.8729	9.3729	0	5.3345	94.665
458	319.66	0.2283	1.96	9.2479	11.436	1.9963	17.139	80.865
462	322.18	0.0368	6.84	2.3779	9.2547	0.39764	73.908	25.694

Table 3 - Statistical measures of grain size produced by the program SDSZ. FW refers to statistics developed by Folk and Ward, 1957; I refers to statistics developed by Inman, 1962; T refers to statistics developed by Trask, 1930.

sample #	depth (m)	FW mean	FW median	FW sorting	FW skewness	FW kurtosis	I mean	I median	I sorting	I skew1	I skew2	I kurtosis	T median	T mean	T sorting	T skewness	T kurtosis
463	0.7	6.77	6.91	1.48	0.17	1.33	6.77	6.98	1.29	0.16	0.4	1.12	0.01	0.01	1.8	0.94	0.25
466	3.15	1.71	2.31	1.94	0.54	1.09	1.71	2.6	1.83	0.48	1.1	0.85	0.3	0.29	2.42	0.45	0.27
200	6.09	7.6	7.8	1.66	0.22	1.98	7.6	7.9	1.09	0.27	0.54	2.4	0.01	0	1.7	0.71	0.24
201	7.48	7.42	7.42	1.7	0.05	1.79	7.42	7.42	1.22	0	0.3	1.95	0.01	0.01	1.77	0.94	0.09
204	10.5	8.5	8.67	2.37	0.07	1.75	8.5	8.75	2.15	0.11	0.06	0.98	0	0	2	0.75	0.05
205	11.9	7.63	7.86	1.59	0.27	1.81	7.63	7.98	1	0.35	0.67	2.61	0.01	0.01	1.76	0.73	0.27
208	16.1	7.66	7.75	1.56	0.14	1.92	7.66	7.79	0.98	0.14	0.5	2.61	0	0	1.68	0.77	0.26
211	17.9	7.83	7.98	1.92	0.12	2.29	7.83	8.05	1.36	0.16	0.2	2	0	0	1.66	0.94	0.06
213	18.7	7.91	8.09	1.88	0.15	2.22	7.91	8.18	1.37	0.2	0.3	1.87	0	0	1.65	0.97	0.23
216	24.6	7.81	7.98	2.31	0.08	2	7.81	8.07	1.87	0.14	0.05	1.44	0	0	1.91	0.86	0.06
218	26.5	7.32	7.46	1.55	0.16	2	7.32	7.53	1.01	0.21	0.4	2.41	0.01	0.01	1.63	0.73	0.21
221	33.6	7.43	7.55	1.52	0.16	1.91	7.43	7.61	0.96	0.19	0.48	2.59	0.01	0.01	1.67	0.69	0.21
223	35.6	7.72	7.94	2.08	0.18	1.64	7.72	8.05	1.77	0.18	0.4	1.23	0	0.01	1.98	0.89	0.08
226	39.8	8.16	8.39	2.29	0.12	1.42	8.16	8.5	2	0.17	0.15	1.12	0	0.01	2.34	1.13	0.08
226	39.8	7.94	8.15	2.29	0.14	1.35	7.94	8.25	2.07	0.15	0.27	1	0	0.01	2.38	1.11	0.15
228	41.7	5.93	6.23	1.34	0.33	1.03	5.93	6.37	1.34	0.33	0.53	0.67	0.02	0.02	1.85	0.7	0.28
231	47	7.21	7.32	1.12	0.23	1.37	7.21	7.37	1	0.16	0.61	1.04	0.01	0.01	1.53	0.94	0.24
233	52.4	7.68	7.8	1.66	0.18	1.9	7.68	7.86	1.21	0.14	0.64	1.87	0	0.01	1.69	0.91	0.2
236	56.7	6.69	6.9	1.39	0.3	1.11	6.69	7	1.33	0.23	0.66	0.8	0.01	0.01	1.84	0.83	0.27
238	58.8	6.95	6.78	1.01	-0.23	1.74	6.95	6.69	0.81	-0.33	-0.32	1.47	0.01	0.01	1.39	1.35	0.19
243	63.5	6.91	7.01	1.19	0.26	1.12	6.91	7.06	1.15	0.13	0.69	0.78	0.01	0.01	1.68	0.99	0.27
245	65.2	7.24	7.45	1.33	0.24	1.67	7.24	7.56	1.03	0.31	0.43	1.63	0.01	0.01	1.58	0.75	0.25
248	68.3	5.49	5.83	1.37	0.35	1.15	5.49	6	1.33	0.38	0.57	0.75	0.02	0.02	1.77	0.69	0.25
250	70.8	6.03	6.28	1.22	0.31	0.89	6.03	6.41	1.25	0.31	0.5	0.56	0.02	0.02	1.86	0.71	0.3
253	73.8	7.79	7.84	1.68	0.08	1.88	7.79	7.87	1.07	0.07	0.3	2.5	0	0.01	1.76	0.93	0.24
260	86.6	7.09	7.09	1.92	0.01	1.33	7.09	7.09	1.6	0	0.05	1.29	0.01	0.01	2.19	0.95	0.14
263	91.3	8.43	8.07	2.78	-0.08	1.45	8.43	7.89	2.93	-0.19	0.03	0.48	0	0	2.33	1.06	0.06
265	93.8	7.65	7.76	1.6	0.14	2.23	7.65	7.82	0.98	0.18	0.38	2.71	0	0	1.59	0.76	0.18
268	98.2	6.72	6.54	2.23	0.08	0.82	6.72	6.45	2.22	-0.12	0.47	0.66	0.01	0.03	3.6	1.99	0.4
268	98.2	8.23	8.61	2.03	0.23	1.98	8.23	8.8	1.61	0.36	0.25	1.52	0	0	1.79	0.83	0.2
270	100	8.17	8.23	2.48	0.06	1.28	8.17	8.27	2.38	0.04	0.14	0.79	0	0.01	2.58	1.14	0.11
273	102	6.46	6.76	1.7	0.29	0.97	6.46	6.91	1.6	0.28	0.55	0.86	0.01	0.01	2.38	0.72	0.31
278	110	6.13	6.35	1.39	0.23	0.94	6.13	6.46	1.48	0.22	0.35	0.45	0.01	0.02	1.92	0.83	0.27
278	110	5.39	5.86	1.27	0.54	1.06	5.39	6.1	1.26	0.57	0.88	0.7	0.02	0.02	1.77	0.55	0.3
280	112	7.16	7.13	1.79	-0.06	1.41	7.16	7.12	1.44	-0.03	-0.24	1.45	0.01	0.01	2.03	1.31	0.13
283	116	8.57	8.3	2.84	-0.06	1.47	8.57	8.16	3.01	-0.14	0.02	0.46	0	0	2.33	0.72	0.05
285	117	8.3	8.7	2.16	0.2	1.77	8.3	8.9	1.75	0.34	0.15	1.42	0	0	1.97	0.79	0.07
285	117	8.3	8.7	2.16	0.2	1.78	8.3	8.9	1.75	0.34	0.14	1.42	0	0	1.97	0.79	0.07
293	126	7.64	7.78	1.71	0.16	1.99	7.64	7.85	1.16	0.18	0.46	2.21	0.01	0.01	1.7	0.88	0.23
298	131	6.25	6.51	1.4	0.26	0.96	6.25	6.64	1.4	0.28	0.4	0.66	0.01	0.01	1.99	0.72	0.28
300	132	8.14	7.79	2.85	-0.11	1.75	8.14	7.62	2.86	-0.18	-0.04	0.64	0	0	2.14	0.96	0.04
300	132	7.79	7.3	2.72	-0.13	1.29	7.79	7.06	2.71	-0.27	0.02	0.67	0	0.01	2.7	1.86	0.11
305	136	6.84	7.02	1.47	0.2	1.65	6.84	7.11	1.22	0.22	0.42	1.32	0.01	0.01	1.63	0.94	0.24
308	137	7.18	7.36	1.63	0.22	1.56	7.18	7.46	1.16	0.24	0.6	1.97	0.01	0.01	1.87	0.82	0.28
310	138	6.98	7	1.85	0.1	1.28	6.98	7.01	1.55	0.02	0.42	1.28	0.01	0.01	2.2	1.13	0.25
313	141	6.65	6.61	1.42	0.1	1.72	6.65	6.59	1.17	-0.05	0.57	1.33	0.01	0.01	1.57	1	0.18
315	143	6.63	6.63	1.69	-0.04	1.27	6.63	6.63	1.47	0	-0.17	1.14	0.01	0.01	2.01	1.15	0.14
318	146	7.18	7.28	1.39	0.17	1.96	7.18	7.33	1.03	0.14	0.57	1.82	0.01	0.01	1.52	1.01	0.24
320	147	5.87	6.04	1.34	0.23	1.01	5.87	6.12	1.32	0.19	0.45	0.71	0.02	0.02	1.88	0.83	0.32
322	148	7.31	7.29	1.85	0.06	1.42	7.31	7.27	1.47	-0.02	0.38	1.5	0.01	0.01	2.09	1.01	0.27
323	149	7.02	7.27	1.86	0.26	1.96	7.02	7.4	1.53	0.25	0.65	1.38	0.01	0.01	1.69	0.93	0.21
325	152	8.52	8.82	2.16	0.14	1.61	8.52	8.97	1.76	0.26	0.05	1.4	0	0	2.11	1.12	0.09
325	152	8.54	8.87	2.19	0.16	1.58	8.54	9.03	1.84	0.27	0.1	1.26	0	0	2.12	0.92	0.15
328	157	7.63	7.57	1.7	0.02	1.66	7.63	7.54	1.22	-0.08	0.32	1.95	0.01	0.01	1.85	1.01	0.24
328	157	7.63	7.57	1.7	0.02	1.65	7.63	7.54	1.22	-0.08	0.32	1.95	0.01	0.01	1.85	1.01	0.24
330	163	5.58	5.93	1.46	0.37	0.85	5.58	6.1	1.53	0.34	0.6	0.5	0.02	0.02	2.15	0.64	0.32
332	164	6.42	6.52	1.41	0.15	1.11	6.42	6.56	1.3	0.11	0.35	0.94	0.01	0.01	1.91	0.98	0.31
333	165	5.96	6.09	1.82	0.09	0.98	5.96	6.15	1.79	0.11	0.12	0.71	0.02	0.02	2.43	0.95	0.26
335	168	7.81	8.24	2.36	0.23	1.38	7.81	8.46	2.12	0.31	0.32	1.02	0	0.01	2.41	0.78	0.1
338	175	7.49	7.8	1.89	0.25	1.73	7.49	7.96	1.39	0.34	0.49	1.85	0.01	0.01	1.92	0.77	0.1
340	177	7.63	7.91	2.3	0.19	1.64	7.63	8.05	2.07	0.2	0.35	1.02	0.01	0.01	2.07	0.65	0.07
343	183	7.59	7.93	1.82	0.28	1.83	7.59	8.1	1.28	0.39	0.52	2.04	0.01	0.01	1.83	0.82	0.14
345	185	6.4	6.51	1.64	0.11	1.36	6.4	6.56	1.44	0.12	0.23	1.11	0.01	0.01	1.89	0.91	0.2
348	189	6.27	6.51	1.87	0.29	0.94	6.27	6.64	1.88	0.2	0.64	0.62	0.01	0.02	2.51	0.67	0.24
353	195	7.15	7.31	1.62	0.14	2.01	7.15	7.38	1.16	0.2	0.22	1.97	0.01	0.01	1.63	0.76	0.08
358	201	7.77	7.82	1.6	0.1	1.95	7.77	7.84	1.05	0.07	0.45	2.36	0	0	1.67	0.92	0.25

Table 3 - Statistical measures of grain size produced by the program SDSZ. FW refers to statistics developed by Folk and War(1957; I refers to statistics developed by Inman, 1962; T refers to statistics developed by Trask, 1930.

sample #	depth (m)	FW mean	FW median	FW sorting	FW skewness	FW kurtosis	I mean	I median	I sorting	I skew1	I skew2	I kurtosis	T median	T mean	T sorting	T skewness	T kurtosis
358	201	7.87	7.88	1.25	0.26	1.57	7.87	7.89	0.93	0.02	1.36	1.78	0	0	1.6	0.92	0.24
363	209	3.5	3.19	0.95	-0.64	2.11	3.5	3.04	0.8	-0.58	-1.61	1.29	0.09	0.1	1.28	1.24	0.07
365	213	8.22	7.63	2.98	-0.22	2.32	8.22	7.33	2.9	-0.31	-0.23	0.74	0	0	1.86	1.12	0.03
370	221	7.01	7.33	1.58	0.26	3.55	7.01	7.49	0.87	0.56	-0.18	3.33	0.01	0.01	1.35	0.88	0.05
375	227	2.97	3.08	2.42	0.1	0.96	2.97	3.14	2.43	0.07	0.22	0.63	0.13	0.21	3.25	0.87	0.23
378	234	4.91	4.7	1.96	-0.09	0.97	4.91	4.59	2.05	-0.16	-0.03	0.5	0.03	0.06	2.46	1.57	0.19
380	235	3.53	3.64	1.71	0.16	1.06	3.53	3.69	1.7	0.1	0.37	0.66	0.09	0.1	2.13	0.78	0.2
383	238	6.18	6.17	1.57	0.05	0.82	6.18	6.16	1.7	-0.01	0.15	0.39	0.01	0.02	2.26	1.01	0.25
385	238	5.83	5.42	2.58	-0.24	0.78	5.83	5.21	2.74	-0.23	-0.36	0.46	0.02	0.06	4.3	2.34	0.2
392	251	6.18	5.54	2.31	-0.27	0.79	6.18	5.22	2.41	-0.4	-0.2	0.5	0.01	0.05	3.68	3.8	0.25
395	253	6.93	6.28	2.73	-0.22	0.88	6.93	5.95	2.74	-0.36	-0.14	0.63	0.01	0.03	4.23	3.24	0.19
398	262	3.41	3.85	1.55	0.44	1.07	3.41	4.07	1.52	0.43	0.76	0.72	0.09	0.09	2	0.54	0.27
400	266	5.95	5.78	1.6	-0.13	1.23	5.95	5.7	1.46	-0.17	-0.18	0.96	0.02	0.02	1.94	0.99	0.13
402	267	7.76	8.15	2.32	0.22	1.59	7.76	8.35	2.07	0.28	0.33	1.05	0	0	2.13	0.61	0.07
405	271	8.01	8.29	2.17	0.16	1.7	8.01	8.43	1.8	0.23	0.21	1.34	0	0	2.02	1.01	0.08
407	276	7.01	7.11	1.6	0.18	1.55	7.01	7.16	1.36	0.11	0.55	1.22	0.01	0.01	1.74	1.05	0.28
409	278	7.16	6.65	2.36	-0.2	1.76	7.16	6.4	2.26	-0.34	-0.11	0.8	0.01	0.01	1.93	0.99	0.05
418	288	7.6	6.86	2.55	-0.27	2.08	7.6	6.49	2.36	-0.47	-0.15	0.91	0.01	0.01	1.85	0.86	0.03
419	289	5.83	5.67	2.16	-0.03	0.71	5.83	5.59	2.36	-0.1	0.05	0.36	0.02	0.04	3.65	1.57	0.31
423	295	7.25	7.4	1.56	0.16	1.96	7.25	7.47	1.18	0.18	0.37	1.71	0.01	0.01	1.59	0.95	0.25
426	298	4.34	4.87	1.94	0.41	0.9	4.34	5.14	2.03	0.39	0.65	0.49	0.05	0.05	2.61	0.53	0.29
430	301	3.49	4.03	1.63	0.49	0.97	3.49	4.29	1.63	0.49	0.81	0.65	0.09	0.08	2.19	0.45	0.29
431	302	5.74	5.63	1.85	-0.02	0.97	5.74	5.57	1.9	-0.09	0.06	0.58	0.02	0.02	2.41	0.89	0.17
436	304	3.98	4.19	1.3	0.32	1.17	3.98	4.3	1.22	0.26	0.7	0.87	0.06	0.07	1.73	0.83	0.27
438	306	4.78	4.85	1.48	0.03	1.53	4.78	4.88	1.29	0.08	-0.05	1.15	0.04	0.04	1.67	0.85	0.13
441	307	6.44	6.37	1.19	-0.04	1.01	6.44	6.33	1.21	-0.09	0.04	0.6	0.01	0.01	1.73	1.1	0.23
443	308	4.7	4.78	1.45	0.04	1.54	4.7	4.82	1.27	0.09	-0.01	1.13	0.04	0.04	1.65	0.84	0.15
448	311	3.27	3.49	2	0.2	0.92	3.27	3.61	2.05	0.16	0.37	0.56	0.1	0.13	2.69	0.65	0.21
451	313	5.88	5.78	1.95	0	1.21	5.88	5.73	2.02	-0.07	0.11	0.53	0.02	0.02	2.06	0.77	0.13
453	316	6.82	6.96	1.55	0.09	1.36	6.82	7.03	1.33	0.15	0.08	1.2	0.01	0.01	1.84	0.93	0.21
458	320	7.35	6.28	3.05	-0.4	2.16	7.35	5.75	2.88	-0.55	-0.44	0.84	0.01	0.01	2.01	1.11	0.01
462	322	2.98	3.32	1.68	0.32	1.3	2.98	3.49	1.58	0.32	0.58	0.87	0.13	0.13	1.9	0.71	0.21

Table 4 - Channel sample grain size data.

core #	sample #	depth (m)	wt.% sand + gravel	wt.% coarse silt	wt.% fine silt	wt.% clay
OL92-3	All	5.3401	29.648	15.998	19.580	34.775
OL92-1	6A+7A	6.9500	3.8520	12.823	22.960	60.365
	8A	8.9900	1.1171	0.0000	24.085	74.798
	9B+C	12.675	1.2732	8.1167	19.841	70.769
	11A+B	18.105	2.6042	8.5938	23.125	65.677
	13A+B+C	23.245	17.825	13.103	32.573	36.499
	14A+B	26.275	1.8868	15.094	15.094	67.924
	17A+B	32.690	49.847	12.207	24.415	13.530
	18A+B+C	35.435	3.1198	9.9164	33.593	53.370
	19A+B	38.445	7.6187	20.495	22.818	49.068
	20A+B	41.490	15.419	18.141	36.281	30.159
	21A+B	44.615	2.7165	8.6022	65.761	22.920
	22A+B	47.060	2.6217	7.4905	44.944	44.944
	23A (B)	49.920	2.4066	19.720	38.811	39.062
	25A+B	53.875	3.6780	25.497	38.184	32.641
	26A+B	56.730	5.5000	7.8700	31.500	55.100
	27A+B	59.800	2.4968	18.272	38.928	40.303
OL92-2	1A+B	62.675	2.1158	41.080	34.537	22.267
	2A+B	65.565	4.1520	23.907	39.151	32.790
	3A+B	68.490	6.7950	39.638	28.313	25.255
	4A+B	71.855	5.1572	59.249	1.4505	34.143
	6A+B	75.465	5.7260	14.805	38.876	40.593
	7A+B	78.000	0.68681	6.8681	20.604	71.841
	8A+B	81.125	0.90090	5.1480	15.444	78.507
	9A+B	84.145	0.82106	7.0020	22.924	69.253
	10A+B	87.205	4.7321	12.520	29.050	53.698
	11A+B	90.255	3.3752	7.5897	16.072	72.963
	12A+B	93.300	2.7165	8.4890	16.978	71.817
	13A+14A	95.840	48.587	0.0000	21.739	29.674
	15A+B	99.340	1.2271	6.4582	20.229	72.085
	16A+B	102.34	7.6282	20.679	32.562	39.130
	22A+B	110.40	4.8263	15.444	30.888	48.842
	23A+B	112.85	4.1000	8.2000	42.600	45.0000
	25A	115.73	1.8046	0.0000	24.060	74.135
	26A+B	117.73	9.9838	20.529	47.039	22.449
	27A+B	120.78	6.4778	16.194	26.991	50.337
	28A+B (B)	123.42	0.78766	4.5308	22.770	71.912
	28B+C	125.56	1.0140	8.6930	28.617	61.676
	29A+B	127.99	2.6875	0.0000	67.189	30.123
	30A+31A	131.13	7.4986	15.939	31.699	44.863
	31B+C	133.85	4.1801	8.0386	24.116	63.666
	32A+B	136.58	2.9697	18.758	40.530	37.742
	33A+B	140.53	1.9903	10.273	25.371	62.365
	34A+B	143.54	7.7844	19.162	33.533	39.521
	35A+B	146.46	3.7774	17.882	34.657	43.683
	36A+37A	148.93	3.3223	0.0000	38.760	57.918
	39A+B	153.20	4.0000	5.4000	17.4000	73.2000
	40A+B	155.90	3.2094	12.669	29.561	54.561
	44A+45A	163.76	6.3158	22.556	22.556	48.571
	47A+B	167.68	5.3712	14.757	27.532	52.340
	51A+B	172.77	1.9789	11.145	21.692	65.184
	52A+53A	175.99	1.2000	15.200	7.5000	76.100
	55A+B	183.24	3.1482	13.889	23.148	59.815
	56A+B	186.27	6.6277	19.476	39.669	34.227
	57A+B	189.26	16.408	16.424	25.995	41.173
	58A+B	192.13	30.269	11.315	16.973	41.443
	59A+B	195.11	5.0916	8.1466	32.586	54.175
	59B+C	196.94	0.96930	6.4620	32.310	60.258
	60B+C	200.38	4.8108	14.094	50.522	30.573
	61A+B	202.93	5.2250	5.8055	29.028	59.942
	63A+64A	208.60	24.160	3.7313	14.925	57.183
	65+66A+B	213.34	4.7155	13.008	45.528	36.748
	65+66C+D	215.66	41.848	5.1348	15.404	37.612
	69A+B	220.73	4.6185	15.060	40.161	40.161
	70A+B	223.09	3.1139	9.8140	43.019	44.053
	71A+B	225.71	23.100	9.7000	29.300	37.800
	81A+B (A)&(B)	235.08	50.812	17.725	17.725	13.737
	82A+B	237.67	52.778	3.8314	19.157	24.234
	83A+B	240.61	56.940	11.018	10.456	21.586
	85A+B	245.35	57.143	5.1480	10.296	27.413
	88A+B	253.77	59.619	17.618	7.0472	15.715
	89A	255.31	24.717	31.201	21.469	22.614
	93A+94A	267.13	6.5253	0.0000	32.626	60.848
	95A+B	271.24	1.7022	0.0000	22.695	75.603
	97A+B	276.60	1.6482	10.753	29.626	57.973
	98A+99A	279.03	42.164	11.258	18.567	28.011
	100A+B	283.11	8.2876	15.276	44.310	32.127
	100B+C	285.21	1.8868	0.0000	30.189	67.925
	101A+B	288.46	7.1212	6.0606	42.424	44.394
	102A+B	292.55	6.6740	0.0000	26.258	67.068
	103A+B	296.22	11.175	13.710	25.010	50.105
	104A+B	298.99	81.579	6.0296	4.8680	7.5232
	104B+C	301.04	86.385	3.0942	2.7229	7.7974
	105A+B	303.03	35.282	25.177	19.346	20.194
	105B+C	305.12	60.506	14.973	11.306	13.216
	106A+B	306.81	22.569	30.393	28.000	19.038
	106B+C	308.66	22.783	29.703	33.128	14.387
	107A+B (A)&(B)	311.68	42.732	12.480	25.171	19.618
	108A+B	315.97	16.200	11.655	29.137	43.007
	109A+B	319.42	43.606	18.399	7.3597	30.635
	110	321.73	63.727	12.593	9.7183	13.962

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Clay Mineralogical Analyses of the Owens Lake Core

by

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Abstract

X-ray diffraction analyses of the <2 μm fraction of channel samples from the Owens Lake core show illite and smectite to be the dominant clay minerals (accounting for up to 90%), with lesser amounts of chlorite and kaolinite present. Quartz, K-feldspar, and plagioclase are also found in the <2 μm fraction. Two end-member X-ray diffractograms have been identified which characterize predominantly illite- or predominantly smectite-bearing sediments. Increases in smectite content with depth correlate directly with increases in mean grain size and carbonate content with depth, and correlate inversely with increases in illite content with depth.

Introduction

Owens Lake is the first in a chain of lakes lying to the east of the Sierra Nevada. The lake, which lies at the southern end of the topographically closed Owens Valley, receives runoff primarily from the Sierra Nevada via the Owens River and its tributaries. During "pluvial" periods (high ratio of precipitation to evaporation), Owens Lake exceeded the confines of the southern Owens Valley and spilled over a sill into the China and Searles Lake basins (Smith, 1984). During drier periods, the lake shrank and remained at a level nearer to or lower than the spillover sill. In this paper, we report results of clay mineralogical analyses conducted on sediments from a 323-m long core of Owens Lake which reflect the variations in pluvial-interpluvial climate.

Methods

Part of the clay-sized fraction from the channel sample grain size analysis (see Menking and others, 1993) was collected for mineralogical analysis. Clays were mounted on glass microscope slides using the filter-peel technique (Moore and Reynolds, Jr., 1989) and were scanned with a Norelco Step-Scanning X-Ray Diffractometer at U.C. Santa Cruz. A 0.02 °2Θ step size and 5 second dwell time were used. Since the crystalline structures of clay minerals differ primarily in their lattice spacing parallel to the c-axis, the c-axis reflections are most useful in ascertaining which clays are present in any given sample. The filter-peel technique, which ensures the greatest degree of preferred orientation of clay platelets, produces the strongest c-axis reflections, and is therefore favored over other methods of sample preparation.

All minerals were identified by diffraction peak locations and/or by various thermal and chemical treatments (see table 1). To test for the presence of smectite minerals (clay minerals with hydrated inner-layer cations), sample slides were placed on a fritted platform in a covered Pyrex dish containing ethylene glycol. The dish was placed for 8 or more hours into an oven heated to 60 °C to allow the ethylene glycol to completely replace any interlayer water held by smectite. Given its larger molecular size, ethylene glycol expands the smectite lattice to a larger spacing than when water is held in the interlayer sites. This lattice expansion is easily noted by a shift in the location of the smectite (001) peak on the X-ray diffractogram from 14 Å (angstroms) in the air-dried state to 17 Å when glycolated. After glycolation, samples were re-scanned and changes in peak location and intensity were noted. Chlorite and kaolinite display overlapping diffraction patterns. Therefore, to determine which of these minerals was producing 7 Å and 3.5 Å reflections, clays were mounted on X-ray-amorphous tile slides and heated to 550 °C for 1 hour. At this temperature, kaolinite becomes amorphous causing a reduction in peak intensity in those samples containing it. The chlorite peak may also shift to 6.3 to 6.4 Å due to dehydroxylation of the inner brucite layer (Moore and Reynolds, 1989). Illite, quartz, K-feldspar and plagioclase were identified by inspection.

Results

X-Ray Diffraction determinations of the clay mineralogy of channel samples show illite, smectite, chlorite and kaolinite to be the primary clay minerals, with some samples containing clay-sized quartz, plagioclase, and potassium feldspar. From a visual inspection of the X-ray diffractograms, we have identified two end-member mineral assemblages. Figure 1 shows a scan representative of those samples displaying small smectite but large illite, quartz, and feldspar peaks, while figure 2 displays a typical large smectite but small illite, quartz, and feldspar peak pattern. Because of the presence of these two end-member patterns, we measured the peak areas of several clay and non-clay minerals in each sample to see if any regular pattern or periodicity existed in the deposition of clays and non-clays. Peak areas of smectite (glycolated (001)), illite (001), quartz (100), plagioclase (002) and K-feldspar (002) were measured and ratioed against each other for each channel sample. Chlorite and kaolinite are both present, and, due to overlapping diffraction peaks, are not easily decoupled from one another. Therefore, we measured the combined chlorite-kaolinite reflection at 7.11 Å (12.4 °2Θ).

Next, we compared ratios between samples. Smectite/quartz and plagioclase/K-feldspar ratios behave inversely, with smectite/quartz ratios showing a low value during what we interpret to be the last full glacial maximum in the Sierra Nevada range (ca. 20 ka, and ~20 m depth in the core), while the plagioclase/K-feldspar value is high (figure 3). Unlike the **negative** correlation to plagioclase/K-feldspar ratios, smectite/quartz values correlate **positively** with channel sample carbonate content (figure 4). Illite/quartz and chlorite-kaolinite/quartz values do not correlate positively or negatively to carbonate content. However, they do correlate positively to each other, and to the K-feldspar/quartz and plagioclase/quartz ratios. Likewise, the K-feldspar/quartz and plagioclase/quartz ratios behave similarly.

In addition to looking at how peak-area ratios vary with depth, we employ another technique, described by Hallberg and others (1978) and modified by

Hay and others (1991), to determine the relative abundances of clay minerals in the clay-sized fraction of the core. This technique is based upon the fact that certain clay mineral diffraction peaks are inherently larger or smaller than others. For instance, a sample containing equal proportions of smectite and illite will typically display a glycolated smectite (001) peak that is about three times larger than the corresponding illite (001) peak. Therefore, conversion of diffraction peak areas to relative abundances of the minerals from which those peaks arise requires only multiplication of the illite peak area by three, summation of this product with the smectite peak, and the assumption that the two minerals constitute 100% of the clay minerals present. The 7 Å combined chlorite-kaolinite peak is typically half as intense as the 17 Å glycolated smectite peak such that a multiplication factor of 2 can be used to raise chlorite-kaolinite to parity with smectite. Figure 5 shows the results of this analysis for the Owens Lake core. Smectite and illite are the dominant phases, with chlorite-kaolinite accounting for only about 10% of the clay minerals (chlorite-kaolinite is not shown in figure 5 but represents the offset between the smectite and illite curves). In addition, smectite and illite are inversely abundant, with smectite concentrations very low during the "last glacial maximum" (ca. 20 m depth), while illite concentrations are high. Comparison of smectite and illite abundances, versus depth, to both the carbonate curve from the channel sample analyses and the mean grain size curve from the point sample analyses shows striking similarities (figure 6).

Discussion

Like Newton (1991), we interpret the presence of non-clay minerals (quartz, plagioclase, and K-feldspar) in the clay-sized fraction to be the result of glacial abrasion in the Sierra Nevada which produced large volumes of glacial flour. Of the true clay minerals, illite and chlorite may be recycled from metasedimentary roof pendants, but smectite is more likely produced from the weathering of feldspars during soil formation, and it may, therefore, be more indicative of climates conducive to chemical weathering (Chamley, 1989). Smectite is also a common weathering product of volcanic ash, so care must be taken to distinguish between true climatic variations and volcanic events (Chamley, 1989). It is interesting to note that the illite/quartz and chlorite-kaolinite/quartz peak area ratios correlate positively with the K-feldspar/quartz and plagioclase/quartz ratios. Since feldspars typically indicate immature, mechanically produced sediments, their correlation with illite and chlorite (though probably not kaolinite) may indicate a mechanical origin for these clays. Conversely, smectite/quartz correlates negatively with plagioclase/K-feldspar. Since plagioclase is less resistant to weathering than is K-feldspar, plagioclase/K-feldspar ratios should be **lower** in chemically weathered sediments than in those sediments unaltered by chemical processes. Because smectite is a chemical weathering product, ratios of smectite/quartz should be **high** in those sediments that were chemically altered and **low** in those sediments that were unaltered. Therefore, smectite/quartz and plagioclase/K-feldspar ratios should, and do, behave inversely (figure 3).

An alternative explanation for the variation between predominantly smectite and illite sedimentation is that smectite may have formed authigenically in Owens Lake during periods of high salinity. The fact that the percent smectite versus depth curve (derived using the multiplicative factors of Hallberg and others, 1978) so closely resembles the percent carbonate versus depth curve (figure 6) may indicate an authigenic origin for much of the smectite content of the core. In addition, authigenic K-feldspar is quite common in saline lakes (Hay and others (1991) found it in Searles Lake sediments). If smectite and K-feldspar are largely authigenic, the smectite/quartz and plagioclase/K-feldspar ratio curves would still vary inversely. In this instance, the varying smectite/quartz and plagioclase/K-feldspar values would result not from the differential chemical weathering of plagioclase and K-feldspar but from the periodic precipitation of K-feldspar and smectite in an authigenic setting. Times characterized by active authigenic mineral formation would be relatively enriched in smectite over quartz and in K-feldspar over plagioclase. Periods with less authigenic activity would show lower values of smectite relative to quartz and of K-feldspar relative to plagioclase. Presently, we can not rule out either a detrital or authigenic origin for clay minerals and feldspars in the core. Future work will attempt to answer whether these minerals are detrital, authigenic, or both.

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TYPICAL SMALL SMECTITE - LARGE QUARTZ AND FELDSPAR PEAK SCAN

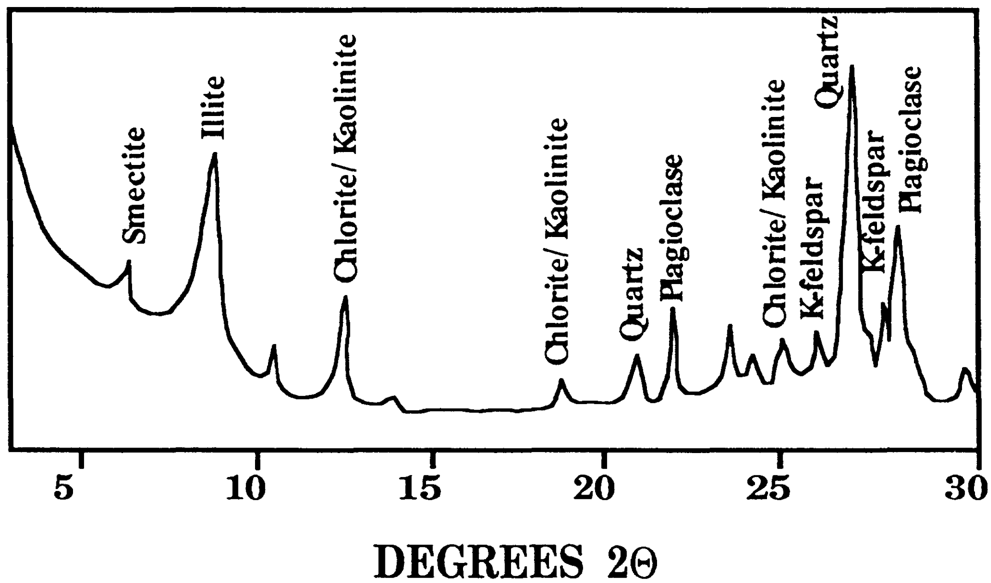

Figure 1 - Typical small smectite-large quartz plus feldspar peak XRD scan. Note the small smectite peak and the large and abundant quartz and feldspar peaks.

TYPICAL LARGE SMECTITE - SMALL QUARTZ AND FELDSPAR PEAK SCAN

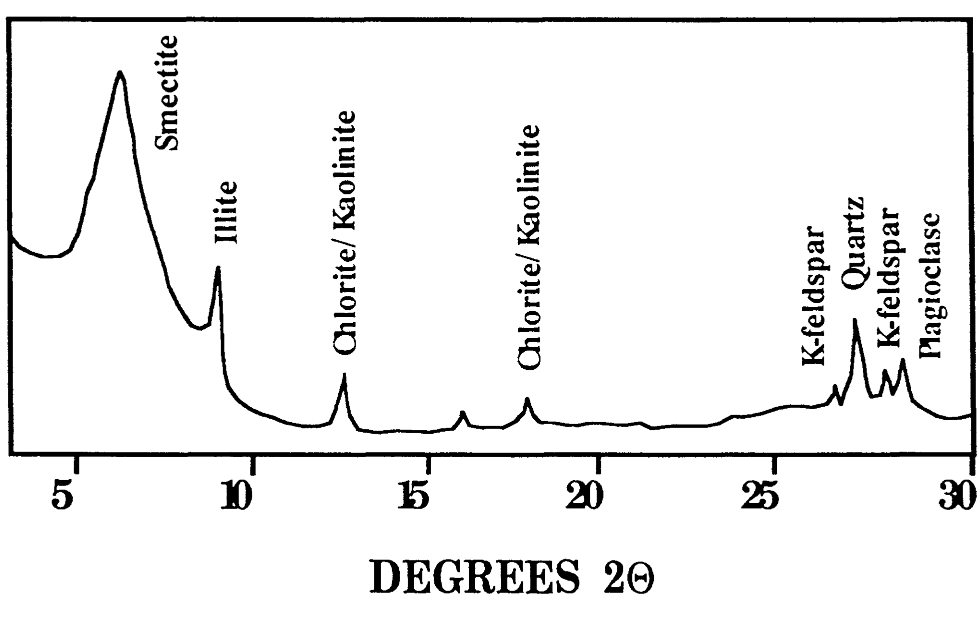

Figure 2 - Typical large smectite-small quartz plus feldspar peak XRD scan. Note the huge smectite peak and the relative lack of significant quartz and feldspar peaks.

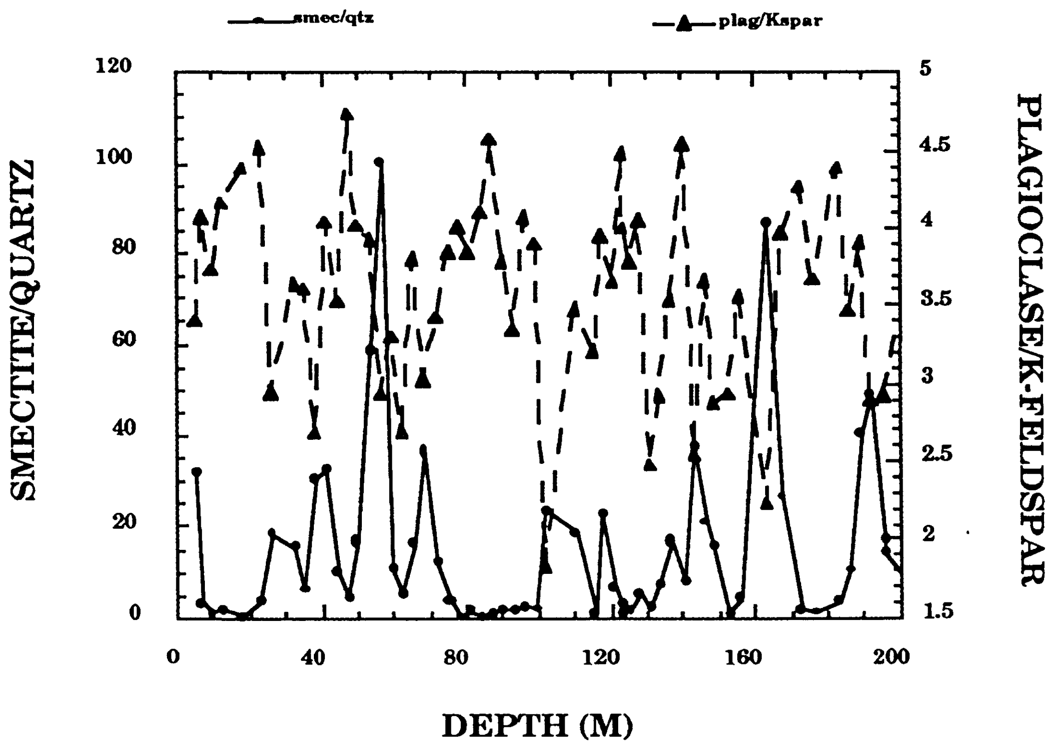

Figure 3 - Smectite/quartz and plagioclase/K-feldspar with depth. The two curves are inversely correlated.

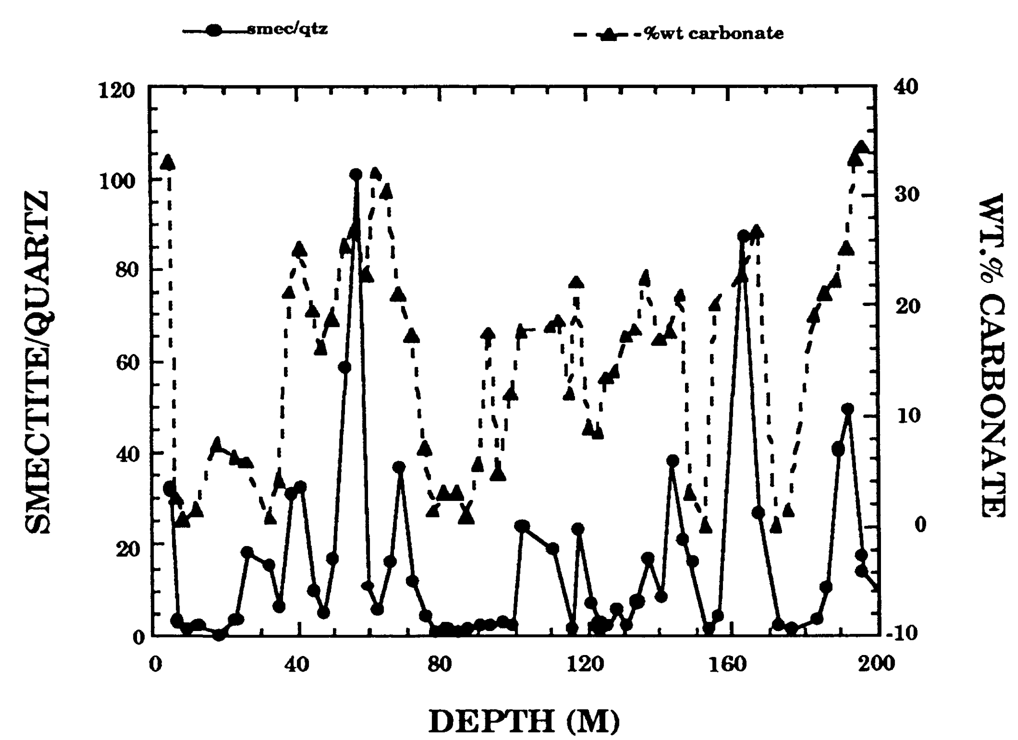

Figure 4 - Smectite/quartz and carbonate content plotted against depth. The two curves are positively correlated.

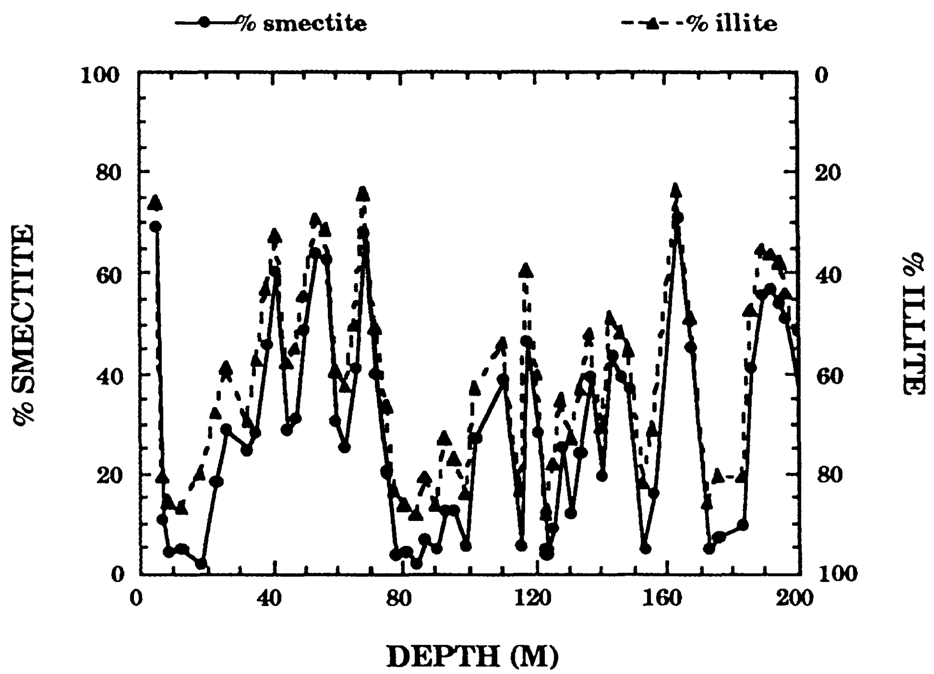

Figure 5 - Plot showing percentages of smectite and illite as calculated by the method of Hallberg and others (1978), and Hay and others (1991). Note the inverse correlation of smectite and illite.

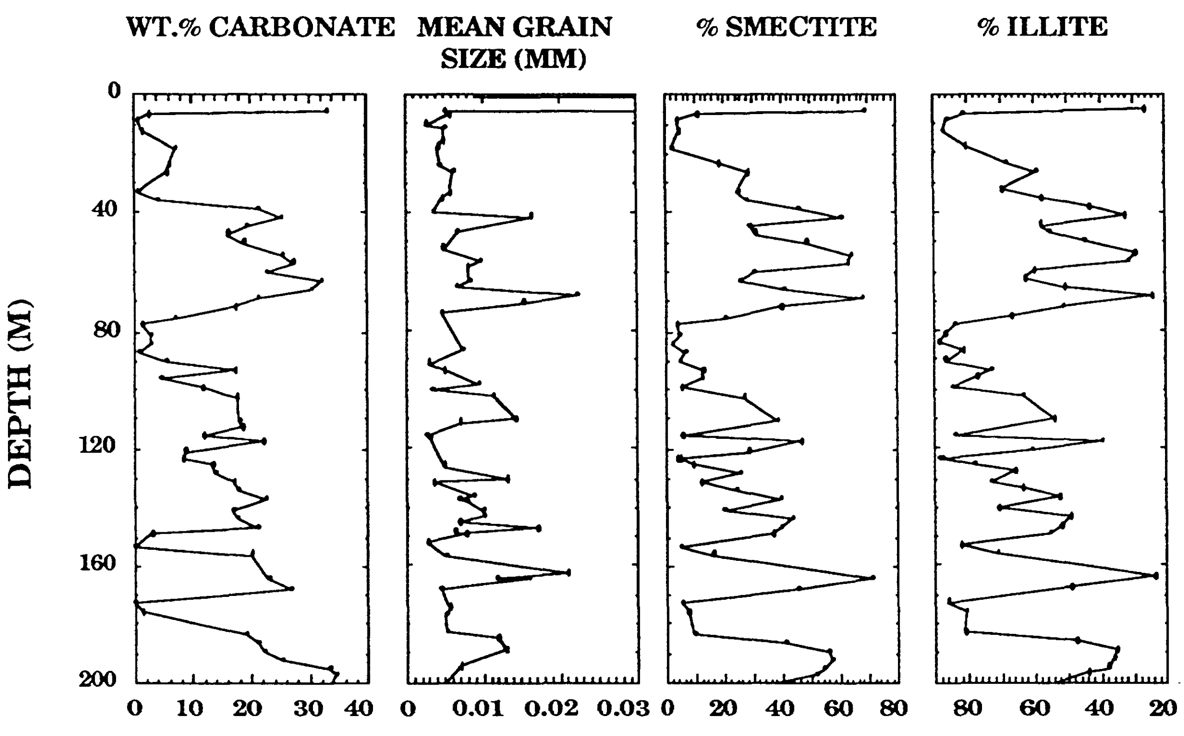

Figure 6 - Comparison of smectite, illite, and carbonate contents, and mean grain size with depth. Smectite, illite, and carbonate contents from channel sample analyses; mean grain size from point sample analyses.

Appendix

Table 1 - Peak areas of selected clay and non-clay mineral reflections, in counts per second.

sample #	depth (m)	smectite	illite	chlorite	quartz	K-feldspar	plagioclase
AII	5.3401	8424.7	1070.4	287.40	263.40	134.40	455.80
6A+7A	6.9500	1286.3	3251.4	501.80	412.10	260.30	1057.7
8A	9.7561	522.50	3884.4	690.40	485.00	355.60	1323.6
9B+C	12.675	706.10	4626.1	678.00	387.80	343.20	1426.1
11A+B	18.105	109.80	1469.0	482.50	469.20	247.40	1084.4
13A+B+C	23.245	920.30	1148.1	346.80	251.00	168.80	760.80
14A+B	26.275	5873.5	4070.1	1266.5	319.70	365.60	1072.4
17A+B	32.690	6055.9	5637.8	665.70	388.30	356.80	1294.7
18A+B+C	35.435	1864.8	1283.2	484.00	293.50	250.00	899.40
19A+B	38.445	2800.7	887.00	341.60	91.500	174.50	466.90
20A+B	41.490	9462.8	1705.7	539.00	291.10	185.70	749.10
21A+B	44.615	1327.3	891.00	303.90	132.20	99.600	350.20
22A+B	47.744	1312.8	778.70	286.90	271.20	107.50	508.30
23A	49.920	4554.9	1404.4	316.60	270.70	152.60	612.40
25A+B	53.875	10391	1592.0	521.60	177.60	112.00	438.90
26A+B	56.730	23779	3978.1	1053.7	237.00	189.90	554.50
27A+B	59.800	3614.7	2354.2	573.20	333.30	160.00	526.50
1A+B	62.675	824.00	677.80	190.50	152.60	66.000	177.60
2A+B	65.565	3974.2	1644.6	414.40	245.20	163.10	618.10
3A+B	68.490	7715.6	926.90	433.90	211.10	145.10	437.70
4A+B	72.012	3964.2	1708.1	452.90	331.00	187.30	639.60
6A+B	75.465	1461.0	1611.2	473.40	350.30	223.20	856.50
7A+B	78.079	387.70	3128.8	704.60	551.70	324.90	1298.3
8A+B	81.125	809.40	5396.2	836.90	534.30	391.20	1500.2
9A+B	84.150	281.40	4602.4	747.00	447.70	348.50	1425.1
10A+B	87.205	575.50	2449.3	561.40	468.00	263.00	1201.4
11A+B	90.255	513.20	3268.1	496.20	286.20	297.30	1123.6
12A+B	93.300	1124.1	2212.8	663.00	603.90	331.90	1105.9
13A+14A	96.372	1095.4	2295.2	472.30	405.10	213.30	865.90
15A+B	99.340	820.30	4524.6	816.10	395.30	354.50	1379.5
16A+B	102.34	6348.2	4995.5	1172.0	267.50	344.30	628.70
22A+B	110.40	6473.1	3041.7	624.30	345.60	189.80	657.60
25A	115.73	717.80	3691.3	706.60	614.40	369.60	1180.9
26A+B	117.73	4617.5	1317.1	684.10	199.10	167.10	657.20
27A+B	120.76	1596.6	1148.5	316.50	237.50	187.60	683.00
28A+B	123.42	513.30	4556.3	619.40	399.10	328.70	1468.5
28A+B	123.42	459.50	2206.9	323.00	150.00	231.40	921.70
28B+C	125.56	436.70	1269.2	308.80	252.30	205.70	776.70
29A+B	128.02	1892.3	1639.8	338.50	350.90	164.80	665.40
30A+31A	131.13	1169.3	2443.3	756.10	500.80	340.90	844.10
31B+C	133.85	3190.6	2823.3	835.90	429.40	245.40	715.80
32A+B	136.58	4155.7	1837.5	429.30	246.90	155.60	550.00
33A+B	140.53	2804.3	3400.7	668.80	340.10	259.30	1175.5
34A+B	143.54	5825.2	2211.3	509.10	154.20	157.60	399.60
35A+B	146.46	3623.2	1594.0	405.60	171.20	163.20	595.00
36A+37A	148.93	5054.5	2544.9	540.20	313.80	268.10	767.20
39A+B	153.20	343.10	2118.9	513.20	319.90	258.80	757.70
40A+B	155.98	1829.5	2766.4	749.40	429.90	328.00	1163.0
44A+45A	163.76	12569	1414.0	480.50	144.50	131.60	293.00
47A+B	167.68	6631.9	2394.1	419.00	248.50	83.100	328.90
51A+B	172.77	987.40	5712.5	899.00	511.90	332.70	1413.5
52A+53A	176.49	772.50	2970.5	675.70	531.60	375.50	1374.1
55A+B	183.24	1349.8	4032.0	728.60	372.10	281.60	1232.3
56A+B	186.27	3239.6	1260.8	449.40	308.20	199.30	688.90
57A+B	189.26	9855.8	2102.2	793.90	244.10	239.80	935.40
58A+B	192.13	11467	2447.3	661.80	233.40	124.00	357.40
59A+B(+C)	195.85	3111.5	730.00	231.10	178.00	98.700	287.60
59A+B(+C)	195.85	7768.5	2239.0	368.50	541.20	263.20	764.70
60B+C	200.38	1704.4	877.30	205.40	177.80	105.90	365.80
61A+B	203.93	1684.4	1151.8	229.30	212.00	163.90	667.50
63+64A	208.60	2151.6	4860.1	620.40	230.90	174.50	685.10
65+66A,B	213.34	8187.7	1128.7	333.10	151.10	109.00	271.70
65+66C,D-67A	217.20	9323.8	1697.4	476.60	258.60	146.40	585.90
65+66C,D-67A	217.20	12287	1638.9	443.80	0.0000	102.80	328.90
69A+B	220.73	4823.8	1799.3	505.40	194.20	145.90	518.50
70A+B	223.14	1588.3	723.70	185.10	164.20	115.40	506.10
71A+B	225.71	3918.4	615.60	128.70	108.90	79.700	339.30
81A+B	235.08	6788.9	4951.8	703.20	204.60	233.70	797.70
82A+B	237.67	1921.4	3233.2	535.70	375.30	307.90	1149.9
83A+B	240.61	1780.7	3278.6	793.40	371.90	357.50	1432.2
85A+B	245.35	3026.4	3730.4	642.50	326.40	323.60	925.00
88A+B	253.84	6908.7	1757.5	369.50	154.50	135.50	461.00
89A	255.31	3377.5	1067.2	412.20	204.40	138.10	680.10
93A+94A	267.13	3084.3	8711.4	1286.4	414.20	442.70	1655.7
95A+B	271.24	1843.3	8235.4	1258.6	434.90	389.60	1545.9
97A+B	276.60	1192.7	4339.3	939.70	0.0000	322.10	1303.3
98A+99A	279.03	2095.4	2206.7	581.30	323.20	200.40	819.80
100A+B	283.11	3721.8	1129.4	300.40	123.90	61.500	244.50
100A+B	283.11	3258.3	1036.5	281.80	215.70	117.30	253.20
101A+B	288.46	622.30	223.50	117.60	177.00	76.100	274.70
102A+B	292.55	2210.5	1817.4	609.30	340.70	232.70	1043.6
103A+B	296.22	1449.5	686.30	208.50	167.00	139.60	483.60
104A+B+C	301.04	3144.2	552.10	349.40	128.40	106.00	352.60
105A+B	303.03	1217.4	139.70	172.20	111.60	79.700	213.20
105B+C	305.12	1064.0	235.30	93.700	0.0000	0.0000	0.0000
106A+B	306.81	1273.5	478.10	155.60	0.0000	0.0000	0.0000
106B+C	308.66	1513.0	227.70	113.50	0.0000	56.200	209.30
107A+B	311.68	5482.1	782.90	470.30	293.70	203.20	472.30
108A+B	316.16	3029.7	900.00	270.50	177.60	116.00	458.10
109A+B	319.42	7139.9	1387.7	458.80	344.20	191.10	678.50

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOCHEMISTRY OF SEDIMENTS IN OWENS LAKE DRILL HOLE OL-92

by

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1993

INTRODUCTION

In historic time, throughout the Holocence, and during other dry periods of the past (interglacials), Owens Lake was saline and alkaline. During extreme wet periods (glacials), in contrast, the lake must have been flushed and overflowing with fresh water as shown by down-stream evidence at Searles Lake. The postulate of the present study was that the sediment composition should reflect the cycling between glacials and interglacials During the spring of 1992, a 323 m core (7.6 -cm diameter) was recovered from Owens Lake in order to obtain a record of climate history in this part of the Great Basin. Drilling was carried out in three sub-sections: from the surface to 7.16 m (OL-923), from 5.49 to 61.37 m (OL-92-1) and from 61.26 to 322.86 m (OL-92-2), together representing about 800 kyr of sedimentation (Smith, 1993). Sediments were analyzed for chemistry, grain-size, clay-mineralogy, radiocarbon, and pore water volume and composition. We report here on the sediment chemistry, which includes analyses for grain-density organic carbon, carbonate, cation-exchange capacity (CEC), major oxides and minor elements. Results for the other parameters are reported in companion articles (Bischoff et al 1993a, Bischoff et al, 1993b, Menking et al, 1993a and 1993b).

SAMPLING

Both channel and point samples were taken for from the drill core geochemical studies. Channel samples, which are composite strip samples, were taken in a continuous series to represent the entire sedimentary column without gaps (total of 91 samples,) and they constitute the major focus of the geochemical analyses. This methodology avoids the bias of single point samples which may not represent the entire sedimentary unit from which they were taken (for point-sample studies of OL-92 see Bischoff et al, 1993a, b, and Menking et al, 1993). The advantage of the channel samples is that each represents a smoothed or running-mean of conditions represented by the time span of the sample, that no important events are missed, and that geochemical budget calculations can be carried out. The time-resolution of such samples is inverse to the thickness of the section sampled. In the present, study we took strip samples of approximately 3 m length, each deemed to represent about 7000 years of deposition based on the thickness of section above the Bishop Tuff at 309 m (Smith, 1993). Samples were taken longitudinally from the working half of the core with a U-shaped spatula. The resulting sample is a continuous semi-cylindrical strip about 1.5 cm wide and 1 cm deep and about 3 m long. The core tube used in drilling was about 4.5 m long. After each drilling "run" of 4.5 m or less, the drill-string was pulled from the hole and the sediment retrieved from the core tube. In the field, the sediment from each run was divided into 1.5 m "slugs" for convenience of handling. These slugs were labeled in sequence A through D for wrapping, preservation, and transportation to the laboratory. In the majority of runs only two slugs (A and B) were retrieved. The labeling of the channel samples, therefore, first gives the drilling run (1 to 110) and secondly the alphabetical "slugs" (A through D) within the run. For example, a typical channel sample represents two slugs and will have a number like 20 A+B, which translates to run 20, slugs A and B.

The point samples were taken during the drilling operations at every 2 to 3 m (120 samples). They were specially preserved and used for determination of water content and pore water chemistry as reported in the accompanying report (Bischoff et al, 1993a). These samples were also analyzed for organic carbon and for carbonate content (but not the other components). These results are reported here to supplement similar analyses of the channel samples.

LABORATORY PROCEDURES

A. Initial processing and splits

The wet channel-samples (150-200 cc each) were placed in 250 ml centrifuge bottles and suspended in distilled water to flush interstitial salts. The flushing and centrifugation was repeated (typically to three times) until the salinity of the flush was less than 0.1 % as determined by refractometer The samples were then dried at 60°C and mechanically homogenized by light grinding in a ceramic mortar. A 5-gram aliquot was split for Cs treatment and major element analysis. The remaining sample was used for determination of grain-density, organic carbon and carbonate (org C and CO_2), XRD determination of carbonate minerals, and acid-leachable Mg, Ca, and Sr. For the point samples, 1-2 cc aliquots of the wet sediment were dried and ground for determination of organic carbon and carbonate, taken from the same aliquot used for determination of water content reported in Bischoff et al (1993a).

B. Cs treatment and major elements

An aqueous CsCl solution was used to displace all exchangeable cations in the sample with Cs ion. Thus, the amount of Cs taken up by the sample is a measure of its cation-exchange capacity

(CEC). CEC, in turn, should be a measure of the relative abundance of weathering zone clay minerals such as smectite, and a measure of warm weathering conditions. The Cs split was suspended in 200 mls of 0.09 molal CsCl solution and periodically agitated for 24 hours, after which it was collected on filter paper and rinsed of excess solution with distilled water. The sample was then dried at 60°C after which Cs was analyzed by the U.S. Geological Survey Analytical Laboratory (Bi-Shia King and P. Lamothe, analysts) using energy-dispersive X-ray fluorescence spectrometry (XRF). Standards were mixtures of an analyzed granite (1 ppm Cs) and a Cs-saturated standard smectite (13% Cs), previously analyzed for absolute Cs content by ICP. The energy-dispersive XRF analysis was non-destructive so the sample was retrieved and analyzed in turn for the major rock-forming oxides SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, and MnO, by dispersive XRF. LOI (loss on ignition at 900°C) was determined gravimetrically as part of the sample-fusion step in the XRF analysis. Dispersive XRF and LOI analyses were performed by the U.S. Geological Survey Analytical Laboratory (D. Hopkins, analyst). Because the samples contain significant amounts of X-ray absorbing Cs, which is lacking in the usual XRF analyzed-rock standards, oxide sums (including Cs_2O) plus LOI were systematically somewhat low (95±2%). Because LOI is unaffected by the Cs, we corrected the sum discrepancy by normalizing the major oxides plus Cs_2O to sum to 100 % minus LOI. A split of each channel sample was also analyzed for minor elements by semi-quantitative optical emission spectroscopy (D. Siems, analyst).

D. Other properties.
Organic carbon and carbonate were analyzed from the bulk sample by standard coulometry (UIC, Inc. Coulometrics Model 5010 CO2 Coulometer) which successively measures the carbonate as CO_2 released by strong acid attack and then the total carbon in the sample. Org C is calculated as the difference between total carbon and carbonate carbon (see Engleman, Jackson and Norton, 1985; and Huffman, 1977). Splits of bulk samples were leached in 3 molar HCl overnight for analysis of acid-leachable cations. After centrifugation, the supernate was analyzed for Ca, Mg and Sr by standard atomic absorption spectroscopy. Standard XRD scans of powder-mounts were performed on a selection of 36 carbonate-rich samples to identify the major carbonate minerals. Grain densities were determined on six composites of the channel samples using a gas comparison pyncnometer (Beckman model 930). After weighing, the sample's volume was measured by the pyncnometer which maintains equal and precisely measured pressures of helium gas in matched sample and reference cylinders. The amount of helium gas displaced by the sample in the sample cylinder is accurately measured by pressure deviations. Sample density is simply the weight divided by the volume.

RESULTS AND DISCUSSION

Analytical results for carbonate, organic carbon, carbonate mineralogy, and leachable Ca, Mg, and Sr are given in tables 1 and 2; for major oxides, LOI, and Cs_2O in table 3; minor elements in table 4; and densities in Table 5. Table 6 summarizes bulk sediment contents of $CaCO_3$, organic carbon, CEC, and density, while table 7 summarizes the bulk sediment composition. Carbonate (CO_2,) and organic carbon (org C) show cyclic co-variation down the core (Fig. 1). It is remarkable that both point samples (representing ca 40 yrs each) and channel samples (representing ca 8000 yrs each) show almost coincident patterns, indicating that even on the small scale of the point samples the sediments are representative of larger thicknesses of sediment. This observation points to rather slowly changing homogeneous conditions rather than widely fluctuating conditions on a decade scale. Based on radiocarbon results (Bischoff et al, 1993b), maximum glacial conditions at 17 to 25 kyrs occur at 10 to 17 m depth in the core, where CO_2 and org C display conspicuous and sharp minima, very close to zero values. These results suggest that at glacial maxima the lake was overflowing with cold fresh water and was relatively non-productive. Five similar minima in these parameters continuing down the core to about 230 meters are interpreted as successively older glacial maxima. Conversely, the recurring and broader maxima in CO_2 and org C are interpreted to represent full interglacial conditions during which the lake was the terminus and was saline and biologically highly-productive. Below 230 m there is a striking change in depositional conditions from silty clays to the prevalence of thick sandy units as described in the accompanying reports (Smith, 1993; Menking et al, 1993), which may signal irregular fluctuations from lacustrine to non-lacustrine conditions. For the section above 230 m, however, lacustrine conditions apparently prevailed. The narrowness of the carbonate minima and the relative thickness of the maxima down the core suggest that closed lake conditions were only periodically interrupted by brief periods of overflow (Fig. 1). XRD results on selected samples (Table 1) indicate that calcite is the dominant carbonate mineral, with detectable dolomite occurring in about a third of the samples, and aragonite in only two. The relative amounts of Ca and Mg carbonates, calculated by balancing the analyzed acid-leachable Ca and Mg against analyzed CO_2, indicates that the $MgCO_3$ component accounts for only about 5 mole % of the total carbonate with the rest being Ca. This suggests that about 86 % of the total acid-leachable Mg is actually non-carbonate (Fig. 2) which we postulate to be authigenic Mg-hydroxysilicates, varyingly crystalline and amorphous, and including such phases as sepiolite, kerolite, and stevensite (Jones, 1986). Such acid-soluble authigenic phases form in saline lakes by reaction of dissolved Mg and silica in alkaline solution, both reacting directly with each other and/or reacting with preexisting clastic phyllosilicates that were either suspended in the water column or at the sediment-water interface. Thus, calculating averages from Tables 1 and 3 indicates that of the total bulk Mg, 9% is as carbonate, 57% as acid-soluble authigenic silicate, and 34% is in the non-leachable clastic component. Fig. 2 shows that abundance of both carbonate-Mg and authigenic Mg-silicate follows that for total-carbonate and that both Mg phases are likely indicators of saline and alkaline conditions.

The Cs_2O content of each channel sample (Table 3) is a function of both the relative percent clay in the sample, and of the CEC of the clays therein. The parameter of interest is the CEC of the clay-fraction, which is obtained from the analytical results by normalizing the Cs content (carbonate-free basis) to the weight fraction of the <2 μ component of the sample (reported in Menking et al,1993b). The variation of this clay-normalized CEC with depth (Fig. 3) shows a remarkable correlation with carbonate down to 230 m. As with $CaCO_3$, CEC shows a conspicuous and sharp minimum coinciding with the glacial maximum at 10-20 m, and others successively deeper in the core at the same points of carbonate minima. This correlation suggests that during glacial maxima the clay-size material has a low exchange capacity, perhaps representing a glacial rock-flour component. Below 230 m, normalized CEC shows dampened cyclical variation that are de-coupled from the carbonate pattern. If CEC is a reflection of drainage-basin conditions rather than deposition-basin conditions, then CEC cycles might represent climatic cycles even though the depositional basin is alternating between lacustrine and non-lacustrine conditions. The average CEC of clay material in the core is 32.7 meq/100 g (table 6) which compares to a range of 80-150 meq/100g for pure smectites and to about 10-40 meq/100g for pure illite (Grimm, 1968, p. 189). Menking et al (1993b) report that illite and smectite are the dominant clay minerals in the Owens sediment. During the interglacials, CEC reaches values within the pure smectite range, while during the glacials CEC is within the range of pure illite.

Major oxides and minor elements (Tables 3 and 4) show little systematic variation with depth in the core. Most variation is explainable by variations of sand:silt:clay proportions. Table 5 shows that grain density is remarkably constant at 2.63±0.05 g/cc. Table 6 shows that average Owens Lake sediment has about 12.5 % $CaCO_3$ and about 0.92 % organic carbon. The average bulk composition, normalized after removing carbonate, organic carbon, and acid-soluble Ca and Mg (Table 7), shows remarkable similarity in all major oxide components to granodiorite, the predominant rock of the Sierran batholith. The minor components of Owens sediment (Table 7) show the same strong granodiorite affinity and a contrast to average shale with the single exception of Zr (56 ppm versus 500 in granodiorite and 120 ppm in shale). Granodioritic Zr is primarily zircon which fractionates with the sand fraction, and therefore, is relatively depleted in the dominantly silt-clay sediment of the lake basin. Triangular diagrams of all the data points show the same general affinity to granodiorite, but with small scale variability attributable to grain-size variations. The Al_2O_3-Na_2O-K_2O plot (Fig. 4a) shows a grouping of points towards the Al_2O_3-rich side but close to the Lamark granodiorite, a rock typical of the drainage to Owens Lake from the east-central Sierra Nevada (Bateman et al, 1963). The Fe_2O_3-Na_2O-K_2O plot (Fig. 4b) shows a pattern elongate with respect to the Fe_2O_3 apex with the Lamark granodiorite at the center of the trend. Samples relatively enriched in Fe_2O_3, tending toward average shale, are clay-rich samples, while those in the opposite direction are rich in arkosic sand. The Fe_2O_3-SiO_2-Al_2O_3 plot (Fig 4c) shows an elongate trend with respect to the SiO_2 apex with the Lamark granodiorite at the mid-point. The SiO_2-depleted side trends toward average shale and represent the more clay-rich samples, while the SiO_2-enriched represent sandy units. The bifurcation of the trend on the SiO_2-enriched side distinguishes between quartz sands and arkosic sands.

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Table 1

Analyses of sediment channel-samples from OL-92 (1, 2, and 3) for wt % carbonate (CO_2), wt % organic carbon (org C) wt % acid-leachable Mg, Ca, ppm Sr, and XRD carbonate mineralogy (min; c=calcite, d=dolomite, a= aragonite). Sample designation refers to drilling run (numerical) and slug (alphabetical). Depth refers to midpoint of sample from surface, and range refers to half-length of channel sample, both in meters (i.e. ,depth ± range indicates depth span of sample)

sample	depth	range	CO_2	org C	Mg	Ca	Sr	min
core OL-92-3								
All	5.34	1.82	19.1	2.64	3.47	16.4	1400	c,a
core OL-92-2								
6A+7A	6.95	1.46	1.39	0.90	0.79	1.67	85	
8A	8.99	0.46	0.25	0.33	1.05	0.63	49	
9B+C	12.68	1.35	0.62	0.26	1.18	1.05	34	
11A+B	18.10	0.96	3.17	1.01	0.85	1.95	66	
13A+B+C	23.24	1.53	2.69	1.58	0.41	2.76	92	
14A+B	26.28	1.51	2.47	1.88	0.64	2.20	56	
17A+B	32.69	1.22	0.70	0.98	0.51	0.99	36	
18A+B+C	35.43	1.52	4.14	1.20	0.94	3.87	222	
19A+B	38.44	1.49	9.32	1.71	2.50	7.77	605	
20A+B	41.49	1.48	11.0	1.58	3.35	8.93	602	c,d
21A+B	44.61	1.5	8.52	1.66	0.97	7.14	266	c
22A+B	47.06	0.960	7.04	1.72	0.76	6.20	261	c
23A (A)	49.92	0.77	8.22	2.76	3.11	6.37	269	
25A+B	53.87	1.37	11.2	2.46	4.14	8.20	525	c,d
26A+B	56.73	1.48	12.0	1.89	3.03	9.85		
27A+B	59.80	1.51	9.98	1.12	1.88	7.34	400	
core OL-92-1								
1A+B	62.67	1.41	14.1	1.29	3.07	9.32	515	c,d
2A+B	65.57	1.42	13.4	1.73	2.45	10.3	226	c,d,a
3A+B	68.49	1.50	9.28	0.75	2.32	7.37	412	c
4A+B	71.85	1.40	7.61	1.00	1.94	6.11	224	c,d
6A+B	75.46	1.05	3.06	0.67	0.64	2.85	210	
7A+B	78.00	1.44	0.55	0.22	1.10	0.71	42	
8A+B	81.13	1.53	1.25	0.01	1.26	0.98	43	
9A+B	84.15	1.49	1.26	0.14	1.23	1.47	57	
10A+B	87.21	1.46	1.10	0.43	0.79	1.23	56	
11A+B	90.26	1.51	2.39	0.11	1.32	2.59	108	
12A+B	93.30	1.50	7.62	0.40	0.95	6.85	271	c
13A+14A	95.84	1.00	2.02	0.28	0.37	2.13	63	
15A+B	99.34	1.50	5.15	0.29	2.06	4.32	340	c
16A+B	102.3	1.45	7.70	0.68	2.26	6.30	535	c,d
22A+B	110.4	0.94	7.86	1.00	1.74	7.37	395	c
23A+B	112.8	1.51	8.11	0.84	0.519	7.40	261	
25A	115.7	0.49	5.17	0.53	1.77	4.59	307	c
26A+B	117.7	1.52	9.70	0.57	1.40	8.75	538	c
27A+B	120.8	1.53	3.82	0.46	1.08	3.59	225	
28A+B	123.4	1.12	1.61	1.11	1.14	1.69	190	
28B+C	125.6	1.01	5.82	0.62	0.85	5.34	51	c
29A+B	128.0	1.41	6.08	1.11	0.55	5.65	230	c
30A+31A	131.1	1.46	7.50	0.54	1.86	6.42	570	c,d
31B+C	133.8	1.26	7.77	0.46	2.16	6.59	548	c
32A+B	136.6	1.48	9.86	0.86	1.06	9.14	447	c
33A+B	140.5	1.49	7.39	0.56	1.94	6.89	516	c
34A+B	143.5	1.44	7.72	1.18	2.35	6.87	512	c
35A+B	146.5	1.22	9.18	1.28	1.77	8.52		c
36A+37A	148.9	1.25	7.11	0.46	2.18	7.01	83	
39A+B	153.2	1.31	1.53	0.51	1.54	1.78	91	

Table 1 (cont'd)

sample	depth	range	CO_2	org C	Mg	Ca	Sr	min
40A+B	155.9	1.39	8.82	0.69	1.28	8.31	503	c
44A+45A	163.8	1.07	10.0	1.07	2.95	8.83	693	c,d
47A+B	167.7	0.95	11.8	0.63	2.73	9.59	627	c,d
51A+B	172.8	1.05	0.01	0.16	0.78	0.31	1	
52A+53A	176.0	1.83	0.51	0.14	1.02	0.85	33	
55A+B	183.2	1.44	8.33	0.48	0.85	7.39	284	c
56A+B	186.3	1.43	9.24	1.27	0.68	8.32	441	c
57A+B	189.3	1.37	9.77	0.64	2.82	7.79	559	c,d
58A+B	192.1	1.50	11.1	0.53	3.35	8.98	586	c,d
59A+B+C	195.1	1.13	14.6	1.60	1.77	11.4	757	
59B+C	196.9	0.70	15.1	1.57	1.70	12.7	790	c
60B+C	200.4	1.23	14.8	2.94	1.92	11.0	551	c,d
61A+B	202.9	1.33	4.43	3.75	0.40	4.16	120	
63A+64A	208.6	1.51	0.60	0.20	0.80	0.68	36	
65+66A+B	213.3	1.43	10.9	0.68	1.97	8.88	528	c,d
65+66C+D	215.7	0.89	5.06	0.68	1.66	4.71	298	
69A+B	220.7	1.00	9.18	0.98	1.59	7.55	422	c
70A+B	223.1	1.37	6.04	1.84	0.57	5.58	262	c
71A+B	225.7	1.24	10.6	1.28	0.51	8.02	393	c
81A+B	235.1	0.87	0.03	0.05	0.33	0.24	2	
82A+B	237.7	1.22	0.6	0.00	0.30	0.23	23	
83A+B	240.6	0.81	0.04	0.07	0.31	0.13	1	
85A+B	245.4	0.91	0.19	0.07	0.25	0.43	6	
88A+B	253.8	1.27	0.02	0.10	0.15	0.15	3	
89A	255.3	0.27	0.01	0.19	0.20	0.11	1	
93A+94A	267.1	1.15	0.01	0.27	0.83	1.00	6	
95A+B	271.2	1.36	0.59	0.16	1.37	1.21	354	
97A+B	276.6	1.06	2.46	0.49	1.23	2.42	112	
98A+99A	279.0	1.24	3.66	0.21	0.87	3.47	210	
100A+B	283.1	0.38	10.5	1.25	1.05	9.36	294	c
100B+C	285.2	1.73	13.1	3.12	0.47	11.5	237	
101A+B	288.5	1.51	3.59	4.56	0.21	3.52	88	
102A+B	292.6	1.04	0.16	0.41	0.61	0.29	3	
103A+B	296.2	1.52	0.01	2.31	0.47	0.24	3	
104A+B	299.0	1.07	0.01	0.09	0.13	0.06	1	
104B+C	301.0	0.97	0.01	0.06	0.10	0.06	1	
105A+B	303.0	1.02	0.01	0.50	0.16	0.11	1	
105B+C	305.1	0.67	0.19	0.13	0.089	0.16	3	
106A+B	306.8	1.02	0.33	0.12	0.129	0.31	25	
106B+C	308.7	0.83	0.62	0.22	0.078	1.04	29	
107A+B	311.7	1.51	5.54	0.36	0.398	4.63	255	
108A+B	316.0	1.52	15.6	1.44	0.838	12.7	263	c
109A+B	319.4	1.32	0.08	0.35	0.354	0.17	1	
110	321.7	0.70	0.01	0.03	0.075	0.13	1	

Table 2
Carbonate (as CO_2), and organic carbon (org C) content of point-samples of Owens Lake OL-92 drill hole.

sample	depth m	wt % org C	wt % CO_2
463	1.00	2.0	3.52
464	2.00	1.5	11.3
465	3.00	0.52	24.6
466	4.00	0.84	23.6
201	7.48	1.7	1.88
202	8.11	0.27	0.72
203	9.51	1.8	4.05
204	10.49	0.16	0.36
205	11.92	1.4	5.39
208	16.06	1.9	6.84
211	17.94	1.9	4.82
213	18.70	2.6	2.54
216	24.61	1.5	0.29
218	26.46	2.1	2.95
221	33.59	0.77	0.77
223	35.56	1.3	7.91
226	39.85	0.64	6.22
228	41.72	1.9	12.5
231	46.99	1.6	6.33
233	52.37	2.8	5.38
236	56.65	2.1	8.27
238	58.80	1.5	14.3
240	61.76	2.2	7.16
243	63.48	1.4	12.2
245	65.23	1.4	8.67
248	68.35	0.48	7.58
250	70.78	1.4	6.76
253	73.79	1.7	9.75
255	75.76	0.36	0.14
258	79.72	0.11	0.79
260	86.61	0.50	2.54
263	91.26	0.13	2.64
265	93.78	0.46	7.48
268	98.18	0.31	5.76
270	100.18	0.28	5.35
273	102.18	0.78	7.84
275	103.36	1.1	7.95
278*	110.40	0.83	9.73
280	111.65	0.81	10.7
283	115.78	0.09	3.15
285	117.00	1.1	5.71
288	120.09	1.1	8.68
290	122.86	0.20	1.47
293	126.22	0.79	4.04
295	128.21	1.0	3.33
298	130.78	0.98	8.87
300	131.77	0.40	7.11
303*	134.49	1.6	9.95
305	136.24	1.2	11.4
308	137.18	0.83	10.1
310	138.31	1.6	12.5
313A*	141.27	1.1	8.55
315A	143.01	1.8	7.85
318A	145.55	0.74	9.94
320A	147.27	1.3	13.9
323A	149.23	0.14	5.92

Table 2 (cont'd)

sample	depth m	wt % org C	wt % CO_2
325A	152.32	0.07	1.87
328A	156.74	0.78	9.89
330A	162.92	0.50	12.0
333A&B	164.54	1.4	9.70
335A	168.28	0.27	12.7
340A	177.08	0.13	2.43
343A	182.95	0.38	7.87
345A	185.36	1.5	7.26
348A*	189.25	0.81	20.8
350A*	191.54	1.8	18.7
353A	195.09	1.1	14.9
355A*	196.28	1.3	15.9
363A	209.04	0.15	0.61
365A*	213.07	0.61	12.4
368A	217.03	0.04	0.55
370A	221.41	1.6	5.84
373A	225.29	0.67	9.55
375	227.30	0.02	0.06
378A	233.51	0.03	0.15
380	234.89	0.02	0.02
383A	237.53	0.15	0.02
385A	238.46	0.02	0.05
388A	244.77	0.02	0.02
390A	245.67	0.04	0.04
392A	250.90	0.03	0.05
395B	253.17	0.13	0.04
398A	262.07	0.03	0.08
400A	266.12	0.28	0.14
402A	266.97	0.08	0.04
405	270.86	0.07	0.32
406A	271.85	0.09	0.03
409A	278.36	0.43	3.80
410A	279.15	0.21	3.97
412A	283.24	0.42	10.2
415A	286.53	2.8	18.6
416A	287.07	6.2	14.6
418A	288.14	6.6	0.71
419A	288.89	1.7	2.67
421A	291.85	0.92	0.02
423A	295.46	0.35	0.11
426A	297.99	1.3	0.01
428A	298.86	0.07	0.01
430A	300.75	0.04	0.01
431A	301.83	0.54	0.01
433A	302.64	2.0	0.01
436A	304.01	0.01	0.02
438A	305.98	0.04	0.10
441A	307.11	0.34	1.29
443A	308.36	0.03	0.15
446A	310.39	0.05	0.77
447A	310.82	0.54	11.9
448A	311.21	0.05	0.76
449A	311.74	0.01	0.07
451A	312.83	1.3	9.64
453A	315.58	1.2	5.86
456A	318.46	0.05	0.01
458A	319.66	1.3	0.01

Table 3

Major oxides, Cs_2O, and ignition loss (LOI) as wt. % of dry sediment channel-samples from OL-92 drill hole. Sample designations are the same as listed in Table 1 as indicated by depth to mid-ponts. Analyses by the U.S.G.S. Analytical Laboratory; major oxides by x-ray fluorescence spectroscopy, LOI (900°C) by gravimetry (D. Hopkins, analyst), Cs_2O by non-dispersive X-ray fluorescence spectrsocopy (P. Lamothe and Bi-Shia King, analysts).

Depth	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cs_2O	LOI
5.34	31.1	3.19	1.46	7.69	25.7	0.58	0.73	0.16	0.093	0.052	2.90	26.3
6.95	58.8	13.9	5.18	2.87	3.79	2.23	3.11	0.63	0.22	0.10	2.58	6.59
8.99	57.4	16.0	5.94	3.28	2.75	2.54	3.79	0.71	0.22	0.13	2.37	4.89
12.7	57.8	16.4	5.94	3.30	2.93	2.72	3.80	0.72	0.23	0.14	1.83	4.18
18.1	57.7	13.7	5.37	2.58	4.53	2.07	3.01	0.63	0.22	0.11	1.56	8.56
23.2	61.1	11.8	3.97	1.68	5.37	2.20	2.67	0.45	0.23	0.10	1.27	9.21
26.3	59.1	12.7	4.95	2.15	4.82	2.10	2.69	0.59	0.24	0.11	2.67	7.93
32.7	64.7	12.0	4.59	1.99	2.31	1.72	2.48	0.54	0.21	0.09	1.49	8.08
35.4	56.6	12.6	4.72	2.81	6.79	1.89	2.71	0.56	0.40	0.12	1.67	9.12
38.4	45.8	9.41	3.61	5.46	13.0	1.61	2.03	0.45	0.18	0.09	2.02	16.4
41.5	43.0	9.29	3.20	7.00	13.4	1.63	1.85	0.43	0.19	0.08	2.17	17.7
44.6	54.4	8.48	3.40	2.55	11.3	1.28	1.75	0.40	0.19	0.09	1.42	14.7
47.1	56.7	9.05	3.35	2.35	9.70	1.41	1.96	0.42	0.18	0.08	1.65	13.1
49.9	48.7	8.45	3.34	6.44	9.51	1.33	1.89	0.40	0.20	0.08	2.54	17.1
53.9	43.3	7.50	3.09	7.78	12.4	1.17	1.60	0.37	0.15	0.07	2.72	19.8
56.7	43.8	8.42	3.23	6.24	14.0	1.32	1.76	0.39	0.19	0.08	2.23	18.3
59.8	50.0	9.71	3.77	4.23	11.7	1.33	2.04	0.45	0.30	0.09	1.54	14.8
62.7	43.3	8.70	3.48	6.17	14.0	1.21	1.82	0.41	0.27	0.08	1.57	19.0
65.6	41.8	7.18	2.94	6.31	16.3	1.16	1.50	0.34	0.24	0.07	1.95	20.3
68.5	48.5	10.5	3.36	4.98	12.2	1.97	2.24	0.48	0.20	0.09	2.01	13.5
71.9	47.3	11.7	4.52	5.25	9.75	1.67	2.43	0.53	0.22	0.11	2.37	14.1
75.5	58.2	13.1	5.20	2.32	5.77	2.19	2.78	0.59	0.35	0.15	1.54	7.80
78.0	60.1	13.4	5.40	2.35	5.94	2.26	2.86	0.62	0.35	0.16	2.18	4.38
81.1	55.8	16.8	6.22	3.60	3.40	2.79	3.94	0.74	0.22	0.16	1.73	4.58
84.1	56.0	16.0	6.48	3.51	4.06	2.58	3.92	0.75	0.23	0.16	1.46	4.87
87.2	59.5	14.7	5.57	2.77	3.46	2.49	3.30	0.67	0.26	0.14	1.70	5.47
90.3	53.1	15.8	6.43	3.59	5.55	2.51	3.84	0.75	0.22	0.16	1.76	6.24
93.3	50.5	11.8	4.72	2.77	11.4	1.93	2.70	0.57	0.24	0.13	1.38	11.8
95.8	65.7	12.9	2.83	1.27	3.81	3.14	3.55	0.31	0.13	0.11	0.965	5.28
99.3	49.5	14.2	5.71	4.54	8.06	2.29	3.55	0.70	0.20	0.14	2.26	8.76
102.4	46.9	11.9	4.41	4.78	10.8	1.92	2.89	0.57	0.17	0.10	3.36	12.2
110.4	48.3	10.8	4.06	4.16	11.4	1.66	2.49	0.50	0.20	0.09	2.85	13.5
112.8	50.6	10.2	4.05	2.23	12.2	1.65	2.21	0.49	0.21	0.10	2.83	13.2
115.7	50.0	13.8	5.80	4.15	8.58	2.14	4.28	0.68	0.22	0.15	1.84	8.40
117.7	47.7	10.5	4.09	3.63	13.6	1.80	2.24	0.53	0.30	0.11	1.53	14.0
120.8	54.3	13.4	4.96	3.31	6.92	2.33	3.12	0.62	0.24	0.13	2.84	7.88
123.4	55.0	15.5	6.21	3.42	4.04	2.50	3.87	0.76	0.20	0.15	3.33	5.03
125.6	53.4	12.3	4.59	2.46	9.14	2.12	2.88	0.58	0.19	0.12	3.23	9.04
128.0	54.4	10.6	4.21	2.13	9.18	1.75	2.30	0.48	0.27	0.09	3.28	11.3
131.1	48.7	12.5	4.48	4.50	10.7	2.07	3.46	0.59	0.18	0.11	2.35	10.4
133.8	47.7	12.1	4.68	4.70	10.9	1.92	3.41	0.60	0.18	0.11	2.54	11.1
136.6	47.0	10.3	4.02	3.10	14.1	1.64	2.21	0.50	0.20	0.10	2.86	13.9
140.5	47.1	12.0	4.71	4.68	10.9	1.89	3.14	0.59	0.18	0.12	3.19	11.5
143.5	46.9	10.6	4.25	5.24	11.0	1.52	2.41	0.49	0.17	0.09	2.98	14.3
146.5	46.1	9.99	3.99	4.45	12.9	1.57	2.14	0.49	0.19	0.09	3.18	14.9
153.2	54.2	16.8	6.67	3.67	3.64	2.76	5.52	0.76	0.19	0.17	1.88	3.79
155.9	45.8	11.7	4.37	3.25	13.6	1.86	2.83	0.54	0.21	0.12	2.65	13.0
163.8	44.1	9.76	3.64	5.78	13.3	1.60	2.18	0.47	0.18	0.09	3.39	15.5
167.7	41.8	9.97	3.74	5.65	14.8	1.49	2.81	0.45	0.16	0.09	2.71	16.3
172.8	58.4	15.9	5.83	3.15	2.25	2.78	3.73	0.71	0.20	0.12	2.93	4.01

Table 3 (cont'd)

Depth	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cs_2O	LOI
176.0	56.1	16.4	6.22	3.36	2.94	2.70	4.25	0.73	0.20	0.15	3.06	3.88
183.2	48.3	12.1	4.83	2.62	12.4	2.09	2.72	0.59	0.25	0.15	2.33	11.6
186.3	47.9	11.0	4.10	2.49	13.7	1.93	2.22	0.54	0.27	0.12	2.37	13.4
189.3	46.0	11.0	3.78	5.71	12.3	2.08	2.53	0.50	0.19	0.09	2.33	13.5
192.1	46.9	9.93	2.83	5.88	13.0	2.01	2.44	0.35	0.12	0.07	1.88	14.6
195.1	40.6	8.09	3.17	4.07	19.1	1.50	1.64	0.40	0.26	0.09	1.57	19.5
196.9	39.4	8.08	3.19	4.05	19.6	1.44	1.64	0.40	0.25	0.09	1.75	20.1
200.4	39.2	8.12	3.54	4.38	18.2	1.42	1.63	0.41	0.57	0.12	1.14	21.2
202.9	56.1	10.6	4.26	1.80	7.10	1.92	2.10	0.52	0.24	0.08	1.43	13.9
208.6	60.4	15.4	5.51	2.79	3.12	3.24	3.34	0.75	0.22	0.12	1.17	3.89
213.3	45.7	9.64	3.80	4.65	14.2	1.56	2.08	0.46	0.27	0.10	1.93	15.7
215.7	60.8	12.2	2.34	2.90	6.74	2.78	2.98	0.38	0.13	0.05	1.19	7.49
220.7	48.0	10.6	4.30	4.07	11.8	1.58	2.21	0.49	0.23	0.10	1.93	14.7
223.1	56.5	9.96	4.11	2.00	8.73	1.68	2.07	0.46	0.24	0.09	1.41	12.7
225.7	53.0	9.66	3.30	1.85	13.0	1.82	2.07	0.37	0.20	0.12	1.14	13.7
235.1	69.4	14.2	2.57	1.20	2.20	3.31	3.62	0.33	0.11	0.06	1.31	1.60
237.7	70.1	14.1	2.37	1.05	2.22	3.54	3.55	0.32	0.12	0.06	1.21	1.39
240.6	67.7	14.4	3.08	1.44	2.24	3.25	3.51	0.39	0.13	0.07	2.35	1.67
245.4	70.1	14.0	2.41	1.07	2.63	3.38	3.71	0.31	0.12	0.07	0.498	1.66
253.8	70.5	13.5	2.39	0.884	1.80	3.43	3.73	0.31	0.14	0.05	1.04	2.20
255.3	68.1	13.6	2.87	1.27	1.56	3.24	3.73	0.38	0.11	0.06	1.85	3.47
267.1	58.2	15.9	6.15	3.25	2.50	2.72	3.80	0.76	0.19	0.13	2.08	4.36
271.2	55.4	16.4	6.92	3.91	2.87	2.64	3.99	0.83	0.21	0.178	2.05	4.57
276.6	54.3	15.1	6.36	3.73	4.91	2.22	3.55	0.77	0.20	0.14	2.10	6.62
279.0	60.2	14.1	3.53	2.38	6.04	2.99	3.40	0.46	0.15	0.08	0.742	5.95
283.1	47.5	9.72	3.90	3.03	14.4	1.39	1.95	0.45	0.25	0.12	1.24	16.1
285.2	49.7	5.06	2.34	1.39	17.8	0.694	0.89	0.23	0.27	0.09	0.710	20.9
288.5	64.2	7.66	3.26	1.08	5.81	1.42	1.44	0.35	0.26	0.06	0.678	13.8
292.6	62.1	14.4	5.42	2.53	1.84	2.40	3.33	0.66	0.18	0.14	1.85	5.06
296.2	63.7	12.4	4.57	1.99	1.58	2.22	2.74	0.58	0.18	0.08	1.64	8.33
299.0	72.8	13.4	1.24	0.43	1.47	3.66	4.13	0.18	0.06	0.04	0.254	2.35
301.0	72.7	12.9	1.33	0.45	1.08	3.54	4.19	0.17	0.05	0.04	0.350	3.16
303.0	71.9	12.4	1.85	0.64	1.04	3.17	3.83	0.25	0.09	0.04	0.710	4.09
305.1	73.2	12.3	1.26	0.35	0.82	3.41	4.40	0.15	0.01	0.05	0.212	3.87
306.8	72.0	12.4	1.44	0.48	0.96	3.19	4.36	0.16	0.01	0.05	0.339	4.67
308.7	71.7	12.3	1.54	0.53	1.39	3.18	4.28	0.19	0.06	0.05	0.307	4.41
311.6	60.5	11.7	2.78	1.47	7.94	2.65	3.05	0.38	0.16	0.09	0.525	8.70
316.0	43.9	7.33	2.96	2.07	19.9	1.18	1.46	0.32	0.23	0.12	0.551	20.0
319.4	69.4	13.7	2.66	1.06	1.87	3.14	3.46	0.34	0.12	0.05	0.742	3.50
321.7	73.7	13.6	1.09	0.46	1.96	3.51	3.91	0.20	0.07	0.04	0.117	1.35

Table 4
Minor-element composition (ppm) of sediment channel-samples from OL-92 drill hole. Analyses by semi-quantitative optical emission spectroscopy. U.S.G.S. Analytical Laboratory (D.F. Siems, analyst)

Depth	B	Ba	Be	Co	Cr	Cu	Ga	Mo	Ni	Pb	Sc	V	Y	Zr
5.34	100	300	0.5	20	15	15	10	2.5	15	15	3	50	5	20
6.95	100	700	1	20	30	30	30	0	30	30	10	70	15	50
8.99	70	700	1	30	50	30	30	0	50	30	10	70	15	50
12.7	30	1000	1	20	50	30	50	2.5	70	30	10	100	15	50
18.1	30	700	1.5	20	30	30	30	2.5	30	30	7	100	15	50
23.2	50	300	2	10	30	20	30	2.5	15	30	5	70	15	50
26.3	30	700	1.5	20	50	50	50	5	30	30	10	100	20	70
32.7	50	700	1.5	20	50	50	50	0	30	30	10	100	20	70
35.4	50	500	1.5	15	30	20	20	2.5	20	15	7	70	15	50
38.4	50	300	1	10	30	20	20	2.5	15	20	5	70	10	20
41.5	50	300	1	5	20	15	15	5	15	20	5	70	10	30
44.6	50	300	1	5	50	20	20	0	30	20	7	70	15	50
47.1	50	300	1.5	5	30	20	20	0	15	15	5	70	15	30
49.9	70	300	2	5	20	20	15	2.5	18	18	5	70	8	30
53.9	70	300	1	5	20	20	20	2.5	15	20	5	70	15	30
56.7	70	300	1	5	50	20	20	5	15	20	5	70	10	50
59.8	70	500	1.5	10	30	20	20	2.5	30	20	7	70	15	50
62.7	70	300	1.5	5	30	20	20	0	15	20	7	100	15	50
65.6	70	300	1	5	20	15	15	0	7	20	5	50	10	30
68.5	70	300	1.5	5	20	15	15	0	10	15	5	70	10	30
71.9	70	500	1	15	50	230	30	2.5	20	30	7	100	15	50
75.5	70	700	1.5	15	30	30	30	2.5	20	30	7	70	15	70
78.0	20	1000	1	20	50	20	30	2.5	20	20	10	100	15	50
81.1	20	1000	1	20	30	30	50	0	20	20	10	100	15	50
84.1	30	1000	1	20	30	30	30	0	20	20	10	100	15	50
87.2	30	1000	1	20	50	30	50	0	20	30	10	100	20	70
90.3	30	1000	1	30	30	30	30	0	20	20	10	100	15	50
93.3	50	700	0.5	15	30	20	30	0	20	20	7	100	10	50
95.8	50	300	3	10	15	15	30	2.5	30	70	7	50	15	50
99.3	30	700	0.5	30	30	30	30	0	20	20	10	100	15	30
102.3	50	700	1	20	50	30	50	5	30	20	10	100	15	50
110.4	70	500	1.5	15	50	20	20	5	20	20	7	100	15	50
112.8	300	300	1	15	30	20	30	2.5	20	20	7	100	15	70
115.7	70	700	1	30	30	50	30	5	70	20	10	100	15	30
117.7	50	500	1	15	30	20	20	2.5	20	20	7	70	15	70
120.8	70	500	1	20	30	30	30	5	20	20	7	100	15	70
123.4	130	600	0.8	20	40	30	30	5	18	20	7	85	15	50
125.6	70	700	1	30	30	30	50	2.5	70	20	10	100	15	50
128.0	200	300	1	10	30	20	20	0	15	15	5	50	10	30
131.1	70	700	1	15	30	20	30	10	20	20	7	70	15	50
133.8	70	700	1	20	30	30	50	10	20	20	7	70	15	50
136.6	100	300	1.5	15	50	20	30	2.5	20	20	7	70	15	50
140.5	70	700	1.5	20	30	20	30	10	20	15	7	70	15	70
143.5	70	300	1.5	10	30	20	20	2.5	20	15	7	70	15	50
146.5	100	300	1.5	5	30	20	30	2.5	15	20	7	70	15	50
153.2	70	700	1.5	30	50	30	50	7	30	30	10	100	20	30
155.9	70	700	1	20	30	20	30	2.5	20	20	7	100	20	50
163.8	70	300	1	15	50	20	15	10	20	10	5	100	15	50
167.7	100	500	1	20	50	20	30	15	30	20	7	70	15	70
172.8	70	1000	1	50	70	30	50	5	30	20	10	150	20	70
176.0	70	1000	1	30	50	30	50	0	30	20	10	150	20	50
183.2	70	500	1	20	30	30	30	0	20	15	7	100	15	50
186.3	70	500	1	20	50	30	20	2.5	20	15	7	150	15	100

Table 4 (cont'd)

Depth	B	Ba	Be	Co	Cr	Cu	Ga	Mo	Ni	Pb	Sc	V	Y	Zr
189.3	70	500	1.5	15	50	20	20	7	50	15	7	100	15	50
192.1	50	500	1	10	30	20	30	10	20	20	5	70	10	30
195.1	70	300	1	5	30	20	20	2.5	15	15	5	70	10	30
196.9	70	300	1	5	30	20	30	22	15	15	7	70	15	70
200.4	70	300	1	10	30	20	20	2.5	20	20	7	70	15	30
202.9	70	300	1.5	10	30	30	30	0	20	20	7	70	15	50
208.6	20	500	1	20	20	30	30	0	15	20	10	70	15	50
213.3	50	500	1	15	50	30	30	7	20	20	7	50	15	50
215.7	30	1000	1	5	15	15	20	5	15	20	5	50	20	30
220.7	30	1000	1.5	15	50	30	30	7	20	20	7	70	20	540
223.1	50	500	1.5	15	30	30	30	2.5	15	20	7	70	15	50
225.7	30	300	1	10	30	20	20	2.5	15	20	7	70	10	30
235.1	15	7000	1.5	10	15	15	20	3	12.5	20	7	70	13	50
237.7	10	700	1.5	5	15	15	20	2.5	10	20	5	50	10	50
240.6	15	1000	1.5	10	20	20	30	0	15	20	7	70	15	50
245.4	15	700	1.5	5	10	15	20	0	7	15	5	50	5	50
253.8	20	3000	1.5	5	20	15	30	7	15	20	7	50	20	50
255.3	30	1000	1.5	10	20	20	50	7	15	30	7	70	15	70
267.1	30	2000	1	30	50	30	50	0	30	20	10	150	20	100
271.2	50	1500	1	50	50	50	50	0	30	30	15	150	20	70
276.6	30	5000	1	30	30	50	50	0	30	20	10	100	15	50
279.0	30	5000	1.5	15	15	20	30	7	15	20	5	50	10	70
283.1	30	3000	1	10	30	20	30	5	15	20	5	70	10	30
285.2	20	1500	1	5	20	20	15	7	70	15	5	30	5	30
288.5	20	2000	1.5	5	15	30	20	2.5	10	15	5	30	10	30
292.6	20	1500	1.5	20	30	50	50	2.5	20	20	7	70	15	50
296.2	30	5000	1.5	20	50	50	50	10	20	20	10	100	20	100
299.0	15	300	1.5	0	5	10	30	5	7	30	3	20	10	30
301.0	20	1000	1.5	0	5	10	50	5	7	30	3	15	15	50
303.0	20	1000	2	5	15	20	30	7	7	30	5	30	15	70
305.1	30	300	2	0	5	10	50	7	7	50	3	15	15	70
306.8	20	1000	3	0	15	15	50	7	7	30	3	10	15	30
308.7	30	1000	3	5	15	15	50	7	7	50	5	20	15	50
311.7	20	4000	2	5	20	20	30	7	15	20	7	60	15	110
316.0	20	1500	1	5	30	20	20	2.5	15	15	7	70	5	30
319.4	20	1500	1.5	5	30	15	30	5	20	20	5	70	15	50
321.7	15	1500	2	0	15	7	30	2.5	7	20	3	20	10	50

Table 5
Densities of composite samples from the OL-92 core[1]

sample	weight g	volume cc	density g/cc	
composite 1	11.39	4.33	2.63	
"	"	4.39	2.59	
"	"	4.38	2.60	av.=2.61
composite 2	11.72	4.42	2.65	
"	"	4.52	2.59	
"	"	4.50	2.60	av.=2.62
composite 3	10.86	4.04	2.69	
"	"	4.07	2.67	
"	"	4.07	2.67	av.=2.68
composite 4	10.06	3.72	2.71	
"	"	3.77	2.67	
"	"	3.76	2.68	av.=2.69
composite 5	12.22	4.59	2.66	
"	"	4.67	2.62	
"	"	4.66	2.62	av.=2.63
composite 6	10.86	4.16	2.61	
"	"	4.26	2.55	
"	"	4.25	2.56	av.=2.57

1
- Composite 1: OL-92-1, 6A+7A to 13A+B+C
- Composite 2: OL-92-1, 14A+B to 27A+B plus OL-92-2, 1A+B to 9A+B
- Composite 3: OL-92-2, 10A+B to 33A+B
- Composite 4: OL-92-2, 34A+B to 60B+C
- Composite 5: OL-92-2, 61A+B to 93A+94A
- Composite 6: OL-92-2, 95A+B to 110

Table 6

Averaged characteristics of sediments from Owens Lake OL-92 drill hole. Values are reported as mean ± 1σ

$CaCO_3$	12.5 ± 10.9 %
org C	0.92 ± 0.87 %
CEC (cfb)*	32.7± 6.8 meq/100g
grain density	2.63±0.05 g/cc

* Cation exchange capacity for clay-size fraction on a carbonate-free basis

Table 7

Averaged composition of sediment from Owens Lake OL-92 drill hole, on an acid-insoluble basis (carbonate-free), compared to granodiorites and average shale

	Owens sediment	GSP-1[1]	Lamarck granodiorite[2]	average shale[3]
SiO_2	68.60	67.38	66.92	58.1
Al_2O_3	14.77	15.25	15.19	15.4
Fe_2O_3t	5.05	4.32	5.05	7.52
CaO	2.92	2.02	3.79	3.11
MgO	2.41	0.96	1.74	2.44
Na_2O	2.67	2.80	3.16	1.3
K_2O	3.53	5.53	3.82	3.24
TiO_2	0.62	0.66	0.47	0.65
P_2O_5	0.26	0.28	0.18	0.17
MnO	0.13	0.04	0.08	0.06
sum	99.96	99.24	100.40	100.00
B	61	<3		310
Ba	980	1300		460
Be	1.3	1.5		<4
Co	14	6		8
Cr	31	13		500
Cu	26	33		192
Ga	31	22		50
Mo	4	1		
Ni	21	13		24
Pb	22	51		20
Sc	7	7		7
V	75	53		120
Y	14	30		28
Zr	56	500		120

1. GSP-1 is a granodiorite collected near Silver Plume, Colorado (Flanagan, 1976)
2. Lamarck granodiorite was collected from east central Sierra Nevada, California (Bateman et al, 1963)
3. oxides from Clark (1924), minor elements from Rankama and Sahama (1950)

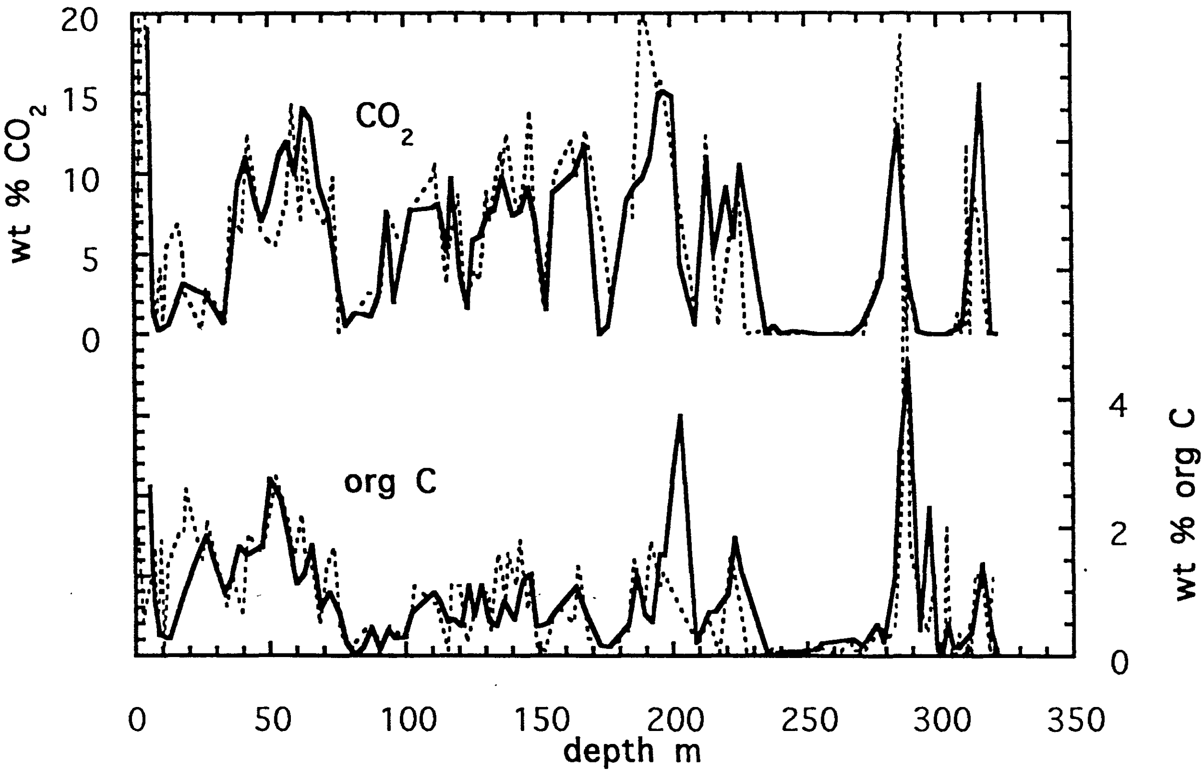

Fig. 1
Carbonate (as CO_2) and organic carbon content of sediments from Owens Lake drill hole OL-92. Solid lines are from channel samples, dotted lines from point samples.

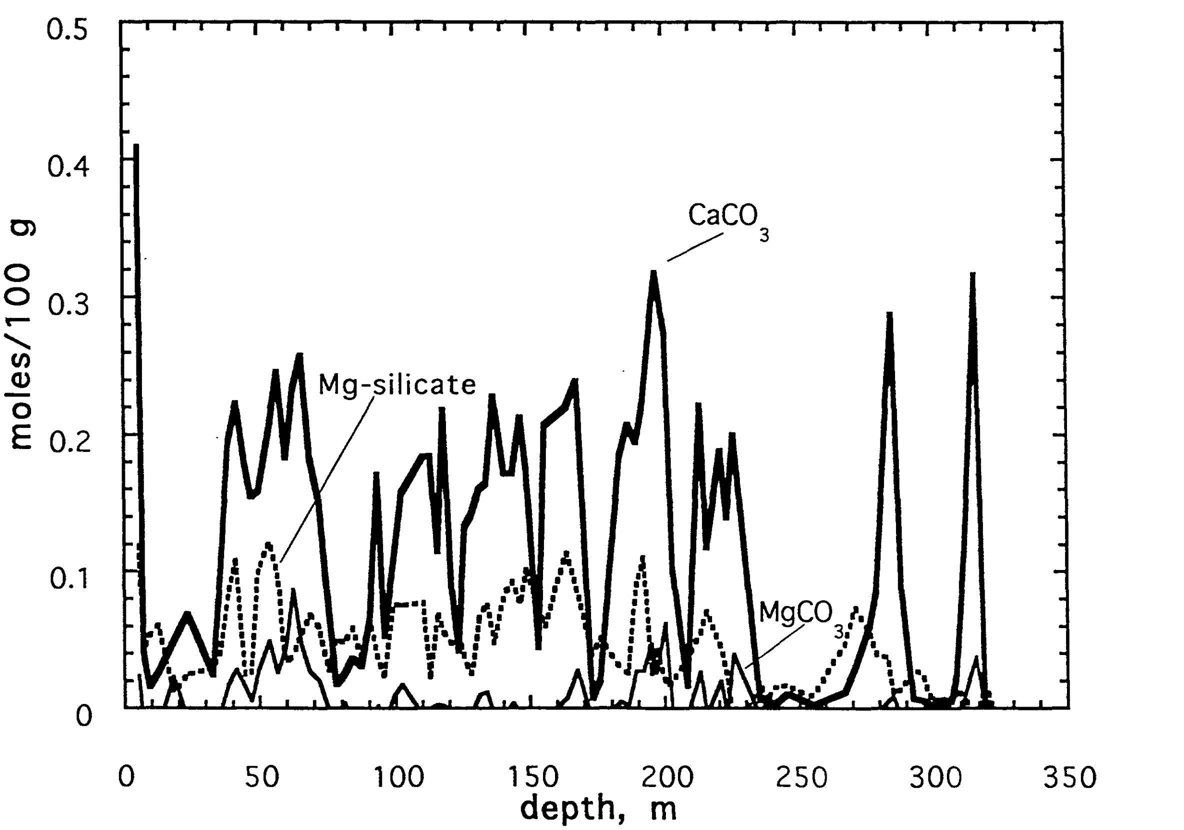

Fig. 2
Relative amounts of $CaCO_3$, $MgCO_3$, and acid-soluble Mg-silicate components on a moles/100g basis of sediments from Owens Lake drill hole OL-92.

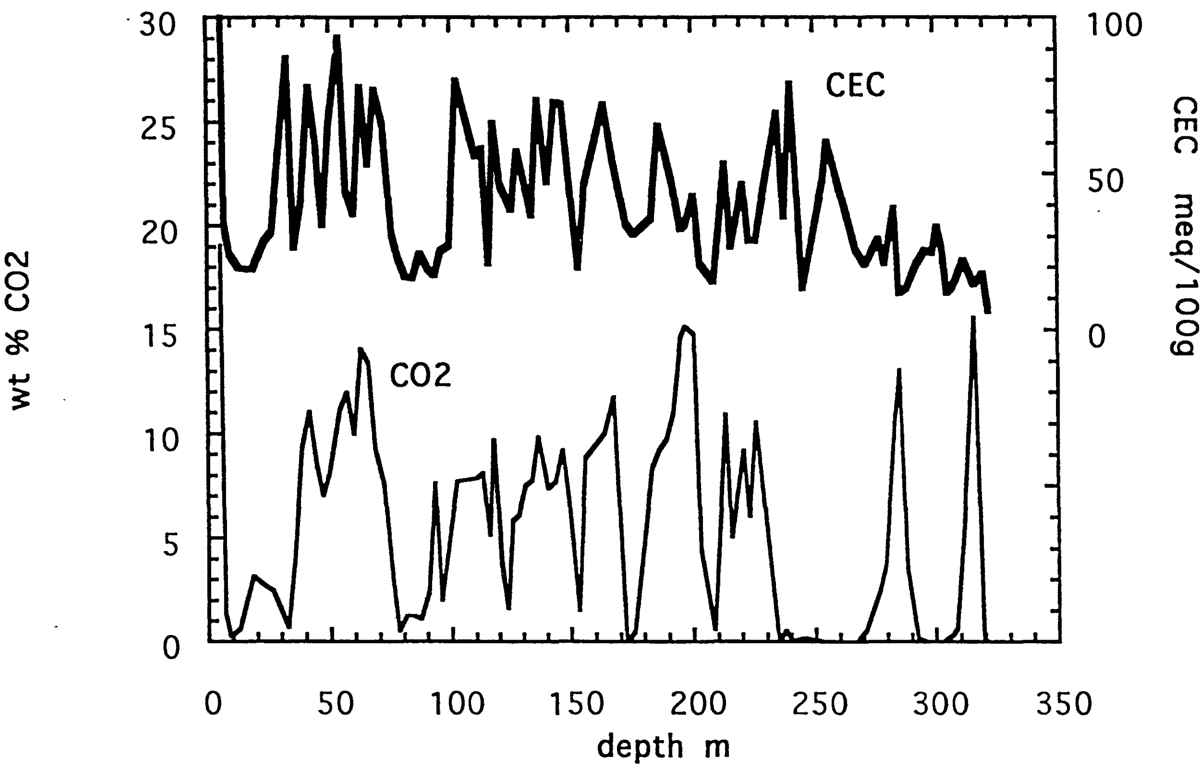

Fig. 3
Co-variation of cation exchange capacity (CEC) of clay fraction and bulk carbonate content (CO_2) with depth in Owens Lake drill hole OL-92

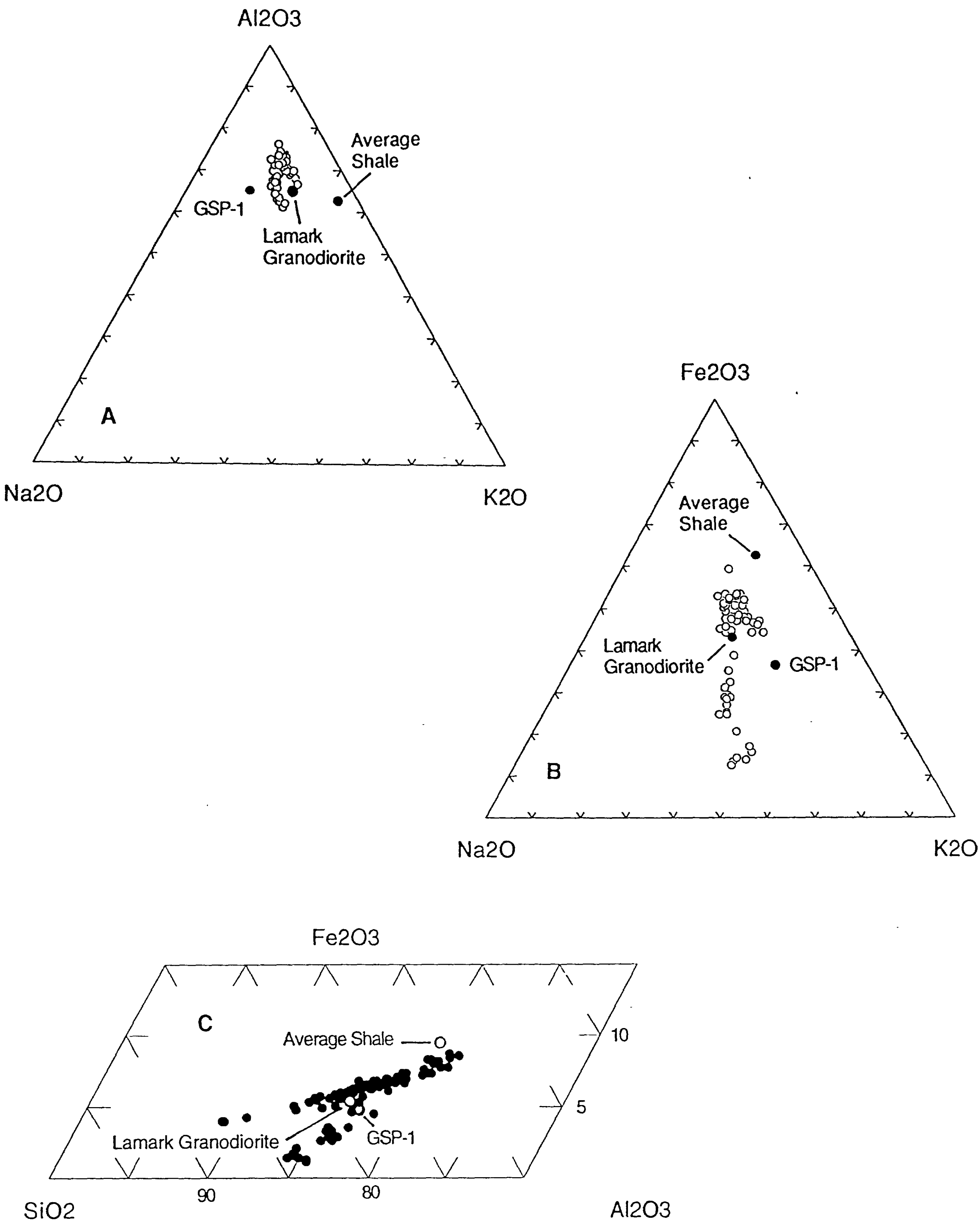

Fig 4
Triangular diagrams showing major oxide composition of sediments from Owens Lake drill hole OL-92 compared to average shale and diorite (GSP-1 and Lamark, see table 7). A. Al-Na-K. B. Fe-Na-K. C. truncated triangle (lower left corner) of Fe-Si-Al.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SEDIMENT PORE-WATERS OF OWENS LAKE DRILL HOLE OL-92

by

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Open-File Report 93-683

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1993

ABSTRACT

The salinity-depth profile of pore-waters from the Owens Lake drill hole OL-92 has been drastically smoothed by post-depositional diffusion of dissolved salts and ground water flow, such that the present pore water composition bears little relationship to past climate. Water content varies erratically down the core, generally decreasing from about 60 wt % at the top to about 20 wt % at 240 m, but water content increases sharply at levels below 240 m to between 40-60 wt %, indicating significant undercompaction for the lowermost 100m. The pore waters are alkaline (pH 8-10) with anionic compositions of $HCO_3 \approx Cl > SO_4$ which is similar to the chemistry of the modern lake before diversion of the source waters. The pore water salinity ranges from 0.4 to 5 wt % TDS. Salinity varies with depth in a smooth pattern with a minimum at 30 m, gradually increasing to a single broad maximum at about 150 meters depth, and declining sharply thereafter to steady low values at 210 meters and below where ground water is apparently flowing at present.

INTRODUCTION

During the spring of 1992, a 323 m core (7.6 -cm diameter) was recovered from Owens Lake in order to obtain a record of climate history and natural climate variation. Drilling was carried out in three sub sections: from the surface to 7.16 m (OL-92-3), from 5.49 to 61.37 m (OL-92-1) and from 61.26 to 322.86 m (OL-92-2), together representing about 800 kyr of sedimentation (Smith, 1993). Sediments were analyzed for grain size, major elements, carbonate, organic carbon, cation-exchange capacity, radiocarbon, and pore-water composition, in order to monitor climatic changes and place them in a temporal context. We report here on the pore water content and composition of samples from the core. The companion article by Friedman et al (1993) reports deuterium/hydrogen ratios on the same samples. Results for other sediment-parameters are reported in other companion articles (Bischoff et al 1993a and 1993b; Menking et al 1993a and 1993b)

SAMPLING PROCEDURES

Samples of fresh wet sediment (60 cc) for the determination of water content and pore water chemistry were taken during the drilling operations at every 2-3 m from clay-rich horizons for the entire length of the core (120 samples). The samples were taken in the field from the freshly split core within minutes of exposure of the fresh sediment. Each sample was trimmed of disturbed sediment adjacent to the core liner, and immediately sealed within a 75 ml air tight glass bottle and kept refrigerated at 5°C until laboratory processing some three months later.

LABORATORY PROCEDURES

For the determination of water content, 1 to 2 cc splits of the fresh sediment were weighed into ceramic crucibles and their weight loss recorded after heating for two days at 100°C. Water content as weight per cent is simply the percentage of weight loss of the sediment. The remaining sample was transferred into a stainless steel cylindrical squeezer (modified after that of Manheim, 1966) which was then pressurized with a simple laboratory hydraulic press (12 ton capacity). The pore water squeezed from the sediment passed through three layers of filter paper and into a polyethylene syringe. Squeezing for 10 to 30 minutes yielded from 3 to 25 ml of pore water, depending on the water content of the sample. The sample was then passed through a swinney-mounted membrane filter (0.45 µm pore size). Two drops were used for immediate measurement of refractive index for salinity, a 1 ml aliquot was used for immediate pH determination by micro electrode, 1-2 ml were injected into a septum-capped evacuated blood tube for isotopic analyses, and the remainder stored in a tightly-capped polyethylene bottle for further chemical analyses. Ct (total dissolved inorganic carbon) was determined by an infrared CO_2-analyzer. Cl was determined by potentiometric titration with an auto-titrator, and sulfate concentration was determined by ion chromatography. The remaining sediment cake was retained for analyses of organic C, carbonate, and grain size as reported in the companion reports by Menking et al (1993a) and Bischoff et al (1993a).

DATA AND DISCUSSION

Results are presented in Table 1 and Figs. 1 and 2. Water content, the measure of compaction, varies erratically down the core, generally decreasing from about 60 wt % at the top to about 20 wt % at 240m (Table 1, Figure 1). Below 240 meters and to the bottom of the core the water content sharply increases to between 40-60 wt %. This zone is characterized by an abundance of sandy units (Smith, 1993). Salinity varies with depth in a smooth pattern (Table 1, Fig. 1) with a minimum at 30 m, gradually increasing to a single broad maximum at about 150 meters depth, and sharply declining thereafter to steady low values at 210 meters and below. The salinity of the modern lake (1872) prior to agricultural activity in the water shed, was about 9% (Gale, 1914).

Assuming that similarly elevated salinity characterizes the various interglacial times when Owens Lake was the terminus, and that fresh waters must have characterized the glacial periods of intense overflow, one might expect about 8 salinity oscillations during the 800 kyr time span of the core. Such cycles are seen in the solid components of the sediments, particularly for carbonate and organic carbon content (Bischoff et al, 1993a) indicating the lake did indeed experience such changes. The salinity-depth profile, therefore, has been drastically smoothed by post-depositional diffusion of dissolved salts. Remnant waters of the last interglacial are the likely explanation only for the first salinity minimum seen at 30-40 m depth. The smooth and gradual increase of salinity in the older sediments below this depth to a maximum at about 150 m is likely the result of diffusional smoothing of older cycles. Diffusion should have had more than sufficient time, therefore, to smooth salinity gradients even lower in the core. The abrupt and erratic decrease of salinity from 150 to 210 m depth, and the erratic and generally low salinities from 210 to the bottom of the hole points to an open system for the basal pore fluids. The most likely explanation for this pattern is that fresher waters are actively moving through the sandy units below 200 m, diffusionally harvesting salt from the overlaying fine-grained sediments in the process. This ground water is moving at different velocities in the varyingly permeable sandy units, and diffusional steady state and smoothing of the salinity gradients has not been achieved.

The pre-1872 water of Owens Lake was characterized by an anionic composition of Cl:Ct:SO_4 about 47:47:6 (mole basis), and Na was the only significant cation (Gale, 1914). With a salinity of about 9% the lake was alkaline and must have had a pH on the order of 10. The average pore water of the sediment, on the other hand, has pH between 8 and 10, a salinity of only 2.7%, and the anionic proportions are Ct:Cl:SO_4 of 52:45:3. The pore water, therefore, is similar in Ct:Cl to the modern lake, but has a lower salinity and a reduced proportion of SO_4, a consequence of the activity of sulfate reducing bacteria that produce the abundant iron monosulfides which blacken the fine grained sediments A depth plot of Ct and Cl (Fig. 2) shows that the relative proportions of the two change with depth. The extremely high salinity of the top 20 meters is not a reflection of the modern (pre-1872) lake. Rather, it is a consequence of almost complete desiccation of the lake in 1912 and the downward migration of the more dense residual-brines. As the lake dried Na carbonate minerals precipitated resulting in the 1 to 2 m thick salt bed at the surface today, and the residual brine became relatively enriched in Cl. This residual brine then percolated downward by gravity displacement and ionic diffusion, affecting the pore water composition down to about 15 m and explaining the reversal in the Ct/Cl ratio as observed in Fig. 2. There is neither sedimentological nor mineralogical evidence in the entire length of the core that such concentrations of brine and precipitation of saline minerals had been attained before. Below about 50 meters depth both Ct and Cl increase in a smooth pattern. At 40 m, Ct and Cl are about equal as they were in the pre-1872 lake. Below this depth the Cl pattern is more spread out than Ct, and in the region of the salinity maximum at 150 m, Ct exceeds Cl, while in the low salinity region below 240 m Cl exceeds Ct. The pattern is most readily explained by relative diffusivity of Cl and HCO_3. With a decreasing salinity gradient in both directions from the maximum at 150 meters, Cl and HCO_3 are diffusing from this maximum both downward and upwards. The coefficient of ionic diffusion for Cl is twice that for HCO_3 (2.3 $\times 10^{-5}$ versus 1.18 $\times 10^{-5}$ $cm^2\ sec^{-1}$; Li and Gregory, 1974) so it is to be expected that Cl transport away from the salinity maximum will be about twice the rate of HCO_3 transport.

The present pore water composition, therefore, bears little relationship to past climate because depth profile has clearly been smeared by post-depositional diffusion of dissolved salts, and modern flow of ground waters. Deuterium/hydrogen ratios in the pore-waters led Friedman et al (1993) to essentially the same conclusions.

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Table 1
Water content and pore water composition of sediments from OL-92. Water content and salinity in wt %. Cl, Ct (total dissolved CO_2), and SO_4 in millimolal (mm). Absence of data entry indicates component was not analyzed.

Sample	depth m	H_2O%	pH	salinity%	mmCl	mmCt	mmSO_4
463	1.00	62.7	9.5	14	1450	511.8	118
464	2.00	58.2					
465	3.00	27.1					
466	4.00	29.0	9.3			450.8	
200	6.09	56.4	9.5	12	1162	506.4	96.3
201	7.48	58.2	9.4	10	929.0	438.2	74.4
202	8.11	46.8	9.4	8.7	829.0	489.1	94.2
203	9.51	58.0	9.5	9.8	898.0	428.4	77.6
204	10.49	44.0	9.1	6.9	733.3	333.1	25.5
205	11.92	63.1	9.5	7.7	695.5	332.9	57.6
208	16.06	59.0	9.5	9.9	894.3	405.5	76.0
211	17.94	52.9	7.9	2.4	304.2	109.1	
213	18.70	58.6	7.8	2.0	260.6	109.4	
216	24.61	51.3	7.7	1.4	153.0	85.88	0.885
218	26.46	60.0	7.7	1.2	134.0	87.89	0.883
221	33.59	53.5	8.1	1.0	92.63	95.77	0.122
223	35.56	60.7	8.2	1.0	87.47	106.1	0.143
226	39.85	53.5	8.7	1.0	84.03	85.22	0.338
228	41.72	55.1	8.8	1.1	85.75	89.53	0.658
231	46.99	53.3	8.9	1.2	92.63	131.9	0.188
233	52.37	63.4	8.9	1.5	103.0	129.7	1.52
236	56.65	52.9	8.9	1.5	106.4	161.2	1.07
238	58.80	47.2	8.7	1.7		147.0	1.08
240	61.76	54.9	8.9	1.9	116.7	164.5	0.576
243	63.48	53.5	8.9	1.8	121.9	163.3	0.883
245	65.23	51.6	8.8	1.8	123.6	163.8	0.752
248	68.35	33.1	9.0	2.0	128.8	172.9	0.775
250	70.78	44.2	9.4	2.0	206.7	192.5	7.71
253	73.79	42.7	9.2	2.0	139.2	163.5	0.515
255	75.76	39.0	9.2	2.1	151.3	182.1	2.56
258	79.72	37.9	9.3	2.4	175.5	186.3	4.80
260	86.61	41.3	9.3	2.4	170.3	208.3	0.874
263	91.26	30.4	9.4	2.6	187.6	218.7	3.97
265	93.78	48.8	9.4	2.7	180.7	230.7	1.90
268	98.18	42.6	9.5	3.0	194.5	232.3	8.47
270	100.18	33.2	9.2	3.0	194.5	240.7	1.08
273	102.18	34.6	9.4	3.0	201.5	241.6	7.30
275	103.36	29.9	9.2	3.5	201.5	264.9	4.64
278*	110.40	40.1					
280	111.65	45.6	9.5	3.4	204.9	282.7	9.22
283	115.78	27.3	9.7	3.5	204.9	291.8	2.15
285	117.00	31.3	9.6	3.6	206.7	293.3	7.25
288	120.09	29.9	9.7	3.9	210.1	297.8	5.26
290	122.86	42.4	9.7	3.8	213.6	287.5	1.24
293	126.22	46.5	9.6	3.9	215.4	309.1	5.47
295	128.21	48.1	9.7	3.9	215.4	308.7	1.94
298	130.78	46.8	9.7	4.0	215.4	306.6	4.08
300	131.77	25.8	9.8	4.0	213.6	299.9	3.51
303*	134.49	33.1		4.1			
305	136.24	44.2	9.7	4.4	225.8	303.9	4.96
308	137.18	45.6	9.8	4.2	222.3	326.2	2.44
310	138.31	41.3	9.8	4.2	218.8	337.0	1.97
313A*	141.27	29.4					
315A	143.01	38.6	9.6	4.4	227.5	347.5	2.28
318A	145.55	34.7	9.9	3.7	225.8	343.1	4.21
320A	147.27	40.7	9.7	4.4	234.5	314.2	9.06
322B	148.47	27.8	9.5	4.8	234.5	347.3	1.97
323A	149.23	24.1	10	5.0	231.0	351.3	3.35
325A	152.32	28.4	9.8	4.5	220.6	339.8	2.85
328A	156.74	37.3	9.8	4.5	222.3	339.9	4.75

Table 1 (cont'd)

Sample	depth m	H_2O%	pH	salinity%	mmCl	mmCt	$mmSO_4$
330A	162.92	26.5	9.9	4.5	217.1	334.0	5.00
333A&B	164.54	29.2	9.8	4.4	211.9	314.9	7.31
335A	168.28	19.5		4.5	232.7	333.7	
338A	174.83	36.2	9.8	4.4	199.7	324.6	4.46
340A	177.08	28.9	9.8	3.9	192.8	315.7	1.05
343A	182.95	38.7	9.7	3.8	187.6	311.6	3.61
345A	185.36	37.4	9.8	3.6	184.1	290.5	5.49
348A*	189.25	33.7					
350A*	191.54	26.0		4.0			
353A	195.09	33.2	9.7	2.8	158.2	239.4	2.66
355A*	196.28	40.6					
358A	200.92	32.6	9.7	2.4	142.6	205.9	4.02
360A	203.62	41.1	9.5	1.8	134.0	180.2	8.39
363A	209.04	32.2	9.8	0.70			
365A*	213.07	33.9					
368A	217.03	16.6	8.9	1.3	172.0	125.8	32.9
370A	221.41	44.4	9.3	0.90	132.3	125.5	6.92
373A	225.29	29.7	9.0	1.5	111.6	115.0	4.99
375	227.30	14.7		2.1	144.4	122.6	10.6
378A	233.51	22.5	9.2	1.7	121.9	107.2	18.7
380	234.89	16.6	8.6	1.4	111.6	39.08	51.2
383A	237.53	24.2	9.8	1.5	111.6	108.6	2.24
385A	238.46	13.4		2.2	115.0	113.8	3.23
388A	244.77	16.8	8.9	1.5	115.0	79.32	2.57
390A	245.67	19.5	9.8	1.6	111.6	107.8	0.629
392A	250.90	21.7	9.8	1.7	115.0	101.6	0.914
395B	253.17	28.8	9.6	1.6	113.3	102.1	6.79
398A	262.07	23.3	7.9	1.5	106.4	4.814	
400A	266.12	27.7	9.2	1.3	108.1	96.24	17.3
402A	266.97	29.8	10.0	1.1	103.0	70.27	3.38
405	270.86	31.0	9.4	1.1	99.52	71.32	1.86
406A	271.85	33.5	9.8	1.1	96.07	69.68	1.64
407A	276.00	35.4	8.6	1.1	94.35	71.19	21.0
409A	278.36	33.5	8.8	1.2	89.19	64.33	5.67
410A	279.15	16.7		1.7	88.85	2.290	
412A	283.24	34.7	8.5	0.80	87.43	51.69	11.3
415A	286.53	45.2		0.70	84.02	47.38	7.16
416A	287.07	52.1	8.4	0.70	82.32	49.00	4.22
418A	288.14	54.8	8.1	0.60	81.19	30.09	17.2
419A	288.89	40.4	8.4	0.60	82.89	30.99	11.3
421A	291.85	40.6	7.8	0.90	84.31	39.77	40.7
423A	295.46	34.8	8.8	0.60	88.85	39.13	5.68
426A	297.99	29.0	8.3	0.60	93.39	29.04	11.4
428A	298.86	30.2	7.9	0.60	91.97	11.29	20.5
430A	300.75	28.2	8.6	0.60	88.85	29.61	8.41
431A	301.83	34.7	8.3	0.60	91.97	28.32	6.41
433A	302.64	51.5	8.2	0.60	90.27	24.50	10.8
436A	304.01	24.4	8.6	0.70	93.39	16.37	12.9
438A	305.98	37.9	8.6	0.50	87.43	40.31	1.22
441A	307.11	31.6	8.4	0.90	96.23	23.69	2.38
443A	308.36	32.4	8.9	0.80	88.85	36.47	2.14
446A	310.39	24.0	8.1	1.0	91.97	4.144	24.5
447A	310.82	23.5	8.2	0.60	93.39	18.96	18.4
448A	311.21	24.3	8.3	0.60	84.31	7.935	20.4
449A	311.74	26.6	8.6	0.80	88.85	18.84	6.79
451A	312.83	37.0	8.2	0.60	90.27	16.02	19.1
453A	315.58	41.4	8.2	0.50	90.27	24.65	7.57
456A	318.46	18.2	8.2	0.70	93.39	3.520	28.5
458A	319.66	29.9	8.4	0.40	93.39	17.30	2.04
460A	321.24	11.8	8.4	1.2	84.31	2.200	
462A	322.18	19.7	7.8	0.80	75.23	14.30	40.0

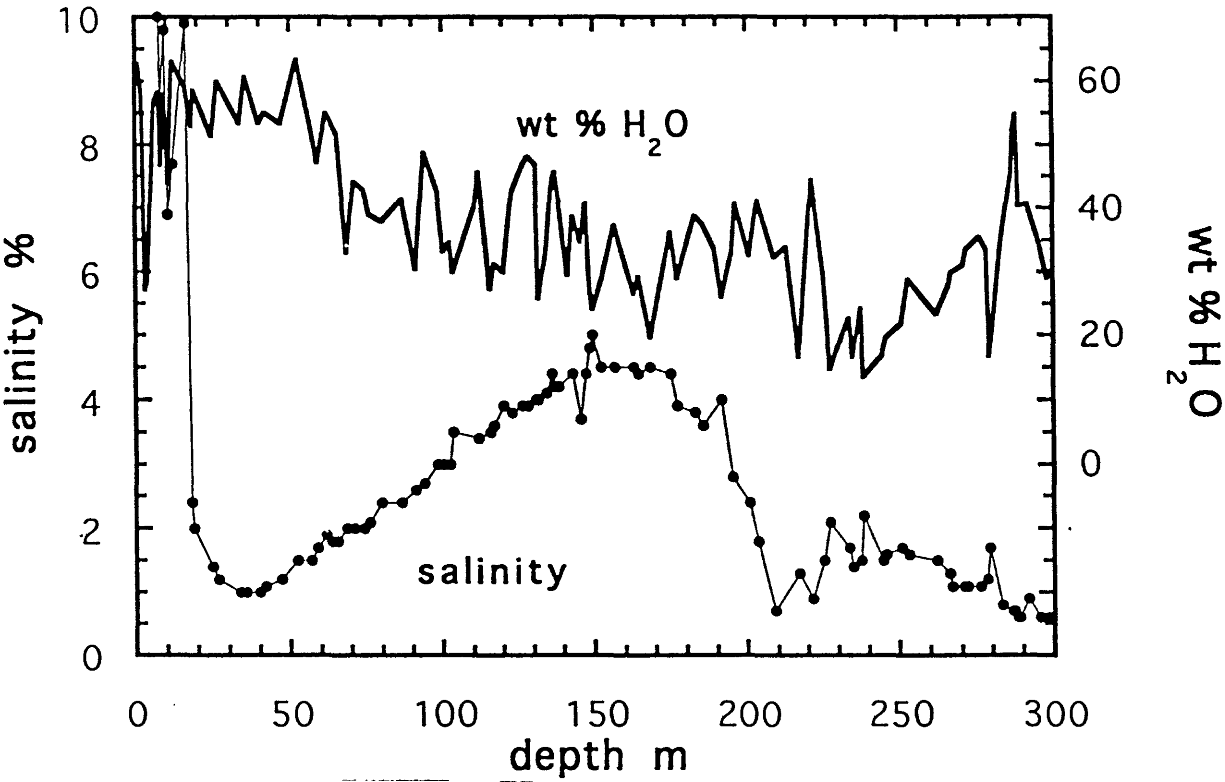

Fig. 1

Sediment water-content and pore-water salinity variation with depth in Owens Lake drill hole OL-92.

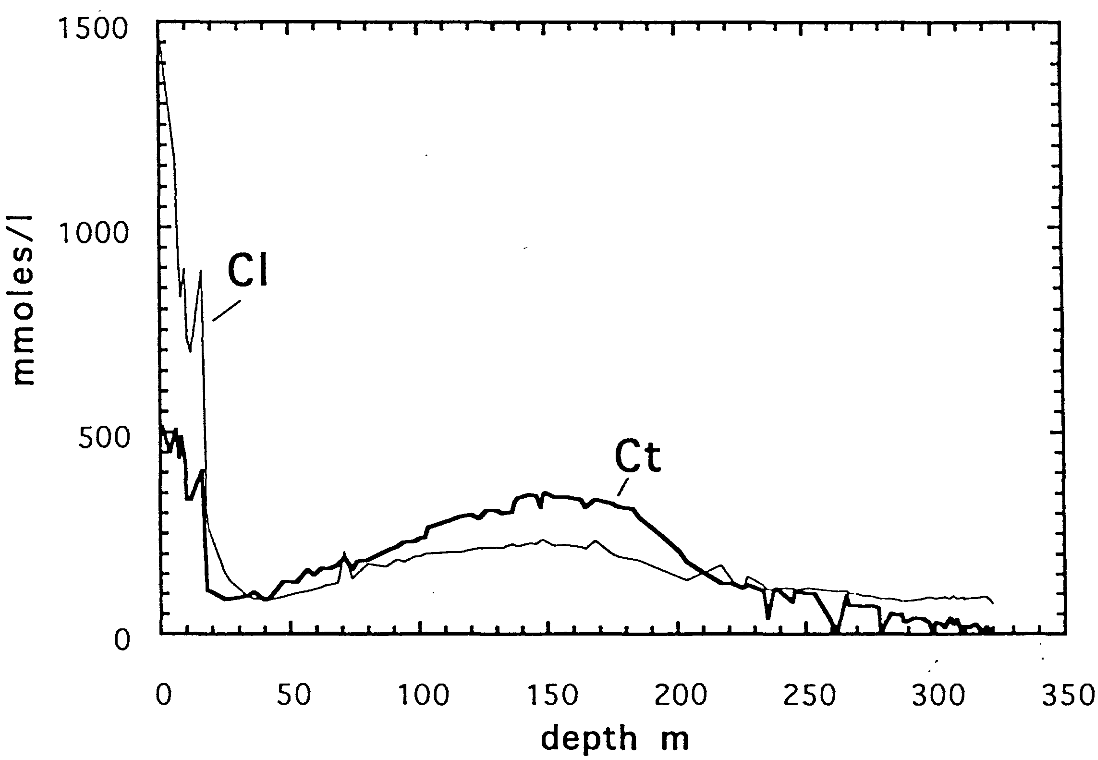

Fig. 2

Pore-water Cl and Ct (total dissolved carbonate species) concentration with depth in Owens Lake drill hole OL-92.

U.S. DEPARTMENT OF THE INTERIOR

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Isotope Geochemistry of Owens Lake Core OL-92

by

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Open-File Report 93-683

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INTRODUCTION

During times when the Laurentide Ice Sheet (LIS) was large, the southern branch of the polar jet stream was forced south over the Great Basin area of the western United States (Antevs, 1948; Kutzbach, 1987; Benson and Thompson, 1987). This observation suggests the hypothesis that when the size (height) of the LIS increased, the jet stream was forced farther south and when the size (height) of the LIS decreased, the jet stream retreated north. In the modern world, maximum precipitation occurs near the axis of the jet stream, and precipitation decreases rapidly to the south of its axis (Starrett, 1959). Cloudiness and decreased air temperatures occur at and north of the jet stream.

The hydrolgic balance of surface-water systems in the Great Basin of the western United States should have responded to the migration of the jet stream. When the jet stream was positioned over or south of a particular surface-water system, decreased evaporation and increased precipitation should have resulted in an increase in the effective wetness of the surface-water system. The Owens Lake basin is the first in a chain of once-connected basins located on the eastern side of the Sierra Nevada. When water in Owens lake exceeded a depth of ~60 m, it overflowed southward along a series of channels to China Lake.

When a lake changes from a closed to an open (spilling) condition, the residence time of water in the lake basin decreases. And as the rate of spill (throughput) of water increases, the residence time further decreases. The $\delta^{18}O$ and $\delta^{13}C$ values of lake water are a function of its residence time. Preferential loss of isotopically light oxygen during evaporation causes an increase in the $\delta^{18}O$ value of lake water. The $\delta^{13}C$ value of lake water increases with increasing carbon dioxide exchange between the lake and the atmosphere; therefore, the longer the residence time of water in a lake basin, the heavier the values of $\delta^{18}O$ and $\delta^{13}C$.

We report here the $\delta^{18}O$ and $\delta^{13}C$ values of the total inorganic carbon fraction of channel samples taken from cores OL-92-2. The reader is referred to Bischoff and others (1993) for details of the coring, sampling, and sample preparation procedures.

LABORATORY PROCEDURES

Sediment samples were analyzed at the University of Michigan Stable Isotope Laboratory using a Finnigan Mat 251 mass spectrometer equipped with a Kiel carbonate-extraction device. Precision for $\delta^{18}O$ and $\delta^{13}C$ was ±0.05 ‰. Data are reported relative to the Peedee Belemnite (PDB) standard.

RESULTS AND DISCUSSION

Analytical results are listed in Table 1 and plotted in Figure 1. Between 110 and 5 m (interval I), peaks and troughs in values of $\delta^{18}O$ and $\delta^{13}C$ covary; this covariance is less pronounced between 190 and 110 m (interval II) and is generally absent below 190 m (interval III).

If it is assumed that the $\delta^{18}O$ value of the uppermost sample (which integrates sediment deposited since about 11,000 yr B.P.) is representative of a closed-basin condition, then all samples having $\delta^{18}O$ values more negative than -4 ‰ were deposited in a spilling lake. The $\delta^{18}O$ maxima and minima that indicate open and closed lake conditions within intervals I and II (Fig. 1) correspond to glacial and interglacial periods that can also be defined on the basis of carbonate (CO_2) and organic carbon (OC) variations (Bischoff and others, 1993).

The volume weighted $\delta^{18}O$ average of Sierra Nevadan precipitation at Tahoe Meadows (2525 m), located about 350 km NNW of Owens Lake, was -14.6 ‰ for 134 samples collected between September 1986 and January 1990 (Benson, 1993). If this value is indicative of $\delta^{18}O$ of precipitation in the Owens Lake catchment area in the past, Owens Lake was little more than a wide spot in the Owens River during times represented by depths of 25 and 97 m in core OL-92(Fig. 1).

The $\delta^{13}C$-depth pattern is more difficult to interpret than the $\delta^{18}O$-depth pattern in core OL-92 (Fig. 1). For interval I, the peak-to-peak and trough-to-trough covariance of $\delta^{18}O$ and $\delta^{13}C$ indicate that low values of $\delta^{13}C$ correspond to times of spill and high values correspond to a closed basin state. This covariance does not occur, however, in intervals II and III. The mean $\delta^{13}C$ value of 35 samples of Walker River water was -10.1 ‰ for the period February 1990 through December 1992 (unpublished data of L. Benson). The $\delta^{13}C$ values of OL-92 sediments are 15 to 20 ‰ more positive than water in present-day rivers that flow from the Sierra Nevada. The $\delta^{13}C$ of carbonate in lake water in equilibrium with atmospheric CO_2 should have a value of about 1 ‰ at 20°C (Friedman and O'Neil, 1977). The higher values shown in Figure 1 indicates that some process other than gas exchange (e.g. variation in productivity) has affected the $\delta^{13}C$ value of Owens Lake water for much of the past.

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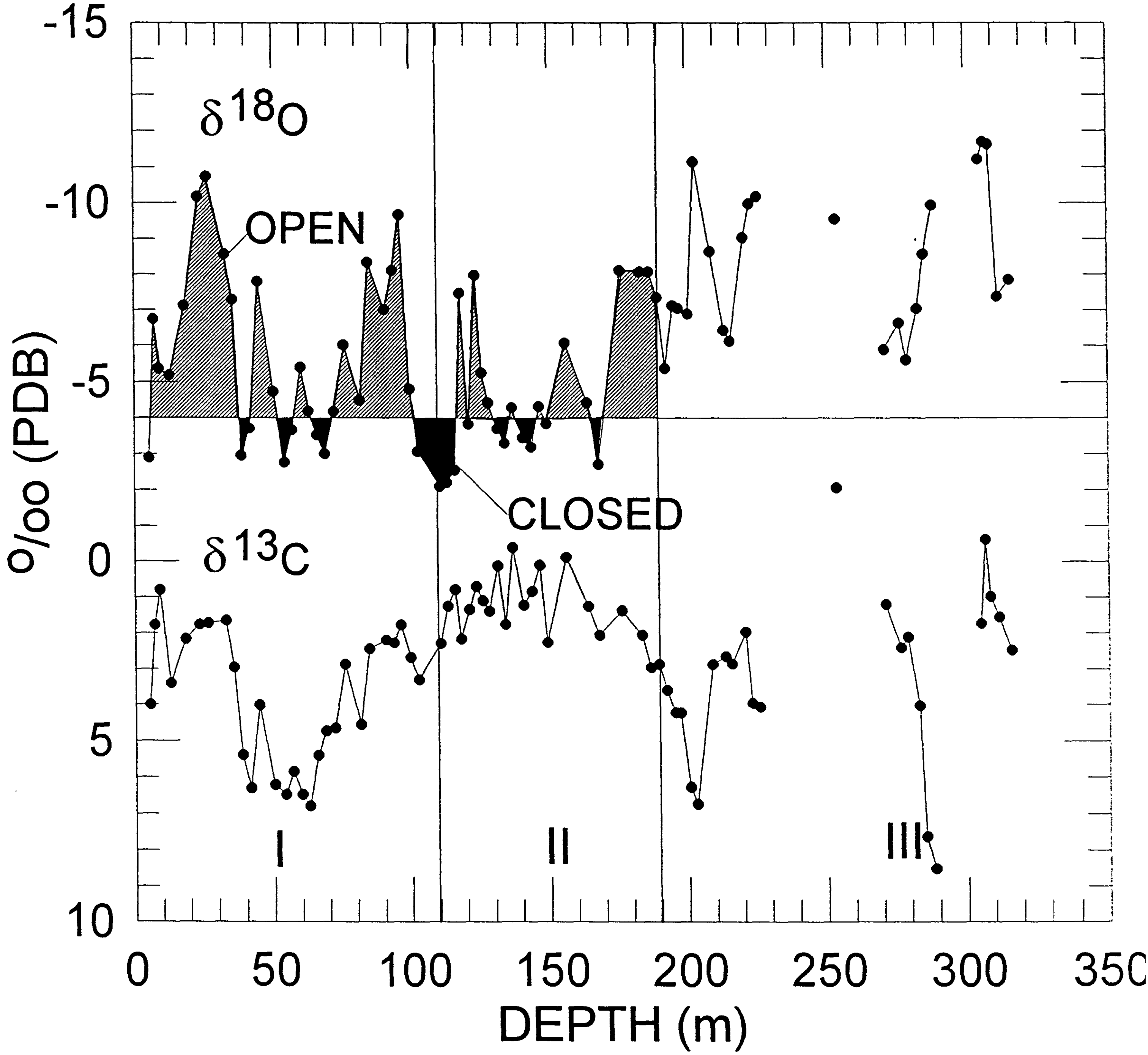

Figure 1. Stable isotope values for the total inorganic carbon fraction in core OL-92. All values are given in parts per thousand relative to the VPDB (Vienna Peedee Belemnite) standard. Gaps in the data indicate samples that did not contain sufficient carbonate for analysis.

TABLE 1

$\delta^{13}C$ and $\delta^{18}O$ analyses of sediment channel samples from OL-92. Results of analyses are reported in parts per thousand relative to the Peedee Belemnite standard. Samples that lacked sufficient carbonate for analysis are indicated by --.

SAMPLE	DEPTH (m)	$\delta^{13}C$ (‰)	$\delta^{18}O$ (‰)	SAMPLE	DEPTH (m)	$\delta^{13}C$ (‰)	$\delta^{18}O$ (‰)
All	5.34	4.00	-2.89	39A+B	153.20	–	–
6A+7A	6.95	1.77	-6.74	40A+B	155.90	-0.12	-6.07
8A	8.99	0.80	-5.36	44A+45A	163.76	1.25	-4.43
9B+C	12.68	3.40	-5.18	47A+B	167.68	2.06	-2.71
11A+B	18.11	2.16	-7.11	51A+B	172.77	–	–
13A+B+C	23.25	1.75	-10.18	52A+53A	175.99	1.38	-8.11
14A+B	26.28	1.71	-10.74	55A+B	183.23	2.05	-8.07
17A+B	32.69	1.64	-8.57	56A+B	186.27	2.97	-8.07
18A+B+C	35.44	2.95	-7.29	57A+B	189.26	2.87	-7.35
19A+B	38.45	5.39	-2.95	58A+B	192.13	3.59	-5.37
20A+B	41.49	6.30	-3.70	59A+B	195.11	4.22	-7.12
21A+B	44.62	4.01	-7.79	59B+C	196.94	4.23	-7.03
22A+B	47.06	–	–	60B+C	200.38	6.27	-6.89
23A	49.92	6.20	-4.74	61A+B	202.93	6.73	-11.14
25A+B	53.88	6.47	-2.76	63A+64A	208.60	2.87	-8.64
26A+B	56.73	5.85	-3.66	65+66A	213.34	2.65	-6.42
27A+B	59.80	6.48	-5.40	65+66C	215.65	2.86	-6.12
1A+B	62.68	6.79	-4.19	69A+B	220.73	1.95	-9.03
2A+B	65.57	5.40	-3.53	70A+B	223.09	3.95	-9.98
3A+B	68.49	4.73	-3.00	71A+B	225.71	4.07	-10.17
4A+B	71.86	4.65	-4.17	81A+B	235.08	–	–
6A+B	75.47	2.87	-6.01	82A+B	237.67	–	–
7A+B	78.00	–	–	83A+B	240.61	–	–
8A+B	81.13	4.55	-4.49	85A+B	245.35	–	–
9A+B	84.15	2.44	-8.35	88A+B	253.77	-2.07	-9.55
10A+B	87.21	–	–	89A	255.31	–	–
11A+B	90.26	2.19	-7.01	93A+94A	267.13	–	–
12A+B	93.30	2.27	-8.11	95A+B	271.24	1.19	-5.89
13A+14A	95.84	1.77	-9.68	97A+B	276.60	2.40	-6.62
15A+B	99.34	2.68	-4.81	98A+99A	279.03	2.11	-5.61
16A+B	102.34	3.30	-3.06	100A+B	283.11	4.03	-7.03
22A+B	110.40	2.29	-2.10	100B+C	285.21	7.62	-8.57
23A+B	112.85	1.25	-2.21	101A+B	288.46	8.52	-9.93
25A	115.72	0.79	-2.55	102A+B	292.55	–	–
26A+B	117.73	2.16	-7.47	103A+B	296.22	–	–
27A+B	120.78	1.35	-3.83	104A+B	298.99	–	–
28A	123.42	0.71	-7.97	104B+C	301.04	–	–
28B+C	125.56	1.10	-5.25	105A+B	303.03	–	–
29A+B	127.99	1.39	-4.42	105B+C	305.12	1.73	-11.21
30A+31A	131.13	0.13	-3.70	106A+B	306.81	-0.62	-11.70
31B+C	133.85	1.76	-3.29	106B+C	308.66	0.98	-11.63
32A+B	136.58	-0.40	-4.29	107A+B	311.68	1.55	-7.38
33A+B	140.53	1.23	-3.45	108A+B	315.97	2.48	-7.85
34A+B	143.54	0.84	-3.18	109A+B	319.42	–	–
35A+B	146.46	0.11	-4.31	110	321.73	–	–
36A+37A	148.93	2.25	-3.84				

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DEUTERIUM-HYDROGEN RATIOS OF INTERSTITIAL FLUIDS FROM OWENS LAKE CORE OL-92

by

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ABSTRACT

The δD values of interstitial fluids extracted from the Owens Lake core OL-92 suggest that the fluids in the upper 15 meters of core were from the final desiccation of the lake about 8900 y ago. If this age assignment is correct, then the age of the interstitial fluids in the core cannot exceed 190,000 y. Abrupt changes in δD with depth were observed at several depths in the core, including a rapid change near the bottom of the core. Due to the self-diffusion of water, these large gradients of δD with depth could not persist for long periods of time. For example, a diffusion model for the δD gradient near the core bottom indicates a diffusion "age" of 1000 years for this feature. The existence of the observed δD gradients, plus the unrealistically young age calculated for the sub-bottom sediments based on (1) the diffusion ages of the salinity and δD profiles of the interstitial fluids and (2) the age of the fluid at 15 m depth, indicate that fluid has moved both horizontally and vertically in the core. The vertical movement of fluid suggests loss of fluid, at depth, from the Owens basin.

EXPERIMENTAL

Two µL aliquots of the pore waters, extracted as described by Bischoff et al. (1993a), were first distilled under vacuum to separate salts and then converted to hydrogen gas by reaction with zinc metal at 500°C (Kendall and Coplen, 1985). The deuterium content of the hydrogen gas was then measured using a mass spectrometer that separated the HD^+ from H_2^+, determined the ratio of the two ions, and compared the ratio to that in a sample of standard hydrogen gas. Corrections were made for H_3^+ as well as for other mass spectrometric errors. The results are reported in per mil (‰) units relative to V-SMOW;

$$\delta D\text{, per mil} = \frac{R_{Sample} - R_{Standard}}{R_{Standard}} \times 1000$$

where R_{sample} is the ratio of deuterium to hydrogen in the sample, and $R_{standard}$ is the ratio in the Vienna Standard Mean Ocean Water (V-SMOW). The δD values are precise to ±2‰ (2 sigma).

RESULTS AND DISCUSSION.

The results of the δD analyses are given in Table 1, and plotted versus depth in Figure 1. Several features in the δD depth plot deserve comment.

Upper 10 Meters of Core

The relative enrichment in deuterium found in the upper 10m of the core is probably due to evaporative enrichment that occurred as the lake desiccated after outflow ceased. We will assume that this datum represents the final Holocene desiccation of the lake that Bischoff et al. (1993b) have dated at 8900 y on the basis of the initiation of oolite deposition.

10 to 20 Meters Sub-bottom Depth

Another feature observed in the data is the rapid change in both δD and salinity from approximately 10 to 20 m sub-bottom depth (see Figure 2). Although the changes are not entirely continuous, the change in both δD and salinity can be approximated by smooth curves that are generated by solutions of the diffusion equation, using appropriate diffusion coefficients for NaCl for the salinity curve, and the self-diffusion of water for the δD curve, both calculated for diffusion occurring over a 10,000 y time interval. This suggests that a rapid change in both salinity and δD occurred about 10,000 years ago at a sub-bottom depth of approximately 15 m, and that diffusion has smoothed out the abrupt change with depth in these constituents of the interstitial fluids contained in the sub-bottom sediments.

If this model is valid, then either the age of the sediments equals the "age" of the interstitial fluids, or the enclosing sediments are older than the fluids, and the fluids are moving through the sediments.

Assuming the age of the sediments and the interstitial fluids are the same, the sedimentation rate would be one meter per 590 years and, and if the sedimentation rate was constant, the total age of the sedimentary column would be 190,000 y. However, since the 780,000 y Bishop Ash is present in a lower section of the core (REF), this model is unlikely to be correct.

It is likely that the fluids are moving vertically through the the sediments, and possibly horizontally as well. Horizontal movement is suggested by the small peaks in both δD and salinity with depth, for example the peak at 16 m (Figure 2) which is due to either horizontal movement of fluid, or climate-induced change in these constituents. The latter explanation is unlikely due to the very rapid change of salinity with depth between 16 and 18 m -- a change too large and rapid to be climate-induced. This large gradient in salinity would be smoothed out by diffusion in a few hundred years, unless "replenished" by horizontal movement of fluid in the enclosing sediment. Vertical movement implies that fluids have been leaking out of the Owens basin at depth. It also indicates that the maximum age of the fluids present in the core is approximately 190,000 y.

150 to 200 Meters Sub-bottom Depth

Another feature that deserves comment is the depletion of deuterium in the fluids from 150 m sub-bottom depth to approximately 200 m (Figure 3). The diffusion age of 25,000 y for this feature can be found by calculating the length of time that would be required for self-diffusion of water to produce the observed δD change with depth, assuming that initially a sharp δD interface existed at a depth of 175 m. Although the salinity profile also appears to have a diffusion "age" of 25,000 y, note that the salinity profile is not coincident with the δD profile.

315 to 322 Meters Sub-bottom Depth

Without horizontal movement of fluid, the sharp δD gradient from 315 to 322 m (Figure 4) could not be maintained. Due to the mixing effect caused by the self-diffusion of water, this δD profile could not persist for more than a few thousand years, and suggests that water is moving into the sediments close to the bottom of the sediment column.

MODELS OF THE ANCESTRAL OWENS LAKE

Models of the ancestral Owens Lake can be derived to explain the distribution of deuterium and salinity that is presently observed in the sub-bottom interstitial fluids. Samples of the interstitial fluids indicate that the salinity for the lower 3/4 of the core varied from 0.5% to 4%. Fluids from the lowest 1/5 of the core have salinities of approximately 0.5 - 0.6%.

These minimum salinities of ~5000 ppm were generated in a lake where the inflow is assumed to be 200 ppm, equal to that in the "present" Owens River, and where outflow occurred for periods long enough to fill the downstream Searles basin with more than 1000 m of salts.

Under steady state conditions the amount of salt flowing into the lake equals that flowing out. If the lake is well mixed, then the salinity of the outflow is equal to that in the lake, and the salinity of the lake can be calculated as follows:

$$S_o = S_L \qquad \text{equation 1}$$

$$S_oQ_o = S_iQ_i \qquad \text{equation 2}$$

where S_0 is the salinity of the outflow, Q_0 is the rate of outflow, S_i is the salinity of the inflow, and Q_i is the rate of inflow

$$S_L = \frac{S_i Q_i}{Q_o} \qquad \text{equation 3}$$

$$\frac{Q_i}{Q_o} = \frac{1}{\theta} \qquad \text{equation 4}$$

$$S_L = \frac{S_i}{\theta} \qquad \text{equation 5}$$

In order for the salinity to equal that found in the fluids extracted from the core, either the proportion of inflow escaping as outflow (θ) would have to be very small (~0.05), or we require a model which allows for periodic partial desiccation (seasonally?). The difficulty with a small θ model is that δD would increase to high values (>0 ‰), in contradiction to the low values (~-103‰) that were measured. Another model to explain the high salinity and low δD would require that periodic partial-desiccation of Owens Lake occurred many times in order to increase the salinity from 200 (Owens River inflow) to 5000 ppm. Between desiccations, flooding of the salt (or brine) would occur, as would outflow to China and Searles Lakes. Some of the salt would dissolve and flow out of the Owens basin, but density stratification would prevent complete mixing of the saline and fresh water layers.

CONCLUSIONS

The conclusions of this study are:

(1) the interstitial fluids extracted from the sediments sampled in the Owens Lake Core OL-92 were not deposited contemporaneously with the sediments.

(2) Both vertical and horizontal movement of the fluids within the sediments have been demonstrated.

(3) This fluid movement would result in fluid transport out of the basin. The loss of interstitial fluid from the sub-bottom sediments of another "closed" basin (Searles Lake basin) was proposed by Friedman et al.(1982).

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Table 1. δD and Salinity of Interstitial Fluids

Sub-bottom depth, m	Salinity* %	δD ‰
-1	14	-52
-4		-50
-6.09	12	-48
-7.48	10	
-8.11	8.7	
-9.51	9.8	-58
-10.49	6.9	
-11.92	7.7	-69
17.94	2.4	-70
-18.7	2	
-24.61	1.4	
-26.46	1.2	-83
-33.59	1	
-35.56	1	
-39.85	1	
-41.72	1.1	
-46.99	1.2	-78
-52.37	1.5	
-56.65	1.5	
-58.8	1.7	-68
-61.76	1.9	
-63.48	1.8	
-65.23	1.8	
-68.35	2	
-70.78	2	-84
-73.79	2	
-75.76	2.1	
-79.72	2.4	
-86.61	2.4	-77
-93.78	2.7	
-98.18	3	
-100.18	3	-76
-102.18	3	
-103.36	3.5	
-111.65	3.4	
-115.78	3.5	
-117	3.6	
-120.09	3.9	
-122.86	3.8	
-126.22	3.9	
-128.21	3.9	
-130.78	4	
-131.77	4	
-134.49	4.1	
-136.24	4.4	
-137.18	4.2	
-138.31	4.2	
-143.01	4.4	
-145.55	3.7	-83
-147.27	4.4	
-148.47	4.8	-82
-149.23	5	-79
-152.32	4.5	
-156.74	4.5	-88
-162.92	4.5	
-164.54	4.4	-92
-168.28	4.5	
-174.83	4.4	-90

Table 1, continued. δD and Salinity of Interstitial Fluids

Sub-bottom depth, m	Salinity* %	δD ‰
-177.08	3.9	
-182.95	3.8	-97
-185.36	3.6	
-191.54	4	
-195.09	2.8	-101
-200.92	2.4	-99
-203.62	1.8	
-209.04	0.7	-100
-217.03	1.3	
-221.41	0.9	
-225.29	1.5	
-227.3	2.1	
-233.51	1.7	
-234.89	1.4	
-237.53	1.5	
-238.46	2.2	-106
-244.77	1.5	
-245.67	1.6	
-250.9	1.7	-104
-253.17	1.6	
-262.07	1.5	
-266.12	1.3	
-266.97	1.1	
-270.86	1.1	
-271.85	1.1	
-276	1.1	
-278.36	1.2	
-279.15	1.7	-104
-283.24	0.8	
-283.53	0.7	
-287.07	0.7	
-288.14	0.6	
-288.89	0.6	
-291.85	0.9	
-295.46	0.6	
-297.99	0.6	
-298.86	0.6	
-300.75	0.6	-106
-301.83	0.6	
-302.64	0.6	-106
-304.01	0.7	
-305.98	0.5	-107
-307.11	0.9	
-308.36	0.8	-107
-310.39	1	
-310.82	0.6	
-311.21	0.6	
-311.74	0.8	-105
-312.83	0.6	
-315.58	0.5	-107
-318.46	0.7	-95
-309.66	0.4	
-321.24	1.2	-90
-322.18	0.8	-93

* Salinity data from Bischoff et al. (this volume)

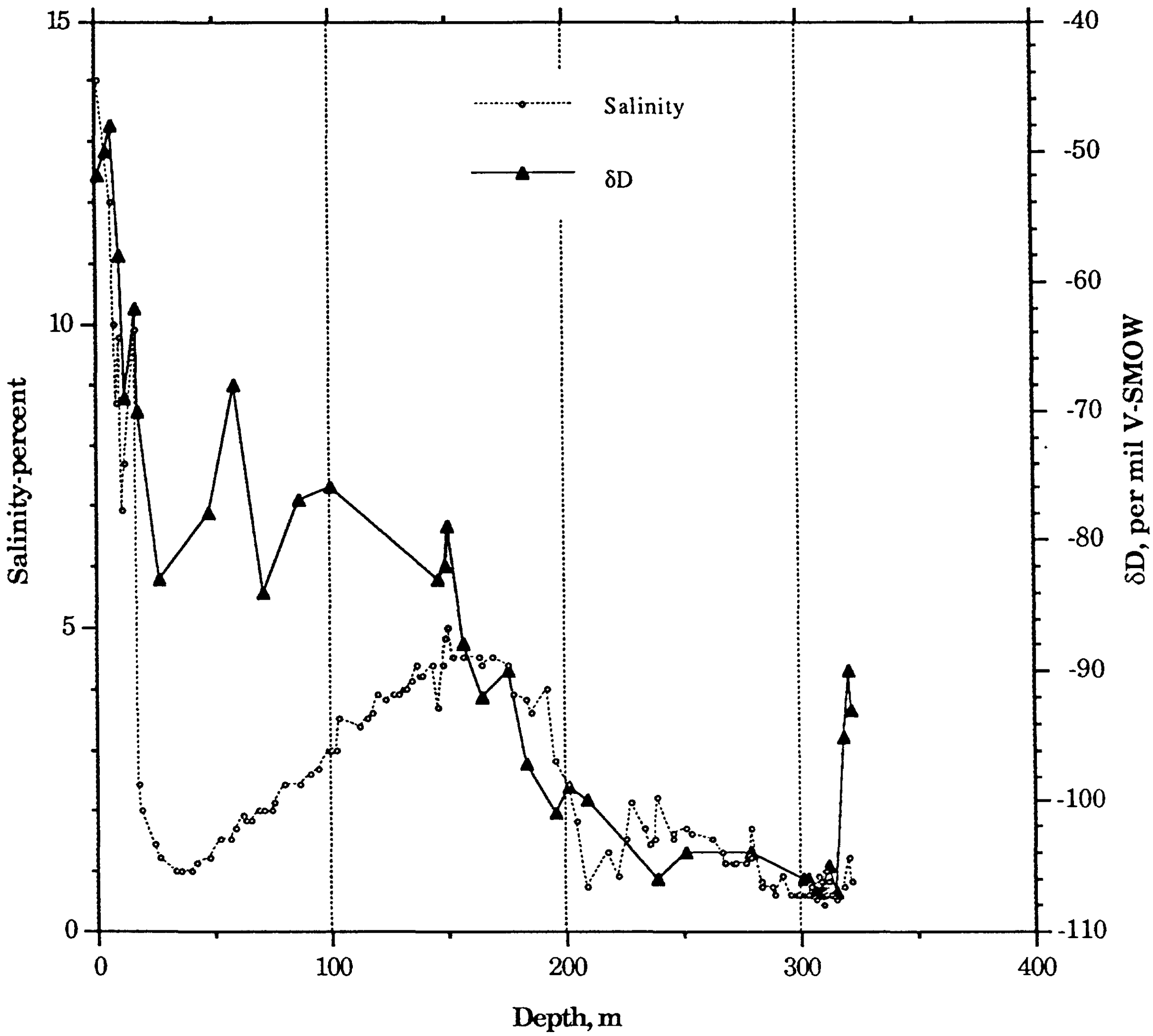

Figure 1. Plot of the salinity and δD of interstitial fluids extracted from Owens Lake core OL-92

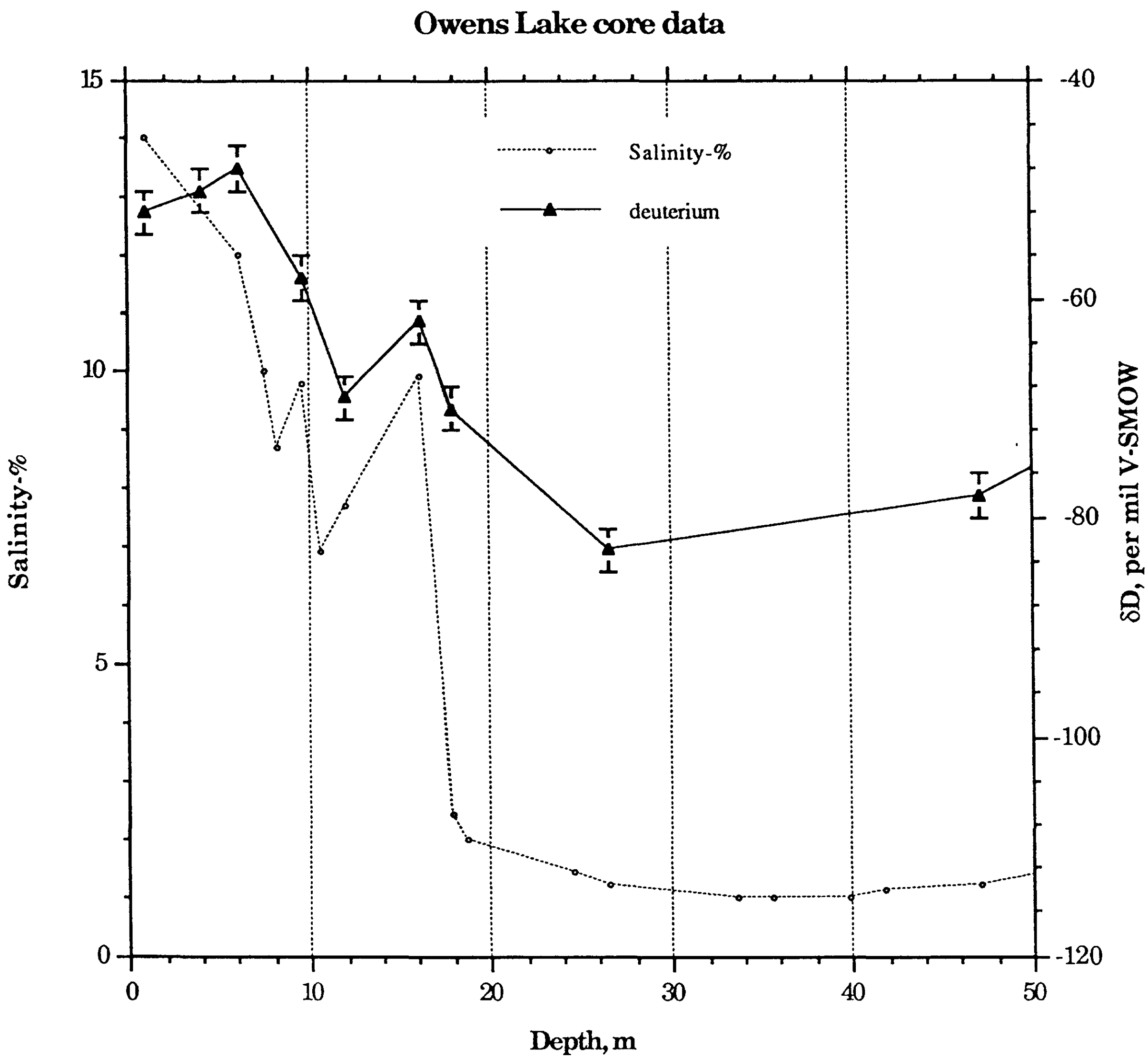

Figure 2. Plot of salinity and δD of fluids extracted from Owens Lake core OL-92. The data from only the first 50 meters of core is shown. Error bars (±2 ‰) are shown for the δD data. The thick dashed lines are plots of the diffusion profile to be expected for both NaCl (salinity) and self-diffusion of water (δD) after 10, 000 years, assuming a sharp discontinuity in both salinity concentration and δD at zero time.

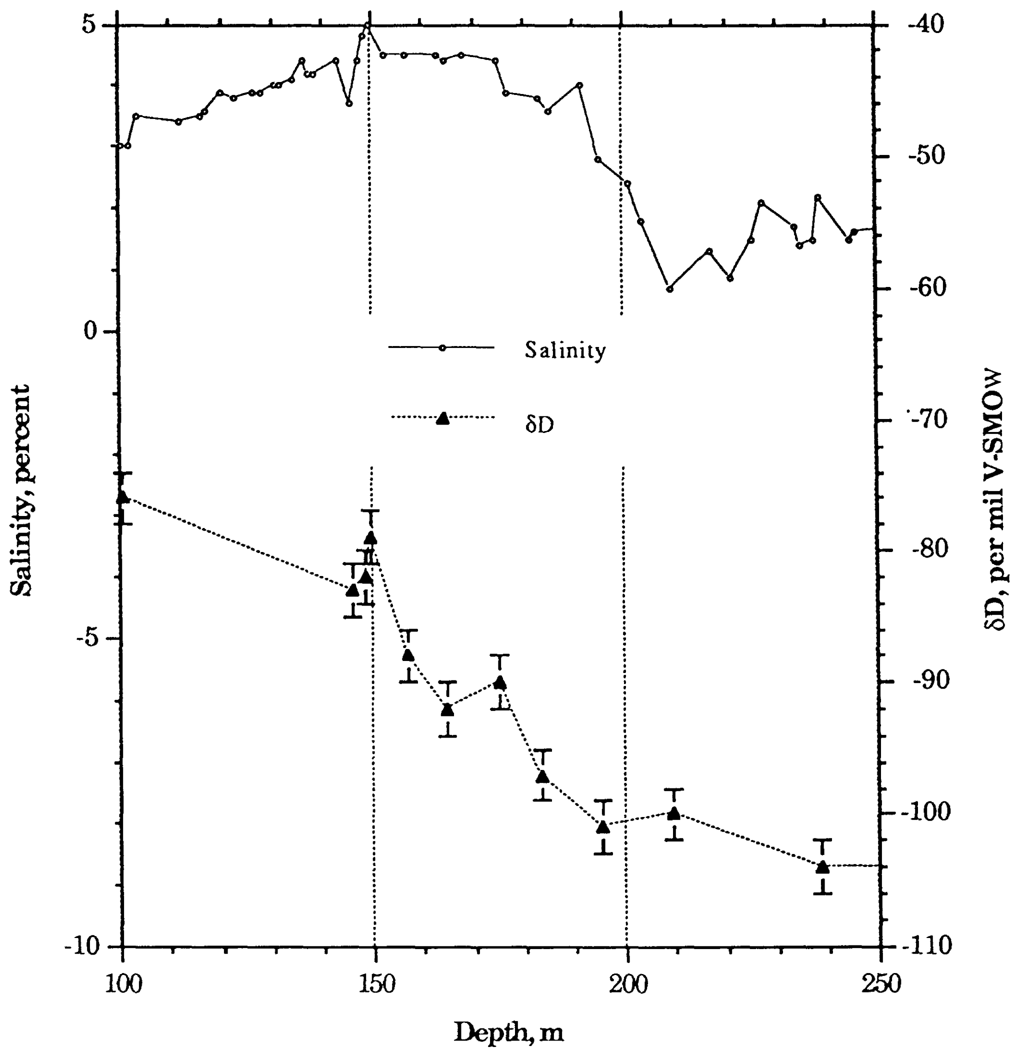

Figure 3. Plot of the salinity and δD for fluids extracted from Owens Lake core OL-92. Only the data for the section 100 m to 250 m is shown.

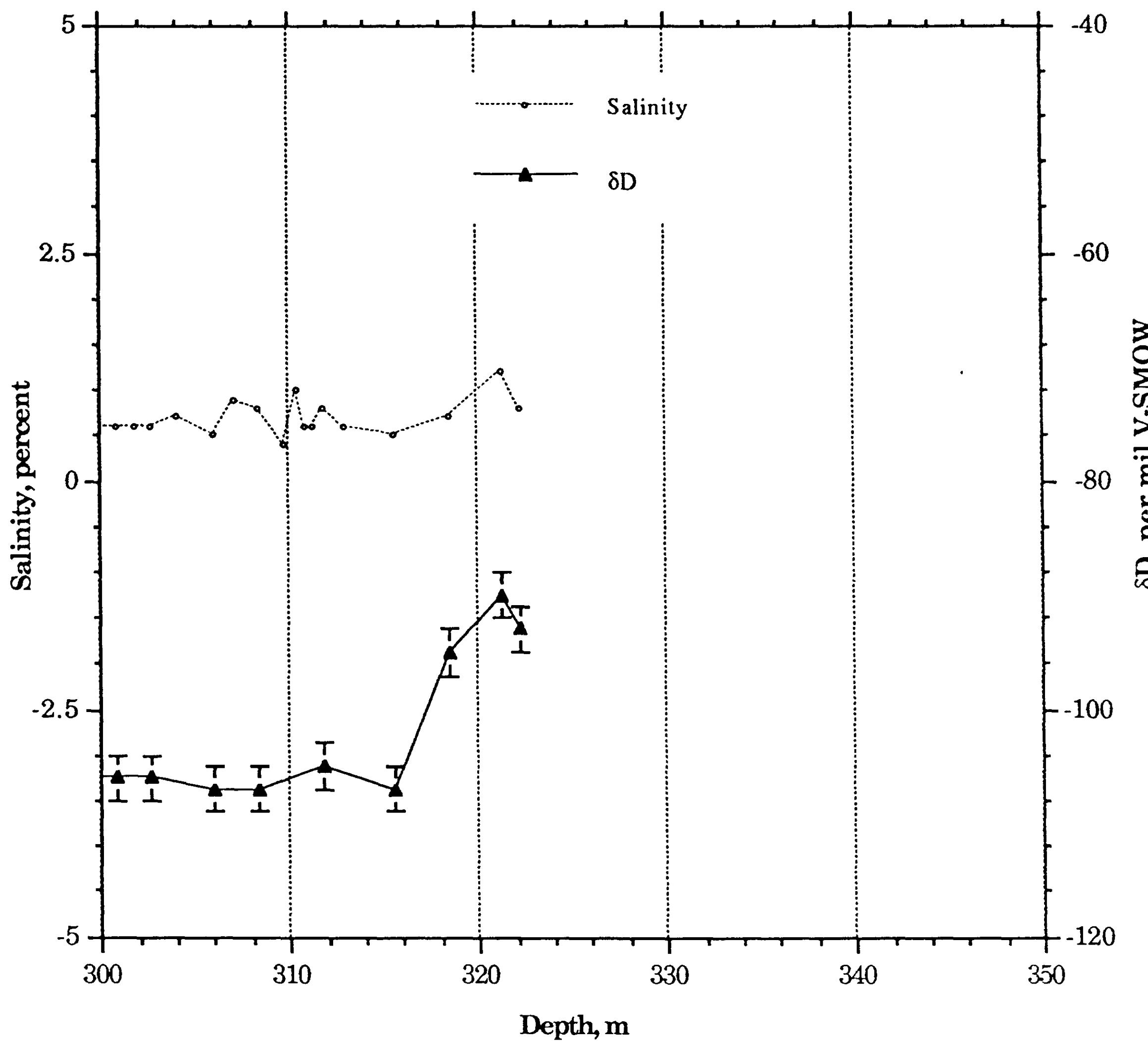

Figure 4. Plot of the salinity and δD for fluids extracted from Owens Lake core OL-92. Only the data for the section 300 m to 322 m is shown.

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THE DISTRIBUTION AND ISOTOPIC COMPOSITION OF SULFUR IN OWENS LAKE CORE OL-92

by

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INTRODUCTION

Total sulfur concentrations and bulk sulfur isotopic compositions are two common parameters used to interpret sulfur geochemistry in modern and ancient sediments. The sedimentary sulfur cycle, however, is driven by many processes (for a discussion of these processes see Goldhaber and Kaplan, 1974; Krouse and McCready, 1979; Migdisov et al., 1983; among others). The relative importance of these processes cannot be evaluated if only total sulfur and its isotopic composition are considered. In order to maximize the amount of information obtained from the sulfur geochemistry of six sediment samples from Owens Lake core OL-92, the different phases of sulfur were separated (acid-volatile sulfides, disulfides, sulfate, and organosulfur), and the isotopic composition of the separated phases determined. Qualitative mineralogy and carbon (organic and carbonate) data augment the sulfur data.

Acknowledgements. I wish to thank George Smith for his care in sampling and shipping the sediment, Tim Klett for his contribution to the analyses, and Cyndi Rice and George Breit for their thoughtful reviews of this paper.

METHODS

SAMPLE HANDLING

The six Owens Lake samples used for sulfur geochemical analysis were selected on the basis of color and lithology of the sediment and to provide a relatively even distribution vertically through core OL-92. All samples were clay-rich, dark colored sediment. These sediments were chosen because they were likely to contain contents of organic matter, an indicator of more reducing conditions that would favor sulfate reduction. Samples were refrigerated in the field and, upon arrival in the laboratory, refrigerated in an inert atmosphere until analyzed several days later. To prevent oxidation of unstable iron monosulfides (FeS), sample splits for sulfur-phase separation were weighed in a glove bag flushed with N_2. The remainder of the sample was dried in a vacuum oven, and the weight loss was used to calculate analytical results on a dry-weight basis. The dried sample was ground in the glove bag. Ground samples were used for qualitative X-ray diffractometry, total-carbon and organic-carbon analyses.

ANALYTICAL METHODS

X-ray diffractometry on packed-powder samples was used to determine mineralogy. The technique used 30kV, 20 mA, nickel-filtered, copper-K_α X-rays and produced diffractograms from 4° to 64° 2θ. Total carbon and organic carbon (C_{Org}) were measured on a commercial apparatus using an induction furnace and a thermal conductivity cell. Carbonate carbon (C_{CO3}) is the calculated difference of C_{Org} from total carbon.

Details of the sulfur separation technique (fig. 1) and its development are described in Tuttle et al. (1986). Samples are reacted first with hot 6*M* HCl and stannous chloride to dissolve sulfates (S_{SO4}) and distill as H_2S the acid-volatile sulfide (S_{AV}, monosulfides); then hot, acidified

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sulfates (S_{SO4}) and distill as H_2S the acid-volatile sulfide (S_{Av}, monosulfides); then hot, acidified 1*M* Cr^{2+} solution is added to the residual solid to extract disulfides (S_{Di}). The sulfur is precipitated as either silver sulfide or barium sulfate. Following the extractions, the residue is fused with an Eschka mixture to extract organically bound sulfur (S_{Org}, organosulfur). This phase is precipitated as barium sulfate. The precipitates are weighed and the weight percent of each species calculated on a dry-weight basis. Total sulfur (ΣS) content is simply the summation of sulfur phase concentrations. The precipitates from the separation procedure (silver sulfide and barium sulfate) are converted to SO_2 and isotopically analyzed using mass spectrometry. All isotope results are reported in per mil (‰) relative to the Cañon Diablo troilite standard (CDT).

SULFUR DISTRIBUTION

In all but one sample (86.6 m), disulfide is the dominant sulfur phase (>69% of the total sulfur). Concentrations of S_{Di} range from 0.02 to 1.1 wt% and generally increase with depth to 154 m (fig. 2*A*). Below this depth, concentrations decrease. The disulfide mineral in all samples is probably pyrite--pyrite was detected by X-ray diffraction in five of the six samples (Table 1).

Acid volatile sulfides are low in concentration (<.25 wt%) relative to S_{Di} concentrations in all samples. S_{Av} concentations increase similarly to S_{Di} with decreasing depth to 154 m. The rate of increase, however, is much smaller than that of S_{Di} (fig. 2*A*).

Organosulfur is below the detection limit in all but 2 samples, which have very small concentrations (S_{Org} <.06 wt%). There are no systematics in the concentrations as a function of depth (fig. 2*A*).

As no attempt was made to separate pore water from sediment, S_{SO4} includes sulfate originally dissolved in the pore water as well as soluble sulfate minerals. Porewater sulfate concentrations calculated using water-loss data and S_{SO4} concentrations, however, are much greater than those reported for similar depths by Bischoff et al. (1993*a*). Isotopic data indicate that the sulfate is not a product of oxidation of unstable monosulfide phases during sample handling. Therefore, small amounts of sulfate salts must be present in the sediment. Calculations indicate that in most cases, less than 0.8 wt% gypsum ($CaSO_4 \cdot 2H_2O$) or 1.6 wt% mirabilite ($Na_2SO_4 \cdot 10H_2O$) would account for the excess sulfate. These small amounts are difficult to detect with bulk X-ray diffraction analysis. However, one sample (86.6 m) containing 1.5 wt% S_{SO4} had detectable anhydrite, which likely formed when gypsum dehydrated in the vacuum oven.

SULFUR ISOTOPIC COMPOSITION

The isotopic composition of sulfate is always enriched in ^{34}S relative to S_{Di} and, in all but one case, to S_{Av} (fig. 2*B*, Table 2). This enrichment is consistent with bacteriogenic H_2S formation as sulfate-reducing bacteria will preferentially reduce ^{32}S, leaving the residual SO_4 enriched in ^{34}S. The composition of the initial sulfate reservoir (before reduction began) was probably close to +8.5‰, the value for sulfate in the Owens River in 1962 (Holser and Kaplan, 1966). Owens Lake is the first of a chain of lakes with Searles Lake being third. Sulfate in brine from Searles Lake salt ranges from +14‰ to +15‰ (Holser and Kaplan, 1966). The sulfate reservoir is very large in Searles Lake and the isotopic composition of the sulfate in precipitated salt beds, unlike that of sulfate in Owens Lake porewater, is unaffected by sulfate reduction. These higher $\delta^{34}S$ values then suggest that sulfate in Owens Lake may have been at times slightly more enriched in ^{34}S than that in Owens River. From the data in Figures 2*B* and 3*B*, it appears that the initial sulfate reservoir probably was never greater than about +12‰.

The $\delta^{34}S$ value for S_{Av} is either equal to or less than that for S_{Di}, except in the deepest sample (312.1 m) where $\delta^{34}S_{Av}$ is greater than $\delta^{34}S_{Di}$ and $\delta^{34}S_{SO4}$. The $\delta^{34}S_{Di}$ and $\delta^{34}S_{SO4}$ values in this sample are quite depleted in ^{34}S relative to values in other samples (fig 2*B*, Table 2). Sulfate that was ultimately derived from oxidation of bacteriogenic, ^{34}S-depleted H_2S may have migrated into the sediment after the acid-volatile sulfides formed. A portion of the ^{34}S-depleted sulfate was then reduced and formed pyrite.

THE ROLE OF ORGANIC MATTER IN THE SULFUR CYCLE OF OWENS LAKE

Organic matter is consumed by bacteria during dissimilatory reduction of sulfate to form H_2S, which eventually reacts with iron to form sulfide minerals such as pyrite. In many cases, the factors controlling sulfide-mineral formation are very complicated and numerous relations between C_{Org}, sulfide S ($S_{Av} + S_{Di}$), and various forms of iron have been described (for example, see Berner, 1984). The sulfide S concentrations in Owens Lake samples are generally inversely proportional to the C_{Org} concentrations (fig. 3*A*). This relation implies that the amount of organic matter preserved in these sediments was dependent on the activity of the sulfate-reducing bacteria--the more sulfate reduced, the less organic matter preserved. An exception to the inverse relation of sulfide S to C_{Org} is the uppermost sample (5.6 m) where the very low C_{Org} is accompanied by very low sulfide S. In this sample, insufficient organic matter was available during deposition and shallow burial to support sulfate-reducing bacteria, hence no sulfide minerals formed.

This hypothesis linking organic matter to disulfide formation is supported by the $\delta^{34}S_{Di}$ data. As more of the sulfate reservoir is reduced by sulfate-reducing bacteria consuming organic matter, the more enriched in ^{34}S the accumulated disulfide reservoir becomes (fig. 3*B*). An exception is the sample at 312.1 m, which contains the most ^{34}S-depleted sulfur as disulfide and sulfate minerals. As described early, this sulfur probably migrated into the sediment after the acid-volatile sulfides formed.

Samples containing relatively large concentrations of C_{Org} have the next lowest $\delta^{34}S_{Di}$ values, indicating that the sulfate reservoir was not completely reduced in these samples. The condition that halted sulfate reduction in the presence of organic matter and sulfate is not obvious from the data collected on this sample suite.

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Table 1. Sample depth, lithologic description (Smith and Bischoff, 1993), mineralogy, and H_2O loss (wt%) upon drying. [Qtz, quartz; Na-spar, sodium feldspar; K-spar, potassium feldspar; cal, calcite; musc/ill, muscovite and (or) illite; chlor, chlorite, py, pyrite, anhy, anhydrite, hal, halite; *, salts precipitated during sample drying.]

Sample Depth (m)	Lithology	Mineralogy	H_2O loss (wt%)
5.6	Clay size, massive sediment	Qtz,Na-spar,calc,musc/ill, chlor	37
43.8	Silty clay w/faint color beds, possibly bioturbated	Qtz,Na-spar,calc,musc/ill, chlor,py,hal*	58
86.6	"	Qtz,Na-spar,calc,musc/ill, py,anhy*,hal*	57
154.0	Clay and silt w/some very fine sand	Qtz,Na-spar,K-spar,calc, musc/ill,py,hal*	30
283.0	"	Qtz,Na-spar,K-spar,calc, musc/ill,py,hal*	36
312.1	"	Qtz,Na-spar,K-spar,calc, musc/ill,chlor,py,hal*	30

Table 2. Sample depth (meters), sulfur and carbon concentrations (weight percent on dry-weight basis), and sulfur isotopic compositions (per mil, relative to CDT). [S_{Av}, sulfur in acid-volatile sulfides; S_{Di}, sulfur in disulfides; S_{Org}, organosulfur; S_{SO4}, sulfur in sulfates (in minerals and pore water); ΣS, total sulfur, C_{CO3}, carbon in carbonate minerals; C_{Org}, carbon in organic matter; --, inadequate amount recovered to determine sulfur isotopic composition.]

Depth (m)	S_{Av} (wt%)	S_{Di} (wt%)	S_{Org} (wt%)	S_{SO4} (wt%)	ΣS (wt%)	C_{CO3} (wt%)	C_{Org} (wt%)	$\delta^{34}S_{Av}$ (‰)	$\delta^{34}S_{DI}$ (‰)	$\delta^{34}S_{SO4}$ (‰)
5.6	<.01	0.02	<.01	<.01	.02	0.18	0.14	–	–	–
43.8	.02	.29	.06	.05	.42	2.1	1.6	2.6	4.7	7.3
86.6	.05	.12	<.01	1.5	1.7	2.6	1.2	-25.0	1.2	15.6
154.0	.08	1.1	<.01	.06	1.2	.83	.13	-7.9	12.3	23.8
283.0	.05	.61	.03	.06	.75	2.5	.58	9.3	9.5	19.2
312.1	.25	.58	<.01	.16	.99	3.0	.47	8.2	-12.8	-5.0

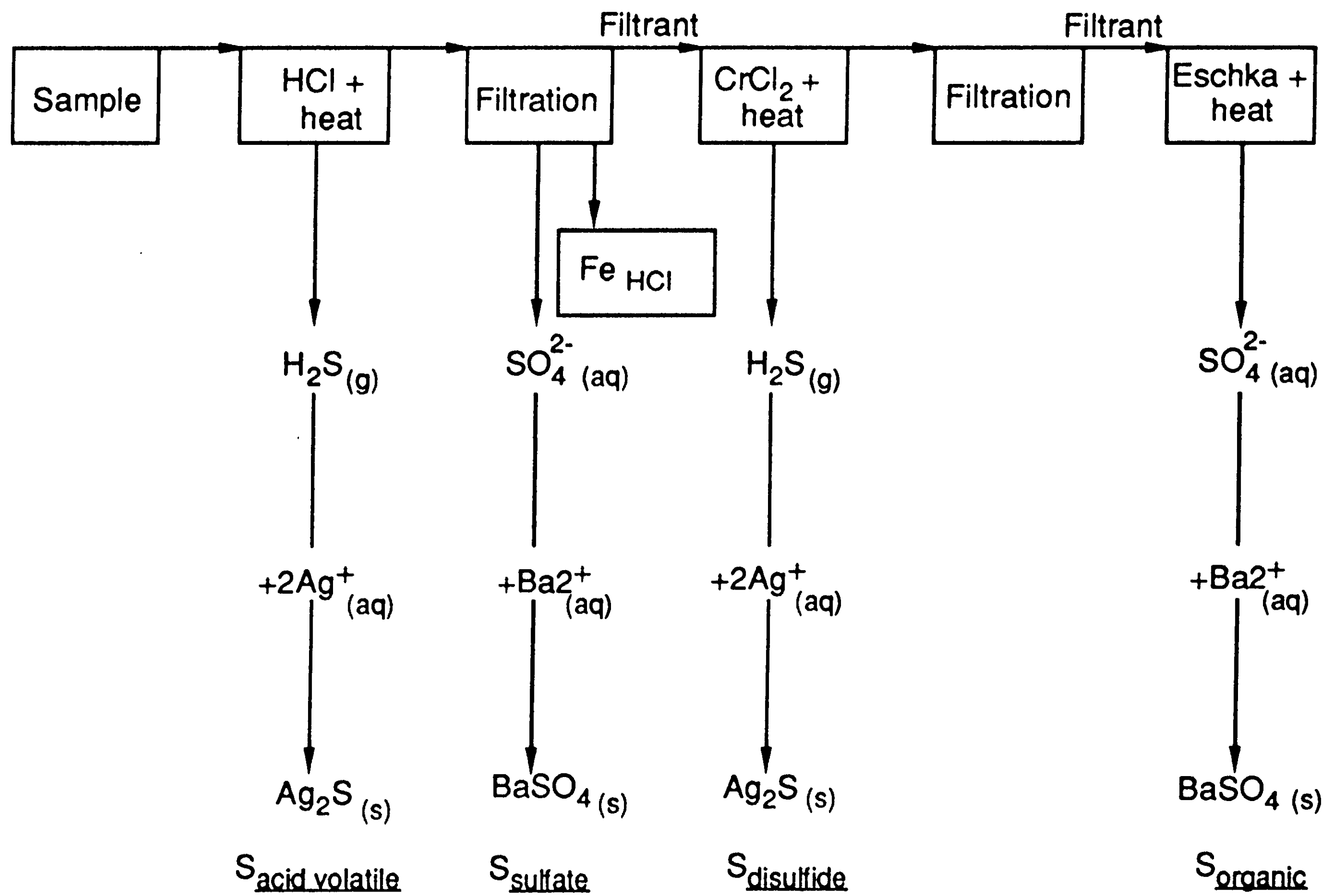


Figure 1. Schematic of the sulfur separation scheme (Tuttle et al., 1986).

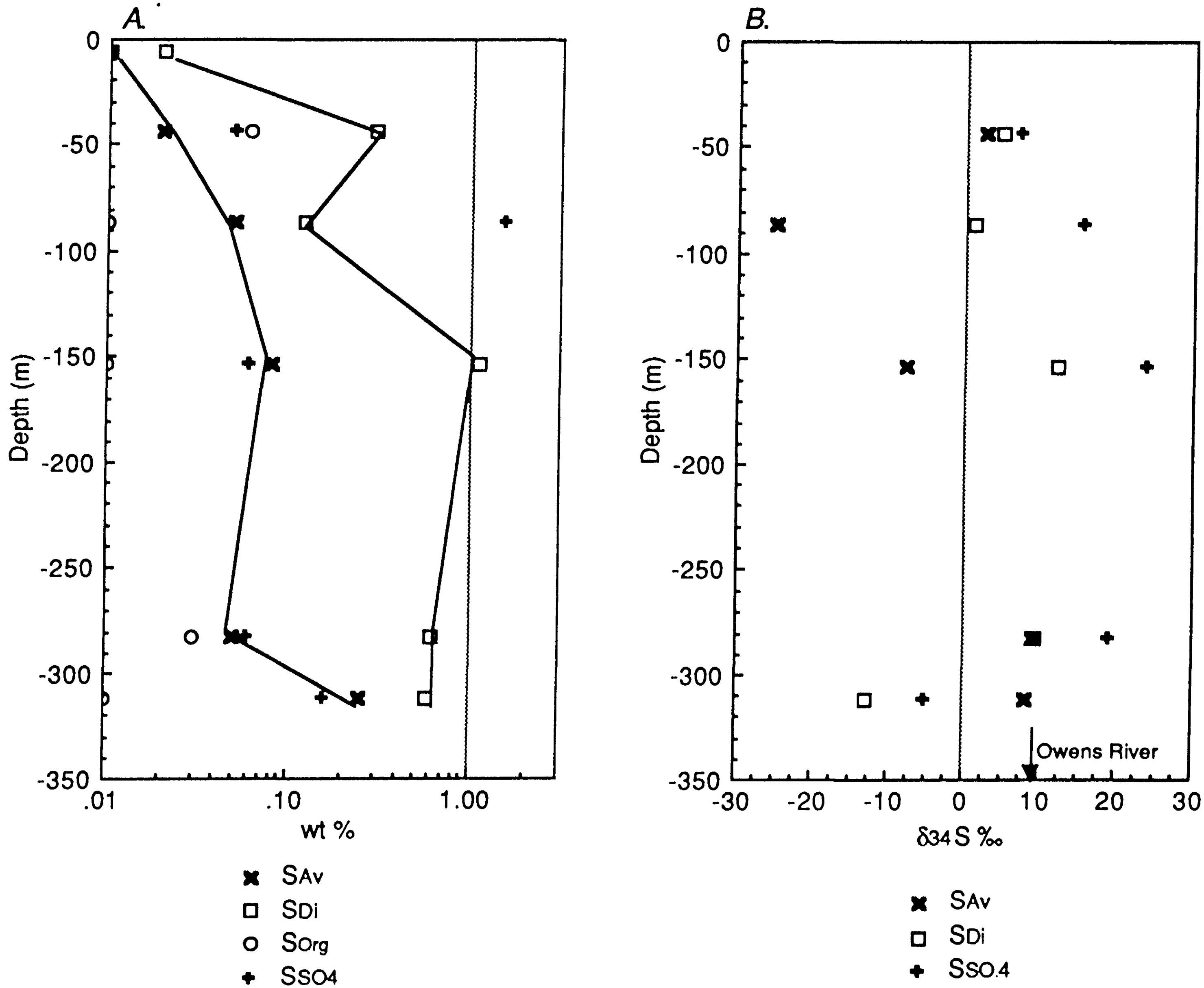
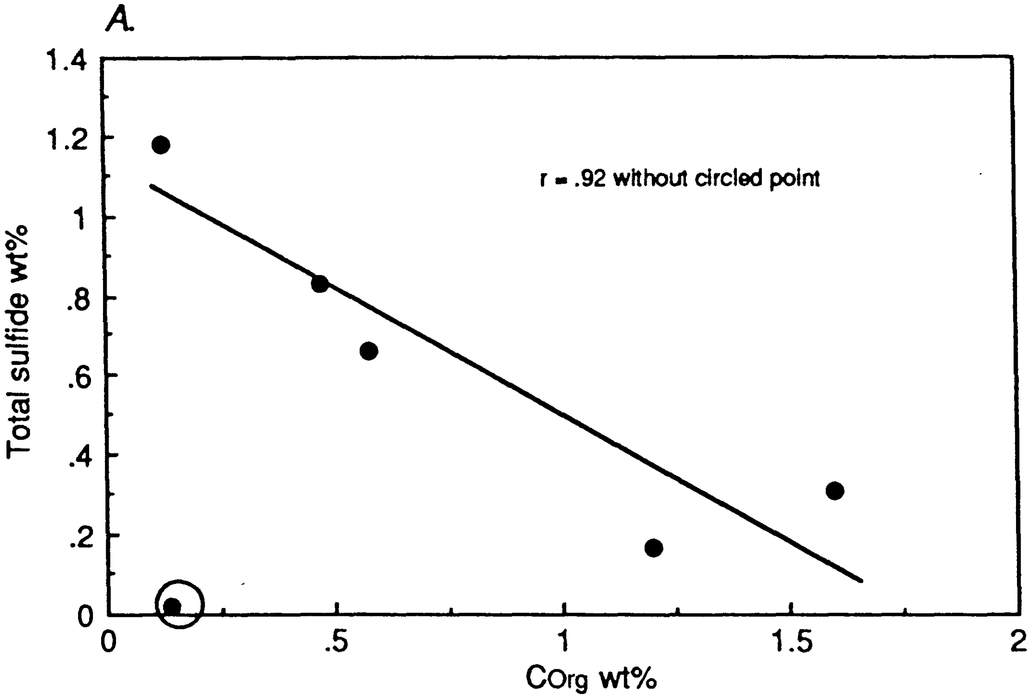


Figure 2. Depth plots of *A*. concentrations (wt%, dry-weight basis) of sulfur in acid-volatile sulfides (S_{Av}), sulfur in disulfides (S_{Di}), organically bound sulfur (S_{Org}), sulfate sulfur in salts and pore water (S_{SO4}) and *B*. $\delta^{34}S_{Av}$, $\delta^{34}S_{Di}$, and $\delta^{34}S_{SO4}$ (‰ relative to CDT). Owens River sulfate isotopic composition from Holser and Kaplan (1966).



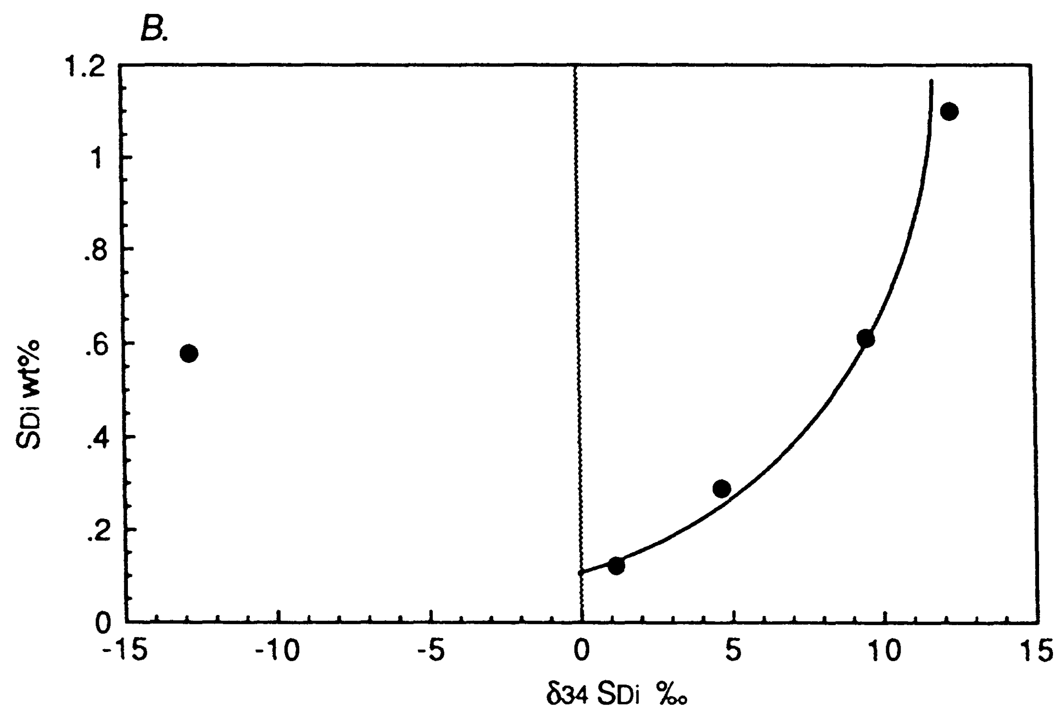


Figure 3. Cross plots of *A*. Concentrations (all wt%, dry-weight basis) of total sulfide (sulfur in acid-volatile sulfides and disulfides) versus organic carbon (COrg) and *B*. concentration (wt%, dry weight basis) of sulfur in disulfides (SDi) versus δ34SDi (‰ relative to CDT). Curve is visually the best fit.

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ROCK- AND PALEO-MAGNETIC RESULTS FROM CORE OL92, OWENS LAKE, CA

by

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ABSTRACT

Paleomagnetic measurements performed on samples from Owens Lake cores OL92-1,2,3 reveal that the composite core, extending to a depth of 323 m, spans nearly the past 800 kyr. The Matuyama/Brunhes transition is identified near the base of the composite section yielding an average sedimentation rate of 40 cm/kyr. Several within-Brunhes excursions (or short polarity events) are evident in field inclination and have been correlated with existing records to provide additional age control. Variations in susceptibility and anhysteretic remanent magnetization, due to changes in the concentration, mineralogy, and size of magnetic grains, reflect paleoclimate change, and also aid in reconstruction of relative paleointensity. Susceptibility has also been used to correlate the OL92 core with other cores drilled from within Owens playa, and to identify a horizon that may mark the Holocene/Pleistocene boundary.

INTRODUCTION

We have recently completed a study of the magnetostratigraphy of three cores obtained by the United States Geological Survey (USGS) from Owens Lake, CA in the spring of 1992 to investigate middle to late Pleistocene climate in the western US. The objectives of our participation in the project were to provide a record of the magnetostratigraphy from a suite of 300 samples taken at roughly 0.5-1.5 m intervals. The composite of the three cores contains mostly fine- to medium-grained lake deposits, and extends to a depth of 323 m and an age of nearly 800 ka (Smith and Bischoff, 1993). The cores, therefore, have potential for providing excellent records of climate and paleomagnetic field changes within the Quaternary. We have performed (and are continuing) paleo- and rock-magnetic studies on a suite of over 500 discrete samples taken from throughout the composite section in order to provide magnetostratigraphy and potential proxies for climate change, and, to study in detail, the Matuyama/Brunhes (M/B) transition and within-Brunhes excursions and secular variation (SV).

PROCEDURES AND RESULTS

SAMPLING TECHNIQUES

Samples were taken from cores OL92-1,2 both on site during drilling (4/92-6/92) and subsequently at the USGS in Palo Alto and Menlo Park (7/92-9/92) where the cores are presently stored. Eight cubic centimeter (cc) discrete samples were taken roughly every meter with additional samples taken in depth ranges where significant deviations in field directions were discovered. Continuous back-to-back samples were taken through most of core OL92-3.

Where the sediment was soft, samples were extracted by pressing plastic boxes into the cutface (surface between working and archive halves) of the core. In regions where the sediment was more lithified, samples were carved from the core using non-magnetic Cu-Be tools and then fit into plastic boxes. Samples were taken from the center of the core to avoid sediment contaminated or disturbed by drilling or remagnetized by the drill string. Some of the samples were later impregnated with a solution of 10% sodium silicate, a non-magnetic, high temperature cement, to prevent them from falling apart.

Samples (from cores OL92-1,2 -- see table 1) are numbered sequentially, grouped by sampling session and distinguished from other samples from the same horizon. For example: the sample labeled C12B belongs to sample 12 taken during the third (C) resampling session and is the second (B) sample from its particular stratigraphic horizon. Samples taken on site do not carry a letter in the first character position of the sample label.

Discrete samples from cores OL92-3 (see tables 2, 3) are numbered sequentially, grouped by slug, and U-channel section. There were two U-channel sections taken per slug, an upper (t) and lower (b) one. For example: the sample labeled, cb12, belongs to sample 12 taken from the lower (b) U-channel section from slug c.

MEASUREMENTS

Remanent magnetization, susceptibility, and anhysteretic remanent magnetization measurements and techniques are discussed below. The data are presented in tables 1 through 3. See Butler (1992) for reference to units, quantities, techniques, etc.

REMANENT MAGNETIZATION

Measurements of the samples' magnetizations were made on a 2G-Enterprises superconducting rock magnetometer housed in a field-free room at the University of California at Santa Cruz Paleomagnetics Laboratory. The samples' natural remanent magnetization (NRM) intensities (J) varied by 3 orders of magnitude (10^{-7} to 10^{-4} emu/cc), with a large fraction of sample NRM's residing in the mid-10^{-7} range (fig. 1). The samples were subjected to alternating field (AF) demagnetization using a Schonstedt AC tumbling sample demagnetizer. Only a few samples were thermally demagnetized due to the fact that the sediment constitution rendered the samples difficult to remove from their plastic boxes (which cannot be heated above 100°C), and the samples tended to disintegrate with heating. Generally, at least fifteen steps were applied in order to isolate any overprint direction in addition to defining accurately the stable direction of magnetization. A least-squares best fit is applied to no less than three points on the demagnetization diagrams to yield 'characteristic' paleomagnetic directions. AF and thermal demagnetization techniques applied to samples from the same horizon reveal essentially the same directions, indicating that AF demagnetization is adequately resolving the characteristic field directions (fig. 2). Although stable characteristic components were adequately defined for most samples, some were unstable during demagnetization and yielded no reliable directions. The cause for unstable behavior may be due to any of a number of reasons, including disturbed sediment, extremely weak NRM's, extremely weak primary paleointensities, unstable magnetic phases, etc.

We have applied a 9-point grading system to the samples' directions based on the quality of their vector component plots. The following examples outline some of the general criteria for the system of grades: 1=multiple (>3) points defining a straight line to the origin with a colinearity less than 2; 2=multiple (>3) points defining a line with a colinearity less than 3; 3=multiple (>3) points defining a line with a colinearity less than 5; 4=multiple (>3) points defining a line with a colinearity less than 6; 5=three or more points defining a line with a colinearity less than 7; 6=three or more points defining a line with a colinearity less than 8; 7=three or more points defining a line with a colinearity less than 9; 8=a cluster of successive points and one additional point to the origin; 9=direction defined by a cluster of points. For samples in which no stable endpoint was reached, NRM directions were plotted, and no grades were assigned.

Because cores OL92-1,2 were rotary drilled, azimuthal orientation of individual core segments has been lost, resulting in a loss of absolute declinations. Therefore, polarity is inferred from inclination alone. Results from the inclination record (fig. 3) show the presence of several low inclination excursions (or possibly short polarity events) within the Brunhes in addition to a reversal of directions at the base of the composite core (here interpreted as the Matuyama/Brunhes polarity reversal).

Since core OL92-3 was not rotary drilled, information on declination was retained. Directions are shown in fig. 4 and given in table 2. Erratic directions above 5.16m are ascribed to the poor recording ability and disruption of the poorly consolidated coarse oolitic sands. Between depths 5.16 and 5.79m erratic directions coincide with a section of core that contains authigenic Na-sulfate and Na-carbonate crystals that formed from the interstitial brines after the core was refrigerated (Smith 1993), apparently indicating that crystal growth has disturbed the magnetization.

SUSCEPTIBILITY

In addition to determining remanence directions, we performed (at U.C. Santa Cruz) low field susceptibility (χ) measurements on discrete samples using a 5 cm diameter Sapphire Instruments (SI) χ coil (fig. 5). Pass-through χ measurements (taken every 3 cm) were performed (at the USGS, Palo Alto, CA) on the entire core OL92-3 prior to its being split, and on the archive halves of selected slugs from cores OL92-1,2 using a 10 cm diameter SI coil. χ varied by three orders of magnitude, but were generally low (~2×10^{-6} in cgs system units) with several near or below the noise level of the instruments (5 cm coil ~1×10^{-7} cgs, 10 cm coil ~1×10^{-6} cgs). Variations in χ, which depends on the amount and types of magnetic material present in a sample, may reflect changes in climate (e.g. mediated through changes in the input of soil, airborn, biogenic or lithogenic sources of magnetic material), or geology (e.g. through volcanic input or changing source areas). The remanent magnetization (fig. 1), on the other hand, depends on the intensity of the Earth's magnetic field in addition to the number and types of magnetic grains in the sample. A first order approximation of the paleointensity can then be obtained by normalizing the NRM to χ (figs. 6,8).

ANHYSTERETIC REMANENT MAGNETIZATION

Anhysteretic remanent magnetization (ARM) measurements were performed on selected samples (fig. 7) in order to derive a more accurate estimate of field intensity variations [achieved by normalizing J to ARM (i.e. J/ARM) -- fig. 8], and to resolve variations in the concentration (inferred from variations in ARM which is proportional to concentration) and particle size (inferred from variations in χ/ARM which is proportional to grainsize) of magnetic grains (fig. 9). The measurements were performed by subjecting the samples to a decaying 1000 Oe peak AF field, and static 0.5 Oe DC field. ARM is a more accurate normalizing factor for paleointensity than χ because it depends, like the NRM, only on grains capable of carrying a remanence.

Samples from two segments of core (depths 70-93m and 148-235m) were subjected to ARM measurements. Magnetizations normalized to ARM span an order of magnitude, suggesting that the character (grain size and/or mineralogy) of magnetic grains varies through the core. Most of the variation occurs between the two measured segments, with values fairly consistent within segments. Although this limits the use of ARM in interpreting intensity variations throughout the core, relative intensities within limited stretches of core may still be valid. In addition, it presents the opportunity to use the measurements to identify distinct lithologic regions that may pertain to climate.

DISCUSSION

THE MATUYAMA/BRUNHES POLARITY REVERSAL

At the base of core OL92-2, the sediments record a 3m section of transitional directions interpreted as the M/B reversal. Although stable reversed directions were not reached by the bottom of the core [indicating that the record of the reversal is incomplete (fig. 10)], inclinations throughout the transition undergo several large swings between normal and reversed directions, suggesting that a fairly large segment of time is represented and that the bulk of the transition is spanned. This is supported by the apparently long duration of the reversal record (over 20 ka) based on the average sedimentation rate [note that the average reversal duration is 3-5 kyr (Bogue and Merrill 1992)]. Assuming then that most of the transition has been recovered, we have taken the middle of the reversal to lie midway through the recovered section of the main sequence of transitional directions (at 320.2m).

Recently, several different workers have derived ages for the Matuyama/Brunhes (M/B) transition, which together with the depth of the transition yield an estimate of the average deposition rate throughout the core. Johnson (1982) calculated an age of 788±5ka, based on correlations with marine oxygen-isotope curves (matched in phase with the astronomical time scale). Spell and Mcdougall (1992) have performed $^{40}Ar/^{39}Ar$ laser fusion measurements on sanidine crystals from reversely magnetized Valles caldera rhyolites (New Mexico). They suggest that their results together with existing dates (Mankinen and Dalrymple, 1979) yield an estimate of 780±10 ka for the age of the reversal. Izett and Obradovich (1992) bracket it between 790 and 760 ka based on laser fusion $^{40}Ar/^{39}Ar$ dating of sanidine from three sources [reversely magnetized Valles caldera rhyolites (New Mexico) and Toba Tuff (Sumatra), and normally magnetized Bishop Tuff]. They deduce an age of 770 ka for the reversal based on sedimentation-rate calculations and the occurrence of the reversal relative to the Bishop Ash in a core from Lake Bonneville. Baksi and others (1992) derived an age of 783±11 ka from $^{40}Ar/^{39}Ar$ incremental heating studies of lava flows erupted during the transition. Since this is the only study involving flows from within the transition, we use this date as the best estimate for the age of the reversal. Nonetheless, because these ages are in relatively close agreement, the particular choice of age (or ages to average) makes little difference.

WITHIN-BRUNHES EXCURSIONS

Several inclination anomalies are identified throughout the section of core stratigraphically above the M/B reversal (figs. 3, 11). Although shallowing of inclination can occur from sedimentological effects, no correlation was found between inclination and concentration (inferred from χ and ARM) and grain size (inferred from χ / χ_{ARM}) of magnetic constituents, clay mineralogy, or concentration of clay minerals (inferred from weight % of clay sized particles). Thus, provided the features represent true field behavior, they may reflect global field excursions (deviations of the dipole), or short or aborted reversals. If so, they should correlate with features seen at globally distributed sites.

In the fashion of Champion and others (1988), we have compared the features with events compiled from several records distributed around the globe (Negrini and others 1987, Bleil and Gard 1989, Harland and others 1990, Nowaczyk 1990, Meynadier and others 1992, Schnepp 1992, Valet and Meynadier 1993). Table 4 gives the assigned identification and ages of the features based on this comparison. Due to the large number of events, and the uncertainty of ages and mechanisms by which the events are generated, we suggest that, at present, these correlations be considered with discretion.

A corroboration of the correlations suggested in table 4 is underway and will require establishing the details (in direction and intensity) of the excursions. Even if such features are not global, regional records (within distances of 3000 km) should be correlative. For this reason we intend to resample OL92, focusing particularly on events such as the Mono Lake (28ka) and Pringle Falls (150ka) excursions, which are recorded at several sites in the western U.S. [Mono lake: Liddicoat (1992), Negrini and others (1984); Pringle Falls: Herrero-Bervera and others(1989), Liddicoat and Bailey (1989), and Negrini and others (1988)]

Negrini and others (1987) describe a record from the Humbolt River Canyon (HRC) containing a longterm trend (10's kyr ~ 100 kyr) of shallow inclinations followed by a prominent excursion. The section also contains the Lava Creek and Dibekulewe ashes. We correlated this record of shallow inclination to a segment in the Owens cores, and correctly inferred the position of the Dibekulewe ash, prior to our knowledge of its place in core OL92-2 (fig. 12). Likewise, the position of the Lava Creek ash in OL92, suggested by the correlation, corresponds to a segment of core loss, which explains why the ash was not identified in the core despite its expected deposition based on the ash's regional distribution. This inferred position of the Lava Creek Ash adds an additional constraint on age. Provided the sites were not both affected by significant drops in deposition rate or contain significant hiatuses, the correlation suggests that the inclination trend spans a significant interval of time, contrary to earlier suggestions (Champion and others 1988), and that the Lava Creek and Dibekulewe ashes are not as close in age as previously thought (Rieck and others 1992). Such a long and pronounced deviation of field directions (from axial dipolar) has significant implications for tectonic studies spanning this time that assume to average secular variation. It should be noted that during this time the field may be nonstationary over 100's kyrs. Applying the average sedimentation rate (40cm/kyr) puts the Dibekulewe ash at ~575ka assuming the inferred location (at ~260m) and age (665ka -- Izett and others 1992) of the Lava Creek ash.

The HRC section is relatively uniform (fine grained) throughout (R. Negrini verbal comm., 5/93) and does not show the pronounced lithologic change found in OL92 (at depth 223m). Since the two basins are relatively close to each other, the lithologic change in OL92 is either due to a very localized shift in the climate pattern or more likely a tectonic/geologic event that altered the basin geometry, perhaps tectonic uplift of the spillway or modification by slides and/or debris- or lava-flows.

The fact that sedimentation rates for OL92 and HRC differ significantly, argues against their similar patterns in inclination being artifacts of sedimentary processes. The Owens record also shows that the trend is dominated by several increasingly prominent shallow inclination excursions (i.e., suggesting the HRC record may have smoothed the excursions). Records of relative inclination from the equatorial Pacific (Valet and Meynadier 1993, Kent and Opdyke 1977) display several swings to low intensity during this same period of time. This implies the events are real (not artifacts of the magnetization process or remagnetization) and are tied to fluctuations in the dipole field (i.e. they are global in nature). The fact that the excursions lie on a secular trend of increasing intensity, may indicate that the excursions are actively involved in the regeneration of field strength, and hence are responsible for the longevity of the Brunhes chron (Valet and Meynadier, 1993).

AGE VERSUS DEPTH

The depth and age of the M/B reversal yield an average sedimentation rate of 40.8cm/1000yr. A five meter segment of ash near the base of the composite section (at depths between 303.5 and 309.1m) has been identified as the Bishop ash (A. Sarna-Wojcicki, verbal comm., 1992). Removing the segment of core logged as ash, and assuming the ash was effectively deposited as an instantaneous pulse, yields an average sedimentation rate of 40.2cm/1000yr.

Depths and correlation ages of shallow inclination events (table 4) are plotted (fig. 13) against an age versus depth curve based on sediment bulk density derived from pore water and salinity measurements (Bischoff and others, 1993b). The curves agree remarkably well and reveal that sediment accumulated relatively steadily through the entire composite core.

MAGNETIC PROXIES FOR CLIMATE

Because χ and ARM both depend on the concentration and mineralogy of magnetic grains, they may potentially reflect variations in climate. This may occur via changes in the source material (e.g. soil production), the rates of detrital input, the production of authigenic phases, or the destruction of existing material (e.g. via reduction diagenesis) in the lake arising from changing climate conditions. Several studies spanning a variety of sedimentary environments have successfully identified correlations between magnetic records and traditional climate indicators (King and Channell, 1991).

Rock magnetic studies of cores from nearby locations on the Owens playa and spanning the upper 25-30m of sediment suggest the presence of magnetite and greigite (Steve Lund, verbal comm. 4/92). Lund found large variations in χ throughout the core which he believes reflect fluctuations in climate between very dry and overflowing conditions. He attributes the variations to changes in the concentration of greigite. The large χ values, which were seen in measurements Lund performed immediately after the cores were taken, dropped significantly within a few hours, presumably due to the alteration of greigite to non-magnetic or more weakly magnetic mineral phases.

Several large χ fluctuations are seen throughout all three OL92 cores. The most prominent of these occurs in the depth range 75-90 m. The drop at near 75 m may be the Termination II boundary between glacial Stage 6 and the subsequent interglacial Stage 5e. There were no comparable advances for nearly 300 years prior to glacial stage 6. The fact that the χ anomaly is so prominent could be due to long term production and storage of weathering products behind terminal moraines (Robert Anderson, verbal comm. 4/92). On the other hand, the χ -high may be due to the presence of greigite, commonly formed during reduction diagenesis in lake environments (Roberts and others 1993) and produced in the deep lake conditions prevailing during this glacial stage. By either of these mechanisms, the other susceptibility highs may also be tied to prominent glacial stages. For example, the highs at depths 210, 242, and 275 m may correspond to glacial stages at 440, 560, and 630 ka respectively.

If χ variations actually reflect climate change they should correspond to fluctuations in other lithologic/chemical climate indicators. Plots of χ, CO_3, Fe_2O_3, and smectite versus depth show striking correlations between these variables (figs. 14-16). Differences in relative amplitudes of fluctuations among these environmental indicators suggest that more than one mechanism is responsible for their coincidence (for example: χ and CO_3 correlations cannot be entirely ascribed to the dilution of a constant fraction of magnetic constituents by the addition of CO_3). Interestingly, the two large peaks (and a prominent low) in χ occurring where CO_3 is zero (235-280m) correspond closely with variations in smectite (fig. 15). They also correlate with Fe_2O_3 (fig. 16), but the first Fe_2O_3 high (at ~240m) is significantly smaller than the second (at ~270m). This first peak is the only place where mol% Fe (calculated from the geochemical analyses -- Bischoff and others 1993a) deviates significantly from the expected mol% Fe [calculated from the % illite (Menking and others 1993a) assuming a single compositional phase of illite (glauconite)] (fig. 17). Such changes in the scaling and correlations of proxies, undoubtedly due to the action of multiple processes, may be useful to identify disitinct lithologic zones reflecting major climate/lake conditions [e.g. χ versus CO_3 suggest perhaps 5 such regimes (0-70, 70-95, 95-145, 145-185, 185-320m)].

THE HOLOCENE/PLEISTOCENE BOUNDARY

The record of continuous pass-through susceptibility (spanning core 3 and the uppermost 17 m of section from core 1 -- figs. 18,19) shows several large fluctuations (near sample measurements 50, 180, 370 and depths 5, 8, 15m respectively). The first and largest (at 5m) is a symmetric anomaly whose upper boundary corresponds to a medium-coarse sand/ fine-medium sand contact (at 4.64m) and whose lower boundary is marked by the oolitic sand/clay contact (at 5.16m). The second anomaly, which is centered within a single drive, is quite asymmetric, with a steeply sided upper boundary and gradual decline to lower values. The third feature is a prominent high frequency anomaly (located at a depth of 15m) that occurs at the base of drive 9 and may represent contamination from the drill string.

The χ anomaly at 8m is remarkably similar in form to the J anomaly across the Holocene/Pleistocene boundary seen in gravity cores taken from nearby locations (Newton, 1991) (fig. 20). Correlating these features allows us to tie the two sets of records together (fig. 21). In light of the correlation, we found other aspects of the cores to be quite consistent. Radiocarbon ages on oolites and humates from the OL92 cores (Bischoff and others, 1993c) agree reasonably well with those from bulk sediment organic carbon from the OWL cores (Lund and others, 1991; Newton, 1991). In addition, the top of the χ anomaly in OL92 is marked by a thin sand layer like the horizon in the OWL cores. The intensity anomaly in OWL-84B and χ anomaly in OL92 span roughly the same thickness of section as do the intervening sediments between the oolite clay boundary and the sand layers in both cores. Finally the sediment color above the boundary in both cores is described as olive brown and below as gray. Newton (1991) identified the sand layer as an aeolian deposit and found mudcracks at the top of the unit below the sand, indicating the lake had desiccated. The sand in OL92 is apparently more poorly sorted and no mudcracks are visible. That the thickness of section represented in the OL92 cores is midway between the OWL84B and OWL87D,F cores is consistent with the OL92 cores being situated geographically between the OWL cores (fig. 22). Evidence exists in both cores for a shallowing of the lake at the oolite/clay boundary. The ages and depths of the base of the oolite bed is ~8kyr in both the OL92-3 and OWL84B cores. We reexamined the OL92 core, after having correlated the χ and J anomalies, in order to resolve apparent discrepancies between OL92 and OWL lithologic descriptions. This revealed the section of mud below the sand was marked by an orange speckled color that manifested only after the cores had sufficiently oxidized during storage (which is why the orange speckles are not in the original log descriptions). This pattern is a distinct characteristic of Newton's description of the unit, and its apparent absence in OL92 was a source of confusion as to how the cores related. Finally, subsequent to reexamining the OL92 cores, we found that it too contained abundant diatoms --the species found (*Stephaodiscus niagarae*) is identical to those noted in the OWL cores (Bradbury 1993).

It seems, therefore, that there is no discrepancy between the OL92 and OWL cores. Whether that boundary marks the passage from the Holocene to the Pleistocene remains unresolved. Lund and others (1991) estimate the boundary's age to be 12,500yr -- consistent with OL92 radiocarbon ages. A similar dry period is found recorded in the Searles Basin that is precisely the same age, but that was not the last of the deep-water lakes in that basin (George Smith, personal comm. 11/93). It may therefore represent an earlier stage of drying, such as the onset of the Late Glacial Interstadial, that occurred at ~12,500 yr, just prior to the Younger Dryas Stadial (Roberts and others 1993).

CONCLUSIONS

We have identified the M/B polarity reversal at a depth of 320.2m in a composite of three cores taken from Owens Lake, CA. The age and depth of the reversal yield an average sedimentation rate of 40cm/1000yrs. This is in good agreement with an average sedimentation rate established on the basis of the depth and age of the Bishop Ash. We also find several excursions of magnetic field directions within the Brunhes epoch and have correlated them with features seen in other records to provide timing throughout the OL92 core. The results are in excellent agreement with an age versus depth curve based on bulk density calculations from pore water data. Both indicate that the sedimentation rate is relatively steady throughout the core. Correlations of the upper 10m of the OL92 core with gravity cores from adjacent sites on the playa have been achieved using continuous χ measurements, and corroborated by reexamining lithology. This correlation reveals a distinct but brief dry period that may mark the Holocene/Pleistocene boundary or a temporary shift from glacial conditions just prior to the onset of the Younger Dryas which preceded the close of pluvial conditions in both Owens and Searles Lakes. Correlations of SV in the OL92 and HRC sections provide additional age control and help constrain the cause of lithologic changes in the OL92 core. Work is being continued in order to fill in gaps, improve the resolution of field excursions, and refine rock magnetic records.

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Figure 16). χ (solid line) and Fe_2O_3 (dashed line) [from Bischoff and others 1993a] versus depth: a) depths 0-100, b)100-200, c) 200-320.

Figure 17). Mol % Fe (dashed line) [calculated from % Fe_2O_3 (from Bischoff and others 1993a)] and expected mol % Fe (solid line), assuming that essentially all the Fe is in illite [calculated from % illite (from Menking and others 1993a)].

Figure 18). Pass-through χ versus sample (measurement sampling is every 3 cm) in core OL92-3. Slug boundaries are shown by vertical lines. The dashed curve shows a repeated measure of slug b.

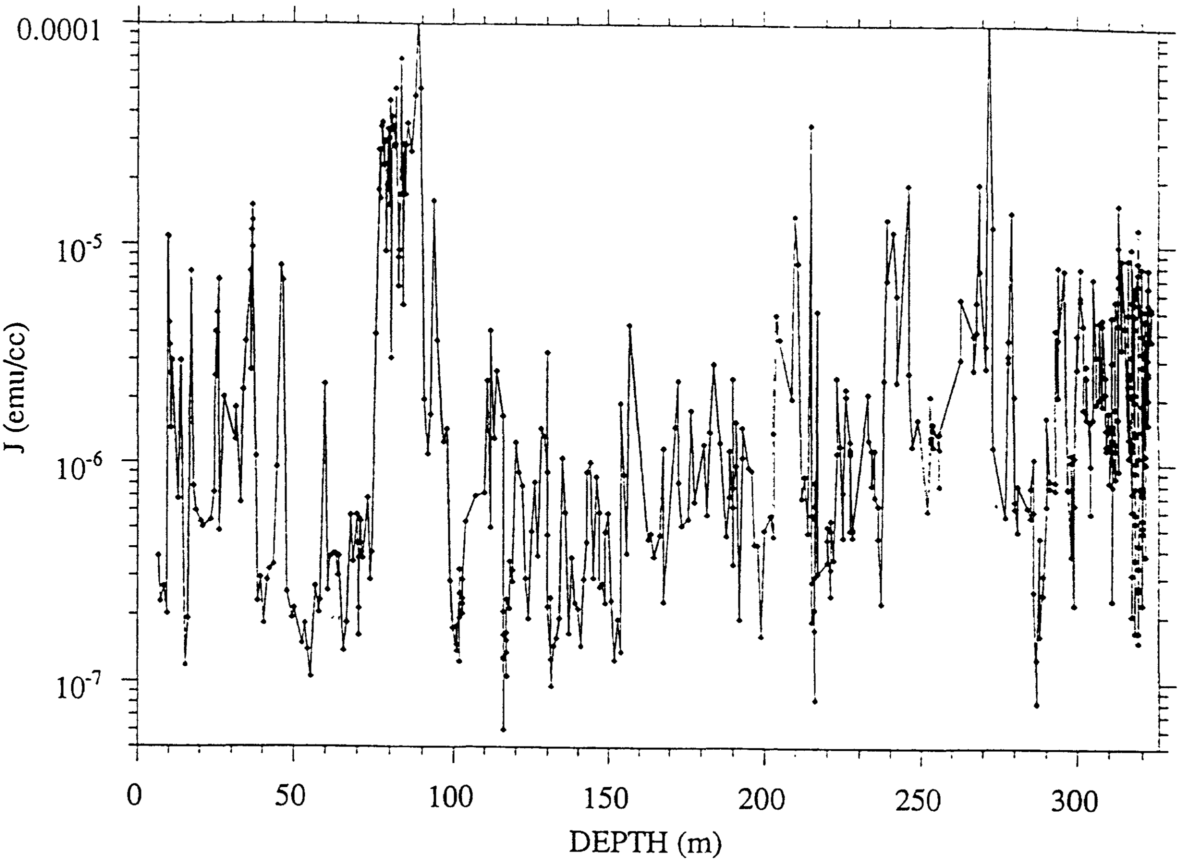
Figure 19). Pass through χ versus sample (measurement sampling is every 3 cm) in core OL92-3,1. Drive tops and bottoms are shown by arrows, and alphanumeric labels identify drive and slug numbers.

Figure 20). Correlation of paleointensity from OWL cores (units are unspecified, but are probably 10^{-6} emu/cc) and χ from OL92-1 (units are in 10^{-6} cgs) across the horizon identified by Newton (1991) as the Holocene/Pleistocene boundary (adapted from fig. 4-7, Newton 1991).

Figure 21). Generalized stratigraphic columns and correlations of OWL and OL92 cores (adapted from fig. 4-4, Newton, 1991). Radiocarbon ages are located with black arrows and Lund and others's 1991 estimate for the H/P unit boundary with a white arrow.

Figure 22). Site locality map showing positions of OWL and OL92 cores within Owens playa.

Figure 1



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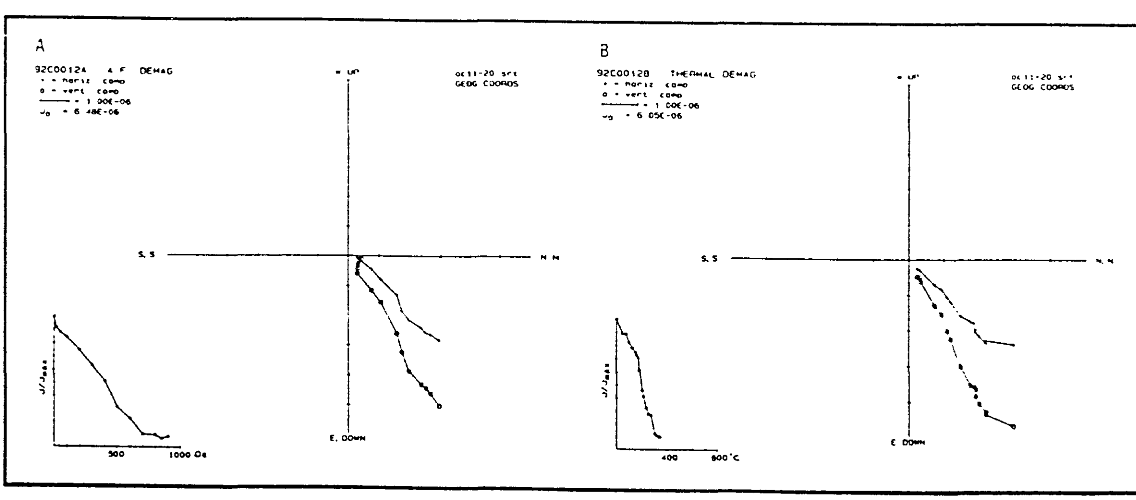

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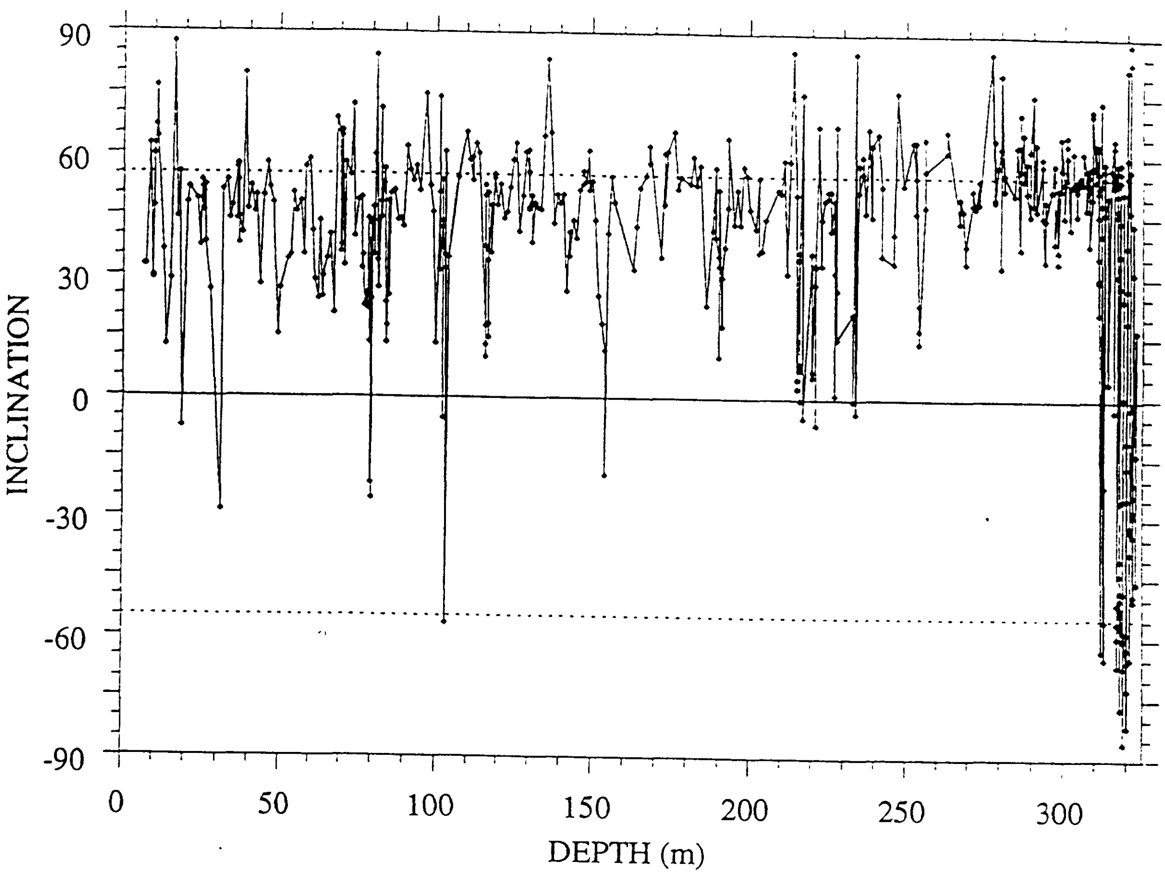

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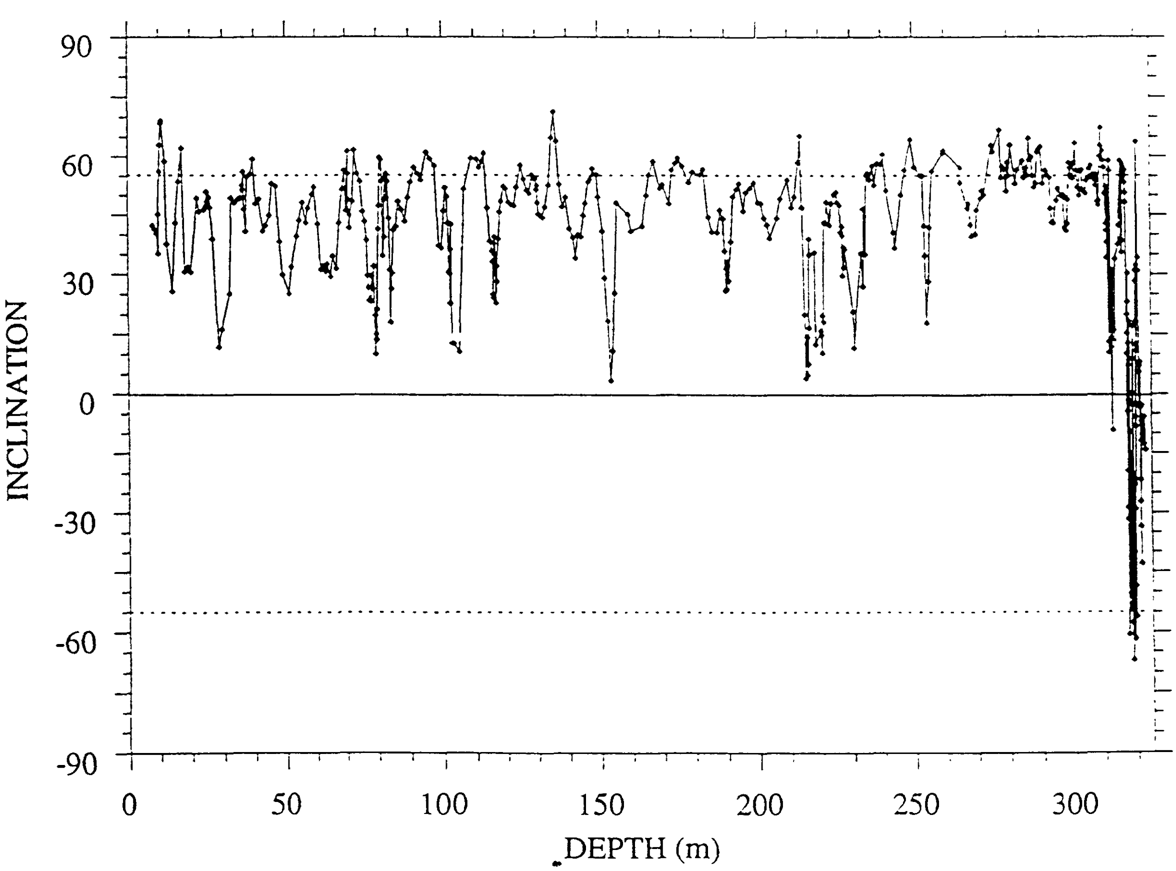
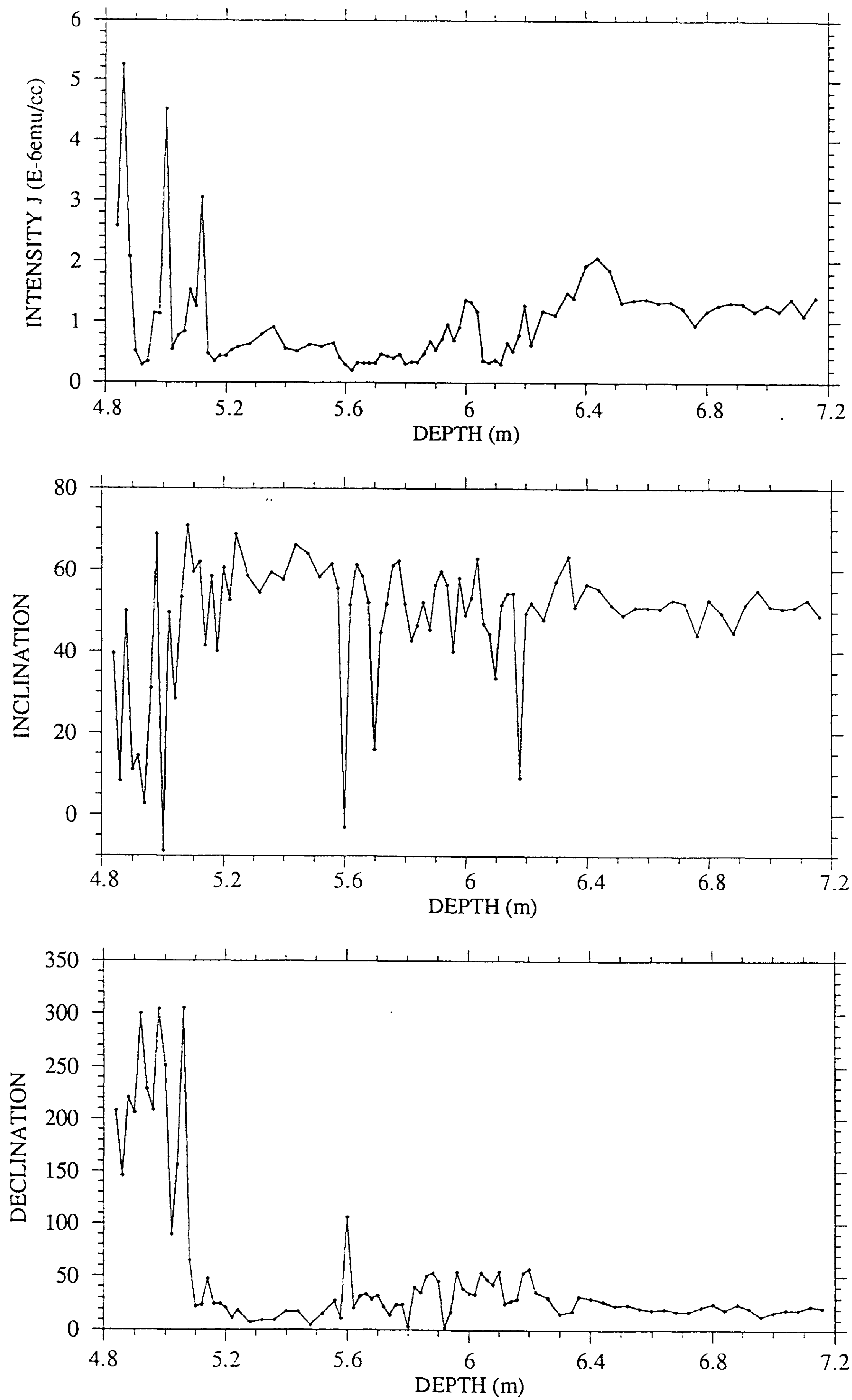
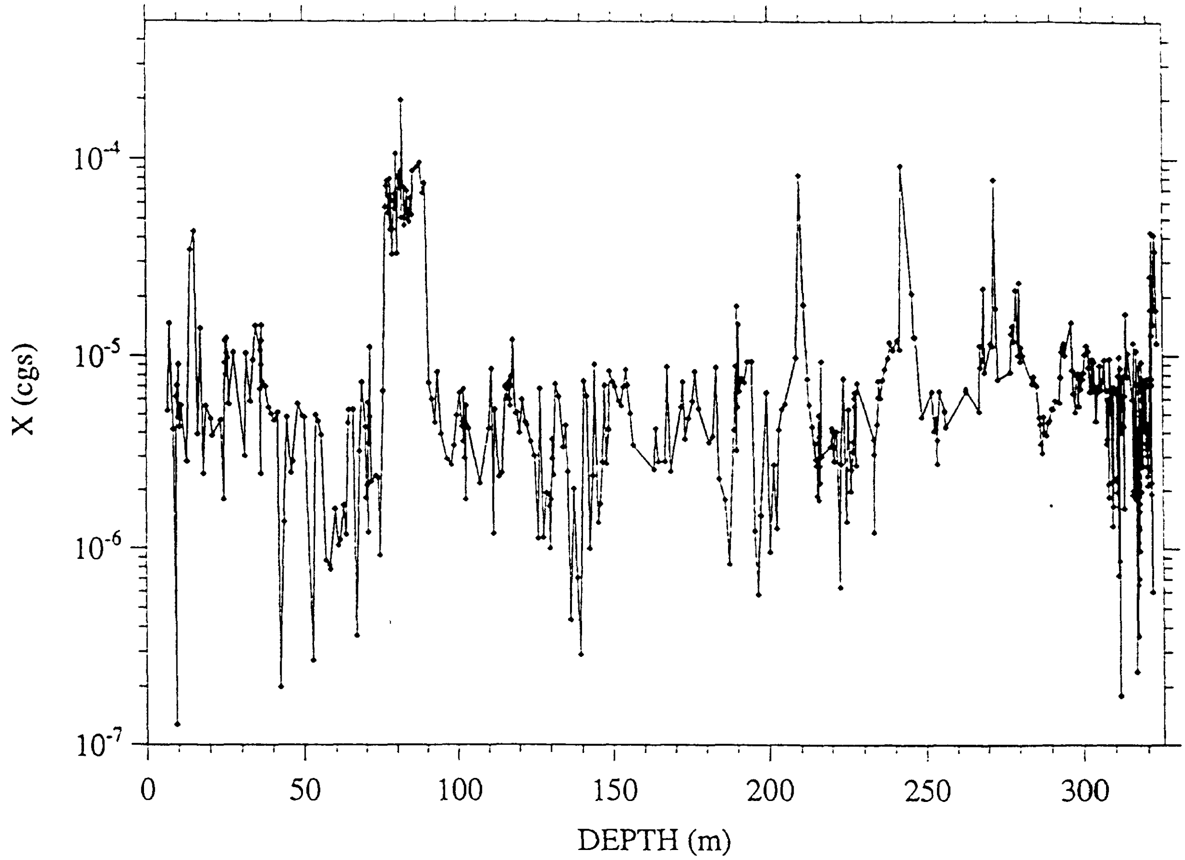


Figure 4



INTENSITY J (E-6emu/cc)
DEPTH (m)
INCLINATION
DEPTH (m)
DECLINATION
DEPTH (m)

Figure 5



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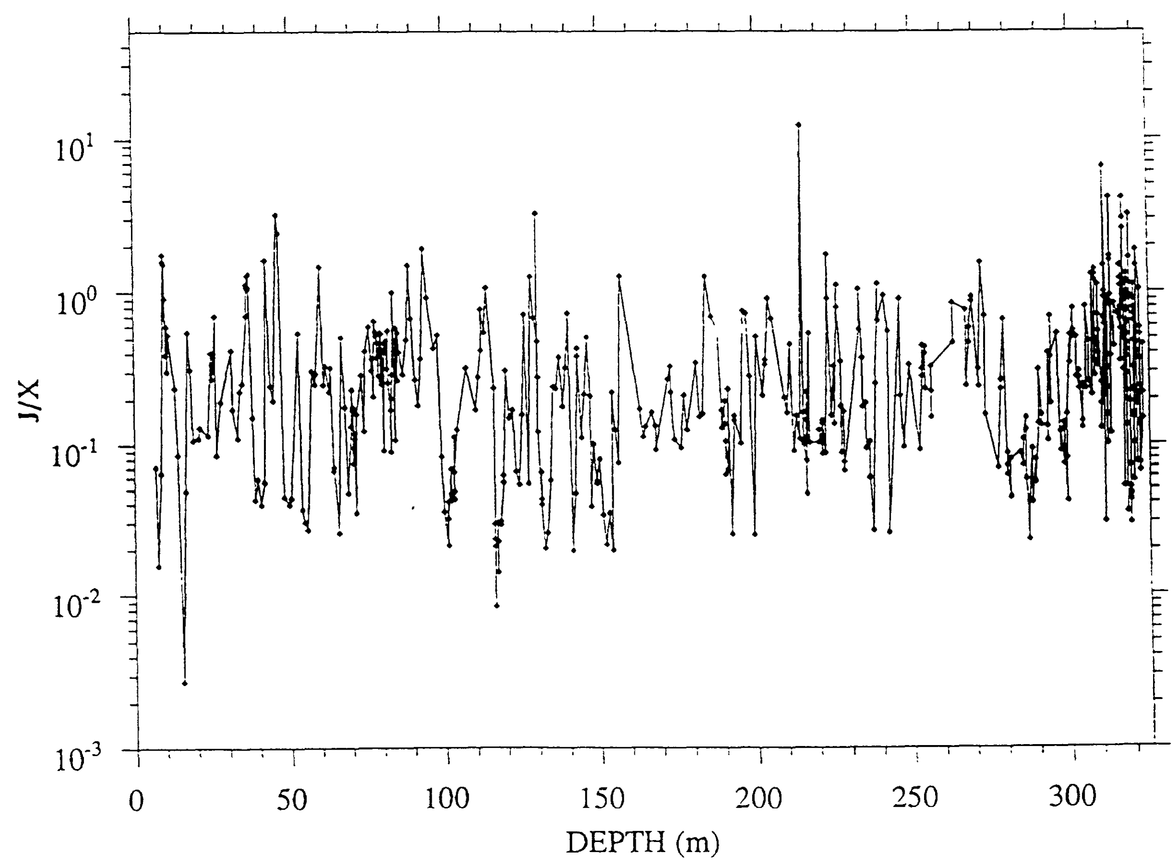

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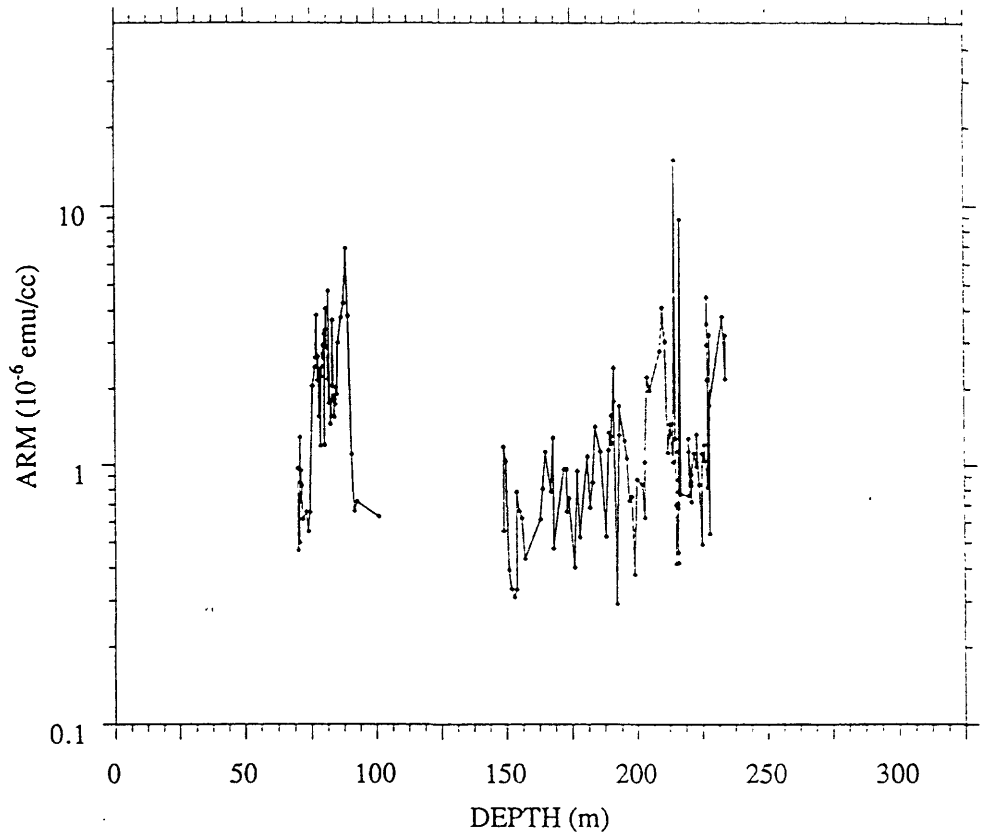

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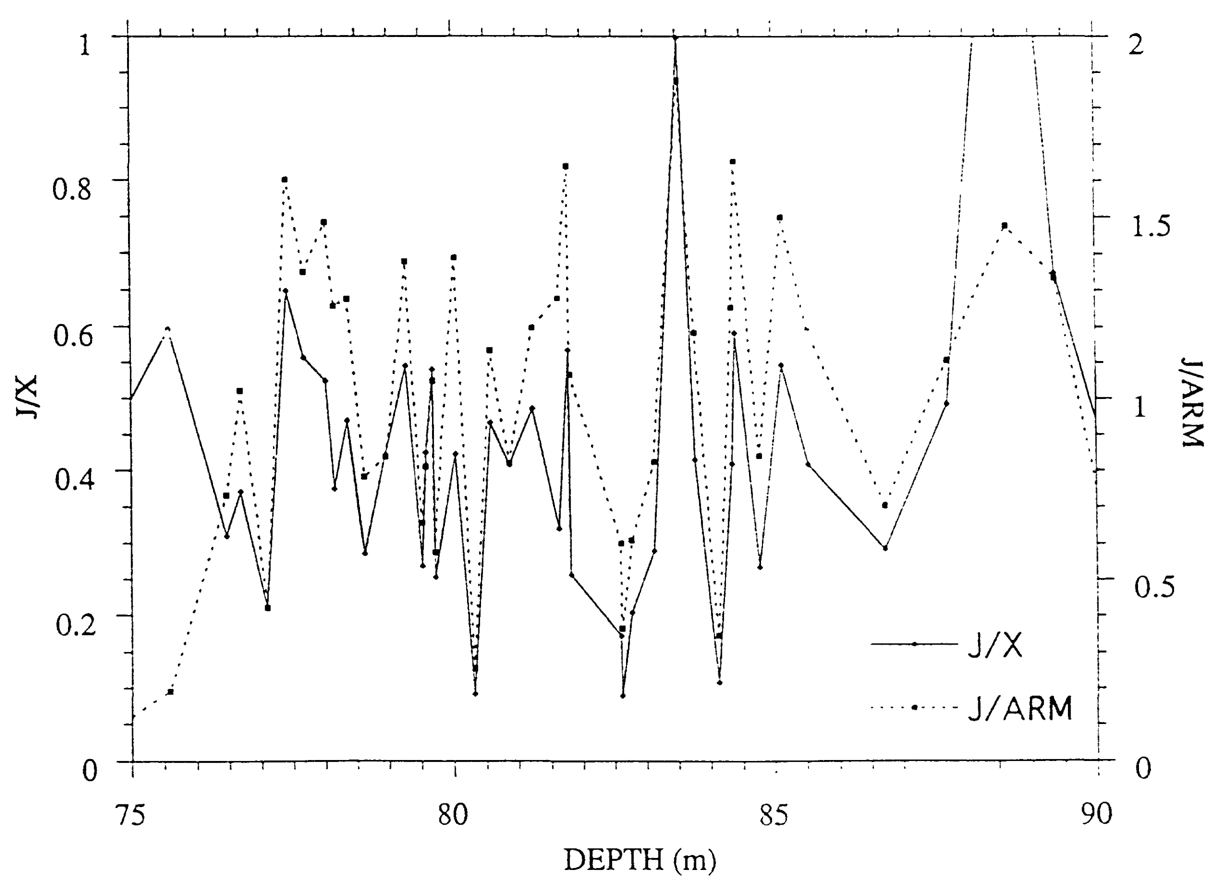

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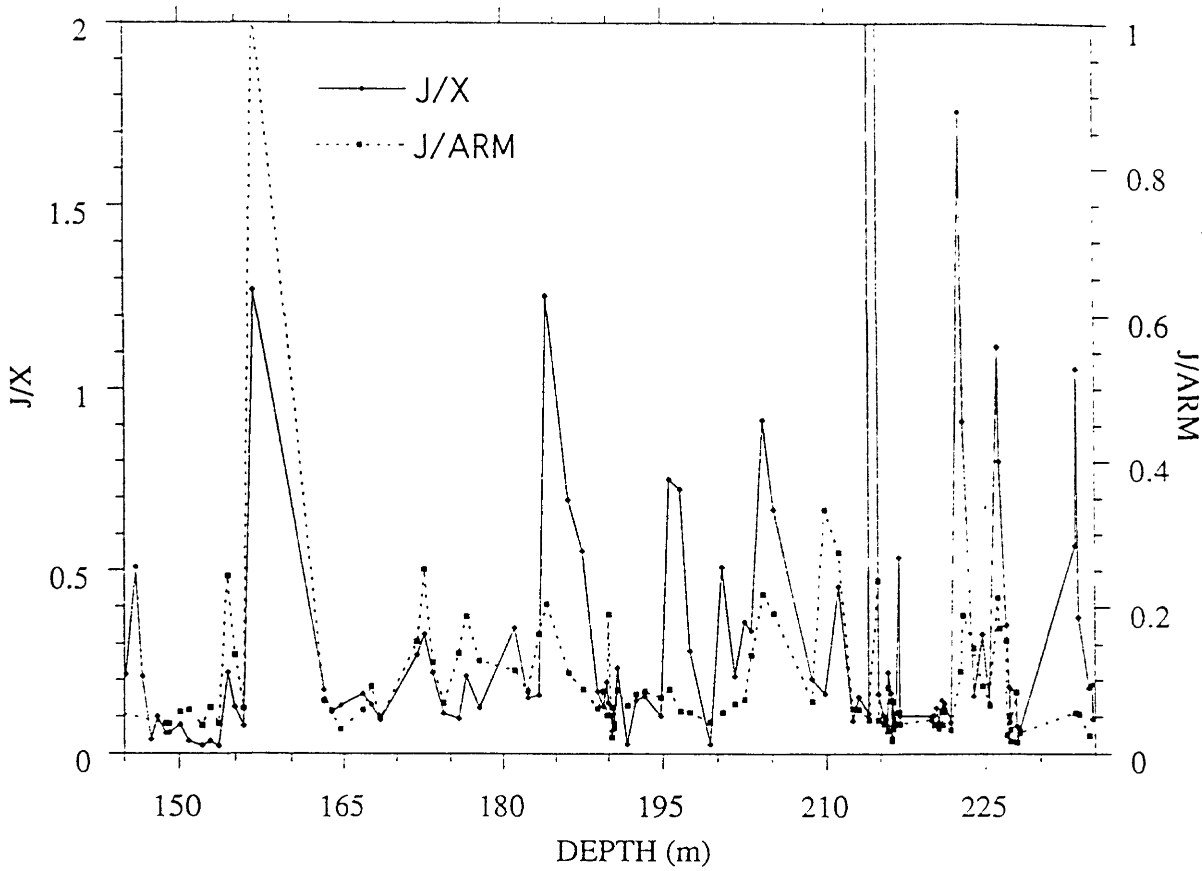

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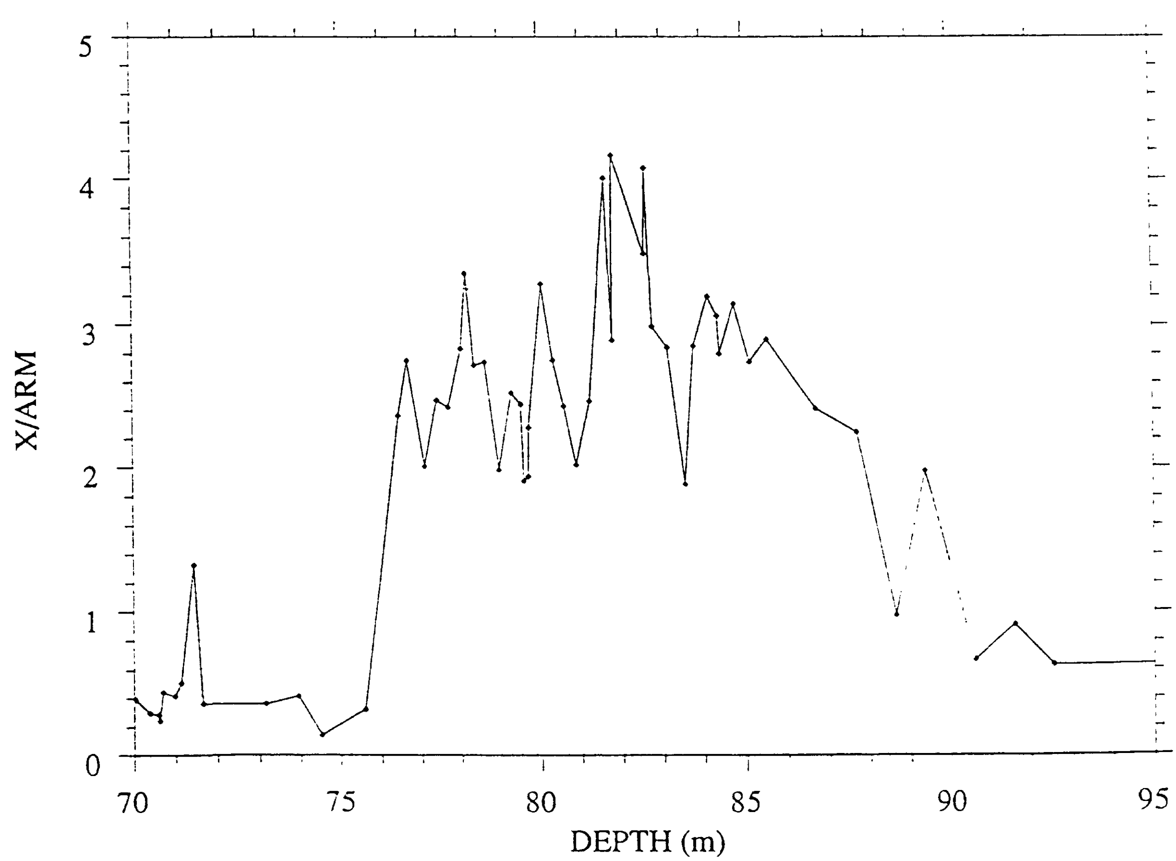

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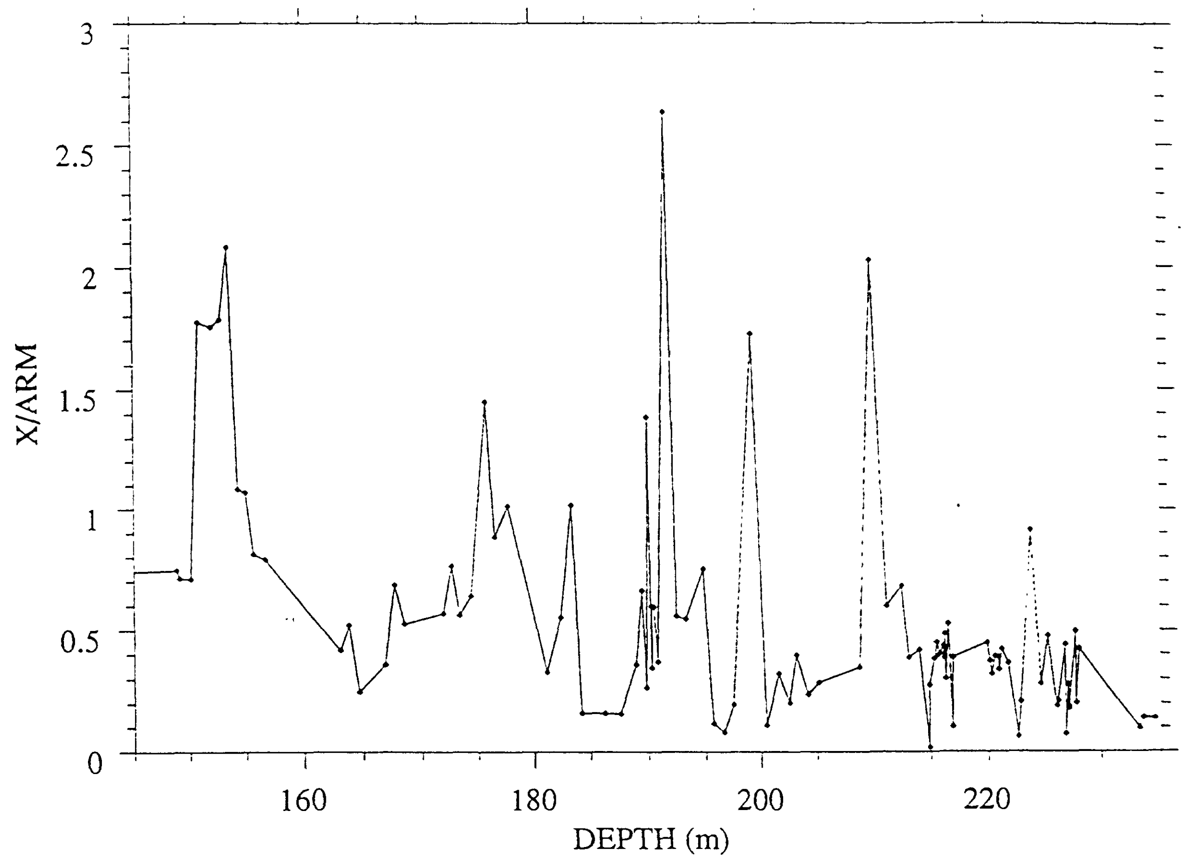

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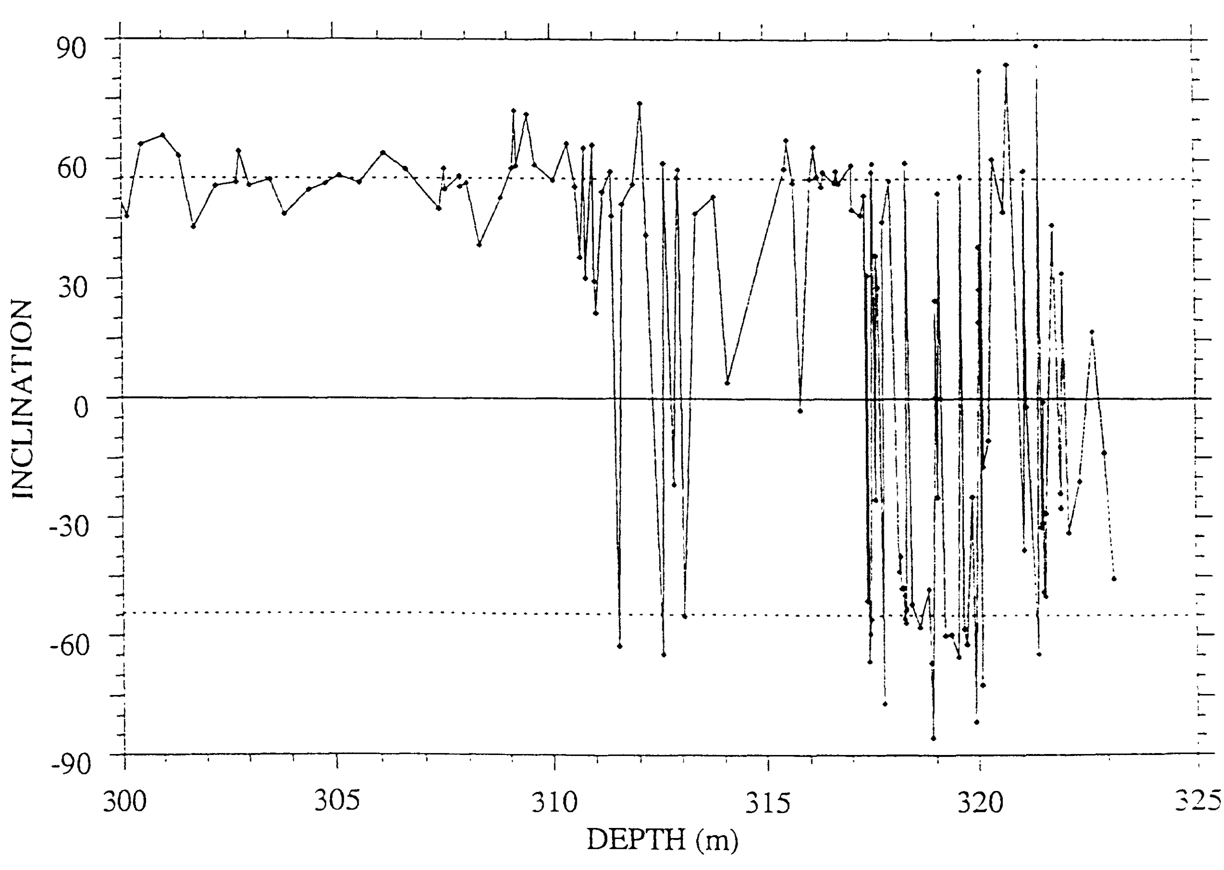

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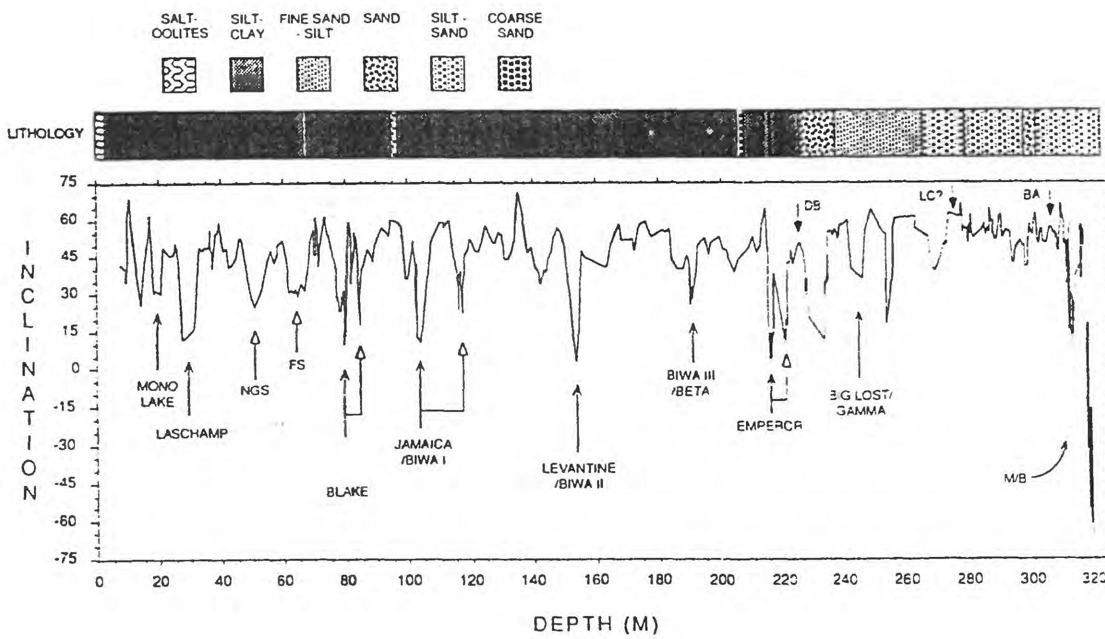
Figure 11



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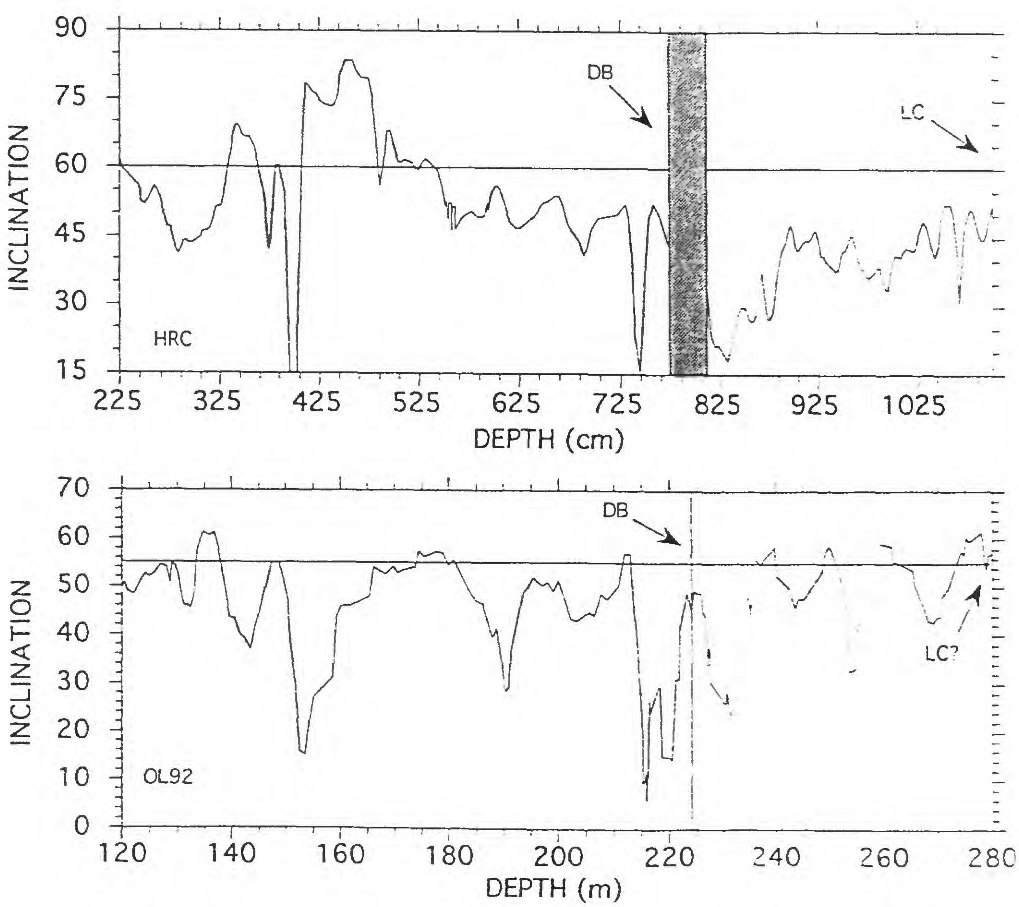

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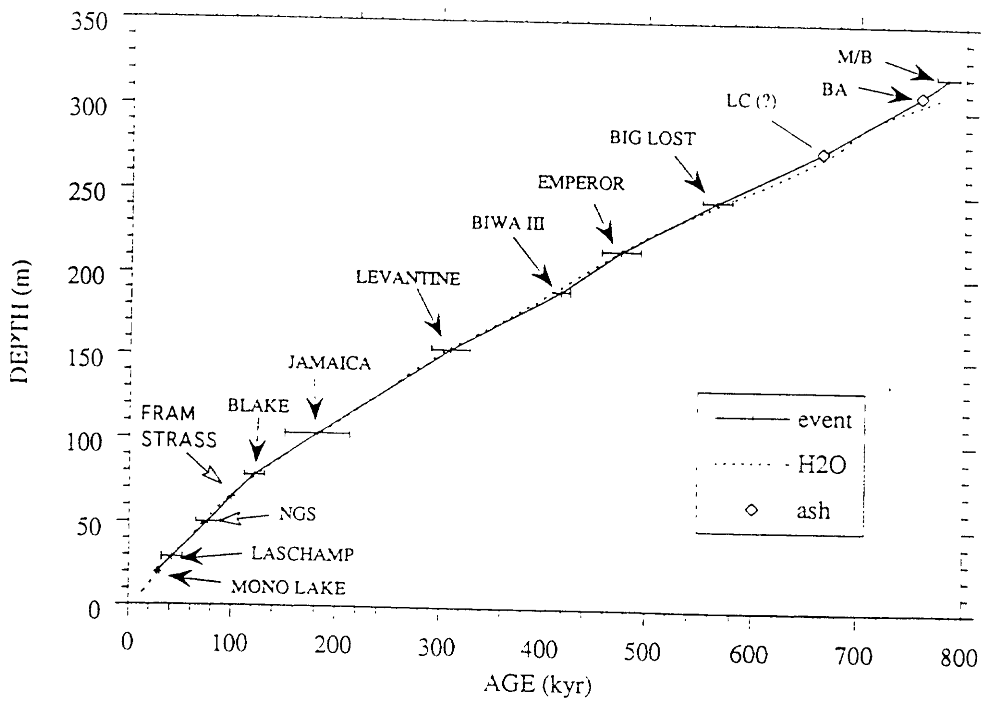

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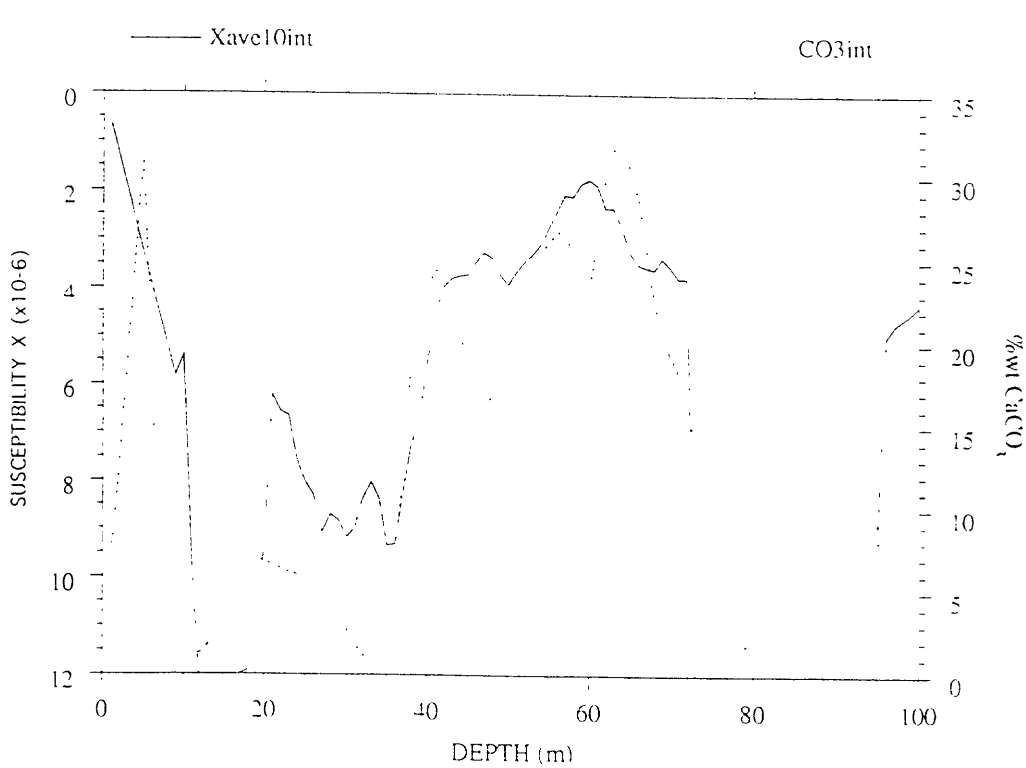

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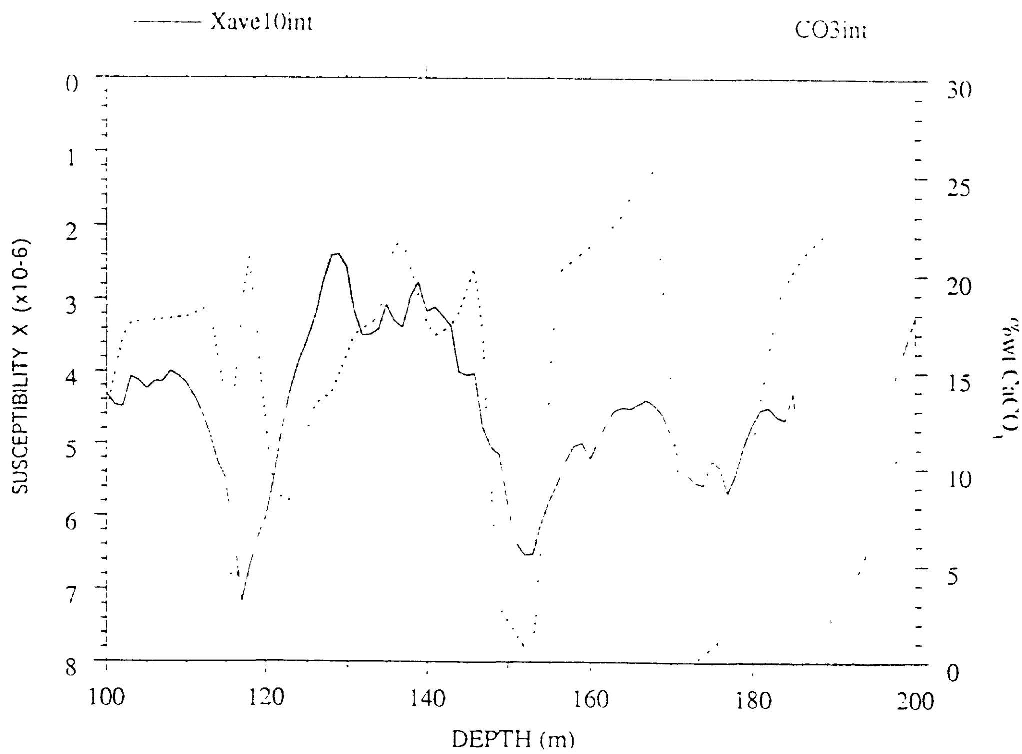
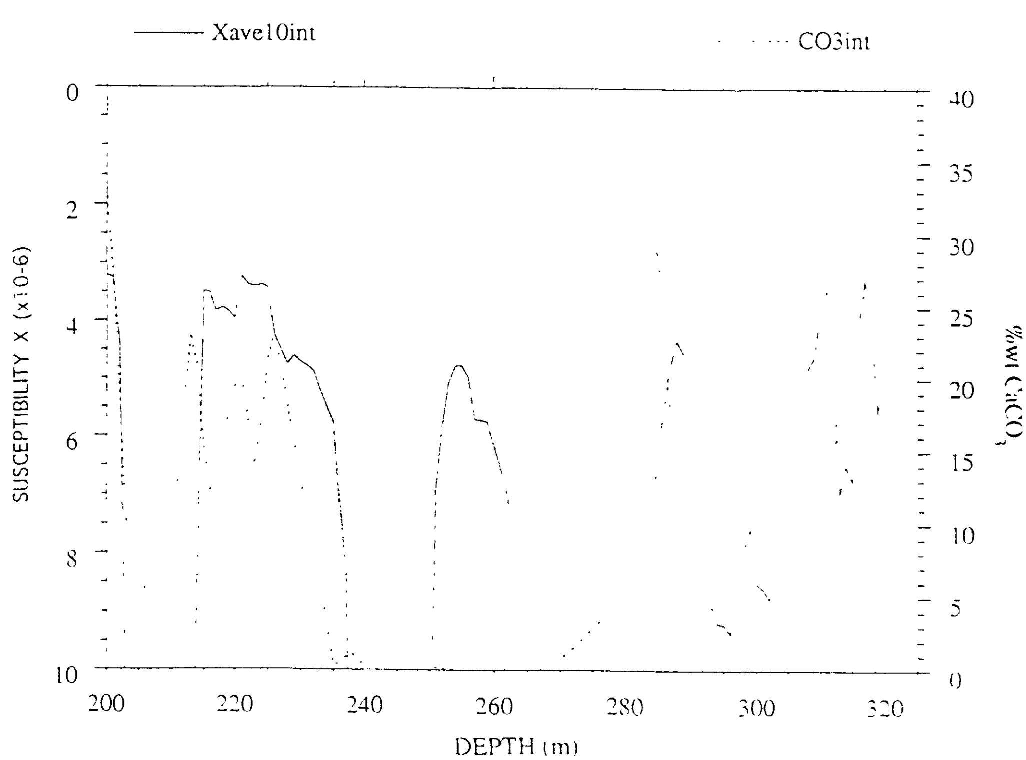


Figure 14c



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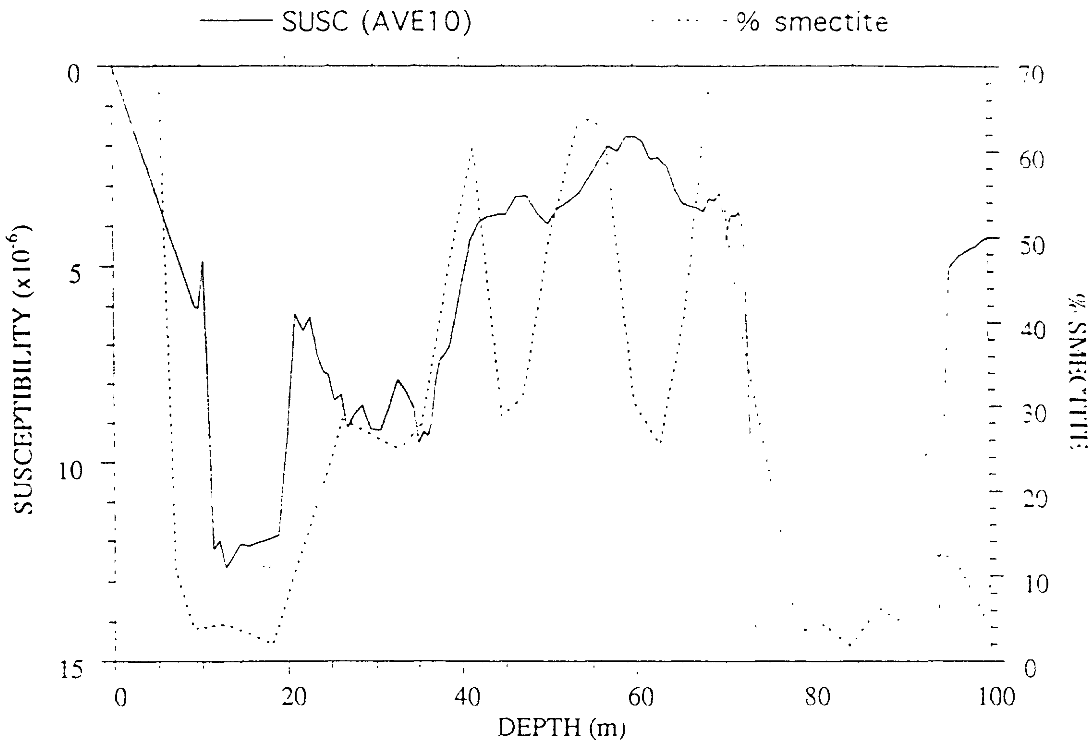


Figure 15b

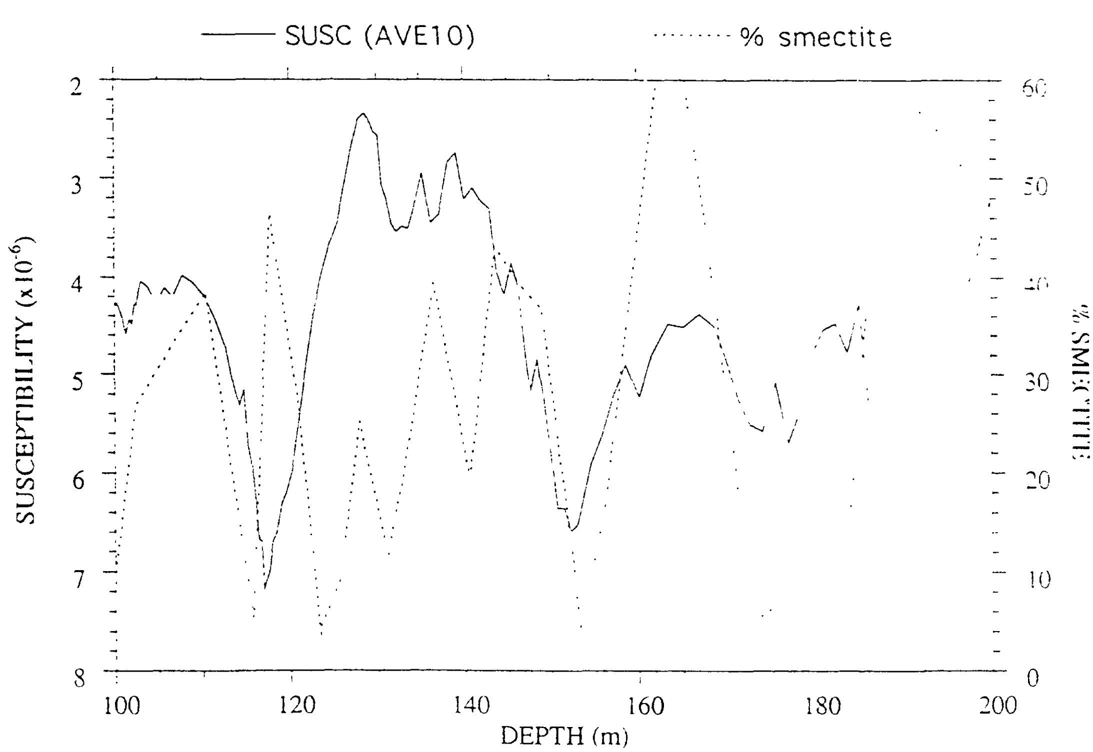


Figure 15c

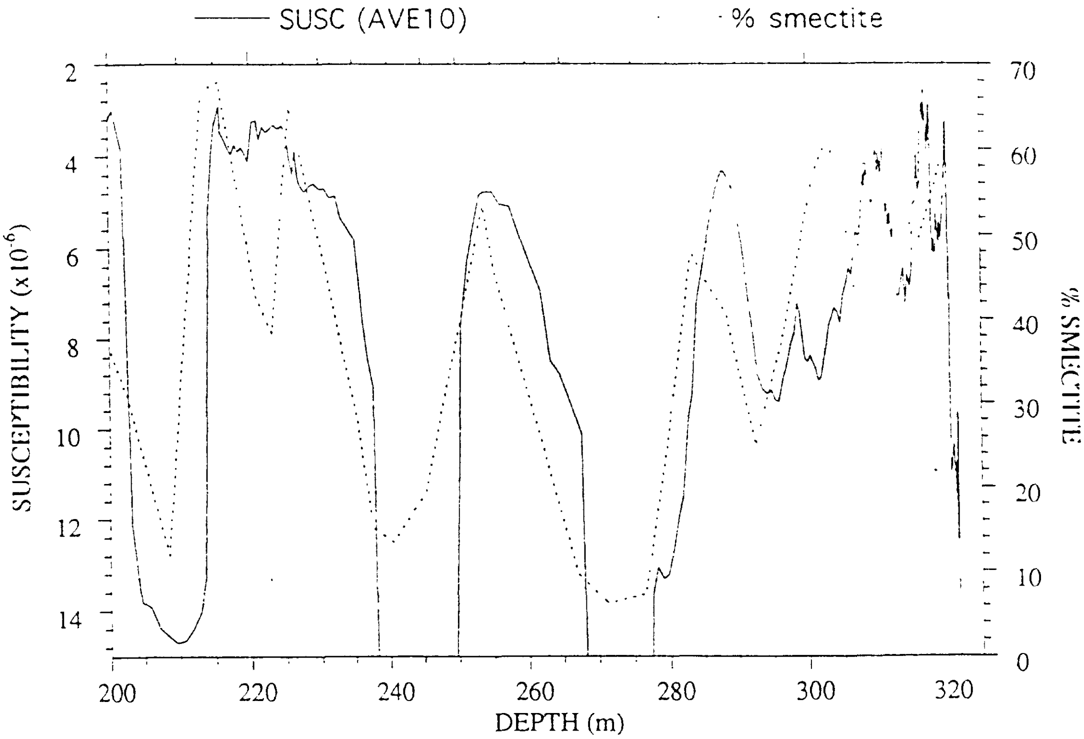


Figure 16a

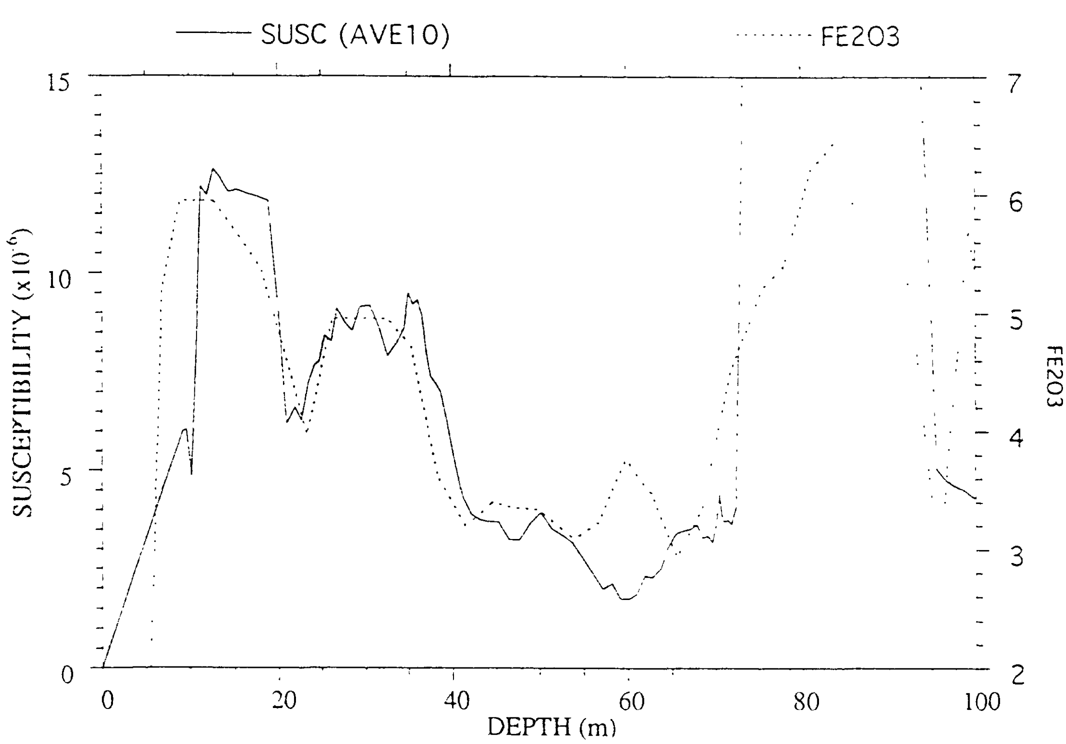


Figure 16b

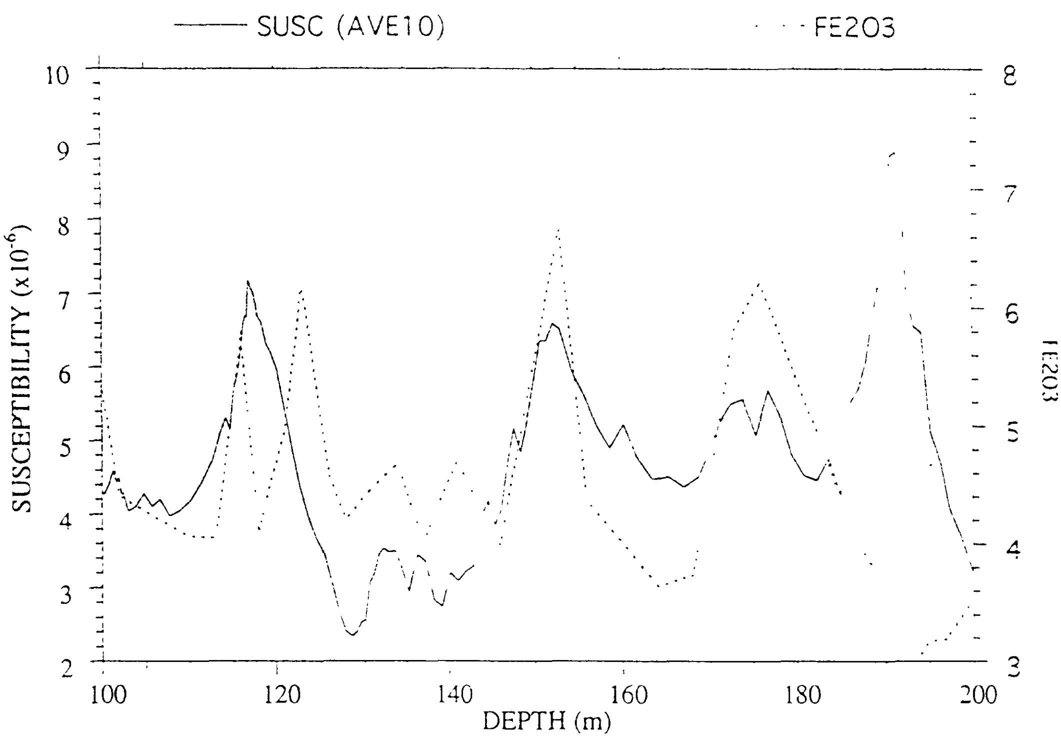


Figure 16c

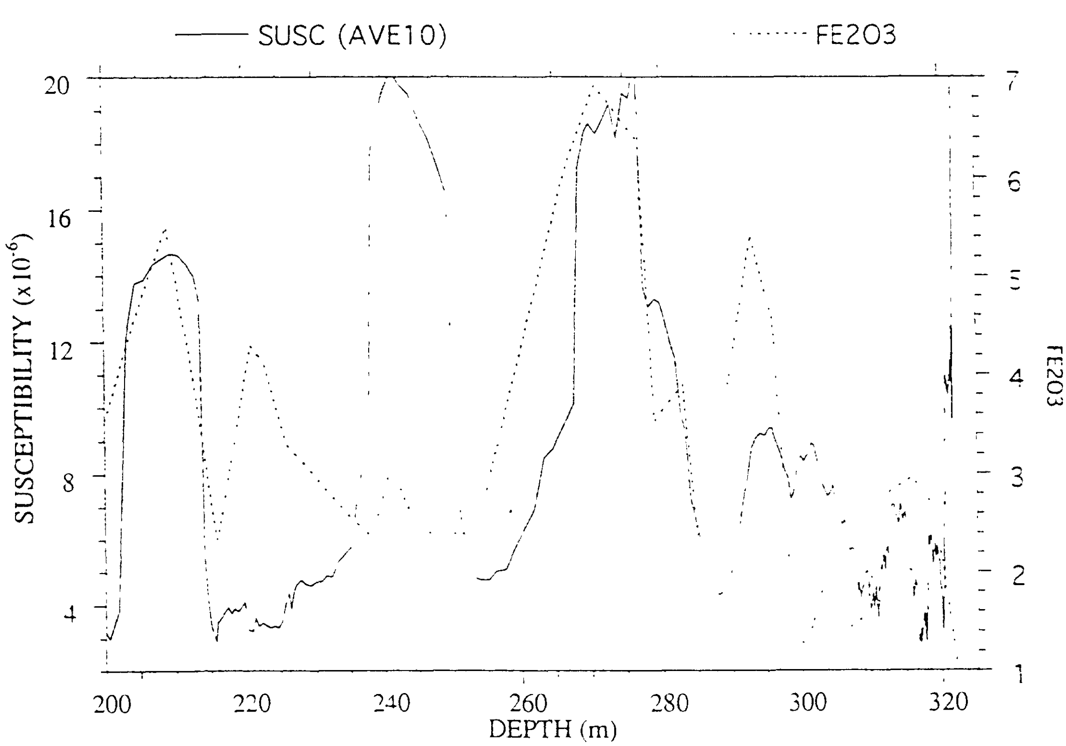


Figure 17

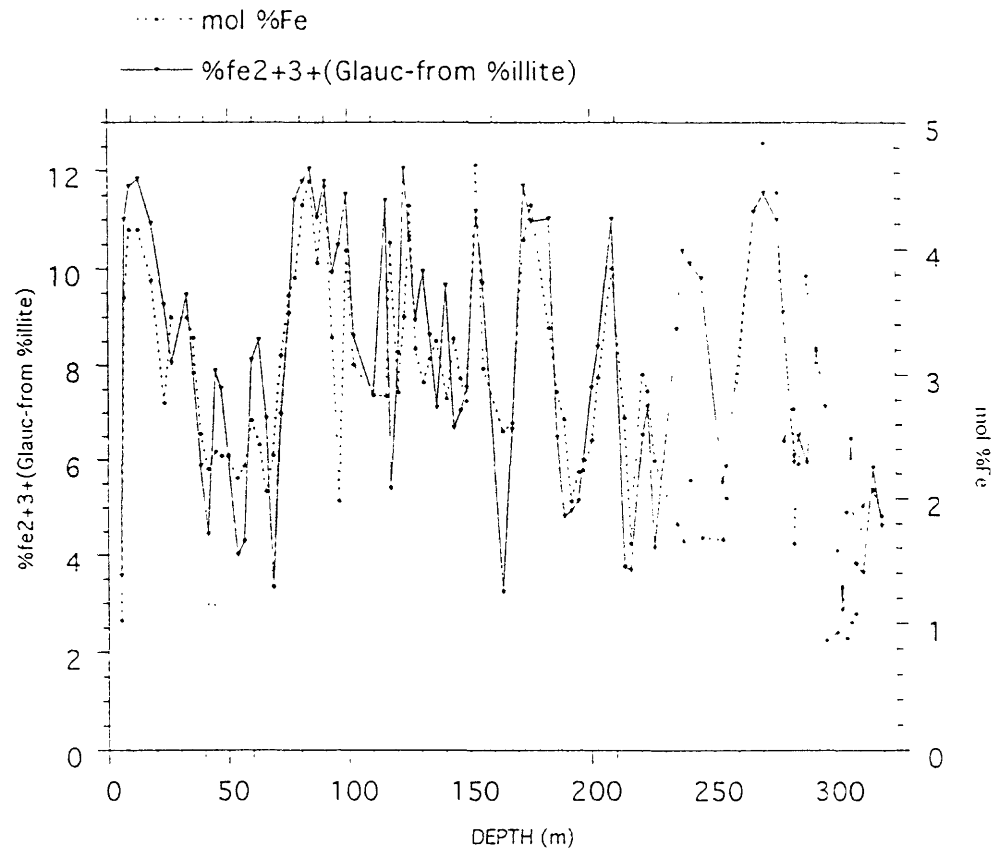


Figure 18

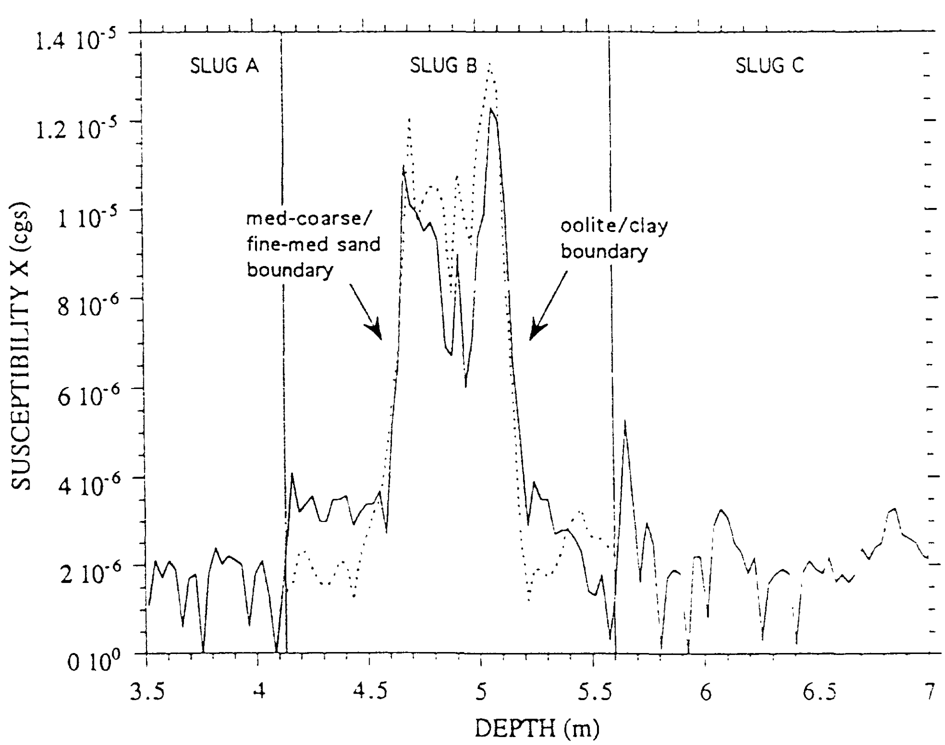


Figure 19

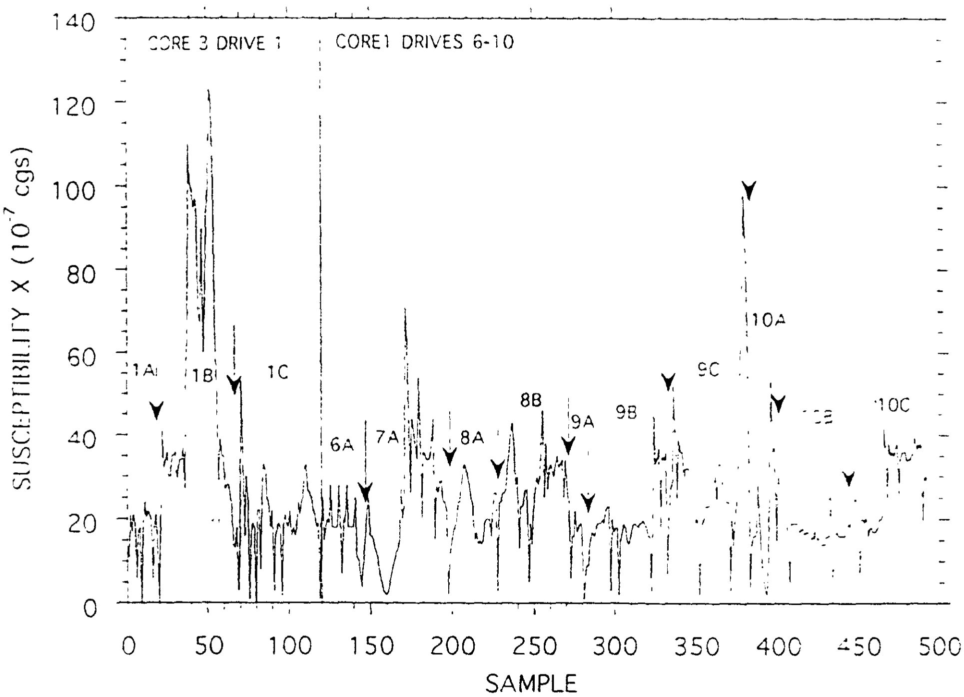


Figure 20

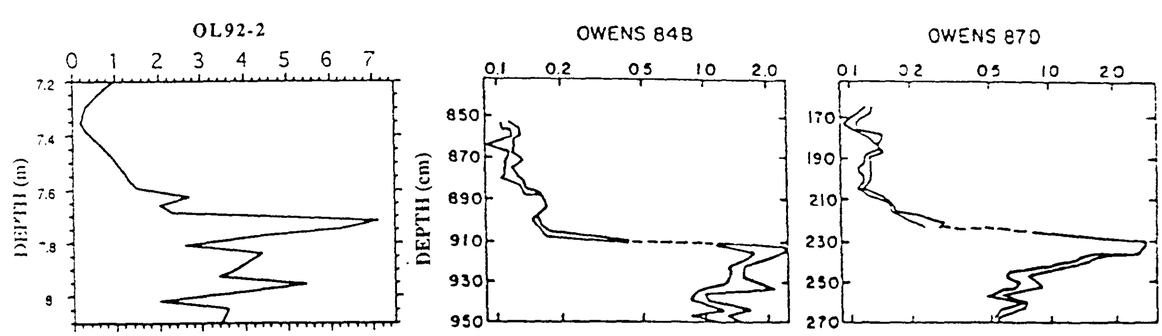


Figure 21

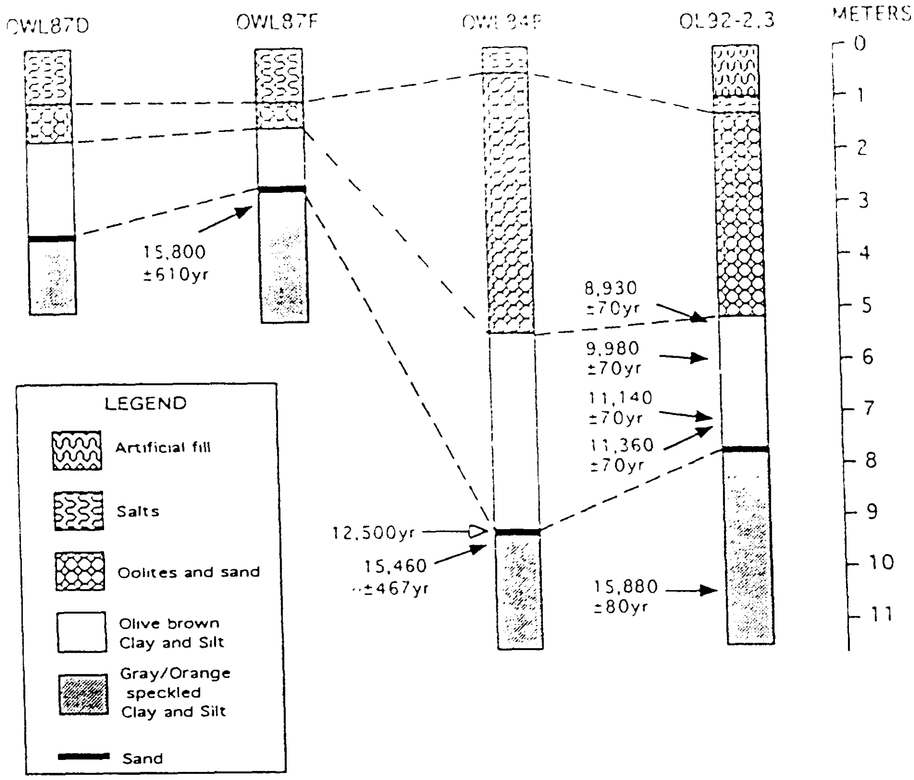
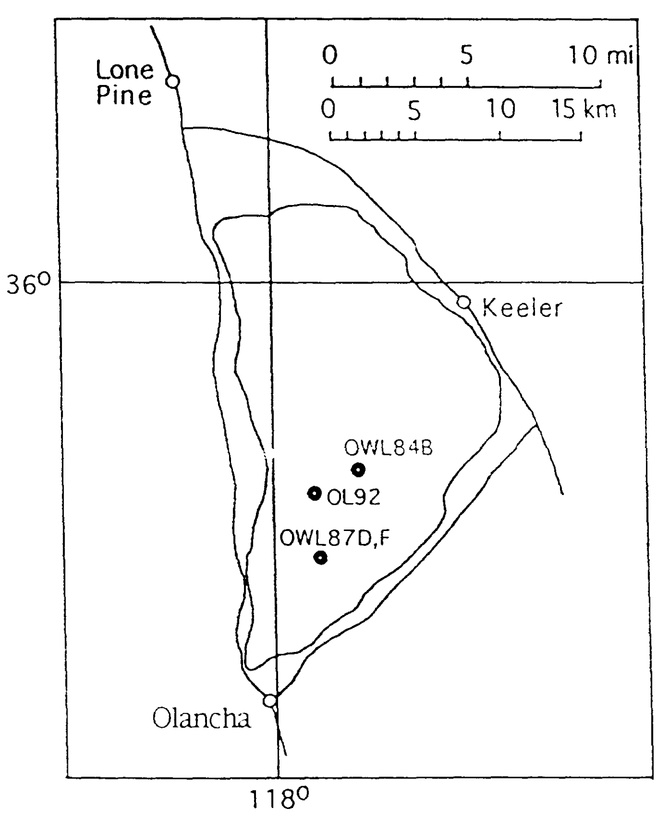


Figure 22



LIST OF TABLES

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
1	6.80	3.69E-07	5.2086E-06	7.08E-02	250	346.5	32.2					3				
2	7.40	2.29E-07	1.4551E-05	1.57E-02	175	359.2	32.3	2.2	42.1			6	6			
3	8.47	2.68E-07	4.1500E-06	6.46E-02	400	345.6	62.2	4.1	56.9			2	2			
4	9.50	2.02E-07	1.2700E-07	1.59E+00	200	316.1	29.6	308.2	-23.2			9	2			
C1	9.59	1.09E-05	6.2000E-06	1.76E+00	400	80.3	28.9					2				
C2	9.81	1.08E-05	7.0800E-06	1.53E+00	450	244.1	46.8					1				
C3	9.99	4.41E-06	4.8100E-06	9.17E-01	350	122.1	59.7					1				
C4	10.18	3.50E-06	8.9968E-06	3.89E-01	200	309.5	62.1					1				
C5	10.40	2.58E-06	4.2900E-06	6.01E-01	200	312.7	66.8	322.6	58.2			2	3			
5	10.67	1.44E-06	4.7200E-06	3.05E-01	450	216.1	76.4	202.5	76.8			3	3			
C6	10.89	2.96E-06	5.5700E-06	5.31E-01	350	163.0	63.9					3				
6	12.87	6.79E-07	2.8400E-06	2.39E-01	350	227.2	36.0	144.7	55.1			2	2			
7	13.84	2.97E-06	3.4530E-05	8.60E-02	20	217.0	12.5					7				
8	15.21	1.18E-07	4.2980E-05	2.75E-03	175	348.4	28.8	40.1	32.2			9	3			
9	16.31	1.92E-07	3.9338E-06	4.88E-02	125	253.5	87.3					1				
10	17.10	7.60E-06	1.3790E-05	5.51E-01	275	111.3	44.2	151.5	49.6	228.4	53.1	2	2			
11	18.00	7.75E-07	2.4600E-06	3.15E-01	200	162.9	55.2	110.6	49.8			3	5			
12	18.82	5.97E-07	5.5547E-06	1.07E-01	200	357.8	-7.7	53.6	26.9			5	3			
13	20.49	5.31E-07	4.7715E-06	1.11E-01	200	77.3	47.7	103.6	47.8			3	3			
14	21.02	5.02E-07	3.8609E-06	1.30E-01	175	49.3	51.5	34.5	39.2			6	1			
15	23.56	5.42E-07	4.6623E-06	1.16E-01	200	59.3	48.6	42.2	38.3			9	1			
16	24.54	7.26E-07	1.8000E-06	4.03E-01	200	9.5	37.1	42.0	39.2			5	3			
C7	24.90	2.54E-06	9.2600E-06	2.74E-01	300	239.2	53.3					5				
C8	25.07	4.03E-06	1.1920E-05	3.38E-01	300	227.9	51.6	298.1	31.5			5	9			
C9	25.25	2.50E-06	8.0800E-06	3.09E-01	250	359.9	47.9			6.9	29.8	5				
C10	25.46	3.96E-06	1.0350E-05	3.83E-01	300	350.0	45.8	45.3	68.2			5	5			
C11	25.63	4.92E-06	1.2250E-05	4.02E-01	375	49.9	50.4					5				
C12	25.85	6.94E-06	9.8400E-06	7.05E-01	415	37.5	52.2	39.5	42.0			3	3			
17	26.17	4.84E-07	5.7003E-06	8.49E-02	175	208.4	38.1	270.9	51.6			3	9			
18	27.67	2.02E-06	1.0440E-05	1.93E-01	250	79.7	26.3	111.6	55.3			2	3			
19	31.25	1.27E-06	3.0400E-06	4.18E-01		243.3	-28.8	58.2	53.3			4	3			
20	31.58	1.80E-06	1.0326E-05	1.74E-01	175	22.6	51.0	9.2	36.2	354.6	47.7	9	2			
21	32.96	6.51E-07	5.8461E-06	1.11E-01	200	283.6	53.3	346.8	43.2			3	3			
22	33.85	2.17E-06	9.5400E-06	2.27E-01	175	284.4	43.9	303.2	52.2			9	3			
23	34.74	3.62E-06	1.4220E-05	2.55E-01		257.2	47.0					9				
24	36.06	7.56E-06	1.0710E-05	7.06E-01		225.7	56.5					3				
C13	36.08	7.60E-06	6.7500E-06	1.13E+00	425	195.1	43.7					3				
C14	36.21	2.69E-06	2.4600E-06	1.09E+00	250	70.1	57.3					1				
C15	36.37	1.16E-05	9.0000E-06	1.29E+00	415	29.8	53.4	51.9	46.1			1		1		
C16	36.55	1.51E-05	1.4350E-05	1.05E+00	450	308.1	57.3					1				
C17	36.68	1.29E-05	1.1910E-05	1.08E+00	400	256.1	37.6					3				
C18	36.84	9.67E-06	7.4000E-06	1.31E+00	425	218.1	44.3					2				
25	37.93	1.07E-06	6.9935E-06	1.53E-01		281.4	40.2					9				
26	38.64	2.30E-07	5.4272E-06	4.24E-02	225	269.4	79.6	58.1	-84.7			3	3			
27	39.55	2.96E-07	5.0266E-06	5.89E-02	150	242.5	46.2					6				

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
28	40.58	1.83E-07	4.6441E-06	3.94E-02	200	46.1	51.9					9				
29	41.67	2.87E-07	5.1358E-06	5.59E-02	300	32.7	45.5	68.2	47.9			7	5			
30	42.27	3.22E-07	2.0000E-07	1.61E+00		119.0	49.7					9				
31	43.63	3.38E-07	1.3800E-06	2.45E-01		340.4	27.5	349.6	57.3			9	7			
32	44.64	9.53E-07	4.8444E-06	1.97E-01	175	236.6	49.5	253.9	60.8			4	3			
33	45.94	8.02E-06	2.4800E-06	3.23E+00	200	192.4	57.7	247.9	59.6			1	5			
34	46.45	6.90E-06	2.8400E-06	2.43E+00	225	239.3	51.5	237.2	54.3			2	2			
35	47.92	2.54E-07	5.6822E-06	4.47E-02	300	352.0	47.7	55.4	25.8			6	9			
36	49.53	1.95E-07	4.9173E-06	3.97E-02	225	162.1	15.2	22.4	29.5			6	9			
37	50.22	2.14E-07	4.8627E-06	4.40E-02	400	95.5	26.6	20.2	63.7			6	9			
38	52.73	1.49E-07	2.7300E-07	5.46E-01	225	3.9	33.8	143.1	37.6			6	9			
39	53.68	1.83E-07	4.9719E-06	3.68E-02	175	355.5	34.8	330.5	32.2			6	9			
40	54.61	1.40E-07	4.6259E-06	3.03E-02	200	302.5	50.2	307.8	14.0			9	9			
41	55.46	1.05E-07	3.8974E-06	2.69E-02		260.6	45.6					9				
42	56.96	2.69E-07	8.7400E-07	3.08E-01	200	213.0	48.2	157.7	70.7			9	9			
43	58.05	2.05E-07	8.1900E-07	2.50E-01	150	190.9	34.9	170.2	66.5			6	9			
44	58.37	2.32E-07	7.8300E-07	2.96E-01	150	206.7	56.8	131.4	54.2			3	9			
45	59.85	2.33E-06	1.6000E-06	1.46E+00	150	248.1	58.6	259.1	53.4			1	3			
46	60.90	2.58E-07	1.0400E-06	2.48E-01	175	89.9	40.7	128.6	44.4			3	3			
47	61.49	3.68E-07	1.1100E-06	3.32E-01	275	52.6	28.7					3	9			
48	62.72	3.79E-07	1.6800E-06	2.26E-01	225	356.7	24.0	350.0	36.7			2	2			
49	63.42	3.79E-07	1.1800E-06	3.21E-01	200	317.1	43.3					3				
50	64.08	3.02E-07	4.4984E-06	6.71E-02	200	285.5	24.5	264.8	54.6			9	7			
51	64.39	3.72E-07	5.2633E-06	7.07E-02	150	286.8	29.6	286.6	54.3			3	3			
52	65.78	1.38E-07	5.3180E-06	2.59E-02	200	231.4	33.9					9				
53	66.83	1.85E-07	3.6400E-07	5.08E-01	200	215.0	39.9	232.1	44.9			7	9			
54	67.92	5.73E-07	3.2100E-06	1.79E-01	125	64.9	20.4	79.1	42.1			5	6			
55	68.84	3.49E-07	7.3600E-06	4.74E-02	200	64.6	68.6					9	9			
56	69.93	5.76E-07	4.3000E-06	1.34E-01	150	273.0	65.3	274.1	49.8			7	5		9.69E-06	5.94E-02
C19	70.04	4.24E-07	1.8300E-06	2.32E-01	200	269.5	35.6	355.7	66.8			5	5		4.67E-06	9.08E-02
C20	70.38	3.65E-07	2.1300E-06	1.71E-01	175	196.5	37.3					8			7.21E-06	5.06E-02
57	70.59	1.62E-07	2.1600E-06	7.50E-02	175	186.7	65.7					7			7.60E-06	2.13E-02
C21	70.62	2.14E-07	1.2100E-06	1.77E-01	125	123.9	64.4					6	9		5.00E-06	4.28E-02
C22	70.70	5.51E-07	5.7600E-06	9.57E-02	140	128.6	54.0	3.8	32.4			2	6		1.29E-05	4.27E-02
C23	70.99	4.25E-07	3.5400E-06	1.20E-01	200	148.5	48.2	52.1	10.6			5	5		8.51E-06	4.99E-02
C24	71.14	5.35E-07	4.8700E-06	1.10E-01		117.8	44.5					4			9.54E-06	5.61E-02
C25	71.45	3.84E-07	1.1055E-05	3.47E-02	135	353.9	32.2					7			8.32E-06	4.62E-02
58	71.65	3.62E-07	2.2400E-06	1.62E-01	300	144.5	57.8	263.4	64.5			3	3		6.16E-06	5.88E-02
59	73.15	6.89E-07	2.3900E-06	2.88E-01	175	81.4	54.8	96.5	55.5			5	4		6.57E-06	1.05E-01
60	73.93	2.89E-07	2.3300E-06	1.24E-01	200	106.6	72.1	105.0	61.9			5	3		5.53E-06	5.23E-02
61	74.51	3.85E-07	9.2900E-07	4.14E-01	175	6.2	39.6					5			6.54E-06	5.89E-02
62	75.58	3.94E-06	6.6100E-06	5.96E-01	350	272.1	48.6					2			2.05E-05	1.92E-01
63	76.46	1.78E-05	5.7440E-05	3.10E-01	200	106.8	49.2	57.9	62.5			1	3		2.43E-05	7.33E-01
C26	76.69	2.71E-05	7.2960E-05	3.71E-01	200	269.6	31.7					1			2.65E-05	1.02E+00
64	77.09	1.63E-05	7.7560E-05	2.10E-01	200	147.7	34.8					1			3.86E-05	4.22E-01

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
C27	77.42	3.46E-05	5.3340E-05	6.49E-01	225	207.0	22.2					1			2.16E-05	1.60E+00
C28	77.69	3.60E-05	6.4680E-05	5.57E-01	225	151.0	22.9					1			2.67E-05	1.35E+00
C29	78.02	2.30E-05	4.3910E-05	5.24E-01	200	313.4	25.3					1			1.55E-05	1.48E+00
C30	78.15	2.98E-05	7.9470E-05	3.75E-01	185	301.2	22.5			70.1	35.1	1			2.37E-05	1.26E+00
65	78.35	2.91E-05	6.1970E-05	4.70E-01	200	283.2	21.6					1			2.28E-05	1.28E+00
C31	78.62	9.32E-06	3.2650E-05	2.85E-01	135	85.3	44.0					1		1	1.19E-05	7.83E-01
C32	78.96	1.87E-05	4.4270E-05	4.22E-01	175	342.4	13.4	5.4	6.7	355.4	22.7	1		3	2.23E-05	8.39E-01
C33	79.28	3.36E-05	6.1580E-05	5.46E-01	200	285.6	38.3					1	1		2.44E-05	1.38E+00
67	79.52	1.79E-05	6.6710E-05	2.68E-01	200	0.5	-21.8	3.3	9.7			1	4		2.73E-05	6.56E-01
C34	79.58	2.39E-05	5.6270E-05	4.25E-01	200	107.0	42.7	99.8	49.7			1	3		2.95E-05	8.10E-01
66	79.69	3.05E-05	5.6440E-05	5.40E-01	200	195.9	24.1	199.9	30.6			1	1		2.91E-05	1.05E+00
C35	79.71	1.52E-05	6.0210E-05	2.52E-01	225	227.4	-25.7					1			2.64E-05	5.76E-01
C36	80.04	4.51E-05	1.0664E-04	4.23E-01	150	200.5	42.4	355.6	36.2			1	5		3.25E-05	1.39E+00
C37	80.32	3.05E-06	3.3030E-05	9.23E-02		301.7	46.8					9			1.20E-05	2.54E-01
68	80.58	3.82E-05	8.1860E-05	4.67E-01	200	136.9	35.0					2			3.37E-05	1.13E+00
C38	80.87	3.34E-05	8.2020E-05	4.07E-01	200	54.5	59.9	3.9	16.3			1	7		4.07E-05	8.21E-01
C39	81.23	3.46E-05	7.1210E-05	4.86E-01	200	138.0	84.2	313.5	53.8			2	5		2.89E-05	1.20E+00
69	81.63	2.79E-05	8.7270E-05	3.20E-01	175	202.8	33.5	216.7	58.7			1	5		2.18E-05	1.28E+00
C41	81.79	2.87E-05	5.0610E-05	5.67E-01	200	276.2	43.3	319.7	25.8			1	5		1.75E-05	1.64E+00
C40	81.81	5.08E-05	1.9821E-04	2.56E-01	200	170.1	26.8	334.6	59.3			1	5		4.76E-05	1.07E+00
C42	82.59	8.71E-06	5.0610E-05	1.72E-01	175	261.2	48.0	357.9	34.6			1	5		1.45E-05	6.01E-01
70	82.61	6.46E-06	7.2100E-05	8.96E-02	100	275.4	71.2					7			1.77E-05	3.65E-01
C43	82.77	9.43E-06	4.6290E-05	2.04E-01	150	63.6	44.2	41.3	33.8			2	6		1.55E-05	6.08E-01
C44	83.13	1.69E-05	5.8280E-05	2.90E-01	200	297.5	51.0					1	5		2.05E-05	8.24E-01
71	83.54	6.91E-05	6.9240E-05	9.98E-01	225	195.2	52.8	169.5	37.6			1	7		3.68E-05	1.88E+00
C45	83.78	2.20E-05	5.3070E-05	4.15E-01	200	146.1	56.5	351.2	54.4			1	3		1.86E-05	1.18E+00
C46	84.12	5.32E-06	4.9210E-05	1.08E-01		84.1	23.2					9			1.54E-05	3.45E-01
C47	84.35	2.27E-05	5.5400E-05	4.10E-01	115	16.1	13.3					1			1.81E-05	1.25E+00
72	84.40	2.86E-05	4.8440E-05	5.90E-01	200	18.0	17.5	22.3	27.7			1	7		1.73E-05	1.65E+00
C48	84.77	1.70E-05	6.3620E-05	2.67E-01	250	157.1	48.3			3.1	3.8	1			2.02E-05	8.42E-01
C49	85.13	2.85E-05	5.2100E-05	5.47E-01	175	15.1	24.9					3		5	1.90E-05	1.50E+00
73	85.53	3.56E-05	8.7030E-05	4.09E-01	200	87.5	50.2	101.8	42.8			1	7		3.00E-05	1.19E+00
74	86.72	2.66E-05	9.1020E-05	2.92E-01	150	241.3	51.0	242.6	47.3			1	5		3.77E-05	7.06E-01
75	87.71	4.72E-05	9.5750E-05	4.93E-01	200	181.5	43.7	160.8	48.1			1	7		4.26E-05	1.11E+00
76	88.64	1.02E-04	6.7400E-05	1.51E+00	225	40.8	44.1	53.2	47.7			1	7		6.91E-05	1.48E+00
77	89.38	5.09E-05	7.5540E-05	6.74E-01	225	271.8	42.0					1			3.82E-05	1.33E+00
78	90.62	1.97E-06	7.3000E-06	2.70E-01	225	231.1	62.0	221.9	62.4			1	3		1.10E-05	1.79E-01
79	91.60	1.10E-06	6.0100E-06	1.83E-01	275	169.6	56.0	151.3	52.5			2	5		6.63E-06	1.66E-01
80	92.55	1.68E-06	4.5300E-06	3.71E-01	220	30.5	53.5	38.9	53.2			3	5		7.20E-06	2.33E-01
81	93.61	1.59E-05	8.2700E-06	1.92E+00	125	220.0	57.2					5				
82	94.68	3.66E-06	3.9500E-06	9.27E-01	100	108.0	51.0					6				
83	96.67	1.25E-06	2.9000E-06	4.31E-01		308.7	74.8					7				
84	97.95	1.44E-06	2.7300E-06	5.27E-01	150	355.2	52.3	355.5	60.6			1	6			
85	98.85	2.85E-07	3.4200E-06	8.33E-02	175	148.2	45.7	190.4	73.7			7	7			
86	99.80	1.76E-07	4.9500E-06	3.56E-02	150	62.5	13.3					9				

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
87	100.62	1.38E-07	6.4600E-06	2.14E-02		86.7	50.7					9				
88	101.27	1.79E-07	4.3100E-06	4.15E-02	175	343.8	74.0					9				
C50	101.47	1.47E-07	4.5900E-06	3.20E-02	150	21.7	31.3	312.6	41.9			5	7			
C51	101.79	2.50E-07	3.6100E-06	6.93E-02	100	267.2	43.5	331.9	62.6	290.0	4.2	7	7			
C52	102.02	3.24E-07	6.7800E-06	4.78E-02	100	245.3	53.8					9		5		
89	102.33	1.24E-07	2.9500E-06	4.20E-02		181.6	-5.6					9				
C54	102.39	1.96E-07	4.2800E-06	4.58E-02		307.6	41.9					9				
C55	102.56	2.26E-07	4.6100E-06	4.90E-02	200	209.2	31.8					9				
C56	102.76	2.04E-07	1.8000E-06	1.13E-01		186.0	34.9					9				
C53	102.89	2.39E-07	5.5600E-06	4.30E-02		291.7	60.7					9				
90	103.01	2.91E-07	4.4100E-06	6.60E-02	275	155.7	-56.9	187.2	57.3			9	2			
91	103.57	5.37E-07	4.2200E-06	1.27E-01	125	165.6	34.5	184.8	39.3			6	6			
92	107.20	7.05E-07	2.1900E-06	3.22E-01	100	207.9	54.5					1				
93	110.15	7.27E-07	4.2200E-06	1.72E-01	125	103.1	65.5					1				
94	111.20	2.41E-06	8.5800E-06	2.81E-01	100	341.4	58.7	339.4	38.1			2	1			
95	111.62	5.02E-07	1.2000E-06	4.18E-01	70	348.6	53.7	12.5	29.5			4				
96	112.08	4.09E-06	5.2600E-06	7.78E-01	150	240.6	59.4					1				
97	113.38	1.30E-06	2.3700E-06	5.49E-01	200	208.7	62.7					1				
98	114.39	2.67E-06	2.4900E-06	1.07E+00	150	170.5	60.4	164.1	62.5			1	1			
C57	115.52	1.65E-06	6.9400E-06	2.38E-01	300	23.3	17.5					6				
C58	115.76	2.07E-07	7.0300E-06	2.94E-02	300	143.0	37.2			65.5	4.1	9				
C59	115.96	6.02E-08	7.1400E-06	8.43E-03	165	132.3	52.6	24.5	12.3			9	6	6		
C60	116.08	1.27E-07	6.0300E-06	2.11E-02		81.2	9.7					9				
99	116.12	1.29E-07	6.1400E-06	2.10E-02	200	51.3	12.8					9				
100	116.26	1.63E-07	6.9600E-06	2.34E-02		4.9	49.9					9				
C61	116.51	1.55E-07	6.8300E-06	2.27E-02		298.0	50.6					9				
C62	116.81	1.06E-07	7.4500E-06	1.42E-02		321.6	18.0					9				
C63	117.13	1.67E-07	5.5400E-06	3.01E-02	225	303.2	36.1			293.4	33.7	9				
101	117.15	1.36E-07	5.9400E-06	2.29E-02	100	256.2	14.7	205.4	36.4			9	7			
C64	117.50	2.35E-07	7.8300E-06	3.00E-02	175	293.4	33.7					9				
C65	117.70	2.14E-07	7.0000E-06	3.06E-02	200	172.3	47.4					6				
102	118.15	3.52E-07	1.2129E-05	2.90E-02	150	102.2	35.7	225.0	46.9			5	5			
103	118.99	2.84E-07	5.0600E-06	5.61E-02		346.6	54.2					9				
104	119.40	3.20E-07	5.1400E-06	6.23E-02		123.5	55.3					9				
105	120.25	1.24E-06	4.0000E-06	3.10E-01	175	34.2	47.5					3				
106	121.21	9.00E-07	5.9400E-06	1.52E-01	75	27.5	52.7	13.5	58.8			4	5			
107	122.18	7.86E-07	4.5700E-06	1.72E-01	200	267.4	44.2	254.9	53.7			2	1			
108	122.75	2.94E-07	4.4100E-06	6.67E-02	350	154.1	45.8					7				
109	123.98	1.94E-07	3.6100E-06	5.37E-02	225	190.7	51.9					5				
110	125.17	4.83E-07	3.0400E-06	1.59E-01	175	71.6	58.8					1				
111	126.36	8.13E-07	1.1300E-06	7.19E-01		171.4	62.9					9				
112	127.06	3.73E-07	6.8296E-06	5.46E-02	150	277.4	41.0					1				
113	127.91	1.45E-06	1.1500E-06	1.26E+00		262.8	49.8					9				
114	128.89	1.33E-06	1.9500E-06	6.82E-01	175	243.4	60.7					1				
115	129.70	9.09E-07	1.9100E-06	4.76E-01		214.9	55.8					5				

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
116	129.96	4.66E-07	1.6600E-06	2.81E-01		170.2	46.5					9				
C66	130.06	3.26E-06	1.0000E-06	3.26E+00	175	167.9	61.2					9				
C67	130.42	2.19E-07	1.8000E-06	1.22E-01	225	190.8	47.1					9		5		
C68	130.68	1.27E-07	2.9300E-06	4.33E-02	175	55.4	49.8			87.5	35.2	6				
117	130.72	2.40E-07	3.6800E-06	6.52E-02	150	134.9	47.7					4				
118	131.11	9.57E-08	2.4100E-06	3.97E-02		96.5	38.3					9				
119	131.92	1.46E-07	7.1600E-06	2.04E-02		346.1	48.0					8				
120	133.03	1.58E-07	6.1700E-06	2.56E-02	100	284.0	46.8					7				
121	134.21	1.95E-07	3.3700E-06	5.79E-02		296.7	46.5					7				
122	135.11	1.06E-06	4.3700E-06	2.43E-01	275	69.7	64.7	251.7	63.6			9	3			
123	135.58	5.92E-07	2.5100E-06	2.36E-01	125	327.9	83.4					5				
124	136.53	1.66E-07	4.3700E-07	3.80E-01		170.2	65.4					9				
125	137.60	3.68E-07	2.0400E-06	1.80E-01		112.4	43.0					9				
126	138.60	2.28E-07	7.1000E-07	3.21E-01	75	5.6	50.2					5				
127	139.60	2.14E-07	2.9100E-07	7.35E-01	200	179.5	48.1					7				
128	140.80	1.46E-07	7.4500E-06	1.96E-02	150	110.5	50.3					5				
129	141.80	2.92E-07	6.2300E-06	4.69E-02	75	24.4	26.3					7				
130	142.70	4.32E-07	1.0000E-06	4.32E-01	125	297.5	41.0	345.5	61.8			3	3			
131	143.49	9.14E-07	2.4000E-06	3.81E-01	125	187.5	35.0	178.3	43.3			3	7			
132	144.25	1.01E-06	9.0500E-06	1.12E-01	100	108.9	43.8	130.2	44.4			6	7			
133	145.17	2.96E-07	1.3700E-06	2.16E-01	150	83.2	39.5					9				
134	146.13	8.69E-07	1.7100E-06	5.08E-01	175	84.0	51.4	79.0	57.3			1	1			
135	146.67	5.93E-07	2.8200E-06	2.10E-01	150	18.1	52.8	343.6	45.5			6	3			
136	147.48	2.70E-07	7.0845E-06	3.81E-02	50	349.9	56.2					5				
137	148.04	2.78E-07	2.7500E-06	1.01E-01		122.7	53.5					9				
138	148.81	2.28E-07	4.1500E-06	5.49E-02		269.1	61.2					9			5.56E-06	4.10E-02
139	149.09	4.80E-07	8.4000E-06	5.71E-02	75	10.5	51.4					9			1.18E-05	4.07E-02
140	150.09	5.89E-07	7.3800E-06	7.98E-02	175	275.0	53.6					5			1.04E-05	5.66E-02
141	150.85	2.34E-07	6.9900E-06	3.35E-02	325	29.6	44.0	27.5	59.9			3	3		3.94E-06	5.94E-02
142	152.04	1.26E-07	5.8500E-06	2.15E-02	225	176.0	25.2	174.4	63.2			6	7		3.33E-06	3.78E-02
143	152.78	1.92E-07	5.5400E-06	3.47E-02		45.5	18.2					9			3.10E-06	6.19E-02
144	153.52	1.37E-07	6.9200E-06	1.98E-02	325	4.6	11.6	316.4	57.6			3	3		3.32E-06	4.13E-02
145	154.31	1.90E-06	8.5200E-06	2.23E-01	250	241.6	-19.6	256.3	-31.7			1	1		7.85E-06	2.42E-01
146	154.94	8.92E-07	7.1000E-06	1.26E-01	200	54.3	40.7	39.9	43.8			2	2		6.63E-06	1.35E-01
147	155.69	3.82E-07	5.0600E-06	7.55E-02	175	114.6	54.9					3			6.22E-06	6.14E-02
148	156.66	4.37E-06	3.4400E-06	1.27E+00	175	331.8	48.4	333.1	56.0			1	1		4.35E-06	1.00E+00
149	163.09	4.47E-07	2.5700E-06	1.74E-01	125	133.1	31.8					9			6.15E-06	7.27E-02
150	163.80	4.74E-07	4.2100E-06	1.13E-01		120.0	42.5					9			8.08E-06	5.87E-02
151	164.66	3.72E-07	2.8200E-06	1.32E-01	150	126.9	52.2	10.8	27.7			9			1.13E-05	3.29E-02
152	166.81	4.66E-07	2.8400E-06	1.64E-01	225	64.6	55.2	65.5	60.1			4			7.87E-06	5.92E-02
153	167.62	1.18E-06	8.8100E-06	1.34E-01	100	26.2	58.4					5			1.28E-05	9.22E-02
154	168.49	2.31E-07	2.5100E-06	9.20E-02		85.8	62.5					9			4.76E-06	4.85E-02
155	171.90	1.48E-06	5.4800E-06	2.70E-01	275	328.3	34.8	343.1	29.5			4	3		9.64E-06	1.54E-01
156	172.62	2.42E-06	7.3900E-06	3.27E-01	300	288.5	60.7	278.6	70.2			3	1		9.64E-06	2.51E-01
157	173.36	8.20E-07	3.7000E-06	2.22E-01		258.7	48.0					5			6.56E-06	1.25E-01

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
158	174.38	5.17E-07	4.7700E-06	1.08E-01	225	67.7	61.2	152.8	54.4			4			7.41E-06	6.98E-02
159	175.79	5.54E-07	5.8500E-06	9.47E-02		305.5	65.9					4			4.03E-06	1.37E-01
160	176.53	1.77E-06	8.3600E-06	2.12E-01	350	232.2	52.0					3			9.44E-06	1.88E-01
161	177.72	6.65E-07	5.3400E-06	1.25E-01	225	10.1	54.9	14.3	74.1			3	7		5.25E-06	1.27E-01
162	181.11	1.23E-06	3.5700E-06	3.45E-01	200	205.6	53.2					1			1.08E-05	1.14E-01
163	182.35	5.79E-07	3.7900E-06	1.53E-01	175	145.3	59.9					6			6.82E-06	8.49E-02
164	183.37	1.40E-06	8.7236E-06	1.60E-01	200	304.0	52.8	313.6	60.6			1	5		8.54E-06	1.64E-01
165	184.16	2.90E-06	2.3100E-06	1.26E+00	150	286.8	57.7					1			1.42E-05	2.04E-01
166	186.18	1.25E-06	1.8000E-06	6.94E-01		326.4	22.9					6			1.13E-05	1.11E-01
167	187.53	4.64E-07	8.3800E-07	5.54E-01		311.2	41.7					6			5.29E-06	8.77E-02
168	188.91	7.04E-07	4.1300E-06	1.70E-01	150	342.2	57.2					4			1.15E-05	6.12E-02
169	189.46	1.15E-06	8.8900E-06	1.29E-01	200	315.9	40.0					6			1.34E-05	8.58E-02
C69	189.81	6.33E-07	3.2400E-06	1.95E-01	150	87.5	35.2			335.2	-4.7	7	6		1.21E-05	5.23E-02
C70	190.01	2.48E-06	1.8070E-05	1.37E-01	50	309.3	32.6			325.7	15.9	9		7	1.30E-05	1.91E-01
170	190.27	3.42E-07	5.4600E-06	6.26E-02		48.6	10.0					9			1.57E-05	2.18E-02
C71	190.30	7.78E-07	7.3800E-06	1.05E-01	115	255.9	51.8					9		6	1.23E-05	6.33E-02
C72	190.53	9.82E-07	1.4480E-05	6.78E-02		21.7	17.8			320.1	7.4	9			2.42E-05	4.06E-02
171	190.82	1.56E-06	6.6300E-06	2.35E-01	100	113.6	29.9					9			1.79E-05	8.72E-02
172	191.72	1.93E-07	7.7037E-06	2.51E-02	100	102.7	37.5					9			2.92E-06	6.61E-02
173	192.50	1.07E-06	7.3200E-06	1.46E-01	75	121.1	47.4					6			1.31E-05	8.17E-02
174	193.30	1.47E-06	9.3400E-06	1.57E-01	50	143.6	64.4					9			1.71E-05	8.60E-02
175	194.84	9.57E-07	9.4157E-06	1.02E-01		10.9	43.2	344.8	52.7			5			1.25E-05	7.66E-02
176	195.65	9.30E-07	1.2400E-06	7.50E-01	125	9.9	51.8	2.7	62.7			7			1.06E-05	8.77E-02
177	196.62	4.22E-07	5.8300E-07	7.24E-01		331.5	43.1					6			7.26E-06	5.81E-02
178	197.51	4.20E-07	1.4900E-06	2.82E-01	75	124.2	57.5					9			7.53E-06	5.58E-02
179	199.32	1.62E-07	6.5199E-06	2.48E-02	100	258.9	55.4					9			3.77E-06	4.30E-02
180	200.42	4.92E-07	9.6500E-07	5.10E-01	150	225.1	47.1					3			8.79E-06	5.60E-02
181	201.57	5.75E-07	2.7141E-06	2.12E-01		219.5									8.40E-06	6.85E-02
182	202.51	4.61E-07	1.2751E-06	3.62E-01		38.1									6.23E-06	7.40E-02
183	203.17	1.39E-06	4.1349E-06	3.36E-01		48.7									1.03E-05	1.35E-01
184	204.18	4.85E-06	5.3007E-06	9.15E-01		352.1									2.22E-05	2.18E-01
185	205.13	3.77E-06	5.6467E-06	6.68E-01		313.2									1.96E-05	1.92E-01
186	208.64	2.01E-06	9.7998E-06	2.05E-01		108.7									2.79E-05	7.20E-02
187	209.87	1.37E-05	8.3390E-05	1.64E-01		245.6									4.11E-05	3.33E-01
188	211.10	8.35E-06	1.8233E-05	4.58E-01		259.8									3.04E-05	2.75E-01
189	212.43	6.92E-07	7.6504E-06	9.05E-02		7.6									1.12E-05	6.18E-02
190	212.99	8.77E-07	5.6285E-06	1.56E-01		167.2									1.45E-05	6.05E-02
191	213.95	4.78E-07	4.3300E-06	1.10E-01	115	331.6	85.7					6			1.03E-05	4.64E-02
192	214.82	3.54E-05	2.9000E-06	1.22E+01	150	197.6	50.7	180.4	55.8			1			1.50E-04	2.36E-01
C73	214.84	5.82E-07	3.5300E-06	1.65E-01	200	270.1	4.7					6		7	1.27E-05	4.58E-02
C74	215.27	2.85E-07	2.7000E-06	1.06E-01	225	236.2	4.8	326.2	54.7	326.0	21.8	9		6	6.98E-06	4.08E-02
C75	215.47	1.89E-07	1.8800E-06	1.01E-01	125	247.0	2.4			12.6	-0.5	6		9	4.15E-06	4.55E-02
193	215.66	2.14E-07	2.7300E-06	7.84E-02	100	187.9	36.2					8			6.80E-06	3.15E-02
C76	215.73	6.42E-07	2.8600E-06	2.24E-01	100	0.3	-0.5					6		7	7.07E-06	9.08E-02
C77	216.02	8.25E-07	4.9400E-06	1.67E-01	100	323.6	7.6			4.2	10.7	5			1.13E-05	7.30E-02

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
C79	216.11	8.34E-08	1.7900E-06	4.66E-02		84.3	7.5			352.6	4.3	9			4.60E-06	1.81E-02
C78	216.15	5.64E-07	3.8300E-06	1.47E-01	125	12.3	8.5					5		9	7.89E-06	7.15E-02
C80	216.26	3.02E-07	2.6800E-06	1.13E-01	200	68.5	7.0			31.1	33.2	6		6	8.76E-06	3.45E-02
C81	216.45	1.74E-07	2.2000E-06	7.91E-02		88.1	34.6					9		7	4.17E-06	4.17E-02
C82	216.82	5.03E-06	9.3600E-06	5.37E-01	175	295.4	75.3	66.3	58.5	14.6	4.3	4		4	8.88E-05	5.66E-02
194	216.87	3.12E-07	3.0100E-06	1.04E-01	225	337.1	-5.0					8			7.71E-06	4.05E-02
C83	219.85	3.52E-07	3.3900E-06	1.04E-01	250	95.9	36.0			55.0	43.5	9		7	7.55E-06	4.66E-02
C84	220.07	4.45E-07	4.2400E-06	1.05E-01	100	103.4	6.7			107.3	70.8	9		7	1.13E-05	3.94E-02
C85	220.28	5.13E-07	4.0800E-06	1.26E-01	200	83.0	5.3			180.7	-65.6	7		8	1.27E-05	4.04E-02
C86	220.54	2.47E-07	2.8400E-06	8.70E-02	300	62.1	32.8			31.8	33.2	7		6	7.18E-06	3.44E-02
C87	220.85	4.93E-07	3.3700E-06	1.46E-01	125	106.2	-6.7	82.6	42.9	16.5	11.8	9	7	4	8.62E-06	5.72E-02
195	220.90	3.28E-07	2.8400E-06	1.15E-01	115	94.2	33.2					8			8.34E-06	3.93E-02
C88	221.12	5.44E-07	3.9000E-06	1.39E-01	200	73.8	28.3					9		6	9.19E-06	5.92E-02
196	221.69	3.60E-07	4.0800E-06	8.82E-02	200	123.5	67.5					9			1.11E-05	3.24E-02
197	222.63	1.12E-06	6.3700E-07	1.76E+00	165	158.3	33.0					6			9.89E-06	1.13E-01
198	222.86	2.51E-06	2.7500E-06	9.13E-01		22.4	44.6					9			1.32E-05	1.90E-01
199	223.85	1.21E-06	7.6500E-06	1.58E-01	165	343.9	49.4					1			8.35E-06	1.45E-01
200	224.69	4.55E-07	1.3843E-06	3.29E-01	125	330.1	49.8					3			4.91E-06	9.27E-02
201	225.35	7.39E-07	5.3188E-06	1.39E-01		226.9									1.11E-05	6.66E-02
202	226.13	2.22E-06	1.9854E-06	1.12E+00		119.3									1.04E-05	2.13E-01
C89	226.29	2.06E-06	2.5700E-06	8.02E-01	135	104.8	41.8	129.4	56.0			1	3		1.20E-05	1.72E-01
203	226.90	1.27E-06	3.6066E-06	3.52E-01		128.6									8.19E-06	1.55E-01
C90	226.95	1.14E-06	3.2200E-06	3.54E-01	500	210.1	31.2					9			4.49E-05	2.54E-02
C91	227.17	1.11E-06	6.0500E-06	1.83E-01	500	338.0	46.0	334.3	64.5			4		9	2.16E-05	5.14E-02
C92	227.21	4.93E-07	5.5400E-06	8.90E-02		351.5	42.3					9			2.94E-05	1.68E-02
C93	227.23	1.17E-06	6.5000E-06	1.80E-01	650	22.7	0.9					9			3.54E-05	3.31E-02
C94	227.81	4.58E-07	2.7000E-06	1.70E-01	275	263.7	67.5					1			5.42E-06	8.45E-02
204	227.86	5.04E-07	6.5573E-06	7.69E-02		65.8									3.21E-05	1.57E-02
205	228.14	4.93E-07	7.2677E-06	6.78E-02		123.9									1.71E-05	2.88E-02
C95	233.21	2.11E-06	3.7000E-06	5.70E-01	175	235.0	21.0	264.3	34.7			5		7	3.79E-05	5.57E-02
C96	233.34	1.29E-06	1.2200E-06	1.06E+00		337.8	-0.6					9				
C97	233.50	1.16E-06	3.1000E-06	3.74E-01	275	169.1	85.5					7			2.17E-05	5.35E-02
206	234.43	7.96E-07	4.4261E-06	1.80E-01		70.4									3.19E-05	2.50E-02
207	234.72	1.16E-06	6.1201E-06	1.90E-01		95.7										
208	234.77	7.06E-07	7.4315E-06	9.50E-02		125.1										
209	235.64	6.42E-07	6.0654E-06	1.06E-01		288.5										
210	236.26	4.53E-07	7.5225E-06	6.02E-02		145.6										
211	236.80	2.29E-07	8.5425E-06	2.68E-02		35.9										
212	237.97	2.45E-06	9.6717E-06	2.53E-01		189.2										
213	238.55	1.32E-05	1.1693E-05	1.13E+00		62.2										
214	239.47	6.99E-06	1.0710E-05	6.53E-01		112.3										
215	241.05	1.16E-05	1.2112E-05	9.58E-01		270.8										
216	241.64	5.98E-06	1.0746E-05	5.56E-01		101.4										
217	242.03	2.40E-06	9.2526E-05	2.59E-02		25.6										
218	245.52	1.90E-05	2.0746E-05	9.16E-01		352.8										

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
219	246.14	2.64E-06	1.2476E-05	2.12E-01		271.0										
220	246.71	1.21E-06	1.2458E-05	9.71E-02		89.3										
221	248.60	1.61E-06	4.8267E-06	3.34E-01		77.1										
222	251.90	6.07E-07	6.5206E-06	9.31E-02		100.1										
223	252.57	1.28E-06	4.0617E-06	3.15E-01		40.6										
C98	253.18	2.07E-06	4.6300E-06	4.47E-01	225	211.4	46.1					6				
C99	253.39	1.34E-06	4.7500E-06	2.82E-01	250	289.5	63.7	258.3	46.7			7	7			
C100	253.62	1.21E-06	2.7500E-06	4.40E-01	325	67.0	17.0	250.4	66.8			9	5			
C101	253.71	1.45E-06	3.6600E-06	3.96E-01	250	222.5	23.3					7				
224	254.35	1.54E-06	6.5752E-06	2.34E-01		141.4										
225	255.91	1.18E-06	5.2456E-06	2.25E-01		174.7										
226	256.00	7.92E-07	5.1728E-06	1.53E-01		181.9										
227	256.38	1.39E-06	4.2621E-06	3.26E-01		211.8										
228	263.04	3.07E-06	6.5752E-06	4.67E-01		228.3										
229	263.06	5.74E-06	6.7573E-06	8.49E-01		195.0										
230	267.12	3.93E-06	5.1545E-06	7.62E-01		25.1										
231	267.32	2.74E-06	1.1290E-05	2.43E-01		266.8										
232	267.62	4.07E-06	8.7611E-06	4.65E-01		208.0										
233	268.13	5.57E-06	9.5261E-06	5.85E-01		15.5										
234	268.65	1.92E-05	2.2057E-05	8.70E-01		359.7										
235	269.02	7.72E-06	8.2510E-06	9.36E-01		358.2										
236	270.97	2.80E-06	1.1566E-05	2.42E-01		276.0										
237	271.47	3.53E-06	1.1220E-05	3.15E-01		283.7										
238	272.15	1.22E-04	7.8521E-05	1.55E+00		297.1										
239	272.63	1.22E-05	1.7467E-05	6.98E-01		101.5										
240	273.20	1.20E-06	7.5406E-06	1.59E-01		106.5										
241	277.09	5.74E-07	8.2320E-06	6.97E-02		241.3										
242	277.56	3.02E-06	1.3004E-05	2.32E-01		127.9										
243	277.87	3.72E-06	1.4096E-05	2.64E-01		131.8										
244	278.30	3.18E-06	1.1856E-05	2.68E-01		78.7										
245	278.97	1.43E-05	2.1727E-05	6.58E-01		282.4										
246	279.60	6.25E-07	1.0035E-05	6.23E-02		71.5										
247	280.08	2.07E-06	2.3603E-05	8.77E-02		107.2										
248	280.35	6.74E-07	9.3611E-06	7.20E-02		309.9										
249	280.61	4.86E-07	1.1091E-05	4.38E-02		134.7										
250	281.06	8.00E-07	1.0071E-05	7.94E-02		95.8										
251	284.06	6.33E-07	7.1938E-06	8.80E-02		332.0										
252	284.53	5.68E-07	7.8312E-06	7.25E-02		276.7										
253	285.09	7.77E-07	7.1938E-06	1.08E-01		7.8										
254	285.51	1.06E-06	7.0117E-06	1.51E-01		187.4										
255	286.13	6.03E-07	4.8262E-06	1.25E-01		271.1										
256	286.43	2.59E-07	4.4439E-06	5.83E-02		348.3										
257	286.79	8.09E-08	3.4968E-06	2.31E-02		330.4										
258	287.27	1.28E-07	3.1326E-06	4.09E-02		285.1										
259	287.72	4.55E-07	4.8627E-06	9.36E-02		201.7										

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
260	288.05	1.63E-07	3.9885E-06	4.09E-02		211.8										
261	288.52	3.07E-07	3.8793E-06	7.91E-02		351.2										
262	288.99	2.51E-07	4.4985E-06	5.58E-02		18.9										
263	289.53	6.42E-07	4.6442E-06	1.38E-01		99.4										
264	290.05	1.65E-06	5.3362E-06	3.09E-01		49.6										
265	290.54	8.40E-07	5.3180E-06	1.58E-01		126.8										
266	291.37	7.82E-07	5.8462E-06	1.34E-01		78.4										
267	292.71	7.61E-07	5.7551E-06	1.32E-01		349.6										
268	292.92	8.29E-07	7.8131E-06	1.06E-01		330.8										
269	293.16	4.17E-06	1.0527E-05	3.96E-01		100.2										
270	293.53	2.06E-06	1.1000E-05	1.87E-01		66.7										
271	293.97	8.05E-06	1.1601E-05	6.94E-01		107.5										
272	294.35	3.78E-06	1.0090E-05	3.75E-01		120.4										
273	296.38	7.79E-06	1.4734E-05	5.29E-01		90.1										
274	296.83	7.66E-07	8.4323E-06	9.08E-02		269.7										
275	297.17	7.75E-07	6.4289E-06	1.21E-01		359.0										
276	297.63	3.78E-07	5.1358E-06	7.36E-02		357.4										
277	298.07	1.11E-06	7.9769E-06	1.39E-01		5.2										
278	298.49	1.03E-06	8.1590E-06	1.26E-01		355.0										
279	298.68	2.26E-07	5.5001E-06	4.11E-02		175.0										
280	299.04	6.51E-07	8.0498E-06	8.09E-02		234.3										
281	299.35	1.08E-06	6.8113E-06	1.59E-01		267.7										
282	299.81	3.96E-06	7.6309E-06	5.19E-01		217.0										
283	300.15	2.78E-06	8.2319E-06	3.38E-01		225.8										
284	300.50	7.93E-06	1.0217E-05	7.76E-01		218.6										
285	301.02	5.68E-06	1.1291E-05	5.03E-01		184.9										
286	301.40	5.91E-06	1.0618E-05	5.57E-01		186.8										
287	301.74	4.39E-06	8.7418E-06	5.02E-01		200.3										
288	302.27	1.81E-06	6.5927E-06	2.75E-01		232.0										
289	302.76	1.63E-06	7.0298E-06	2.32E-01		167.5										
290	302.82	2.87E-06	9.5977E-06	2.99E-01		148.2										
291	303.07	2.55E-06	9.3063E-06	2.74E-01		111.2										
292	303.56	9.92E-07	6.9570E-06	1.43E-01		79.2										
293	303.88	5.94E-07	4.6077E-06	1.29E-01		53.0										
294	304.44	1.58E-06	6.4835E-06	2.44E-01		52.9										
295	304.82	1.63E-06	6.9934E-06	2.33E-01		230.6										
296	305.12	7.16E-06	8.9239E-06	8.02E-01		231.0										
297	305.57	3.16E-06	6.6838E-06	4.73E-01		235.0										
298	306.12	1.92E-06	7.4670E-06	2.57E-01		224.2										
299	306.62	2.02E-06	9.5431E-06	2.12E-01		213.1										
B46	307.37	4.53E-06	3.5100E-06	1.29E+00	325	49.8	47.4	67.2	54.4			1	1			
300	307.50	1.88E-06	6.6656E-06	2.82E-01		310.9										
B47	307.52	4.41E-06	3.7000E-06	1.19E+00	300	309.8	52.4	325.6	57.8			1	1			
301	307.86	2.08E-06	5.9736E-06	3.48E-01		320.3										
B48	307.88	2.80E-06	2.1700E-06	1.29E+00	250	330.9	53.1	339.4	53.1			1	1			

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
B49	308.03	2.61E-06	1.8600E-06	1.40E+00	225	314.7	54.0	332.9	53.4			1	1			
302	308.31	4.68E-06	9.6160E-06	4.87E-01		264.4										
303	308.83	2.56E-06	6.5381E-06	3.92E-01		323.7										
B43	309.09	1.46E-06	1.3100E-06	1.11E+00	175	304.8	57.7	336.0	32.4			6	6			
B44	309.17	1.23E-06	2.2400E-06	5.49E-01	125	282.5	72.1	297.9	57.2			5	5			
304	309.20	2.14E-06	6.5746E-06	3.25E-01		293.1										
B45	309.46	1.17E-06	1.6600E-06	7.05E-01	200	44.2	71.1					3				
305	309.63	1.75E-06	6.9570E-06	2.52E-01		293.8										
306	310.07	1.24E-06	6.7203E-06	1.85E-01		315.0										
307	310.38	8.29E-07	6.4653E-06	1.28E-01		295.2										
B33	310.57	1.49E-06	2.2600E-06	6.59E-01	125	35.9	53.1					6				
B34	310.68	1.53E-06	2.2400E-06	6.83E-01	100	184.4	35.3	191.8	65.3			6	1			
B35	310.78	1.32E-06	1.9700E-06	6.70E-01	100	101.7	62.8	76.4	55.2			9	1			
B36	310.80	1.43E-06	2.3500E-06	6.09E-01	100	19.9	30.1	76.5	57.9			6	6			
B37	310.99	2.38E-07	7.9405E-06	3.00E-02	150	263.7	63.6					9				
B38	311.01	1.07E-06	7.3000E-07	1.47E+00	225	14.1	29.3					7				
B39	311.04	4.81E-06	4.7900E-06	1.00E+00	250	320.5	21.4					7				
308	311.21	2.99E-06	9.8527E-06	3.03E-01		23.8										
B40	311.40	7.98E-07	8.7000E-07	9.17E-01	150	99.5	56.8					9	6			
B41	311.42	1.18E-06	1.8000E-07	6.56E+00	75	304.3	45.7	253.5	38.9			8	3			
B42	311.52	8.71E-07	8.6508E-06	1.01E-01		34.8	-62.8	205.8	31.9			9	9			
309	311.66	1.82E-06	7.7948E-06	2.33E-01		245.7										
B28	311.92	1.26E-06	4.0200E-06	3.13E-01	200	178.9	53.8					6				
310	312.11	1.17E-06	7.4852E-06	1.56E-01		266.4										
B29	312.22	5.64E-06	6.1900E-06	9.11E-01	150	139.6	41.0					6				
311	312.56	4.41E-06	5.4090E-06	8.15E-01		31.4										
B30	312.64	7.48E-06	4.3900E-06	1.70E+00		333.2	59.1					4				
312	312.84	1.64E-06	4.3163E-06	3.80E-01		24.4										
313	312.95	9.42E-07	7.9405E-06	1.19E-01		197.5										
B31	312.99	6.65E-06	1.6200E-06	4.10E+00	225	32.6	57.4					3				
B32	313.07	1.00E-05	6.2800E-06	1.59E+00	225	337.6	-55.4					3				
314	313.39	1.55E-05	1.6373E-05	9.47E-01		90.5										
315	313.82	3.42E-06	7.8312E-06	4.37E-01		37.5										
316	314.11	8.70E-06	1.0290E-05	8.45E-01		224.1										
317	315.48	4.29E-06	5.9735E-06	7.18E-01		42.8										
B26	315.54	1.09E-06	1.9100E-06	5.71E-01		103.5	64.9					9				
B27	315.69	1.33E-06	2.0200E-06	6.58E-01	175	93.8	54.2					3				
318	315.82	8.74E-06	1.1747E-05	7.44E-01		74.0										
B15	316.08	2.14E-06	1.9700E-06	1.09E+00	125	309.2	55.2	327.0	51.7			1	3			
B18	316.16	4.95E-06	4.0800E-06	1.21E+00	125	31.7	63.2					1				
B19	316.25	2.35E-06	2.9900E-06	7.86E-01	150	35.6	55.7					1				
B20	316.36	2.67E-06	1.8200E-06	1.47E+00	125	47.1	53.2	24.8	45.2			3	3			
319	316.39	2.53E-06	7.2302E-06	3.50E-01		145.7										
B21	316.66	6.13E-07	2.4000E-07	2.55E+00	135	26.7	54.2	51.2	51.0			3	1			
320	316.70	5.66E-06	1.0636E-05	5.32E-01		88.5										

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
B22	316.76	7.42E-07			125	28.5	53.9					1				
321	317.05	2.66E-06	6.5600E-07	4.05E+00	100	320.5	58.7	338.2	62.4			1	3			
B23	317.06	3.13E-07	3.6400E-07	8.60E-01	100	22.0	47.4					1				
B24	317.26	1.18E-06	1.0900E-06	1.08E+00	100	27.3	46.0	32.0	51.7			1	1			
B25	317.35	2.09E-06	7.0300E-07	2.97E+00	100	22.7	51.1	30.7	57.6			1	1			
B16	317.36	1.28E-06	4.1900E-06	3.05E-01	475	224.9	-51.1	19.8	54.1			4	4			
B12	317.40	2.04E-07	3.9500E-06	5.16E-02		57.1	31.0					9				
B17	317.40	1.24E-06	1.3100E-06	9.47E-01		221.6	-66.4					9				
B13	317.43	3.18E-06	6.5700E-06	4.84E-01	425	12.5	-59.5					3				
B14	317.45	9.77E-06	8.7200E-06	1.12E+00	400	13.1	-55.9					3				
322	317.53	1.39E-06	7.1574E-06	1.94E-01	125	35.4	56.9	43.8	57.1			1	1			
B6	317.55	9.30E-07	1.2600E-06	7.38E-01	100	214.5	59.0					1				
B7	317.57	5.41E-07	1.8800E-06	2.88E-01	100	139.7	-25.4					9				
B8	317.62	1.43E-06	1.5700E-06	9.11E-01	100	178.7	36.0	216.2	51.9			7	5			
B9	317.65	1.38E-06	2.1700E-06	6.36E-01		202.4	28.0					9				
B10	317.75	3.67E-07	9.8000E-07	3.74E-01		309.6	-77.0					9				
B11	317.78	7.86E-07	1.7300E-06	4.54E-01	350	139.4	44.4			140.9	-29.6	9		1		
323	317.95	1.72E-07	4.9537E-06	3.47E-02	100	76.0	54.6					6				
A14	318.13	5.94E-07	4.4600E-06	1.33E-01	250	254.9	-43.7	101.6	50.1			8	9			
A15	318.15	1.03E-06	4.6600E-06	2.21E-01	350	228.5	-39.9	337.1	44.6			6	7			
A16	318.17	2.14E-06	5.2500E-06	4.08E-01	400	236.9	-48.1			317.3	32.3	3	1			
A17	318.22	5.52E-06	4.2400E-06	1.30E+00	450	332.1	-48.0					1				
A18	318.24	5.93E-06	7.7000E-06	7.70E-01	350	235.4	-55.9					2				
A20	318.24	5.51E-06	6.0100E-06	9.17E-01	400	249.1	-49.8	235.1	-55.0			3	3			
A19	318.26	4.26E-06	6.9600E-06	6.12E-01	435	244.7	-56.8					3				
A21	318.28	4.85E-06	9.3200E-06	5.20E-01	425	250.1	-53.7					3				
A22	318.30	6.51E-06	7.3600E-06	8.85E-01	400	240.9	-53.1					3				
324	318.33	1.97E-06	1.9900E-06	9.90E-01	75	68.1	59.2	41.1	59.4			4	2			
A23	318.42	6.19E-06	5.2800E-06	1.17E+00	475	230.5	-52.1					3				
A24	318.61	7.53E-06	6.7200E-06	1.12E+00	450	207.9	-58.0					1				
325	318.82	8.51E-06	2.6900E-06	3.16E+00	425	178.4	-48.3	92.0	28.3			3	9			
326	318.87	1.20E-05	7.2600E-06	1.65E+00	300	204.9	-66.9	96.0	36.5			1	9			
A25	318.90	3.39E-07	7.4700E-06	4.54E-02	275	322.3	-85.6	10.9	30.0	87.4	-41.8	4	4			
A26	319.00	4.26E-07	5.9700E-06	7.14E-02	50	96.7	0.5	351.0	27.6			8	4			
A27	319.02	2.75E-07	5.3900E-06	5.10E-02	115	339.8	24.6					4				
A28	319.05	2.67E-07	5.8100E-06	4.60E-02		9.5	-24.9					9				
A29	319.11	1.72E-07	4.1200E-06	4.17E-02	50	322.4	51.6					7				
A30	319.14	1.55E-07	5.2400E-06	2.96E-02	50	26.0	0.1	268.7	48.2			9	6			
327	319.21	1.09E-06	5.7400E-06	1.90E-01	375	245.1	-60.1	81.8	62.6			1	9			
328	319.35	6.68E-06	7.1100E-06	9.40E-01	375	272.8	-59.7	132.3	72.4			1	7			
329	319.52	3.99E-06	4.4700E-06	8.93E-01	350	213.4	-65.4	171.8	80.1			5	6			
B1	319.64	7.99E-07	3.5700E-06	2.24E-01		313.4	55.8					9				
330	319.65	8.01E-06	7.2100E-06	1.11E+00	325	211.9	-58.4	187.5	-10.6			4	9			
331	319.72	3.28E-06	6.9300E-06	4.73E-01	450	231.0	-62.3	75.4	72.0			1	7			
332	319.87	7.77E-07	7.6600E-06	1.01E-01	450	127.7	-24.8	8.8	43.1			3	6			

Table 1

SMPL	DEPTH (m)	J (emu/cc)	X (cgs)	J/X	MDF	C1 DEC	C1 INC	C2 DEC	C2 INC	C3 DEC	C3 INC	C1 GRD	C2 GRD	C3 GRD	ARM (emu/cc)	J/ARM
B3	319.93	3.29E-06	4.2100E-06	7.81E-01	250	242.5	-81.6			328.0	-31.9	8		5		
A9	320.03	7.57E-07	2.3900E-06	3.17E-01		47.7	19.3					9				
A10	320.05	1.90E-06	2.6800E-06	7.09E-01	25	69.0	38.1					9				
B4	320.05	1.44E-06	3.0600E-06	4.71E-01	450	224.3	27.3	248.7	32.2			9				
B5	320.07	5.59E-07	3.5000E-06	1.60E-01		174.3	27.4	198.8	56.2			9	7			
A11	320.09	7.32E-07	3.3000E-06	2.22E-01	175	90.0	-72.3			261.3	78.4	4		2		
333	320.10	2.29E-07	4.0300E-06	5.68E-02	100	289.3	82.1					6	5			
A12	320.13	2.86E-06	4.4800E-06	6.38E-01		76.0	-17.0					9				
A13	320.25	4.89E-07	2.1300E-06	2.30E-01	225	96.8	-10.4			171.1	-56.5	9		9		
334	320.37	5.19E-07	3.4300E-06	1.51E-01	425	143.3	60.1					7				
335	320.61	5.12E-06	3.4900E-06	1.47E+00	375	160.7	47.0	147.1	53.4			1	1			
336	320.72	1.62E-06	4.4400E-06	3.65E-01	350	347.3	83.8					5				
A6	321.05	3.73E-06	1.7190E-05	2.17E-01		154.2	-38.3			265.2	70.8	9		9		
A7	321.08	4.62E-06	2.5260E-05	1.83E-01	75	312.7	57.2			263.1	84.5	8		3		
337	321.12	1.02E-06	2.5500E-06	4.00E-01	125	202.9	-2.0					8				
A1	321.37	3.19E-06	4.2562E-05	7.49E-02	450	100.1	-64.7	204.3	-38.9			9	5			
338	321.43	1.01E-06	2.2000E-06	4.59E-01	200	74.1	88.4					6				
339	321.46	3.81E-07	1.9200E-06	1.98E-01		269.6	-32.6					9				
340	321.49	1.11E-06	6.0100E-07	1.85E+00		180.7	-31.6					9				
341	321.51	7.87E-06	7.6300E-06	1.03E+00	400	250.8	-0.9	128.6	-38.9	280.7	-41.0	5	3			
342	321.52	3.73E-06	7.1500E-06	5.22E-01	300	157.4	-49.0					3	9			
343	321.55	4.12E-06	7.0900E-06	5.81E-01	300	118.3	-50.2					3	9			
344	321.58	2.68E-06	1.2730E-05	2.11E-01		212.9	-29.0	296.4	-19.0			9	5			
A2	321.77	5.49E-06	2.3090E-05	2.38E-01	125	187.0	43.6	145.5	48.2			9	6			
A3	321.92	2.60E-06	1.9600E-05	1.33E-01		29.3	-24.0	166.9	65.5			8	3			
A4	321.94	2.02E-06	1.4390E-05	1.40E-01	425	24.0	-27.8			346.6	81.3	9		7		
A5	321.99	6.50E-06	1.7980E-05	3.62E-01	225	296.3	31.4			89.0	29.8	9		9		
A8	322.12	1.54E-06	2.3330E-05	6.60E-02		103.7	-34.0	270.8	63.2			9	7			
345	322.38	3.08E-06	4.1280E-05	7.46E-02		282.4	-20.9	163.6	47.8			8	9			
346	322.69	5.09E-06	3.4240E-05	1.49E-01	450	268.7	17.0	16.4	61.2	326.7	39.0	9	7			
347	322.96	3.73E-06	1.7120E-05	2.18E-01	325	26.2	-13.6	49.4	64.4			4	4			
348	323.15	5.23E-06	1.1580E-05	4.52E-01	425	21.1	-45.7	24.4	20.0			5	5			
B2			6.3378E-06													

Table 2

U-CHANNEL SAMPLES					DISCRETE SAMPLES		
SLUG-SMPL	DEPTH (m)	NRM-DEC	NRM-INC	J(rel.)	NRM-DEC	NRM-INC	J(E-6cmu/cc)
bb1	4.64	270.4	-51.4	59.30			
bb2	4.66	277	-52.6	69.80			
bb3	4.68	271.8	-55.7	77.90			
bb4	4.70	270.9	-59.9	79.70			
bb5	4.72	282.9	-66.3	75.10			
bb6	4.74	297.9	-73.6	68.60			
bb7	4.76	330.6	-76.3	65.30			
bb8	4.78	348.1	-69.7	68.50			
bb9	4.80	346.7	-61.4	76.60			
bb10	4.82	338.8	-54.8	88.50			
bb11	4.84	192.3	-36.7	124.00	207.5	39.5	2.580
bb12	4.86	334.3	-49.4	91.40	145.5	8.2	5.250
bb13	4.88	340.1	-47.1	87.60	220.3	50.0	2.070
bb14	4.90	335.5	-45.1	80.80	205.9	11.0	0.517
bb15	4.92	331.5	-45.8	64.40	299.7	14.3	0.279
bb16	4.94	314.7	-55.4	45.00	228.1	2.7	0.336
bb17	4.96	284.2	-65.4	35.50	208.3	31.0	1.140
bb18	4.98	257.6	-69.1	33.40	304.4	68.7	1.130
bb19	5.00	235.7	-72.7	36.90	250.6	-8.7	4.510
bb20	5.02	195.9	-72.2	45.10	89.6	49.6	0.551
bb21	5.04	175.8	-67.9	54.90	156.2	28.5	0.774
bb22	5.06	165.3	-64.5	66.30	305.4	53.4	0.842
bb23	5.08	157.6	-63.5	76.70	64.6	70.9	1.530
bb24	5.10	159	-63.3	81.90	22.5	59.5	1.250
bb25	5.12	162.5	-62	80.90	24.3	61.9	3.050
bb26	5.14	155.6	-61.6	76.70	47.1	41.6	0.473
bb27	5.16	158.6	-63	56.30	24.8	58.4	0.346
bb28	5.18	153.4	-65.2	45.10	24.8	40.1	0.435
bb29	5.20	159.8	-66.6	39.40	20.6	60.5	0.439
bb30	5.22	171.2	-65.8	37.80	11.7	52.6	0.541
bb31	5.24	170.5	-64.2	38.50	19.3	68.8	0.593
bb32	5.26	170.5	-62.7	40.50			
bb33	5.28	171	-61.8	42.50	7.2	58.5	0.628
bb34	5.30	172.6	-61.4	43.70			
bb35	5.32	170.6	-61.7	44.10	9.6	54.5	0.795
bb36	5.34	163.9	-62.2	43.20			
bb37	5.36	169.7	-62.8	41.70	9.8	59.4	0.913
bb38	5.38	167	-63.9	39.50			
bb39	5.40	165.1	-65.1	37.50	17.4	57.6	0.556
bb40	5.42	167.7	-65.9	35.40			
bb41	5.44	167.6	-66.5	33.90	17.5	66.0	0.510
bb42	5.46	167.2	-66.9	33.40			
bb43	5.48	162.2	-66.9	34.00	5.1	64.0	0.624
bb44	5.50	152.3	-65.6	32.20			
bb45	5.52	141.9	-64.8	30.40	15.9	58.2	0.591
bb46	5.54	133.4	-63.6	27.30			
bb47	5.56	116.5	-60.9	21.30	27.2	61.4	0.650
bb48	5.58	117.3	-59.3	16.10	11	55.6	0.410
bb49	5.60	107	-56	11.50	106.4	-3.0	0.287
ct1	5.62	172.1	-10.7	6.71	21	51.5	0.188
ct2	5.64	166.1	-25.2	9.35	31.5	61.2	0.323
ct3	5.66	163	-30.1	12.20	33.4	58.5	0.318
ct4	5.68	159.6	-36	15.50	29	52.1	0.314

Table 2

U-CHANNEL SAMPLES					DISCRETE SAMPLES		
SLUG-SMPL	DEPTH (m)	NRM-DEC	NRM-INC	J(rel.)	NRM-DEC	NRM-INC	J(E-6emu/cc)
ct5	5.70	156.9	-43.7	18.60	32.3	15.9	0.312
ct6	5.72	153.9	-49.6	20.40	22.3	45.0	0.466
ct7	5.74	155.6	-53.5	21.60	14.4	51.8	0.436
ct8	5.76	157.2	-56.2	22.20	23.9	61.1	0.401
ct9	5.78	163.3	-58.4	22.70	23.9	62.2	0.467
ct10	5.80	163.9	-60.6	23.00	3.2	51.8	0.306
ct11	5.82	157	-62.7	23.70	39.7	42.8	0.343
ct12	5.84	149	-63.5	25.40	34.7	46.5	0.332
ct13	5.86	148	-62.4	28.70	50	52.2	0.468
ct14	5.88	145.3	-61.5	33.10	52.8	45.5	0.673
ct15	5.90	155.1	-59.4	39.80	45.3	56.2	0.539
ct16	5.92	153.2	-57.7	47.40	2.4	59.7	0.707
ct17	5.94	152.5	-55.7	55.10	17.1	56.4	0.956
ct18	5.96	152.2	-54.6	63.40	53.8	40.1	0.699
ct19	5.98	154	-54.5	68.20	38.9	58.1	0.913
ct20	6.00	151.9	-55	68.80	33.8	49.1	1.370
ct21	6.02	150.9	-55.6	65.10	33.3	53.3	1.320
ct22	6.04	148.2	-56.9	59.00	53.4	62.8	1.170
ct23	6.06	144	-59.4	50.80	46.8	47.0	0.351
ct24	6.08	146.3	-61.9	43.90	42.1	44.5	0.325
ct25	6.10	144.6	-64.7	37.40	54.5	33.5	0.367
ct26	6.12	145.9	-64.8	35.80	25.2	51.5	0.300
ct27	6.14	147.4	-62.1	38.30	27.5	54.4	0.649
ct28	6.16	143.2	-60.2	43.10	29.1	54.3	0.518
ct29	6.18	144.1	-58.1	48.30	53	9.1	0.783
ct30	6.20	147.7	-56.6	54.80	57.1	49.5	1.270
ct31	6.22	149.2	-55.1	60.30	35.5	52.1	0.619
ct32	6.24	153.3	-54.2	64.80			
ct33	6.26	157.9	-54.3	69.10	30.4	47.9	1.180
ct34	6.28	165	-56	70.00			
ct35	6.30	156.5	-57.7	66.60	16	57.2	1.110
ct36	6.32	162.5	-59	59.90			
ct37	6.34	157.3	-60	53.10	18.3	63.2	1.470
cb1	6.36	152.8	-58	67.20	31.3	50.9	1.390
cb2	6.38	155.6	-57.2	92.30			
cb3	6.40	155.3	-57	109.00	29.2	56.5	1.930
cb4	6.42	157	-56.9	121.00			
cb5	6.44	162	-57.2	126.00	27.1	55.4	2.060
cb6	6.46						
cb7	6.48	161.4	-58.3	118.00	23.2	51.5	1.850
cb8	6.50						
cb9	6.52	154.9	-58.6	107.00	24.1	49.1	1.320
cb10	6.54						
cb11	6.56	163.1	-58.1	101.00	21	50.9	1.360
cb12	6.58						
cb13	6.60	158	-58.2	96.50	19.1	50.8	1.380
cb14	6.62						
cb15	6.64	156.6	-59.6	94.10	19.9	50.6	1.310
cb16	6.66						
cb17	6.68	164.3	-59.7	90.60	18.4	52.8	1.330
cb18	6.70						
cb19	6.72	162.9	-60	84.70	17.4	51.9	1.220
cb20	6.74						

Table 2

U-CHANNEL SAMPLES					DISCRETE SAMPLES		
SLUG-SMPL	DEPTH (m)	NRM-DEC	NRM-INC	J(rel.)	NRM-DEC	NRM-INC	J(E-6emu/cc)
cb21	6.76	153.3	-60.7	80.70	21.9	44.2	0.948
cb22	6.78						
cb23	6.80	159	-59	80.60	25.3	52.8	1.170
cb24	6.82						
cb25	6.84	160.1	-57.3	83.20	19	49.6	1.270
cb26	6.86						
cb27	6.88	160.6	-56.4	84.40	24.5	44.8	1.310
cb28	6.90						
cb29	6.92	163.4	-56.9	83.60	20.7	51.7	1.300
cb30	6.94						
cb31	6.96	163.6	-57.6	82.80	13.3	55.2	1.170
cb32	6.98						
cb33	7.00	158.6	-56.9	82.30	17.3	51.2	1.280
cb34	7.02						
cb35	7.04	163.4	-53.6	84.30	19.5	50.7	1.170
cb36	7.06						
cb37	7.08	162.4	-51.2	83.30	19.2	50.9	1.380
cb38	7.10						
cb39	7.12	158.4	-53.5	68.40	22.9	52.8	1.100
cb40	7.14						
cb41	7.16				21.6	49.1	1.400

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
3	1	a	3.515	1.10E-06	
3	1	a	3.545	2.10E-06	
3	1	a	3.575	1.70E-06	
3	1	a	3.605	2.10E-06	
3	1	a	3.635	1.90E-06	
3	1	a	3.665	6.00E-07	
3	1	a	3.695	1.70E-06	
3	1	a	3.725	1.80E-06	
3	1	a	3.755	0.00E+00	
3	1	a	3.785	1.80E-06	
3	1	a	3.815	2.40E-06	
3	1	a	3.845	2.00E-06	
3	1	a	3.875	2.20E-06	
3	1	a	3.905	2.10E-06	
3	1	a	3.935	2.00E-06	
3	1	a	3.965	6.00E-07	
3	1	a	3.995	1.80E-06	
3	1	a	4.025	2.10E-06	
3	1	a	4.055	1.30E-06	
3	1	a	4.085	0.00E+00	
3	1	b	4.135	2.30E-06	1.40E-06
3	1	b	4.165	4.10E-06	1.60E-06
3	1	b	4.195	3.20E-06	2.30E-06
3	1	b	4.225	3.40E-06	2.30E-06
3	1	b	4.255	3.60E-06	1.90E-06
3	1	b	4.285	3.00E-06	1.60E-06
3	1	b	4.315	3.00E-06	1.50E-06
3	1	b	4.345	3.50E-06	1.70E-06
3	1	b	4.375	3.50E-06	2.10E-06
3	1	b	4.405	3.60E-06	2.00E-06
3	1	b	4.435	2.90E-06	1.20E-06
3	1	b	4.465	3.20E-06	2.20E-06
3	1	b	4.495	3.40E-06	2.70E-06
3	1	b	4.525	3.40E-06	3.20E-06
3	1	b	4.555	3.70E-06	3.50E-06
3	1	b	4.585	2.70E-06	4.40E-06
3	1	b	4.615	5.20E-06	5.80E-06
3	1	b	4.645	6.50E-06	6.80E-06
3	1	b	4.675	1.10E-05	9.20E-06
3	1	b	4.705	1.01E-05	1.21E-05
3	1	b	4.735	9.90E-06	9.70E-06
3	1	b	4.765	9.50E-06	1.02E-05
3	1	b	4.795	9.70E-06	1.05E-05
3	1	b	4.825	9.30E-06	1.05E-05
3	1	b	4.855	6.90E-06	1.01E-05
3	1	b	4.885	6.70E-06	8.10E-06
3	1	b	4.915	9.00E-06	1.08E-05
3	1	b	4.945	6.00E-06	9.80E-06
3	1	b	4.975	7.10E-06	9.20E-06
3	1	b	5.005	9.40E-06	1.16E-05
3	1	b	5.035	9.90E-06	1.23E-05
3	1	b	5.065	1.23E-05	1.33E-05
3	1	b	5.095	1.20E-05	1.27E-05

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
3	1	b	5.125	1.02E-05	8.40E-06
3	1	b	5.155	6.60E-06	5.90E-06
3	1	b	5.185	5.00E-06	2.60E-06
3	1	b	5.215	2.90E-06	1.20E-06
3	1	b	5.245	3.90E-06	1.90E-06
3	1	b	5.275	3.50E-06	1.90E-06
3	1	b	5.305	3.50E-06	1.70E-06
3	1	b	5.335	2.70E-06	1.90E-06
3	1	b	5.365	2.80E-06	2.30E-06
3	1	b	5.395	2.80E-06	2.90E-06
3	1	b	5.425	2.60E-06	3.10E-06
3	1	b	5.455	2.30E-06	3.30E-06
3	1	b	5.485	1.40E-06	2.70E-06
3	1	b	5.515	1.30E-06	2.60E-06
3	1	b	5.545	1.80E-06	2.60E-06
3	1	b	5.575	3.00E-07	2.40E-06
3	1	b	5.605	1.40E-06	2.20E-06
3	1	c	5.655	5.30E-06	
3	1	c	5.685	3.50E-06	
3	1	c	5.715	1.60E-06	
3	1	c	5.745	3.00E-06	
3	1	c	5.775	2.50E-06	
3	1	c	5.805	1.00E-07	
3	1	c	5.835	1.70E-06	
3	1	c	5.865	1.90E-06	
3	1	c	5.895	1.80E-06	
3	1	c	5.925	0.00E+00	
3	1	c	5.955	2.20E-06	
3	1	c	5.985	2.20E-06	
3	1	c	6.015	8.00E-07	
3	1	c	6.045	2.90E-06	
3	1	c	6.075	3.30E-06	
3	1	c	6.105	3.10E-06	
3	1	c	6.135	2.50E-06	
3	1	c	6.165	2.30E-06	
3	1	c	6.195	1.80E-06	
3	1	c	6.225	2.20E-06	
3	1	c	6.255	3.00E-07	
3	1	c	6.285	1.60E-06	
3	1	c	6.315	1.80E-06	
3	1	c	6.345	1.90E-06	
3	1	c	6.375	1.80E-06	
3	1	c	6.405	2.00E-07	
3	1	c	6.435	1.80E-06	
3	1	c	6.465	2.10E-06	
3	1	c	6.495	1.90E-06	
3	1	c	6.525	1.80E-06	
3	1	c	6.555	2.20E-06	
3	1	c	6.585	1.60E-06	
3	1	c	6.615	1.80E-06	
3	1	c	6.645	1.60E-06	
3	1	c	6.675	1.80E-06	
3	1	c	6.705	2.40E-06	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
3	1	c	6.735	2.10E-06	
3	1	c	6.765	2.40E-06	
3	1	c	6.795	2.50E-06	
3	1	c	6.825	3.20E-06	
3	1	c	6.855	3.30E-06	
3	1	c	6.885	2.70E-06	
3	1	c	6.915	2.60E-06	
3	1	c	6.945	2.50E-06	
3	1	c	6.975	2.20E-06	
3	1	c	7.005	2.10E-06	
3	1	c	7.035	1.80E-06	
3	1	c	7.065	1.90E-06	
3	1	c	7.095	1.00E-07	
3	1	c	7.125	1.90E-06	
1	6	a	5.505	2.50E-06	
1	6	a	5.535	1.50E-06	
1	6	a	5.565	1.80E-06	
1	6	a	5.595	2.00E-06	
1	6	a	5.625	1.90E-06	
1	6	a	5.655	2.80E-06	
1	6	a	5.685	1.80E-06	
1	6	a	5.715	1.80E-06	
1	6	a	5.745	1.80E-06	
1	6	a	5.775	1.80E-06	
1	6	a	5.805	2.80E-06	
1	6	a	5.835	1.80E-06	
1	6	a	5.865	7.00E-07	
1	6	a	5.895	2.00E-06	
1	6	a	5.925	1.90E-06	
1	6	a	5.955	2.80E-06	
1	6	a	5.985	1.80E-06	
1	6	a	6.015	1.80E-06	
1	6	a	6.045	1.80E-06	
1	6	a	6.075	1.80E-06	
1	6	a	6.105	2.50E-06	
1	6	a	6.135	1.10E-06	
1	6	a	6.165	1.00E-06	
1	6	a	6.195		
1	6	a	6.225	4.00E-07	
1	6	a	6.255		
1	6	a	6.285		
1	6	a	6.315		
1	7	a	7.025	2.70E-06	
1	7	a	7.055	1.60E-06	
1	7	a	7.085	1.60E-06	
1	7	a	7.115	1.50E-06	
1	7	a	7.145	1.30E-06	
1	7	a	7.175	1.20E-06	
1	7	a	7.205		
1	7	a	7.235	7.00E-07	
1	7	a	7.265	5.00E-07	
1	7	a	7.295	3.00E-07	
1	7	a	7.325		

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	7	a	7.355	2.00E-07	
1	7	a	7.385	3.00E-07	
1	7	a	7.415	5.00E-07	
1	7	a	7.445	7.00E-07	
1	7	a	7.475	9.00E-07	
1	7	a	7.505		
1	7	a	7.535	1.20E-06	
1	7	a	7.565	1.30E-06	
1	7	a	7.595	1.50E-06	
1	7	a	7.625	2.70E-06	
1	7	a	7.655	2.00E-06	
1	7	a	7.685	2.30E-06	
1	7	a	7.715	7.10E-06	
1	7	a	7.745	6.30E-06	
1	7	a	7.775	4.30E-06	
1	7	a	7.805	2.60E-06	
1	7	a	7.835	4.40E-06	
1	7	a	7.865	4.10E-06	
1	7	a	7.895	3.80E-06	
1	7	a	7.925	3.40E-06	
1	7	a	7.955	5.40E-06	
1	7	a	7.985	4.00E-06	
1	7	a	8.015	2.00E-06	
1	7	a	8.045	3.60E-06	
1	7	a	8.075	3.50E-06	
1	7	a	8.105	3.40E-06	
1	7	a	8.135	3.40E-06	
1	7	a	8.165	3.50E-06	
1	7	a	8.195	3.90E-06	
1	7	a	8.225	4.40E-06	
1	7	a	8.255	1.50E-06	
1	7	a	8.285	2.80E-06	
1	7	a	8.315	2.60E-06	
1	7	a	8.345	2.90E-06	
1	7	a	8.375	2.90E-06	
1	7	a	8.405	2.40E-06	
1	7	a	8.435	2.40E-06	
1	7	a	8.465	2.20E-06	
1	7	a	8.495	2.00E-07	
1	8	a	8.545	1.00E-06	
1	8	a	8.575	1.40E-06	
1	8	a	8.605	1.70E-06	
1	8	a	8.635	1.80E-06	
1	8	a	8.665	1.90E-06	
1	8	a	8.695	2.40E-06	
1	8	a	8.725	2.40E-06	
1	8	a	8.755	2.80E-06	
1	8	a	8.785	3.10E-06	
1	8	a	8.815	3.30E-06	
1	8	a	8.845	3.20E-06	
1	8	a	8.875	3.00E-06	
1	8	a	8.905	2.80E-06	
1	8	a	8.935	2.50E-06	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	8	a	8.965	2.30E-06	
1	8	a	8.995	1.50E-06	
1	8	a	9.025	1.70E-06	
1	8	a	9.055	1.40E-06	
1	8	a	9.085	1.50E-06	
1	8	a	9.115	1.40E-06	
1	8	a	9.145	1.50E-06	
1	8	a	9.175	1.90E-06	
1	8	a	9.205	2.00E-06	
1	8	a	9.235	2.00E-06	
1	8	a	9.265	2.00E-06	
1	8	a	9.295	1.60E-06	
1	8	a	9.325	2.30E-06	
1	8	a	9.355	2.60E-06	
1	8	a	9.385	2.60E-06	
1	8	a	9.415	3.00E-07	
1	8	b	9.465	2.40E-06	
1	8	b	9.495	2.40E-06	
1	8	b	9.525	2.60E-06	
1	8	b	9.555	2.60E-06	
1	8	b	9.585	2.70E-06	
1	8	b	9.615	3.30E-06	
1	8	b	9.645	3.60E-06	
1	8	b	9.675	4.10E-06	
1	8	b	9.705	4.30E-06	
1	8	b	9.735	3.90E-06	
1	8	b	9.765	2.80E-06	
1	8	b	9.795	3.00E-06	
1	8	b	9.825	1.30E-06	
1	8	b	9.855	2.30E-06	
1	8	b	9.885	2.30E-06	
1	8	b	9.915	2.50E-06	
1	8	b	9.945	2.70E-06	
1	8	b	9.975	2.70E-06	
1	8	b	10.005	5.00E-07	
1	8	b	10.035	1.90E-06	
1	8	b	10.065	1.40E-06	
1	8	b	10.095	2.20E-06	
1	8	b	10.125	2.60E-06	
1	8	b	10.155	3.00E-06	
1	8	b	10.185	2.80E-06	
1	8	b	10.215	3.00E-06	
1	8	b	10.245	3.80E-06	
1	8	b	10.275	4.60E-06	
1	8	b	10.305	2.50E-06	
1	8	b	10.335	3.80E-06	
1	8	b	10.365	2.70E-06	
1	8	b	10.395	3.20E-06	
1	8	b	10.425	3.30E-06	
1	8	b	10.455	3.10E-06	
1	8	b	10.485	3.00E-06	
1	8	b	10.515	3.30E-06	
1	8	b	10.545	3.50E-06	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	8	b	10.575	3.20E-06	
1	8	b	10.605	3.30E-06	
1	8	b	10.635	3.40E-06	
1	8	b	10.665	2.50E-06	
1	8	b	10.695	3.40E-06	
1	9	a	10.985	2.70E-06	
1	9	a	11.015	2.40E-06	
1	9	a	11.045	6.00E-07	
1	9	a	11.075	1.60E-06	
1	9	a	11.105	1.60E-06	
1	9	a	11.135	2.20E-06	
1	9	a	11.165	1.70E-06	
1	9	a	11.195	1.80E-06	
1	9	a	11.225	1.90E-06	
1	9	a	11.255	1.90E-06	
1	9	a	11.285	1.00E-07	
1	9	a	11.315	6.00E-07	
1	9	b	11.345	9.00E-07	
1	9	b	11.375	9.00E-07	
1	9	b	11.405	1.40E-06	
1	9	b	11.435	1.70E-06	
1	9	b	11.465		
1	9	b	11.495	1.60E-06	
1	9	b	11.525	1.80E-06	
1	9	b	11.555	1.90E-06	
1	9	b	11.585	1.90E-06	
1	9	b	11.615	1.90E-06	
1	9	b	11.645	2.00E-06	
1	9	b	11.675	1.90E-06	
1	9	b	11.705	2.20E-06	
1	9	b	11.735	2.30E-06	
1	9	b	11.765	2.30E-06	
1	9	b	11.795	3.00E-07	
1	9	b	11.825	2.00E-06	
1	9	b	11.855	1.70E-06	
1	9	b	11.885	1.80E-06	
1	9	b	11.915	1.80E-06	
1	9	b	11.945	2.00E-07	
1	9	b	11.975	1.50E-06	
1	9	b	12.005	1.70E-06	
1	9	b	12.035	1.90E-06	
1	9	b	12.065	1.80E-06	
1	9	b	12.095	1.50E-06	
1	9	b	12.125	1.40E-06	
1	9	b	12.155	1.60E-06	
1	9	b	12.185	1.80E-06	
1	9	b	12.215	1.90E-06	
1	9	b	12.245	1.90E-06	
1	9	b	12.275		
1	9	b	12.305	1.80E-06	
1	9	b	12.335	1.90E-06	
1	9	b	12.365	1.90E-06	
1	9	b	12.395	2.00E-06	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	9	b	12.425	1.90E-06	
1	9	b	12.455	1.80E-06	
1	9	b	12.485	1.60E-06	
1	9	b	12.515	1.60E-06	
1	9	b	12.545	3.00E-07	
1	9	b	12.575	2.10E-06	
1	9	b	12.605	4.50E-06	
1	9	b	12.635	3.30E-06	
1	9	b	12.665	3.50E-06	
1	9	b	12.695	3.70E-06	
1	9	b	12.725	1.80E-06	
1	9	b	12.755	3.50E-06	
1	9	b	12.785	3.40E-06	
1	9	b	12.815	3.60E-06	
1	9	c	12.845	7.00E-07	
1	9	c	12.875	2.20E-06	
1	9	c	12.905	2.70E-06	
1	9	c	12.935	2.90E-06	
1	9	c	12.965	5.20E-06	
1	9	c	12.995	4.10E-06	
1	9	c	13.025	2.50E-06	
1	9	c	13.055	3.90E-06	
1	9	c	13.085	3.60E-06	
1	9	c	13.115	3.60E-06	
1	9	c	13.145	3.00E-06	
1	9	c	13.175	3.20E-06	
1	9	c	13.205	3.20E-06	
1	9	c	13.235	3.20E-06	
1	9	c	13.265	3.00E-06	
1	9	c	13.295	2.80E-06	
1	9	c	13.325	2.40E-06	
1	9	c	13.355	1.90E-06	
1	9	c	13.385	2.00E-06	
1	9	c	13.415	2.00E-07	
1	9	c	13.445	1.20E-06	
1	9	c	13.475	1.90E-06	
1	9	c	13.505	2.00E-06	
1	9	c	13.535	2.30E-06	
1	9	c	13.565	2.30E-06	
1	9	c	13.595	2.30E-06	
1	9	c	13.625	2.40E-06	
1	9	c	13.655	2.60E-06	
1	9	c	13.685	2.80E-06	
1	9	c	13.715	3.10E-06	
1	9	c	13.745	2.30E-06	
1	9	c	13.775	3.30E-06	
1	9	c	13.805	3.30E-06	
1	9	c	13.835	3.00E-06	
1	9	c	13.865	2.70E-06	
1	9	c	13.895	2.60E-06	
1	9	c	13.925	2.40E-06	
1	9	c	13.955	2.40E-06	
1	9	c	13.985	3.00E-07	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	9	c	14.015	2.00E-06	
1	9	c	14.045	1.40E-06	
1	9	c	14.075	2.10E-06	
1	9	c	14.105	2.40E-06	
1	9	c	14.135	2.80E-06	
1	9	c	14.165	5.00E-06	
1	9	c	14.195	6.50E-06	
1	9	c	14.225	8.30E-06	
1	9	c	14.255	9.80E-06	
1	9	c	14.285	8.20E-06	
1	9	c	14.315	5.40E-06	
1	10	a	14.035	4.00E-07	
1	10	a	14.065	1.40E-06	
1	10	a	14.095	1.60E-06	
1	10	a	14.125	1.60E-06	
1	10	a	14.155	1.70E-06	
1	10	a	14.185	2.80E-06	
1	10	a	14.215		
1	10	a	14.245	1.00E-06	
1	10	a	14.275	6.00E-07	
1	10	a	14.305	3.00E-07	
1	10	a	14.335	2.00E-07	
1	10	a	14.365	1.00E-06	
1	10	b	14.315	3.40E-06	
1	10	b	14.345	5.30E-06	
1	10	b	14.375	3.60E-06	
1	10	b	14.405	3.70E-06	
1	10	b	14.435	1.50E-06	
1	10	b	14.465	3.00E-06	
1	10	b	14.495	2.80E-06	
1	10	b	14.525	2.70E-06	
1	10	b	14.555	2.60E-06	
1	10	b	14.585	2.30E-06	
1	10	b	14.615	1.80E-06	
1	10	b	14.645	1.70E-06	
1	10	b	14.675	1.00E-07	
1	10	b	14.705	1.90E-06	
1	10	b	14.735	1.90E-06	
1	10	b	14.765	1.90E-06	
1	10	b	14.795	1.90E-06	
1	10	b	14.825	1.90E-06	
1	10	b	14.855	1.70E-06	
1	10	b	14.885		
1	10	b	14.915	1.80E-06	
1	10	b	14.945	1.60E-06	
1	10	b	14.975	1.70E-06	
1	10	b	15.005	1.70E-06	
1	10	b	15.035	1.70E-06	
1	10	b	15.065	1.60E-06	
1	10	b	15.095	1.50E-06	
1	10	b	15.125	1.60E-06	
1	10	b	15.155	2.00E-06	
1	10	b	15.185	2.00E-07	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	10	b	15.215	1.70E-06	
1	10	b	15.245	1.50E-06	
1	10	b	15.275	1.40E-06	
1	10	b	15.305	1.40E-06	
1	10	b	15.335	1.40E-06	
1	10	b	15.365	1.60E-06	
1	10	b	15.395		
1	10	b	15.425	1.60E-06	
1	10	b	15.455	3.60E-06	
1	10	b	15.485	0.00E+00	
1	10	b	15.515	1.20E-06	
1	10	b	15.545	1.70E-06	
1	10	b	15.575	1.70E-06	
1	10	b	15.605	1.60E-06	
1	10	b	15.635		
1	10	b	15.665	1.60E-06	
1	10	b	15.695	1.60E-06	
1	10	b	15.725	1.60E-06	
1	10	b	15.755	1.80E-06	
1	10	b	15.785	1.90E-06	
1	10	c	15.915	1.80E-06	
1	10	c	15.945	2.10E-06	
1	10	c	15.975	2.40E-06	
1	10	c	16.005	2.50E-06	
1	10	c	16.035	2.40E-06	
1	10	c	16.065	2.30E-06	
1	10	c	16.095	2.00E-07	
1	10	c	16.125	2.00E-06	
1	10	c	16.155	2.00E-06	
1	10	c	16.185	1.90E-06	
1	10	c	16.215	2.10E-06	
1	10	c	16.245	1.60E-06	
1	10	c	16.275	1.80E-06	
1	10	c	16.305	1.80E-06	
1	10	c	16.335	1.70E-06	
1	10	c	16.365	1.70E-06	
1	10	c	16.395		
1	10	c	16.425	1.80E-06	
1	10	c	16.455	2.00E-06	
1	10	c	16.485	2.00E-06	
1	10	c	16.515	2.10E-06	
1	10	c	16.545	4.20E-06	
1	10	c	16.575	3.60E-06	
1	10	c	16.605	2.50E-06	
1	10	c	16.635	3.80E-06	
1	10	c	16.665	3.50E-06	
1	10	c	16.695	3.60E-06	
1	10	c	16.725	3.50E-06	
1	10	c	16.755	3.70E-06	
1	10	c	16.785	3.80E-06	
1	10	c	16.815	2.60E-06	
1	10	c	16.845	3.40E-06	
1	10	c	16.875	3.60E-06	

Table 3

OL92-1,3 PASS-THROUGH SUSCEPTIBILITY					
CORE	DRIVE	SLUG	DEPTH (m)	SUSC1(cgs)	SUSC2(cgs)
1	10	c	16.905	3.60E-06	
1	10	c	16.935	3.60E-06	
1	10	c	16.965	3.40E-06	
1	10	c	16.995	3.40E-06	
1	10	c	17.025	3.40E-06	
1	10	c	17.055	3.50E-06	
1	10	c	17.085	3.60E-06	
1	10	c	17.115	4.00E-06	
1	10	c	17.145	3.60E-06	
1	10	c	17.175	3.80E-06	
1	10	c	17.205	3.70E-06	
1	10	c	17.235	3.80E-06	
1	10	c	17.265	1.70E-06	
1	10	c	17.295	3.00E-06	
1	10	c	17.325	2.90E-06	
1	10	c	17.355	3.40E-06	

Table 4

event	event depth (m)	event age (ka)	age error (kyr)	age source	notes	corrected event age (kyr)
Mono Lake	20	28	2	Champion et al. '88	isotopic	28
Laschamp	29	42	10	Champion et al. '88	isotopic	42
NGS	50	77	12	Nowaczyk '90	sediments, ave	77
Fram Strass	65	100	-	Nowaczyk '90	sediments, ave	100
Blake	78	114	10	Champion et al. '88	sediments, ave	122
Jamaica(B1)	103	182	31	Champion et al. '88	isotopic	182
Levantine(BII)	154	289	19	Champion et al. '88	sediments, ave	310
Biwa III	190	389	9	Champion et al. '88	sediments, ave	417
Emperor	215	443	19	Champion et al. '88	sediments, ave	475
Big Lost	245	565	14	Champion et al. '88	isotopic	565
M/B	320	783	11	Baksi et al. '83	isotopic	783

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Age and Correlation of Tephra Layers in Owens Lake Drill Core OL-92-1 and -2

by

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Abstract

Tephra layers present in the ~320-m-deep bore hole in Owens Lake, Calif., were sampled, petrographically described, and the volcanic glass shards were analyzed by electron-microprobe to chemically characterize the layers, and correlate them to tephra layers that have been previously identified and dated. The purpose of this study is to provide additional age control to paleolimnologic and paleoclimatic studies of the lake sediments.

Tephra layers identified are: the Bishop ash bed, ~760 ka, at depths of ~320 to 304 m; the Dibekulewe ash bed, estimated to be ~470 to ~610 ka, at ~224 m; and one of the "Walker Lake" ash beds, estimated to be 60 to 85 ka, at ~50.7 m. Other tephra layers, the ages of which are poorly constrained, have also been identified. Age constraints provided from other lines of evidence in this study, such as a sedimentation rate curve based on dry bulk density and magnetostratigraphy, provide new age constraints to the undated or poorly dated tephra layers. An average sedimentation rate for the 1992 Owens Valley core is 0.41 mm/yr for the last ~665 ka, compared to 0.35 mm/yr for a core drilled previously into Owens Lake sediments in 1957.

Introduction

Tephra (volcanic ash) layers present in cores from the composite 320-m-deep bore hole drilled in 1992 in Owens Lake, east-central California, were sampled and chemically analyzed to provide correlation and age control to a paleolimnologic study of upper Quaternary lake sediments in this basin. The primary focus of this study is to characterize the history of climatic fluctuations during the latter part of Quaternary time. The volcanic glass shards of tephra samples present in the core were separated and chemically analyzed. Glass compositions were then compared to those of previously analyzed tephra layers, some of them of known age. Correlations were identified on the basis of similar petrographic characteristics, glass chemical composition, and stratigraphic sequence in the Owens Lake drill hole, and at various localities in the Western U.S. where the age, correlation, and stratigraphic sequence of potentially correlative tephra layers have been previously documented.

Methods

Approximately 1 to 3 cm^3 of tephra were sampled from macroscopic tephra layers present in the drill cores, and the volcanic glass shards from these were separated and analyzed using methods described by Sarna-Wojcicki and others (1984). In brief: samples were wet-sieved with water in plastic sieves fitted with nylon screens, and the 200 to 100 mesh size fraction (~80 to 150 µm, respectively) was retained for separation of glass shards. This fraction was placed in an ultrasonic vibrator in water, then treated with a 10% solution of HCl acid for a few minutes, to remove authigenic carbonate adhearing to the glass particles, and with an 8% solution of HF acid for about 30 seconds to one minute, to remove other coatings or altered rinds that may have been present on the glass shards. The glass shards were then separated from other components of the tephra sample using (1) a magnetic separator and/or (2) heavy liquids of variable density made from mixtures of methylene iodide and acetone. The glass separate was mounted in epoxy resin in shallow holes drilled into plexiglass slides, and the slides were ground-down and polished with several size grades of diamond paste. The polished sample was then coated with carbon, and individual shards of some samples were analyzed using a 9-channel SEMQ electron-microprobe and, subsequently, the remaining samples with a JEOL electron-microprobe, both instruments at the U.S. Geological Survey in Menlo Park, Calif.[1] See Sarna-Wojcicki and others, 1984, and Sarna-Wojcicki and others, 1985, for specifics of analytical conditions.

Samples of volcanic glass shards were analyzed for nine elements: SiO2, Al2O3, FeO, MgO, MnO, CaO, TiO2, Na2O, and K2O. Widespread tephra layers, the products of the most voluminous and violent pyrolcastic eruptions, are generally silicic in composition, containing high concentrations of SiO2, Al2O3, K2O, and Na2O. Volcanic glasses of such layers generally contain lower concentrations of FeO and CaO than those of intermediate or basic composition, but still high enough to be measured with precisions of about 2 to 5%. Silicic tephra contains lower concentrations of MgO, MnO, and TiO2, often close to detection limits for these oxides. Silicic tephra erupted from sources in the Cascade Range of the western U.S. (Washington, Oregon, and northern California) have higher concentrations of these latter elements than tephra erupted from interior

[1]The SEMQ electron microprobe, a 9-channel instrument, was replaced with a JEOL electron microprobe, a five-channel instrument, in January of 1993. Standards and duplicate tephra samples analyzed by the two instruments indicate that the same results have been obtained with the two instruments.

sources within the craton of the western U.S., such as the Long Valley Caldera and the Mono Craters (east-central California), the Yellowstone National Park caldera complex (northwestern Wyoming and east-central Idaho), and the Jemez Mountains caldera complex (northern New Mexico)(Sarna-Wojcicki and Davis, 1991). Consequently, comparisons of tephra layers for the purpose of correlation were made with several different combinations of elements, excluding those elements that are present in small quantities close to the detection limit in comparisons of some groups of samples.

Results of chemical analysis of the volcanic glass were compared with our current data base of approximately 3,100 previously analyzed samples of volcanic glass from late Neogene tephra layers collected within the conterminous western U.S. and sediments of the adjacent Pacific Ocean bottom. The best matches were identified using numerical and statistical programs (SIMANAL and RATIONAL; Sarna-Wojcicki and others, 1984). The best matches were then examined for similarities in petrographic characteristics and stratigraphic position and sequence (Sarna-Wojcicki and Davis, 1991). Correlative layers were identified on the basis of these three main criteria: (1) chemical composition of volcanic glass, (2) petrographic characteristics, and (3) stratigraphic position and sequence. Because some of the tephra layers identified in this study have been previously dated at other sites, we are able to assign correlated ages, or at least age estimates, to these layers in the Owens Lake core.

This report summarizes results to date. Of 20 samples submitted for analysis, 17 had a sufficient quantity of volcanic glass shards that they were considered to be air-fall or reworked tephra layers, or ashy sediments. The remaining three samples had very few glass shards, in amounts typical of ambiant concentrations commonly present in fluvial or eolian sediments in this area. The rare glass shards from these three samples were not analyzed. Three of the samples analyzed were bimodal; two different compositions for each of these samples are reported. After the initial analyses were completed and preliminary identifications were made, additional samples were collected and examined from specific depth intervals, where additional tephra layers might be expected to occur based on known stratigraphic sequences and ages from other sites in the western U.S. The latter work was undertaken to see if cryptic, disseminated tephra is present at these depth intervals in the core. Work on 10 additional such samples continues.

Results

Information regarding the analyzed samples is given in Table 1. Results of electron-microprobe analysis are presented in Table 2. Lithologic and petrographic descriptions of the samples analyzed are given in Appendix 1. Individual comparisons for each analyzed tephra sample with the 30 closest matches is given in Appendix II, together with annotations regarding the locations and age information of tephra layers that match most closely with those in the Owens Valley cores.

Our study indicates that the following widespread, dated tephra layers were identified in the Owens Lake bore hole (OL92-1 and -2): the Bishop ash bed in the interval 320.01 to 303.94 m (~0.76 Ma); the Dibekulewe ash bed at 224.15 m (>0.40, <0.665 Ma), and a tephra layer at 50.66 to 50.69 m attributed to early eruptions of the Mono Craters, a correlative of which has been found in core samples from Walker Lake, Nev., estimated to be between 60 and 85 ka based on age control at the latter site. In addition, several zones of what appears to be reworked Bishop ash or chemically similar ash, are present at several different levels in the Owens Lake bore hole, and suggest that the Bishop ash bed was repeatedly reworked within the Owens Lake drainage basin.

The Bishop ash bed:

Abundant coarse- to fine-sand-sized tephra layers are present within the lowermost ~16 m of the core. Several zones within this interval are massive, and the entire interval consists dominantly of tephra that was either direct airfall material or tephra reworked locally by streams and wind within the Owens Valley drainage basin, and deposited in the lowest part of the Owens Lake basin--or probably a combination of these two possible origins. In terms of its composition, the volcanic glass of this tephra is chemically homogenous, and probably represents the products of a single large eruption that was either repeatedly reworked within the Owens Valley drainage system, or of several eruptions spaced closely in time, emanating from the same eruptive source, probably also reworked over some unknown but relatively short period of time.

In terms of their chemical composition, the volcanic glass shards of this material are most similar to a set of Quaternary tephra layers that had their source in the Glass Mountain-Long Valley Caldera area of east-central California, ~155 km to the north of Owens Lake. These layers are referred to as the Glass Mountain set of ash beds (Glass Mountain D, G, and U, plus several other unnamed ash layers from this source), and the Bishop ash

Table 1. Data on tephra samples studied from the Owens Lake core

Sample Number	Core	Depth (m)	Thickness of layer (cm)	Type of underlying, overlying sediment
OL92-S	n/a	surface	1	Lake gravels in quarry east of Owens Lake
OL92-1	92-1	50.6	spot sample	
OL92-1001	"	50.66-50.69	3	Silty clay
OL92-1003	"	52.20-52.25	5	Silty clay
OL92-2	92-2	131.1	spot sample	
OL92-1015	"	216.54	2	Sand, fine to very coarse
OL92-1016	"	224.15	3	Sand, fine to medium
OL92-1018	"	241.14	5	Sand, mostly fine to medium, some silt
OL92-1019	"	266.43	4	Clay, some silt
OL92-1020	"	296.04	5	Clay and silt
OL92-1021	"	303.94	4	Tephra, airfall and reworked
OL92-1022	"	304.44	3	"
OL92-1023	"	304.91	4	"
OL92-1024	"	305.38	2	"
OL92-1025	"	305.93	4	"
OL92-1026	"	306.89	2	"
OL92-1027	"	308.46	1	"
OL92-1028	"	311.08	2	"
OL92-1029	"	311.48	3	"
OL92-1030	"	320.01	1	"

Table 2. Electron-microprobe analysis of volcanic glass shards from tephra layers in Owens Valley Cores OL92-1 and OL92-2, and one surface sample in the vicinity of Owens Lake. Oxides are given in weight percent, recalculated to 100 percent (fluid-free basis). (S) - SEMQ 9-channel probe; (J) - Jeol 5-channel probe.

Sample Number	SiO2	Al2O3	Fe3O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total (R)
OL-92-S (S)	77.73	12.50	0.81	0.03	0.04	0.47	0.03	3.94	4.44	99.99
OL92-1 (J)	76.85	12.82	1.09	0.03	0.03	0.44	0.06	4.11	4.58	100.01
OL92-1 (J)	76.94	12.99	1.06	0.01	0.00	0.41	0.04	4.07	4.47	99.99
OL92-1001 (S)	77.42	12.67	0.78	0.06	0.05	0.77	0.08	3.61	4.56	100.00
OL92-1003 (S)	73.85	14.38	1.07	0.09	0.11	0.47	0.22	5.19	4.62	100.00
OL92-1015 (S)	78.01	12.19	0.77	0.03	0.04	0.47	0.05	3.85	4.57	99.98
OL92-1016 (J)	76.12	13.54	1.29	0.05	0.04	0.59	0.08	4.22	4.06	99.99
OL92-1019 (S)	77.20	12.83	0.76	0.04	0.08	0.42	0.06	4.20	4.42	100.01
OL92-1020 (J)	74.27	14.09	1.39	0.17	0.03	0.91	0.21	3.83	5.10	100.00
OL92-1021 (J)	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01
OL92-1022 (J)	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00
OL92-1023 (J)	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01
OL92-1024 (J)	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00
OL92-1025 (S)	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00
OL92-1026 (J)	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01
OL92-1027MA (J)	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00
OL92-1027MI (J)	76.52	12.90	0.80	0.04	0.05	0.44	0.06	4.10	5.11	100.02
OL92-1028MA (J)	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00
OL92-1028MI (J)	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00
OL92-1029 (J)	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00
OL92-1030 (J)	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00

bed, erupted from the nearby Long Valley Caldera (Gilbert, 1938; Bailey and others, 1976; Izett, 1981; Sarna-Wojcicki and others, 1984, 1991; Izett and others, 1988). These layers were erupted during the period ~1.2 to ~0.76 Ma. There are other, older tephra layers that had their source at or near Glass Mountain (for example, the Tuff of Taylor Canyon), but these can be distinguished fairly easily by their glass chemical composition from the younger set. The youngest, coarsest, and by far the most voluminous tephra layer of the younger set (1.2 to 0.76 Ma) is the Bishop ash bed, the distal air-fall and reworked air-fall ash of the proximal Bishop Tuff.

The proximal Bishop Tuff, including the basal air-fall pumice and overlying ash-flow tuff, as well as distal air-fall ash, have been redated recently, yielding an average age of 0.758 ±0.002 Ma by the laser-fusion $^{40}Ar/^{39}Ar$ method on sanidine crystals separated from this tephra (Sarna-Wojcicki and Pringle, 1992). Previous recent, generally accepted ages of the Bishop Tuff and ash bed were between about 0.73 and 0.74 Ma (Dalrymple, 1980; Izett and others, 1988). The Brunhes Normal-Matuyama Reversed Magnetic Chron Boundary is situated one to several meters below the Bishop ash bed, when both are found in the same stratigraphic sections (Dalrymple and others, 1965; Eardley and others, 1973; Hillhouse and Cox, 1976; Mankinen and Dalrymple, 1979; Colman and others, 1986; Sarna-Wojcicki and others, 1987, 1991). The previous recently estimated age of the Brunhes-Matuyama boundary was 0.73 Ma (Mankinen and Dalrymple). Recent work, and the ages and stratigraphic relations of the Bishop ash bed and the boundary that are discussed above, indicate that the age of the boundary must be older than its previously accepted age. Recently obtained revised ages are 0.775 ±0.005 (Sarna-Wojcicki and Pringle) and ~0.780 to ~0.790 ± ~0.010 Ma (Baksi and others, 1992; McDougall and others, 1992; Obradovich and Izett, 1992). In any case, the Bishop ash bed is normally magnetized, is situated close above the Brunhes-Matuyama boundary, and thus must have been deposited during the Brunhes Normal Magnetic Chronozone. The younger Glass Mountain tephra layers, by contrast, range in age from about 1.0 to 1.2 Ma (although some are probably as young as ~0.9 Ma; Sarna-Wojcicki and others, 1984), are situated stratigraphically below the Brunhes-Matuyama boundary, and are all magnetically reversed (Liddicoat, 1993).

We propose that the thick interval of tephra at the base of Owens Lake drill hole OL92-2, in the cored interval of 303.94 to 320.01 m, is the Bishop ash bed, for the following reasons:

(1) The tephra in this basal interval is thick, coarse, and massive, typical of a tephra layer from a major eruption close to its eruptive source

area. The Bishop ash covered a very large area of the western and central U.S., and was particularly thick near its source, the nearby Long Valley Caldera. Large areas underlain by the air-fall pumice and ash-flow tuff are still exposed at the north end of Owens Valley in the Volcanic Tableland. Direct airfall ash into Owens Lake at the time of eruption, as well as reworking of the ash and tuff from the northern end of Owens Valley, from the entire Owens Valley Drainage system north of the sill between Owens Valley and China Lake, as well as from drainage systems tributary to Owens Valley (Long Valley, Chalfant Valley, Adobe Valley) must have brought large volumes of the tephra into Owens Lake shortly after the eruption, and for some period of time afterward. No other eruption from the Glass Mountain-Long Valley Caldera was as voluminous and widespread as that of the Bishop Tuff.

(2) The shapes of the shards and the mineralogy of the tephra within this basal, 16-m-thick interval is compatible with that of the Bishop ash bed (Appendix I). The tephra is composed of dominantly pumiceous glass shards, with subordinate bubble-wall and bubble-wall-junction shards, and contains sanidine and plagioclase feldspar, quartz, biotite, hornblende, some pyroxene (both ortho- and clino-), as well as minor amounts of allanite and zircon. Some grains of all of these minerals are found with some glass adhering their surfaces. This mineralogy is typical of the Bishop Tuff and ash bed, but is also typical, however, of some of the Glass Mountain tephra layers erupted during the interval ~0.9 to 1.2 Ma. These layers, however, were produced by eruptions of considerably smaller volume, extent, and were consequently much finer, thinner, or absent at distal sites.

(3) The chemical composition of the volcanic glass of this 16-m thick interval in the Owens Valley core is the same as that of the Bishop ash bed (table 2; Appendix II). Some of the ash beds erupted from the Glass Mountain source, however, are chemically similar and cannot be distinguished on the basis of electron-probe analysis alone. Follow-up analysis by X-ray fluorescence and neutron-activation analysis is desirable.

(4) The entire cored section, from the base of the massive tephra interval to the top where Holocene sediments are present, is normally magnetized, and thus suggests that this entire interval was deposited during the Brunhes Normal Magnetic Chron (Glen and others, this volume). A short distance beneath the massive tephra interval, near the base of the drill hole, magnetic inclinations begin to shallow and vary, indicating that a magnetostratigraphic boundary is present. This transition is identified as

part of the Brunhes-Matuyama boundary by Glen and others (this volume), and suggests that the lower part of this transition, with fully reversed inclinations, lies beneath the lowermost recovered cores from this drill hole.

(5) A sedimentation rate curve derived from dry bulk density of the cored sediments, and an assumption that the tephra at the base of the Owens Lake bore hole is the Bishop ash bed (Bischoff, this volume), agrees well with an independent chronology derived from magnetostratigraphy for a number of brief magnetic excursions observed in this bore hole above the Bishop ash bed, in Brunhes time (Glen and others, this volume). That is, the age-depth curve derived from dry bulk density passes through the age-depth points defined by the magnetostratigraphy, within the published age errors of the latter.

Based on these five main arguments, we conclude that the thick tephra interval at the base of the Owens Lake core is the Bishop ash bed. This includes samples OL92-1021, at 303.94 m, through OL92-1030, at 320.01 m.

Ash bed of sample OL92-1020 and ash bed RVS-BL-1

The ash bed at 296.04 m in the Owens Valley bore hole contains 90% glass shards. Chemically, it matches well on the basis of its glass chemical composition with a tephra layer (RVS-BL-1) from the Borrego Badlands of southern California, west of the Salton Sea (R.V. Sharpe, written commun., 1988). No independent age is available for this ash bed. The eruptive source of this tephra is not known. The Bishop ash bed is found close to the latter ash bed in the Borrego Badlands, but their stratigraphic relationships there are not known. Results of the current Owens Lake study now provide a stratigraphic context (close above the Bishop ash bed) and age estimate (>0.665; <0.758 Ma) for this ash bed. Using the sedimentation rate curve of Bischoff (this volume), the age of this layer is estimated to be about 740 ka.

Ash of sample OL92-1019

Ashy diatomaceous clay at 266.43 m in the bore hole contains about 25% glass shards. These are chemically identical to those of the Bishop ash bed and the younger ash layers of Glass Mountain. This sample is most likely the Bishop ash, reworked upward in the section.

The Dibekulewe ash bed

This clayey, very fine grained ash layer, containing 55% glass shards, is present at a depth of 224.15 m in the core. Chemically, the volcanic glass shards of sample OL92-1016 match well with those of the Dibekulewe ash bed of Davis (1978). The latter tephra layer is found at a number of localities in Oregon, California, and Nevada, where it commonly overlies the Lava Creek B ash bed, and is overlain, in turn, by the Rockland ash bed (Davis, 1978; Izett, 1981; Sarna-Wojcicki and others, 1985, 1991). The age of the Dibekulewe ash bed is not known, but the underlying and overlying layers have been dated. The Lava Creek B ash bed is ~665 ka (Izett and others, 1992), and the Rockland ash bed is ~400 ka (Meyer and others, 1991) or ~470 ka (Alloway and others, 1993). Rieck and others (1992) have estimated the age of the Dibekulewe ash bed to be about 610 ka, based on its position close above the Lava Creek B ash bed in the Tulelake core in north-central California, and paleoclimatic inferences made regarding the sedimentation rate in that basin. Data from this study, based on dry bulk density (Bischoff and others, this volume) and magnetostratigraphy (Glenn and others, this volume), however, suggest that the age of the Dibekulewe ash bed is younger, closer to ~500 ka.

Sample OL92-1015

Disseminated glass shards in diatomaceous and calcareous, fine-grained sediment, at a depth of 216.54 m in the core, comprised only about 5% of the very fine-grained, diatomaceous, calcareous sediment. These shards are chemically identical to the Bishop ash bed and the Glass Mountain tephra layers. Because of the large volume and wide dispersal of the Bishop ash bed, and because the glass shards in this sample constitute such a small percentage of the sediment sample and are situated considerably higher in the core than the main body of the Bishop ash bed, are most likely reworked from the latter, and represent a sporadic background contamination.

Sample OL92-1003

This sample, at a depth of 52.25 m in the core, consists of 50 to 55% glass shards. Of these, most are clear, colorless, and 2 to 3 % are brown in color. The chemical composition of shards from this sample are generically similar to rhyolite flows erupted from Mammoth Mountain (~155 km north of Owens Lake), that are dated between 50 and 150 ka by the conventional K-Ar method (Bailey and others, 1976). None of the latter units, however, are sufficiently similar to OL92-1003 to be considered as a correlative.

Iron in particular is higher in the source rocks. The similarity does, however, suggest common provenance. OL92-1003 is most similar to a tephra layer (UCSB-FS-89-6-6BC) present in river terrace sediments of the Owens River near Fish Slough, about 18 km north of Bishop, but we have no independent age or stratigraphic control on this latter layer.

Sample OL92-1003 is also similar to several tephra layers that were exposed along a causeway connecting Negit Island to the north shore of Mono Lake in 1982, when the lake was at its lowest historic level due to diversion of water by the Los Angeles Department of Water and Power. This set of tephra layers unconformably underlies the oldest of the Wilson Creek ash beds (~12 to ~36 ka), and thus is older than about 40 ka (Lajoie, 1968). Tephra layers of this chemical type (that is, similar in glass chemistry to OL92-1003), are intercalated in the causeway section with tephra layers similar in chemical composition to those erupted from Mono Craters, but are somewhat different from both the Wilson Creek beds and Holocene tephra layers derived from Mono Craters. These intercalated beds are considered to be the oldest known beds erupted from the Mono Craters.

The Wilson Creek ash beds are present in a section of lake beds that were deposited during the last high stand of Mono Lake, or pluvial Lake Russell (Lajoie, 1968), a period closely coincident with the last major glaciation and the deep-sea oxygen-isotope stage 2 (Shackleton and Opdyke, 1973; Imbrie and others, 1984). The Wilson Creek lake beds are underlain by a gravel indicating that lower lake levels preceded deposition of the Wilson Creek beds. This lower level probably correlates to the deep-sea oxygen-isotope stage 3. The Negit causeway section underlies both the Wilson Creek beds and the basal gravel, and thus probably correlates with the next older glaciation, and with deep-sea oxygen-isotope stage 4, approximately 60 to 80 ka BP, or with an older high stand of the lake. The available age control is more compatible with the former choice.

Sample OL92-1001

This sample, obtained from a depth of 50.69 m in the core, contains about 75% glass shards. Chemically, this sample matches well with the group of early, Mono Craters-like tephra layers found in the Negit Island causeway section (see above), as well as with tephra layers that are present at depths of about 63 to 79 m in a bore hole in Walker Lake, Nev., about 260 km N. of Owens Lake. At Walker Lake, these beds are estimated to be between 60 and 85 ka, based on radiocarbon ages in the upper parts of the core, several correlated ages in the core obtained by tephra correlations, and uranium series ages in the middle part of the core (Sarna-Wojcicki and others, 1988; John Rosholt, cited in Benson, 1988).

Sample OL92-1

This sample, obtained from a depth of 50.6 m in the Owens Lake core, contained about 75% glass shards, the remainder being crystalline material, both clastic detrital and pyrogenic minerals. This sample was obtained from the first hole drilled in 1992, and consequently cannot be related directly to the stratigraphy in the second core. Two replicate analyses were run on this sample. Chemically, the glass shards of this tephra layer match most closely with tephra layers obtained from depths of ~54 to ~62 m in the Tulelake core, in northern California. The interpolated ages of these layers, based on age control in this core (Rieck and others, 1992) range from about 165 to 550 ka (see Appendix II). Inasmuch as most of the tephra layers of this particular chemical composition in the Tulelake core were erupted from a local source, probably the Medicine Lake Volcano, and have not been found outside of north-central California and south-central Oregon (beyond a radius of about 100 km), they are not likely to be present in Owens Lake, 670 km to the southeast. The ages of these layers in Tulelake core also are not compatible with the chronology and correlations derived on the basis of other tephra units in the Owens Valley core, or the sedimentation rate curve of Bischoff (this volume).

The tephra of this layer is also generically similar to tephra erupted from the Mono Craters, specifically to tephra layers collected by J. O. Davis in the vicinity of Walker Lake, Nev., that range in age from latest Pleistocene to Holocene, but have no precise age control.

Sample OL92-S

This is a surface sample obtained from a quarry in lake gravels east of the bedrock ridge that extends to the Death Valley-Lone Pine Road. Chemically, this tephra layer matches with the Long Valley-Glass Mountain suite of tephra layers, 1.2 to 0.76 Ma in age. Most of the best matches are to the Bailey ash bed, but several good matches are also to the Bishop ash bed. This unit may thus correlate to the Bishop ash bed at ~304 to ~320 m in the Owens Lake core, or it may correlate to an older tephra layer derived from Glass Mountain, such as the 1.2 Ma Bailey ash bed. We cannot discriminate among these on the basis of probe analysis of the glass shards or petrographic criteria alone. Additional studies that could pinpoint the identity of this layer are X-ray-fluorescence and instrumental neutron-activation analyses of the volcanic glass, and paleomagnetic study of the layer and associated sediments. Normal polarity of the tephra layer and associated sediments would indicate that the layer was most likely the Bishop ash bed.

Discussion and Conclusions

The 16-m-thick interval of tephra at depths of ~304 to ~320 m in the Owens Lake core is the Bishop ash bed, based on a combination of several independent lines of evidence. Among these are (1) the exceptional coarseness and thickness of this tephra interval suggest that it was produced by an eruption of exceptional magnitude; (2) its petrographic and chemical (in terms of glass composition) similarity to the Bishop ash bed and its homogeneity; (3) its position within a normally magnetized section that extends to the historic sediments at the top of the core, but close above a paleomagnetic transition from normal to intermediate and scattered directions at the very base of the core, indicates that it is younger than, but close to, the age of the Brunhes-Matuyama boundary (775-790 ka), and in agreement with an age of ~760 ka determined on surface outcrops of the proximal and distal Bishop Tuff and ash bed; (4) the position, size and geometry of the Owens Lake basin and its topographic relation to tributary basins such as Long, Adobe, and Chalfant Valleys, together with the presently known distrubution of the Bishop Tuff and ash bed, suggest that a large volume of Bishop tephra must have fallen on, and subsequently been reworked into, the depositional center of the Owens Lake basin; and (5) an independent age curve based on dry bulk density and an assumption that the 16-m-thick interval is indeed the Bishop ash bed provides reasonable agreement for the ages and positions of identified tephra layers present higher in the core--the Dibekulewe ash bed, and the Walker Lake ash bed (Bischoff, this volume). The same curve is in agreement with the ages and positions of short magnetic reversals and excursions within the Brunhes Normal Chron determined independently by Glenn and others (this volume).

Identification of the 16-m-thick interval near the base of the Owens Valley bore hole as the Bishop ash bed provides a reasonable explanation for the great thickness of tephra at this site. The Owens Lake drainage basin and its tributary basins would be completely blanketed with tephra after the eruption of the Bishop Tuff, because this basin and its tributaries are situated within the fallout region of the Bishop ash bed (Izett, 1981; Izett and others, 1988; Sarna-Wojcicki and Davis, 1991). The streams within these basins would not be transporting anything but tephra for some time after the eruption because their basins would be overloaded with sediment, and that sediment would be loose, easily erodable tephra. The effective density of particles of the tephra, composed dominantly of pumice and glass shards (see Appendix I), is lower (~1.2 to 2.5 g/cc) than the normal clastic load underlying the tephra blanket. The latter load would not begin to move until most of the tephra had been cleared from the channels and slopes of the drainage basin, not only because the tephra is lighter, but because it overlay the normal clastic load.

The winds would undoubtedly be continually moving the tephra around from place to place, building huge drifts and dunes of the material at sheltered sites, only to rework them as wind patterns shifted. The local sink for such eolian dust would be the Owens Lake, for once the ash fell into a lake, it could not be picked up again by the wind (providing the lake, like Owens, stayed wet). The Bishop tephra would continue to be reworked sporadically from thicker, more protected areas within the Owens Lake drainage basin during exceptionally heavy storms, thus accounting for the zones of reworked Bishop tephra that are present higher in the borehole.

The basal layer of Bishop-like tephra at ~320 m in the hole consists of coarse-sand-sized pumiceous shards, but also has a higher component of comagmatic mineral grains than the other samples in this 16-m-thick interval: 20% feldspars and quartz, and 20% biotite, compared to the samples higher in this 16-m interval. This basal zone probably corresponds to the initial direct airfall component from the eruption, the high percentage of the minerals at the base being due to their higher density, and more rapid settling velocity.

How rapidly was the tephra of the Bishop ash bed eroded from the landscape of the Owens Lake drainage basin after the eruption? The 16-m-thick interval near the base of the Owens Lake bore hole is composed dominantly if not entirely of tephra of Bishop-like chemical composition and mineralogy, and this interval corresponds to the major period of reworking following the eruption. At ~297 m, a change to finer grain size, clay and silt, and change in sediment composition, mark a return to "normal" clastic sedimentation in the basin. A meter above this change, at a depth of ~296 m, a younger tephra layer (OL92-1020) of different chemical composition than the Bishop ash bed is present in this finer interval.

The reworking of the Bishop tephra from the landscape probably was quite rapid, despite the large mass of material that was deposited, because the tephra is loose, light, and consequently presents little resistance to erosion. The rate of erosion must have been much more rapid than the average erosion rates calculated from the entire thickness of sediment in the core, or from the sedimentation rate calculated from dry bulk densities (Bischoff, this volume). Eolian deposition was probably also accelerated at this time, because a very large surface area of loose ash was exposed to the wind. A *guess* would be that the drainage system was largely cleared of ash within several centuries to several thousand years, but probably not more than 10 ka. It is important to obtain more precise estimates on the rates of such a clearing process, because the presence of thick and extensive dust veils for periods longer than several millenia should show up as paleoclimatic anomalies in the stratigraphic record, and would document the presence of an additional mechanism for climate forcing, rather than just the earth's precessional parameters alone.

The abovementioned age curve derived from bulk density data (Bischoff, this report) provides a reasonable age estimates for the Dibekulewe ash bed of ~500 ka. Previously, this ash bed has been bracketed between ~620 and ~400 ka, and its age was estimated to be ~610 ka based on its close stratigraphic position to the Lava Creek B ash bed in the Tulelake core (Rieck and others, 1992), and paleoclimatic inferences regarding the relationship of these two units. Recent analyses provide ages of 400 ±60 ka (Meyer and others, 1991) and 470 ±40 ka (Alloway and others, 1992) for the Rockland ash bed, and ~665 (Izett and others, 1992) for the Lava Creek B ash bed. Both the current (~500 ka) and previous (~610 ka) age estimates for the Dibekulewe ash bed are thus compatible with currently available data; we do not know which of the two estimates is closer to the actual age.

The correlated age of the Walker lake tephra identified in the Owens Lake core (sample OL92-1001), ~60 to ~85 ka, is compatible with the ~70 to ~80 ka age estimated from the sedimentation rate curve based on dry bulk density (Bischoff, this volume).

A previously-drilled hole in Owens Lake (Smith and Pratt, 1957) encountered the Lava Creek B ash bed at a depth of ~234 m in the hole, and disseminated shards of what was presumed to be the Bishop ash bed, at ~262 m. We were not able to find the Lava Creek B ash bed as a macroscopic tephra layer in the cores obtained in 1992. Work to try to find it as disseminated shards is still in progress. If the sedimentation rate curve derived from dry bulk densities is accurate, corresponding units are deeper in the 1992 hole than in the previous one. The depth of the Lava Creek B ash bed in the older hole corresponds to an estimated age of ~520 ka in the 1992 hole, considerably younger than the determined age of the

Lava Creek B ash bed. Calculated sedimentation rates down to the estimated position of the Lava Creek ash bed, assuming the sedimentation rate curve of Bischoff (this volume) is correct, are 0.35 mm/yr for the old hole, and 0.41 mm/yr for the 1992 hole.

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Appendix I

Sample Descriptions

We made initial sample evaluations and descriptions using the petrographic microscope. We examined the sieved but otherwise untreated sample in an optic oil having an index of refraction of 1.515. Subsequent sample descriptions were made during processing, after the samples had been sized, treated with acids, and ultrasonically cleaned (see Methods section). Some rarer phases became visible only in the magnetic fractions after separation in the Frantz separator.

Because most if not all of the tephra layers sampled in the Owens Lake cores are at least partly reworked, they contain both the comagmatic pyroclastic airfall material of the tephra layers, plus any accidental xenocrystic or xenolithic fragments from the walls of the magma chamber and the vents, as well as detrital-clastic, authigenic and biogenic material derived from within the Lake Owens drainage basin. The minerals described below include all three types.

Primary comagmatic minerals of the tephra layers can be usually distinguished when they are encased within glass shards, or when they have some glass adhearing to their surfaces. When the glass coatings are absent, it may be difficult or impossible to determine whether a mineral crystal or fragment is derived from the tephra, or whether it is part of the clastic or organic load, unless the mineral grains are readily identifiable as of plutonic, metamorphic, sedimentary, or organic origin.

Abbreviations used for glass shard morphology in sample descriptions given below are:

bw - bubble-wall shards or platy shards. Glass shards that are clear, angular, and have a large radius of curvature which may not be readily apparent under the microscope. These are fragments of shattered glass bubbles, generally formed explosively during eruption. They look like very small pieces of a thin, shattered pane of window glass.

bwj - bubble-wall junction shards, are junctions of two or more bubbles, with parts of the bubbles adhering. These are either y-shaped junctions between spherical or oval bubbles, or curvilinear to straight, ribbed shards, junctions between elongated vesicles.

eig/sob - equant to irregulatly-shaped shards, containing sherical or ovoid vesicles. These may be poorly or well vesiculated. Some types may be very thin-walled and fragile, having the appearance of a fishing net. We refer to such types as "webby".

Glass shards with elongated vesicles are usually:

s - spindle shaped (stubby or drawn-out);
t- tubular; drawn-out into long cylinders or capillaries;
c - conical

The vesicles may be hydrated or not. Usually, the spindle-shaped grains show hydration most readily. The hydration is a function of time and temperature, and probably also of other factors of the tephra sample's history (see Sarna-Wojcicki and Davis, 1991).

Colors used in the initial descriptions of tephra samples are those in the Munsell color chart (Goddard and others, 1979). Colors were noted on untreated hand samples.

OLB-92-S

Unconsolidated, floury, very fine-grained ash, pinkish gray (5 YR 8/1), containing ~80% highly vesiculated, hydrated, webby or ribbed pumiceous glass shards. Shards with bubble-wall (bw) and bubble-wall junctions (bwj) are also common. Platy, blocky shards were rare. Vesicle shapes are mostly elongate spindles (s); tubular (t) and conical (c); the sample also contain equant- to irregularly-shaped grains with spherical to ovoid bubbles (eig/sob) in smaller amounts. Crystalline grains present included calcite (~5%), biotite (~10%), feldspars and quartz (~4%), and ortho- and clino-pyroxenes (~1%). Brown shards comprise <1% of the glass.

After acid treatment, the proportion of glass to crystalline material increased to 90/10. The sample also contained compound glass/crystalline grains and murky, dirty grains of indeterminate composition; grains of zircon and hornblende were also noted.

OL92-1

Light olive-gray sample (5Y 5/2), containing ~70% glass shards, and ~30% of mineral grains. Shards are mostly subangular, ribbed, and/or bw and bwj. Approximately 20% of the shards are blocky. The shards are often vesiculated and slightly to moderately hydrated. Vesicle shapes are mostly s and c; eig/sob are also common. Crystalline minerals present were feldspars (10-12% plagioclase; 1-2% microcline), biotite (5%), hornblende (1-2%), and quartz. The remaining miscellaneous grains are brown shards and altered grains. After acid treatment, the percentage of glass shards increased slightly, and about 5% of microlitic shards became visible. Biotite, hornblende, orthopyroxene, compound grains, and brown glass shards were concentrated in the magnetic (0.6A fraction).

OL92-1001

Very fine-grained, loosely consolidated to unconsolidated sample, yellowish gray (5Y 8/1) in color, consisting of 75-80% glass shards. These were mostly ribbed, hydrated, vesiculated pumiceous shards; 10-12% biotite, ~5% feldspar and quartz; <1% hornblende, <1% zircon, <1% clinopyroxene, <1% brown glass, 2-3% altered or devitrified material. Vesicles types are mostly s; t, c, and eig/sob types are also present. Sample had a slight surficial coating. After acid treatment, ~10% of compound grains became visible.

OL92-1003

Sandy, unconsolidated, small sample with some large glass grains, pale to moderate yellowish brown (10YR 6/2 to 10YR 5/4). Washed residue contained ~40-50% moderately to well vesiculated, hydrated, ribbed and webby shards. The remainder are heavily coated grains and mineral grains. The latter include feldspars, biotite, pink zircon, quartz, apatite, calcite, and magnetite. Brown shards were also present. After acid treatment, proportion of glass shards increased to ~50-55%. About 2-3% of glass fraction are brown shards. Compound grains are common. Vesicles are mostly eig/sob types, but slightly elongate tubes, cones, and spindles make-up a subordinate but significant fraction. A large number of vesicles are not hydrated, and are present with hydrated vesicles within the same shards. Also present are hornblende, pyroxene, and an unidentified isotropic mineral.

OL92-1015

Diatomaceous and calcareous, very fine-grained light olive gray (5Y 6/1) sample. About 5 to 6 % of this sample contains glass shards, and is thus an ashy sediment. Minerals present are zircon, feldspars, greenish biotite, clinopyroxene, orthopyroxene, hornblende, apatite, with a calcite cement. Contains ostracode fragments and mesoscleric sponge spicules. Diatoms present are alkaline and fresh-water to brackish types including: *Stephanodiscus cf. nigrans, Surrirella sp., Campylodiscus sp., Epithemia sp.. Melosira moniliformis, and Navicula sp.*

After acid treatment, most of the biogenic material was eliminated. Sample still contained only ~5% glass shards.

OL92-1016

Very clayey, very fine-grained sample, light olive gray (5Y 5/2) containing ~55% angular, poorly to moderately vesiculated, slightly hydrated shards. These are mostly ribbed, bw/bwj shards. Platy or webby shards make-up a small fraction of the sample. Vesicles are mostly eig/sob types, but t, c, or s types are common. About 35% of the sample is composed of mineral fragments and other materials. Mineral grains are olive green biotite (~15%), feldspars and quartz (~15%), pyroxene (~3-4%), and hornblende (1%). Biogenic components include ~2-3% diatoms (mostly *Campylodiscus* and *Stephanodiscus*), ostracode fragments, and plant debris. The remainder are heavily coated and/or devitrified grains that tend to have a slight to moderate coating of carbonate and clay.

After acid treatment, glass fraction increased to 70% due to elimination of biogenic component and clean-up of heavily coated grains. Magnetic fraction at 0.6A and +8 degree tilt contained biotite, hornblende, clino- and ortho- poyroxenes, oxyhornblende, magnetite, zircon (?), brown shards, and compound grains.

OL92-1019

Diatomaceous clay, light olive gray in color (5Y 6/1), containing mostly fresh-water centric flora and mineral grains. Only ~1-2 % glass shards are visible, although many grains are obscured by a heavy coating. Acids removed biogenic fraction and altered/dirty material. Glass fraction increasd to 25% in residue; it is composed of mostly subangular bw/bwj shards and some ribbed, poorly vesiculated, slightly hydrated grains. Most of the heavy minerals separated in the magnetic fraction (0.6A; +8 degree): biotite, hornblende, pyroxene, etc.

OL92-1020

Coarse, sand-sized tephra, yellowish gray (5Y 7/2) in color. Contains ~90% good, clear, subangular bw and bwj shards and ~10% crystalline material. About 5% of the sample consists of compund, microlitic glass, ~15% of vesiculated, hydrated glass. Vesicles are mostly of the eig/sob type. Also present were t, c, and s shards, the latter with slight elongation. Minerals present are clinopyroxene, feldspars, quartz, biotite, hornblende, and apatite (in decreasing order of abundance). A slight coating on many grains is present.

After acid treatment, more orthopyroxene was observed in sample. The pyroxenes are almost all etched on crystal terminations. A few percent of brown glass shards are present.

OL92-1021 through OL92-1030

The samples from a depth of 303.94 to 320.01 m in the core are described together, inasmuch as they have essentially the same petrographic characteristics and chemical composition, and define a more-or-less uninterrupted, tuffaceous interval containing chemically and petrographically homogenous tephra.

The samples are composed of dominantly coarse- to medium-sand sized tephra, with minor intervals of medium- to very-fine-grained tephra (see table_, below), 50 to 95% of which are glass shards.

OL92-1021

Coarse, sand-sized tephra, yellowish-gray (5Y 7/2). Glass shards comprise 70% of the sample. They are bw/bwj, chunky, subangular; 15% are moderately to strongly ribbed, hydrated, and vesicular. Vesicles are of the s, c, and eig.sob types. A few percent of the glass shards are microlitic or brown. There is a slight pitting and a slight to mederate coating on the shards. Minerals include microcline and plagioclase, quartz, hornblende, and pyroxene. After acids, 5% more of compound grains were observed. These are mostly pumiceous, highly vesiculated shards. Magnetic fraction (0.6A +8 deg.) contained brown shards, compound grains, hornblende, oxyhornblende, orthopyroxene, biotite, apatite, magnetite, and some other dirty, opague to translucent nondescript grains.

OL92-1022

Coarse, sand-sized tephra, yellowish gray (5Y 7/2), consisting of ~85% subangular, chunky, mostly bw and bwj shards that are slightly vesiculated, hydrated, and pitted. Approximately 17% of glass shards are moderately ribbed, and about 2-3% are webby. The remaining 15% are composed of feldspar and quartz (~13%) (including sanidine, plagioclase, microcline; many have glass coatings), biotite, hornblende, and orthopyroxene (~2%). Brown shards make-up <1% of sample. Shards are slightly to moderately coated.

Table 3. Table showing sample number, depth, color, qualitative grain size, and percentage of glass present for the thick, coarse tephra-bearing interval near the base of Owens Lake core OL92-2.

Sample No.	Depth (m)	Color	Grain Size	% Glass Shard
OL92-1021	303.94	5Y 7/2	Crse sand	70
OL92-1022	304.44	5Y 7/2	Crse sand	85
OL92-1023	304.91	10YR 6/2	Crse sand	75
OL92-1024	304.38	5Y 8/1	Crse sand	85
OL92-1025	305.93	5Y 8/1	Crse-fine sd	90
OL92-1026	306.89	5Y 7/2	Crse-med. sd.	95
OL92-1027	308.43	5Y 7/2	Crse-med. sd.	90
OL92-1028	311.08	5Y 5/2	Crse sand	65
OL92-1029	311.48	5Y 5/2	V. fine tephra	85
OL92-1030	320.01	5Y 3/2	Crse sand	55

After acid treatment and magnetic separation, brown and compound shards, hornblende, oxyhornblende, biotite, pyroxene, and magnetite were concentrated in the 0.6A =8 deg. fraction.

OL92-1023

Coarse, sand-sized tephra, very pale yellowish brown (10YR 6/2), with similar shard morphology to OL92-1021 and 1022, consisting of ~75% glass shards. This sample has a higher proportion (~33%) of finely ribbed, pumiceous shards. Also contains pyrogenic (?) sanidine and plagioclase, as well as microcline, quartz, hornblende, orthopyroxene, biotite, and <1% calcite. A light coating of iron oxides covers many of the grains.

OL92-1024

Coarse, sand-sized tephra, yellowish gray (5Y 8/1), containing 85% glass shards. About 75% of these are bw and bwj, subangular, slightly vesiculated and often hydrated. About 25% are moderately to strongly ribbed/webby pumiceous shards. Vesicle shapes are usually elongated s, t, and c's, and eig/sob's as well. Minerals are anhedral to subhedral feldspars (with glass coatings), quarts, hornblende, and biotite. A slight coating covers many grains. Minor pitting is also observed.

OL92-1025

Coarse to fine grained tephra, yellowish gray (5Y 8/1) on weathered surfaces, and very light gray (N8) on fresh inner surfaces, composed of ~90% glass shards. Dominantly frothy glass, strongly ribbed and webby, hydrated and vesiculated pumice. About 5% of sample consists of mineral grains, mostly feldspars and biotite, and 5% is microphenocrystic. There is a slight coating on grains.

OL92-1026

Coarse to medium-sand-sized tephra, 95% subangular glass shards which are slightly coated with iron oxides and carbonate. About 50% of the shards are ribbed and moderately to strongly vesiculated; ~40% are platy, and about 10% are bw and bwj. Vesicle shapes are mostly ovoid and irregular, but cylindrical, spindle, and conical shapes are commonly observed. Most vesicles are partly hydrated. A few percent of brown shards are also present. Minerals are ~2-3% biotite, ~2% feldspar (sanidine and plagioclase), quartz, and pyroxene.

OL92-1027

Coarse to medium sand-sized tephra, yellowish gray (5Y 7/2), containing 90% glass shards that are slightly to moderately coated with iron oxides and carbonate. About 70% of the shards are ribbed bw and bwj; ~20% finely ribbed and pumiceous; ~10 % are platy shards. Vesicles are eig/sob's, with some s and c types. Most vesicles are hydrated. Minerals are biotite (~3), feldspars (<1%), quartz (<1%), calcite (<1%), and compound grains (~5%).

OL92-1028

Coarse, sand-sized tephra, light olive gray (5Y 5/2), composed of 65% slightly- to moderately-carbonate-coated, shards. These are mostly ribbed bw and bwj shards. About 1/3 of these are blocky, solid (unvesiculated). Vesicles are usually eig/sob's, with some s, t, and c types. They are often hydrated. Minerals observed are feldspars (sanidine and plagioclase), commonly with glass coats, and quartz (~combined 30%), biotite (~2%), calcite (~2%), hypersthene, apatite, hornblende (<1% each), and rare garnet (?) grains. A few ostracode fragments are present. After acid and ultrasonic clean-up, zircon and clinopyroxene are visible, and allanite (?).

OL92-1029

Very fine-grained tephra, light olive gray (5Y 5/2) containing ~85% glass shards, most of which are ribbed, slightly curved, with subordinate platy, bw and bwj. Vesiculated shards are common. There is a slight to to moderate coating of carbonate on many of the grains. Biogenic fragments, diatoms, pollen, octracodes, and sponge spicules, are a minor proportion of the sample. Minerals present are feldspars (plagioclase), quartz, biotite, and ilmenite (?). The magnetic (0.6A +8 deg.) fraction contained a very small amount of sample that included hornblende, pyroxene, biotite, epidote(?), and brown glass shards, as well as some compund grains.

OL92-1030

Basal tephra sample, consisting of coarse, pumiceous, sand-sized tephra, olive gray (5Y 3/2), containing ~55% subrounded, subangular, chunky, moderately-vesiculated, hydrated, mostly ribbed bwj and pumiceous shards. About 20% of the sample is pyrogenic biotite, ~20% feldspars plus quartz, ~1-2% hornblende, and <1% isotropic, altered mineral. Many of the grains are obscured by an iron oxide coating.

After acid and ultrasonic cleaning, and magnetic separation, the magnetic fraction (0.6A +8 deg.) contained grains of minerals such as olivine (?) and epidote (?) (or pinkish thulite?), allanite, and zircon.

Appendix II

This appendix compares the average composition of volcanic glass shards separated from tephra samples in the Owens Lake cores, obtained in 1992 (OL92-1 and OL92-2), with analyses of volcanic glass shards from tephra layers sampled at other sites in the western U.S.. Each analysis is an average of between about 15 and 20 individual shards. Comparisons are for the 6 major oxides, Na2O, Al2O3, SiO2, K2O, CaO, and Fe2O3. Each sample was compared with all other samples analyzed by our project (Tephrochronology of the Western Region, Branch of Western Regional Geology, Geologic Division, U.S. Geological Survey, Menlo Park, Calif.) and those of other projects, that are entered into our Probe Data, Conterminous Western United States, data base (PDBCWUS), consisting of about 3100 sample analyses. The chemically closest samples are ranked using the similarity coefficient (labelled "Sim. Co.", in the tables) (Sarna-Wojcicki and others, 1984).

The first sample in each comparison is the Owens Lake core sample being compared, and the value of the similarity coefficient for comparison of the sample with itself is 1.000, the highest possible value for a perfectly identical sample pair. This sample is entered for reference, and for visual comparison with other samples for the remaining oxides, MgO, MnO, and TiO2, which are usually present in low concentrations and not included in the calculations of the similarity coefficients, to avoid unwieldly scatter in the comparison procedure. The best matches are then examined for the three latter oxides, to see if compositions are similar, within the errors of the analyses for these three oxides. To clarify this last procedure, replicate analyses on a sample may indicate that MnO values range from 0.02 to 0.05 for a particular sample. Inclusion of such data for MnO into the calculation of the rankings, for example of a sample that had 0.02 percent MnO as opposed to another that had 0.04 Mn0, would reduce the similarity coefficient for some sample pairs to the point where they might show up low in the ranking, or not show up at all, even though other oxides compared very well. By leaving these oxide out of the calculation, we can then visually examine the rankings, and spot obvious outliers for these three oxides. For example, an average value of 0.10 % MnO would generally be considered significantly different from one of 0.03%, given that between 15 and 20 shards were analyzed from each population.

The second through 11-th samples are listed in the annotations, which follow each table of comparisons for each sample, giving the identity and age of the tephra units in question, if known, and their sampling localities. Additional information regarding the precise location and stratigraphic details of specific matching samples can be obtained from the lead author on request.

Sample 0L92-S

Listing of 30 closest matches for COMP. NO. 2921 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2921	OL-92-S T270-8	12/16/92	77.73	12.50	0.81	0.03	0.04	0.47	0.03	3.94	4.44	99.99	1.0000
2	587	PICO-161, T49-2	12/09/82	77.17	12.85	0.81	0.04	0.03	0.48	0.10	3.96	4.57	100.01	0.9852
3	2920	OL92-1015 T270-7	12/16/92	78.01	12.19	0.77	0.03	0.04	0.47	0.05	3.85	4.57	99.98	0.9785
4	279	PICO-73, T39-3		77.29	12.83	0.79	0.03	0.04	0.45	0.06	4.03	4.48	100.00	0.9784
5	282	PICO-78(1), T37-8		76.41	12.75	0.80	0.03	0.05	0.47	0.06	4.15	4.30	99.02	0.9782
6	274	PICO-39A(2), T20-6		77.47	12.75	0.75	0.03	0.04	0.46	0.05	3.95	4.49	99.99	0.9780
7	20	BHA-I, T18-10		77.56	12.72	0.76	0.03	0.03	0.47	0.05	3.83	4.56	100.01	0.9774
8	270	PICO-21, T2-8		77.06	13.00	0.79	0.03	0.04	0.47	0.05	3.88	4.67	99.99	0.9773
9	1277	PICO-39A (2) BULK T20-6	7/1/85	77.77	12.51	0.75	0.03	0.07	0.45	0.07	3.89	4.47	100.01	0.9771
10	441	23-24-16B, T2-15		77.25	12.90	0.76	0.06	0.05	0.48	0.06	3.92	4.51	99.99	0.9766
11	273	PICO-39A(1), T8-6		77.32	12.99	0.75	0.04	0.05	0.46	0.05	3.90	4.44	100.00	0.9753
12	69	DSDP-2, T9-4		77.69	12.46	0.81	0.05	0.03	0.48	0.08	3.67	4.73	100.00	0.9743
13	1825	FLV-1-CS T145-4	8/24/87	77.63	12.72	0.73	0.03	0.09	0.47	0.07	3.80	4.45	99.99	0.9741
14	2759	ET-CFD-1 T250-3	2/26/92	77.07	12.60	0.80	0.04	0.04	0.46	0.09	3.95	4.95	100.00	0.9741
15	264	PICO-5(1), T2-7		77.30	12.93	0.77	0.03	0.04	0.48	0.06	3.83	4.55	99.99	0.9732
16	449	66W5, T5-7		77.59	12.74	0.74	0.03	0.05	0.45	0.07	3.88	4.44	99.99	0.9725
17	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9724
18	262	PICO-3, T2-18		77.14	12.92	0.78	0.04	0.05	0.49	0.05	3.89	4.63	99.99	0.9714
19	1932	SAFZ-6 T163-3	5/14/88	77.73	12.62	0.74	0.03	0.04	0.44	0.06	3.96	4.37	99.99	0.9699
20	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9699
21	31	BT-7, T20-1		77.54	12.60	0.76	0.03	0.03	0.45	0.05	3.86	4.66	99.98	0.9696
22	272	PICO-24, T2-16		77.34	12.89	0.76	0.04	0.03	0.49	0.07	3.84	4.53	99.99	0.9695
23	1884	JT-6387-1 T150-3	11/9/97	77.34	12.89	0.76	0.03	0.07	0.46	0.06	3.81	4.59	100.01	0.9693
24	1885	JT-41186-1 T150-4	9/11/87	77.34	12.89	0.76	0.03	0.07	0.46	0.06	3.81	4.59	100.01	0.9693
25	26	BT-1, T2-13		77.32	12.91	0.80	0.03	0.03	0.43	0.05	3.85	4.57	99.99	0.9690
26	3082	KRL-880605-G T285-4	8/6/93	77.25	13.02	0.81	0.03	0.03	0.51	0.06	3.76	4.53	100.00	0.9683
27	2907	FLV-3.5 T268-7	11/16/92	77.11	12.71	0.77	0.05	0.05	0.49	0.08	3.96	4.79	100.01	0.9679
28	144	JANDA-328, T2-12		77.42	12.87	0.74	0.04	0.02	0.47	0.05	4.10	4.28	99.99	0.9676
29	100	ELSI-1, T2-9,		77.42	12.85	0.75	0.02	0.03	0.46	0.05	4.10	4.31	99.99	0.9675
30	444	63CJ-26(3), T1, N-ASW-2, P		77.64	12.88	0.74	0.03	0.02	0.46	0.07	3.72	4.43	99.99	0.9673

Annotations to sample *OL92-S*:

2. Bailey ash bed, Sexton Canyon, S. flank Ventura Avenue anticline, Ventura Co., Calif. Bailey ash bed is 1.2 ±0.4 Ma, based on zircon fission-track date (Izett and others, 1974).
3. Ash in Owens Lake core, inferred to be reworked Bishop ash bed or one of the Glass Mt. ash beds.
4. Bailey ash bed, W. of Ventura River, N. flank Ventura Avenue anticline, Ventura Co., Calif.
5. Bailey ash bed, W. and near locality 4, N. flank Ventura Avenue anticline, Ventura Co., Calif..
6. Bailey ash bed, east of Padre Juan Canyon, N. flank Ventura Avenue anticline, Ventura Co., Calif.
7. Tephra from borings, NE San Joaquin Valley. Post Laguna(?). Sample from D. E. Marchand (deceased); exact location not available.
8. Bailey ash bed, east of Pitas Point, S. flank of Ventura Avenue anticline, Ventura Co., Calif.
9. Bailey ash bed, same as sample 6.
10. Bishop ash bed, San Joaquin Valley, near Alpaugh, Tulare Co., Calif. (Sarna-Wojcicki and others, 1984).
11. Bailey ash bed, same as samples 6 and 9.

Sample OL92-1 (1)

Listing of 30 closest matches for COMP. NO. 2961 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2961	OL92-1 T274-1	3/31/93	76.85	12.82	1.09	0.03	0.03	0.44	0.06	4.11	4.58	100.01	1.0000
2	844	GS-90		76.95	12.93	1.06	0.01	0.03	0.44	0.07	4.11	4.41	100.01	0.9876
3	1193	TULELAKE 2054 (57.60M) T90-8	3/1/85	77.29	12.58	1.10	0.00	0.04	0.44	0.04	4.04	4.47	100.00	0.9876
4	2413	TULELAKE SAMPLE 1243 T208-5	5/24/90	77.22	12.52	1.12	0.00	0.04	0.43	0.04	4.14	4.48	99.99	0.9822
5	761	BO-17		76.70	12.90	1.11	0.02	0.04	0.46	0.06	4.00	4.70	99.99	0.9797
6	2412	TULELAKE SAMPLE 1242 T208-4	5/24/90	77.27	12.63	1.07	0.00	0.03	0.42	0.08	4.07	4.43	100.00	0.9789
7	1190	TULELAKE 2038 (53.67M) T90-5	2/28/85	77.07	12.56	1.12	0.04	0.03	0.45	0.07	3.97	4.69	100.00	0.9784
8	1274	TULE LAKE 310 (61.55M) T73-10	2/16/84	77.29	12.67	1.05	0.00	0.04	0.45	0.05	4.00	4.43	99.98	0.9774
9	2949	OL92-1 T274-1 JEOL	3/12/93	76.94	12.99	1.06	0.01	0.00	0.41	0.04	4.07	4.47	99.99	0.9760
10	1203	TULELAKE 2119 (59.35M) T91-4	3/1/85	77.39	12.55	1.00	0.01	0.04	0.44	0.05	4.11	4.41	100.00	0.9754
11	1207	TULELAKE 2099 LAP (55.37M) T91	3/1/85	76.67	12.81	1.22	0.03	0.05	0.44	0.07	4.03	4.68	100.00	0.9749
12	1306	ASW 61585 52E T100-7	7/2/85	77.41	12.48	1.13	0.02	0.05	0.43	0.06	4.04	4.38	100.00	0.9746
13	1284	ASW61585-52A T100-3	07/02/85	76.93	12.72	1.19	0.02	0.05	0.45	0.08	4.13	4.43	100.00	0.9746
14	1195	TULELAKE 2067 (61.57M) T90-10	3/1/85	77.35	12.46	1.06	0.00	0.04	0.47	0.06	4.08	4.48	100.00	0.9742
15	755	BO-3		76.43	13.02	1.10	0.03	0.04	0.49	0.08	4.11	4.71	100.01	0.9734
16	1204	TULELAKE 2148 (33.31M) T91-5	3/1/85	77.01	12.50	1.22	0.03	0.05	0.43	0.05	4.13	4.58	100.00	0.9731
17	1192	TULELAKE 2053 (56.44M) T90-7	3/1/85	77.12	12.58	1.17	0.02	0.04	0.42	0.06	4.12	4.47	100.00	0.9729
18	1200	TULELAKE 2099 (55.37M) T91-1	3/1/85	76.71	12.88	1.13	0.05	0.05	0.49	0.08	4.06	4.55	100.00	0.9729
19	517	CL-0590(100-200), T66-2	11/03/83	76.82	12.83	1.07	0.07	0.05	0.45	0.06	3.82	4.83	100.00	0.9727
20	3007	JY-92-70 T278-5	5/7/93	76.72	13.02	1.11	0.02	0.05	0.40	0.06	4.16	4.46	100.00	0.9726
21	3047	JY-92-64 MAJ T282-6	7/7/93	76.66	12.86	1.12	0.01	0.04	0.44	0.05	4.49	4.34	100.01	0.9718
22	622	TULELAKE-296, T63-6(2)	09/02/83	76.97	12.63	1.10	0.06	0.04	0.48	0.11	3.94	4.67	100.00	0.9718
23	1201	TULELAKE 2102 (55.69M) T91-2	3/1/85	76.70	12.76	1.14	0.05	0.04	0.47	0.07	4.02	4.74	99.99	0.9717
24	2871	BL-3986 T264-6	08/20/92	76.68	12.74	1.14	0.01	0.06	0.41	0.06	4.32	4.57	99.99	0.9715
25	845	GS-91		76.73	13.02	1.13	0.02	0.03	0.48	0.08	4.11	4.41	100.01	0.9712
26	2414	TULELAKE SAMPLE 1244 T208-6	5/24/90	77.28	12.48	1.14	0.02	0.05	0.41	0.06	4.12	4.45	100.01	0.9708
27	2263	T189-4 1359-M	5/9/89	77.44	12.51	1.11	0.00	0.03	0.41	0.06	4.10	4.33	99.99	0.9708
28	739	S-20		76.83	12.90	1.09	0.03	0.07	0.51	0.06	4.00	4.50	99.99	0.9687
29	624	TULELAKE-315, T61-7	08/17/83	76.81	12.90	1.10	0.01	0.05	0.47	0.03	4.32	4.30	99.99	0.9684
30	606	TULELAKE-260, T69-5	12/xx/83	76.51	12.81	1.19	0.05	0.05	0.47	0.07	4.08	4.76	99.99	0.9670

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Annotations to sample OL92-1 (1):

2. Middle ash bed, 2 mm, Mt. Jefferson, Toquina Range, N. of Tonopah, Nev. Attr. to Mono Craters by J. O. Davis (deceased). Age unknown.
3. Ash bed in Tulelake, N. Calif., core at 57.60 m depth. Age estimate is ~325 ±50 ka (Rieck and others, 1992).
4. Ash bed in Tulelake, N. Calif., core at 56.75 m depth. Age estimate is ~280 ±50 ka (Rieck and others, 1992).
5. Ash bed in the vicinity of Walker Lake, Nev., coll. by J. O. Davis (deceased) and inferred to be Holocene.
6. Ash bed in Tulelake, N. Calif., core at 57.40 m depth. Age estimate is ~320 ±50 ka (Rieck and others, 1992).
7. Ash bed in Tulelake, N. Calif., core at 53.67 m depth. Age estimate is ~165-170 ±25 ka (Rieck and others, 1992).
8. Ash bed in Tulelake, N. Calif., core at 61.55 m depth. Age estimate is ~550 ±75 ka.
9. Replicate analysis of OL92-1.
10. Ash bed in Tulalake, N. Calif., core at 59.35 m depth. Age estimate is ~390 +20-50 ka (Rieck and others, 1992).
11. Ash bed in Tulalake, N. Calif., core at 55.37 m depth. Age estimate is ~225 ±25 ka (Rieck and others, 1992).

Sample OL92-1 (2)

Listing of 30 closest matches for COMP. NO. 2949 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2949	OL92-1 T274-1 JEOL	3/12/93	76.94	12.99	1.06	0.01	0.00	0.41	0.04	4.07	4.47	99.99	1.0000
2	2412	TULELAKE SAMPLE 1242 T208-4	5/24/90	77.27	12.63	1.07	0.00	0.03	0.42	0.08	4.07	4.43	100.00	0.9877
3	844	GS-90		76.95	12.93	1.06	0.01	0.03	0.44	0.07	4.11	4.41	100.01	0.9840
4	3007	JY-92-70 T278-5	5/7/93	76.72	13.02	1.11	0.02	0.05	0.40	0.06	4.16	4.46	100.00	0.9836
5	2263	T189-4 1359-M	5/9/89	77.44	12.51	1.11	0.00	0.03	0.41	0.06	4.10	4.33	99.99	0.9788
6	2414	TULELAKE SAMPLE 1244 T208-6	5/24/90	77.28	12.48	1.14	0.02	0.05	0.41	0.06	4.12	4.45	100.01	0.9783
7	2961	OL92-1 T274-1	3/31/93	76.85	12.82	1.09	0.03	0.03	0.44	0.06	4.11	4.58	100.01	0.9760
8	1193	TULELAKE 2054 (57.60M) T90-8	3/1/85	77.29	12.58	1.10	0.00	0.04	0.44	0.04	4.04	4.47	100.00	0.9753
9	1274	TULE LAKE 310 (61.55M) T73-10	2/16/84	77.29	12.67	1.05	0.00	0.04	0.45	0.05	4.00	4.43	99.98	0.9744
10	617	TULELAKE-277, T61-4	08/17/83	77.28	12.42	1.12	0.00	0.05	0.41	0.04	4.25	4.42	99.99	0.9741
11	2413	TULELAKE SAMPLE 1243 T208-5	5/24/90	77.22	12.52	1.12	0.00	0.04	0.43	0.04	4.14	4.48	99.99	0.9735
12	1192	TULELAKE 2053 (56.44M) T90-7	3/1/85	77.12	12.58	1.17	0.02	0.04	0.42	0.06	4.12	4.47	100.00	0.9727
13	618	TULELAKE-277(200-325), T62-4	08/25/83	77.23	12.58	1.14	0.01	0.05	0.40	0.04	4.16	4.38	99.99	0.9714
14	2871	BL-3986 T264-6	08/20/92	76.68	12.74	1.14	0.01	0.06	0.41	0.06	4.32	4.57	99.99	0.9712
15	1195	TULELAKE 2067 (61.57M) T90-10	3/1/85	77.35	12.46	1.06	0.00	0.04	0.47	0.06	4.08	4.48	100.00	0.9703
16	1306	ASW 61585 52E T100-7	7/2/85	77.41	12.48	1.13	0.02	0.05	0.43	0.06	4.04	4.38	100.00	0.9698
17	1203	TULELAKE 2119 (59.35M) T91-4	3/1/85	77.39	12.55	1.00	0.01	0.04	0.44	0.05	4.11	4.41	100.00	0.9687
18	615	TULELAKE-276, T61-3	08/17/83	77.04	12.67	1.15	0.00	0.03	0.40	0.03	4.29	4.39	100.00	0.9670
19	616	TULELAKE-276(200-325), T62-3	08/25/83	77.19	12.53	1.16	0.01	0.05	0.40	0.05	4.22	4.39	100.00	0.9662
20	1184	TULELAKE 2053 (56.44M) pum t89	2/28/85	77.21	12.59	1.18	0.01	0.03	0.40	0.04	4.17	4.38	100.01	0.9659
21	686	TULE LAKE 275, T73-7, 55.91 m	2/16/84	77.39	12.51	1.15	0.01	0.04	0.38	0.06	3.98	4.49	100.01	0.9632
22	1194	TULELAKE 2055 (57.94M) T90-9	3/1/85	77.44	12.53	1.06	0.01	0.04	0.48	0.03	3.99	4.41	99.99	0.9632
23	2851	BL-3492 T262-5	7/29/92	76.97	12.55	1.14	0.02	0.03	0.42	0.04	4.44	4.40	100.01	0.9621
24	761	BO-17		76.70	12.90	1.11	0.02	0.04	0.46	0.06	4.00	4.70	99.99	0.9617
25	845	GS-91		76.73	13.02	1.13	0.02	0.03	0.48	0.08	4.11	4.41	100.01	0.9607
26	2869	BL-3495 T264-4	08/20/92	76.92	12.60	1.15	0.00	0.04	0.40	0.04	4.45	4.39	99.99	0.9606
27	1284	ASW61585-52A T100-3	07/02/85	76.93	12.72	1.19	0.02	0.05	0.45	0.08	4.13	4.43	100.00	0.9596
28	623	TULELAKE-296(200-325), T62-5	08/25/83	76.54	13.06	1.06	0.06	0.05	0.48	0.09	3.93	4.74	100.01	0.9587
29	517	CL-0590(100-200), T66-2	11/03/83	76.82	12.83	1.07	0.07	0.05	0.45	0.06	3.82	4.83	100.00	0.9587
30	1190	TULELAKE 2038 (53.67M) T90-5	2/28/85	77.07	12.56	1.12	0.04	0.03	0.45	0.07	3.97	4.69	100.00	0.9585

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Annotations to sample OL92-1 (2):

2. See annotations to sample OL-92 (1).
3. See annotations to sample OL-92 (1).
4. Ash bed from Mohawk Valley, N. Sierra Nevada, Calif. Age and stratigraphic context unknown.
5. Obsidian of Cougar Butte, Medicine Lake Volcano, N. Calif. K-Ar age of ~580 ka, J. A. Donelly-Nolan, written commun., 1989.
6. Ash bed in Tulelake, N. Calif., core at 56.46 m depth. Age estimate is ~275±50 ka (Rieck and others, 1992).
7. Replicate analysis of same sample (OL92-1).
8. Ash bed in Tulelake, N. Calif., core at 57.60 m depth. Age estimate is ~325 ±50 ka (Rieck and others, 1992).
9. Ash bed in Tulelake, N. Calif., core at 61.55 m depth. Age estimate is ~550 ±50 ka (Rieck and others, 1992).
10. Ash bed in Tulelake, N. Calif., core at 56.22 m depth. Age estimate is ~265 ±50 ka (Rieck and others, 1992)
11. See annotations to sample OL-92 (1).

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Sample OL92-1001

Listing of 30 closest matches for COMP. NO. 2918 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2918	OL92-1001 T270-5	12/16/92	77.42	12.67	0.78	0.06	0.05	0.77	0.08	3.61	4.56	100.00	1.0000
2	1262	*WL 5-19 78.91m	5/29/85	77.29	12.54	0.79	0.06	0.05	0.84	0.08	3.62	4.73	100.00	0.9756
3	2837	911005C T260-1	7/14/92	77.01	12.92	0.76	0.17	0.07	0.75	0.11	3.77	4.43	99.99	0.9755
4	1260	*WL 4-26 6a7.04m t95-7	5/29/85	77.27	12.59	0.84	0.04	0.05	0.74	0.06	3.73	4.70	100.02	0.9699
5	1964	WL-4-27 (68.59M) T163-8	5/15/88	76.85	13.06	0.85	0.04	0.06	0.75	0.06	3.64	4.69	100.00	0.9697
6	334	RS-2(2), T34-6		77.51	12.82	0.81	0.16	0.02	0.74	0.15	3.39	4.40	100.00	0.9692
7	216	MILL-10, T30-5		77.78	12.72	0.80	0.14	0.04	0.75	0.16	3.52	4.09	100.00	0.9687
8	1258	*WL 4-26 66.79m t95-5	5/29/85	76.94	12.84	0.81	0.05	0.04	0.73	0.07	3.77	4.75	100.00	0.9682
9	302	PU-1, T18-1		77.92	12.57	0.78	0.13	0.04	0.75	0.15	3.69	3.97	100.00	0.9681
10	1962	WL-4-25 (62.76M) T164-6	5/15/88	76.91	12.91	0.79	0.05	0.05	0.70	0.09	3.62	4.87	99.99	0.9675
11	860	LM-15		77.08	13.23	0.80	0.13	0.06	0.78	0.10	3.21	4.61	100.00	0.9656
12	1570	WLC-85-2 (11.34M) T128-1	8/18/86	76.89	12.97	0.84	0.04	0.05	0.75	0.08	3.54	4.85	100.01	0.9656
13	2595	EL-1-M T230-5	7/2/91	76.61	13.14	0.85	0.06	0.04	0.79	0.08	3.64	4.79	100.00	0.9650
14	1110	61484-42 ASW T82-12	10/11/84	78.15	12.64	0.79	0.12	0.03	0.77	0.12	3.38	4.00	100.00	0.9649
15	333	RS-2(1), T32-8		77.76	12.74	0.82	0.14	0.02	0.75	0.15	3.50	4.12	100.00	0.9647
16	1983	WL-5-16 (73.40m) T164-12	5/22/88	76.37	13.29	0.81	0.05	0.04	0.75	0.10	3.70	4.89	100.00	0.9642
17	1963	WL-4-26 (66.50M) T163-7	5/15/88	76.67	13.24	0.84	0.04	0.04	0.73	0.07	3.66	4.70	99.99	0.9634
18	1958	WL-4-17 (39.81M) T162-12	5/15/88	76.91	12.98	0.84	0.04	0.05	0.72	0.05	3.70	4.70	99.99	0.9632
19	696	RSCS2		77.33	12.80	0.89	0.01	0.00	0.81	0.05	3.50	4.60	99.99	0.9628
20	1007	jod 5/5/83a t74-1	5/30/84	78.01	12.52	0.84	0.15	0.03	0.77	0.13	3.62	3.93	100.00	0.9614
21	1039	WL 4-26-3.06, T78-12	08/18/84	76.97	12.78	0.86	0.04	0.05	0.73	0.06	3.65	4.87	100.01	0.9610
22	1300	WL 5-13 64.51M T99-15	07/01/85	77.18	12.74	0.88	0.04	0.06	0.73	0.07	3.53	4.78	100.01	0.9596
23	907	DR-12		76.27	13.53	0.73	0.09	0.03	0.81	0.12	3.61	4.81	100.00	0.9594
24	1243	WL 4-26 66.40m T93-12	5/2/85	76.71	13.12	0.83	0.05	0.04	0.71	0.06	3.70	4.78	100.00	0.9580
25	1045	DSDP 36-10-2 SSA, T78-5	07/18/84	76.90	12.80	0.85	0.04	0.04	0.72	0.09	3.73	4.83	100.00	0.9580
26	1037	WL 3-7-2.66	08/18/84	76.74	13.00	0.82	0.06	0.03	0.83	0.08	3.51	4.92	99.99	0.9573
27	1959	WL-4-18 (43.53M) T162-13	5/15/88	77.01	12.97	0.82	0.04	0.04	0.67	0.06	3.63	4.77	100.01	0.9572
28	1259	*WL 4-26 66.87m t95-6	5/29/85	77.01	12.69	0.88	0.04	0.04	0.73	0.09	3.81	4.71	100.00	0.9572
29	1480	6VI84-1-5.5M T117-13	3/6/86	76.73	13.08	0.87	0.06	0.05	0.74	0.08	3.55	4.85	100.01	0.9568
30	1084	PS 84 1HR T81-1	9/4/84	78.31	12.44	0.77	0.13	0.04	0.74	0.15	3.40	4.01	99.99	0.9567

Annotations to sample OL92-1001:

2. Ash bed in Walker Lake, W. Nev., core at 78.91 m. Age estimate is 70-85 ka (Sarna-Wojcicki and others, 1988; Benson, 1988).
3. Upper Miocene tephra layer, San Francisco Bay area. Not a good match with respect to MgO and TiO2.
4. Ash bed in Walker Lake, W. Nev., core at 67.04 m. Age estimate is 60-80 ka (Sarna-Wojcicki and others, 1988; Benson, 1988).
5. Ash bed in Walker Lake, W. Nev., core at 68.59 m. Age estimate is 60-80 ka (Sarna-Wojcicki and others, 1988; Benson, 1988).
6. Upper Pliocene Ishi Tuff, NE Sacramento Valley. Not a good match with respect to MgO, TiO2.
7. Same unit as 6, above.
8. Ash bed in Walker Lake, W. Nev., core at 66.79 m. Age estimate is 60-80 ka (Sarna-Wojcicki and others, 1988; Benson, 1988).
9. Same unit as 6 and 7, above.
10. Ash bed in Walker Lake, W. Nev., core at 62.76 m. Age estimate is 60-80 ka (Sarna-Wojcicki and others, 1988; Bensopn, 1988).
11. Ash bed S. of Oreana, Nev., of unknown age and strat. context, coll. by J. O. Davis. Not a good match with respect to MgO.

Sample OL92-1003

Listing of 30 closest matches for COMP. NO. 2919 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2919	OL92-1003 T270-6	12/16/92	73.85	14.38	1.07	0.09	0.11	0.47	0.22	5.19	4.62	100.00	1.0000
2	2547	UCSB-FS-89-6-6BC T225-5	4/22/91	73.00	14.93	1.11	0.11	0.10	0.49	0.21	5.20	4.86	100.01	0.9706
3	1676	SPRG-2 T133-3	10/21/86	75.36	14.03	1.09	0.04	0.05	0.47	0.06	4.68	4.21	99.99	0.9584
4	1925	1-JWB-1-CM-3 T154-2	2/24/88	72.87	14.90	1.29	0.12	0.12	0.48	0.20	5.10	4.92	100.00	0.9470
5	1027	KRL-71082 (II-3) (592) T58-3	6/22/84	72.65	14.86	1.27	0.12	0.00	0.49	0.24	5.26	5.11	100.00	0.9407
6	1924	1-JWB-1-CM-2 T154-1	2/.24/88	72.82	14.97	1.30	0.12	0.11	0.50	0.20	5.06	4.92	100.00	0.9373
7	624	TULELAKE-315, T61-7	08/17/83	76.81	12.90	1.10	0.01	0.05	0.47	0.03	4.32	4.30	99.99	0.9324
8	755	BO-3		76.43	13.02	1.10	0.03	0.04	0.49	0.08	4.11	4.71	100.01	0.9294
9	623	TULELAKE-296(200-325), T62-5	08/25/83	76.54	13.06	1.06	0.06	0.05	0.48	0.09	3.93	4.74	100.01	0.9291
10	1195	TULELAKE 2067 (61.57M) T90-10	3/1/85	77.35	12.46	1.06	0.00	0.04	0.47	0.06	4.08	4.48	100.00	0.9280
11	761	BO-17		76.70	12.90	1.11	0.02	0.04	0.46	0.06	4.00	4.70	99.99	0.9261
12	3047	JY-92-64 MAJ T282-6	7/7/93	76.66	12.86	1.12	0.01	0.04	0.44	0.05	4.49	4.34	100.01	0.9256
13	2961	OL92-1 T274-1	3/31/93	76.85	12.82	1.09	0.03	0.03	0.44	0.06	4.11	4.58	100.01	0.9256
14	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9253
15	845	GS-91		76.73	13.02	1.13	0.02	0.03	0.48	0.08	4.11	4.41	100.01	0.9234
16	622	TULELAKE-296, T63-6(2)	09/02/83	76.97	12.63	1.10	0.06	0.04	0.48	0.11	3.94	4.67	100.00	0.9230
17	1201	TULELAKE 2102 (55.69M) T91-2	3/1/85	76.70	12.76	1.14	0.05	0.04	0.47	0.07	4.02	4.74	99.99	0.9230
18	753	BO-1		76.45	13.11	1.09	0.03	0.04	0.51	0.07	4.00	4.70	100.00	0.9224
19	1132	T1249 (Tulelake) T84-8 k,ca i	12/3/84	77.29	12.57	1.03	0.01	0.05	0.47	0.07	4.20	4.31	100.00	0.9224
20	844	GS-90		76.95	12.93	1.06	0.01	0.03	0.44	0.07	4.11	4.41	100.01	0.9220
21	1200	TULELAKE 2099 (55.37M) T91-1	3/1/85	76.71	12.88	1.13	0.05	0.05	0.49	0.08	4.06	4.55	100.00	0.9219
22	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9210
23	759	BO-15		76.67	13.03	1.11	0.03	0.06	0.50	0.09	3.91	4.61	100.01	0.9208
24	754	BO-2		76.55	13.03	1.14	0.03	0.06	0.50	0.08	4.01	4.61	100.01	0.9200
25	3063	ANA-B LOFE(2) T282-2	7/26/93	74.39	14.27	1.21	0.02	0.08	0.36	0.04	4.80	4.82	99.99	0.9198
26	1157	K-RA-14C T85-10	12/4/84	75.76	13.50	1.13	0.03	0.07	0.56	0.04	4.53	4.37	99.99	0.9198
27	1194	TULELAKE 2055 (57.94M) T90-9	3/1/85	77.44	12.53	1.06	0.01	0.04	0.48	0.03	3.99	4.41	99.99	0.9197
28	2980	9-11-85-5P T276-1	4/7/93	74.14	14.92	1.22	0.11	0.11	0.41	0.23	4.61	4.25	100.00	0.9196
29	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9189
30	2897	FLV-1.2 T267-2	10/27/92	76.87	12.61	1.01	0.02	0.03	0.52	0.04	4.29	4.62	100.01	0.9187

Annotations to sample OL92-1003:

2. Ash bed from Owens River terrace (core 6, unit 6B, C) at Fish Slough, 12 mi. N. of Bishop, Calif. Late Pleistocene (?)..
3. Pliocene (?) tephra layer, Sprague River area, central Oregon. Not good match with respect to MgO, TiO_2.
4. Ash bed in road cut, in alluvial fan, Cedar Mountain area, Nev. Late Pleistocene (?). Coll. by J. W. Bell, Nevada Bur. Mines. Marginal match with respect to Fe_2O_3.
5. Ash bed exposed in Negit causeway at low lake level (1982), Mono Lake; within tephra sequence >40 ka; estimated to be 60-85 ka (Sarna-Wojcicki and others, 1988; Benson, 1988). Marginal match with respect to Fe_2O_3.
6. Ash bed at base of wash, in fan alluvium, Cedar Mountain area, Nev. Late Pleistocene (?). Coll. by J. W. Bell, Nevada Bur. Mines. Marginal match with respect to Fe_2O_3.
7. through 11. Not good matches with respect to MgO, TiO_2, and in some instances, other oxides as well.

Sample OL92-1015

Listing of 30 closest matches for COMP. NO. 2920 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2920	OL92-1015 T270-7	12/16/92	78.01	12.19	0.77	0.03	0.04	0.47	0.05	3.85	4.57	99.98	1.0000
2	20	BHA-I, T18-10		77.56	12.72	0.76	0.03	0.03	0.47	0.05	3.83	4.56	100.01	0.9887
3	264	PICO-5(1), T2-7		77.30	12.93	0.77	0.03	0.04	0.48	0.06	3.83	4.55	99.99	0.9839
4	269	PICO-15, T1, N-ASW-58, P		77.88	12.23	0.76	0.04	0.04	0.47	0.05	3.72	4.80	99.99	0.9834
5	1884	JT-6387-1 T150-3	11/9/97	77.34	12.89	0.76	0.03	0.07	0.46	0.06	3.81	4.59	100.01	0.9813
6	1885	JT-41186-1 T150-4	9/11/87	77.34	12.89	0.76	0.03	0.07	0.46	0.06	3.81	4.59	100.01	0.9813
7	31	BT-7, T20-1		77.54	12.60	0.76	0.03	0.03	0.45	0.05	3.86	4.66	99.98	0.9807
8	272	PICO-24, T2-16		77.34	12.89	0.76	0.04	0.03	0.49	0.07	3.84	4.53	99.99	0.9787
9	1355	29068502 T107-2	8/30/85	78.16	12.15	0.76	0.03	0.04	0.44	0.07	3.72	4.63	100.00	0.9785
10	270	PICO-21, T2-8		77.06	13.00	0.79	0.03	0.04	0.47	0.05	3.88	4.67	99.99	0.9785
11	2921	OL-92-S T270-8	12/16/92	77.73	12.50	0.81	0.03	0.04	0.47	0.03	3.94	4.44	99.99	0.9785
12	1277	PICO-39A (2) BULK T20-6	7/1/85	77.77	12.51	0.75	0.03	0.07	0.45	0.07	3.89	4.47	100.01	0.9784
13	441	23-24-16B, T2-15		77.25	12.90	0.76	0.06	0.05	0.48	0.06	3.92	4.51	99.99	0.9784
14	2382	FLV-136-WP T203-6	4/16/90	77.86	12.35	0.74	0.03	0.04	0.44	0.08	3.90	4.57	100.01	0.9783
15	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9775
16	2080	CRAW-88-2D3 T172-10	10/5/88	77.66	12.62	0.76	0.03	0.04	0.46	0.05	3.70	4.69	100.01	0.9771
17	1825	FLV-1-CS T145-4	8/24/87	77.63	12.72	0.73	0.03	0.09	0.47	0.07	3.80	4.45	99.99	0.9770
18	2343	FLV-69-PA T195-3	7/21/89	78.04	12.31	0.74	0.02	0.06	0.44	0.05	3.77	4.55	99.98	0.9770
19	274	PICO-39A(2), T20-6		77.47	12.75	0.75	0.03	0.04	0.46	0.05	3.95	4.49	99.99	0.9765
20	262	PICO-3, T2-18		77.14	12.92	0.78	0.04	0.05	0.49	0.05	3.89	4.63	99.99	0.9759
21	2910	FLV-7.4 T269-2	11/16/92	77.62	12.29	0.74	0.04	0.06	0.46	0.09	3.82	4.88	100.00	0.9759
22	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9742
23	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9741
24	273	PICO-39A(1), T8-6		77.32	12.99	0.75	0.04	0.05	0.46	0.05	3.90	4.44	100.00	0.9735
25	1354	29068501 T107-1	8/30/85	78.06	12.27	0.76	0.04	0.04	0.44	0.07	3.64	4.67	99.99	0.9733
26	587	PICO-161, T49-2	12/09/82	77.17	12.85	0.81	0.04	0.03	0.48	0.10	3.96	4.57	100.01	0.9733
27	2348	FLV-94-WP T195-8	7/21/89	78.08	12.37	0.72	0.03	0.06	0.45	0.05	3.82	4.43	100.01	0.9731
28	1827	FLV-3-CS T145-6	8/24/87	77.68	12.69	0.73	0.05	0.09	0.48	0.05	3.68	4.56	100.01	0.9729
29	449	66W5, T5-7		77.59	12.74	0.74	0.03	0.05	0.45	0.07	3.88	4.44	99.99	0.9723
30	2907	FLV-3.5 T268-7	11/16/92	77.11	12.71	0.77	0.05	0.05	0.49	0.08	3.96	4.79	100.01	0.9722

Annotations to sample OL92-1015:

2. Tephra from borings, NE San Joaquin Valley. Post Laguna(?). Sample from D. E. Marchand (deceased); exact location not available.
3. Bailey ash bed, W. side Ventura River, S. flank Ventura Avenue anticline, Ventura Co., Calif. Bailey ash bed is 1.2 ±0.4 Ma, based on zircon fission-track date (Izett and others, 1974).
4. Bishop ash bed, E. side Ventura River, S. flank Ventura Avenue anticline, Ventura Co., Calif. The Bishop ash is dated as 0.756 ±0.002 Ma, by laser-fusion $^{40}Ar/^{39}Ar$ analysis on sanidine grains (Sarna-Wojcicki and Pringle, 1992).
5. Tephra layer in late Neogene alluvium of indeterminate age, near Mormon Point, Death Valley, collected by J. C. Tinsley.
6. Same as for 5, above.
7. Bishop Tuff, basal part of ash-flow tuff overlying basal Bishop air-fall pumice, Insulating Aggregates Quarry, 11 mi. N. of Bishop, Calif.
8. Bishop ash bed in Hall Canyon, E. of Ventura River, S. flank of the Ventura Avenue anticline, Ventura Co., Calif.
9. Tephra bed, Columbus Salt Marsh, W.-Central Nev. Bishop ash bed (?).
10. Bailey ash bed, near Pitas Point, W. of Ventura River, S. flank Ventura Ave. Anticline, Ventura Co., Calif.
11. OL92-S, surface outcrop of ash bed in auarry, near Owens Lake (see above).

Sample OL92-1016 Major Mode

Listing of 30 closest matches for COMP. NO. 2935 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2935	OL92-1016 MAJ T272-1 JEOL	3/3/93	76.12	13.54	1.29	0.05	0.04	0.59	0.08	4.22	4.06	99.99	1.0000
2	627	TULELAKE-318, T61-8(1)	08/17/83	76.32	13.31	1.31	0.05	0.03	0.59	0.07	4.28	4.05	100.01	0.9914
3	341	SAM-25A, T33-3		76.50	13.30	1.30	0.06	0.01	0.59	0.07	4.12	4.05	100.00	0.9906
4	193	LD-19, T3,4		76.65	13.17	1.30	0.05	0.03	0.61	0.07	4.06	4.06	100.00	0.9812
5	165	JOD-20-6-78C, LAH-4, T11-13		76.50	13.24	1.29	0.04	0.03	0.62	0.08	4.10	4.10	100.00	0.9810
6	703	LD-19		76.59	13.13	1.30	0.05	0.03	0.61	0.07	4.11	4.11	100.00	0.9808
7	628	TULELAKE-318, T61-8(2)	09/01/83	76.93	12.86	1.28	0.04	0.04	0.59	0.05	4.08	4.13	100.00	0.9802
8	530	JOD-20-6-78C, LAH-4, T63-2	09/01/83	76.89	13.03	1.27	0.05	0.03	0.58	0.06	4.05	4.05	100.01	0.9795
9	342	SAM-25B, T38-4		75.69	13.09	1.28	0.04	0.04	0.61	0.06	4.27	3.93	99.01	0.9795
10	2767	#4077 T251-3	2/27/92	76.48	13.06	1.33	0.05	0.03	0.62	0.07	4.23	4.13	100.00	0.9770
11	2856	BL-3498 T263-2	7/30/92	76.82	13.04	1.25	0.05	0.02	0.61	0.06	4.21	3.94	100.00	0.9764
12	1658	AA-29 JOD	09/12/86	76.94	12.74	1.27	0.03	0.04	0.60	0.08	4.12	4.18	100.00	0.9743
13	626	TULELAKE-315(200-325), T62-6	08/25/83	76.76	13.14	1.21	0.05	0.03	0.57	0.07	4.16	4.01	100.00	0.9733
14	865	LM-21		76.29	13.43	1.27	0.04	0.03	0.66	0.05	4.11	4.11	99.99	0.9716
15	1196	TULELAKE 2069 (62.02M) T90-12	3/1/85	77.20	12.85	1.28	0.04	0.03	0.60	0.06	3.91	4.03	100.00	0.9716
16	3100	CCRK-2 T289-2	11/4/93	76.67	13.31	1.23	0.04	0.03	0.62	0.07	3.95	4.07	99.99	0.9691
17	1197	TULELAKE 2079 (48.98M) T90-13	3/1/85	76.59	12.90	1.24	0.08	0.06	0.60	0.09	4.12	4.32	100.00	0.9679
18	779	GS-20		76.21	13.44	1.27	0.05	0.03	0.72	0.06	4.21	4.01	100.00	0.9634
19	933	DR-45		76.23	13.42	1.27	0.04	0.04	0.70	0.08	4.11	4.11	100.00	0.9631
20	47	CCRK-1, T1, N-ASW-77, P		77.02	12.62	1.31	0.05	0.03	0.65	0.08	4.13	4.12	100.01	0.9628
21	3009	JY-92-73 T278-8	5/7/93	75.18	13.86	1.24	0.09	0.04	0.61	0.13	4.33	4.52	100.00	0.9610
22	840	GS-86		76.36	13.33	1.28	0.04	0.04	0.68	0.06	4.01	4.21	100.01	0.9593
23	645	TULELAKE-834, T61-15(1)	08/17/83	76.58	13.09	1.12	0.08	0.04	0.60	0.09	4.16	4.24	100.00	0.9593
24	646	TULELAKE-834, T61-15(2)	08/26/83	76.64	13.14	1.09	0.08	0.03	0.61	0.14	4.15	4.13	100.01	0.9571
25	1737	ASW 61585-51B T-136-5	4/22/87	76.21	12.98	1.44	0.08	0.05	0.56	0.12	4.23	4.32	99.99	0.9566
26	621	TULELAKE-296, T61-6	08/17/83	75.70	13.47	1.21	0.09	0.04	0.56	0.14	4.16	4.63	100.00	0.9565
27	2766	#4076 T251-2	2/27/92	76.80	12.80	1.16	0.05	0.04	0.58	0.08	4.15	4.35	100.01	0.9559
28	1188	TULELAKE 2036 (53.14M) T90-3	2/28/85	76.13	13.05	1.22	0.10	0.03	0.61	0.15	4.11	4.59	99.99	0.9558
29	647	TULELAKE-834(200-325), T62-7	08/25/83	77.15	12.80	1.13	0.09	0.04	0.59	0.10	3.97	4.13	100.00	0.9553
30	1130	T1240 (Tulelake) T84-6 ca,k i	12/3/84	76.48	12.87	1.19	0.10	0.05	0.59	0.12	4.06	4.54	100.00	0.9541

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Annotations to sample OL92-1016:

2. Dibekulewe ash bed at 62.27 m in Tulelake, N. Calif., core (Rieck and others, 1992). This ash bed is bracketed between the Rockland ash bed. above (410-470 ka; Meyer and others, 1991) and the Lava Creek B ash bed, below (~665 ka; Izett and others, 1992).

3. Dibekulewe ash bed, Mohawk Valley, N. Sierra Nevada, N. Calif. Coll by S. A. Mathieson.

4 through 6 Dibekulewe ash bed, Oreana area, W.-central Nev. Coll by J. O. Davis.

7. Replicate analysis of 2 (above).

8. Same unit as 4 through 6 (above).

9. Replicate analysis of 2 (above).

10. Dibekulewe ash bed from Butte Valley, N. Calif., core at 35.94 m. Coll. by D. P. Adam.

11. Dibekulewe ash bed from Buck Lake, S.-central Ore., core at 20.85 m. Coll. by D. P. Adam.

Sample OL92-1019

Listing of 30 closest matches for COMP. NO. 2966 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2966	OL92-1019 T274-2	3/24/93	77.20	12.83	0.76	0.04	0.08	0.42	0.06	4.20	4.42	100.01	1.0000
2	294	PICO-143, T36-4		76.45	12.91	0.76	0.04	0.01	0.42	0.06	3.93	4.43	99.01	0.9863
3	276	PICO-41A. T8-8		77.38	12.94	0.73	0.03	0.05	0.42	0.04	4.01	4.39	99.99	0.9829
4	145	JC-239, T43-4		77.40	12.81	0.74	0.03	0.04	0.44	0.06	4.20	4.27	99.99	0.9817
5	271	PICO-23, T2-11		77.28	12.87	0.77	0.04	0.05	0.42	0.07	3.89	4.61	100.00	0.9780
6	283	PICO-78(2)(100-200), T38-1		76.33	12.93	0.73	0.03	0.04	0.41	0.06	4.24	4.24	99.01	0.9779
7	2930	LW-SL3.1.92 T271-2 2SH JEOL	2/24/92	77.23	12.93	0.77	0.03	0.03	0.42	0.08	3.89	4.60	99.98	0.9777
8	2379	FLV-129-DS T203-3	4/16/90	78.05	12.28	0.74	0.02	0.04	0.42	0.07	4.03	4.36	100.01	0.9776
9	284	PICO-78(3), T36-7		76.59	12.86	0.72	0.04	0.04	0.42	0.05	4.13	4.16	99.01	0.9769
10	2071	ARCH-88-1 T172-1	9/28/88	77.66	12.73	0.74	0.04	0.03	0.43	0.07	3.87	4.44	100.01	0.9756
11	2273	T191-5 N.DARWIN	5/10/89	77.70	12.62	0.77	0.01	0.03	0.41	0.05	3.90	4.50	99.99	0.9752
12	280	PICO-74, T36-5		76.55	12.99	0.74	0.03	0.04	0.42	0.07	4.12	4.05	99.01	0.9750
13	100	ELSI-1, T2-9,		77.42	12.85	0.75	0.02	0.03	0.46	0.05	4.10	4.31	99.99	0.9745
14	577	LCB-1, T52-8	03/25/83	77.37	12.62	0.74	0.04	0.04	0.43	0.06	4.04	4.65	99.99	0.9741
15	279	PICO-73, T39-3		77.29	12.83	0.79	0.03	0.04	0.45	0.06	4.03	4.48	100.00	0.9734
16	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9730
17	1932	SAFZ-6 T163-3	5/14/88	77.73	12.62	0.74	0.03	0.04	0.44	0.06	3.96	4.37	99.99	0.9728
18	285	PICO-80, T22-6		77.09	12.91	0.83	0.04	0.04	0.43	0.08	4.29	4.28	99.99	0.9720
19	953	DR-66		77.71	12.70	0.73	0.03	0.04	0.42	0.07	3.80	4.50	100.00	0.9718
20	2504	MH002 T220-5	1/31/91	77.52	13.04	0.75	0.04	0.04	0.43	0.05	3.85	4.27	99.99	0.9710
21	2226	FLV-66-MA T185-1	2/28/89	77.74	12.66	0.75	0.02	0.04	0.43	0.07	3.79	4.51	100.01	0.9710
22	2497	FLV-164A-WP T219-7	12/20/90	77.84	12.68	0.71	0.03	0.03	0.42	0.07	4.00	4.23	100.01	0.9706
23	274	PICO-39A(2), T20-6		77.47	12.75	0.75	0.03	0.04	0.46	0.05	3.95	4.49	99.99	0.9692
24	449	66W5, T5-7		77.59	12.74	0.74	0.03	0.05	0.45	0.07	3.88	4.44	99.99	0.9690
25	41	BT-11D2, T13-13		77.17	13.13	0.76	0.02	0.04	0.42	0.05	3.73	4.66	99.98	0.9689
26	2574	FLV-161-MT T227-8	6/13/91	77.35	12.80	0.77	0.03	0.07	0.41	0.06	3.82	4.69	100.00	0.9685
27	273	PICO-39A(1), T8-6		77.32	12.99	0.75	0.04	0.05	0.46	0.05	3.90	4.44	100.00	0.9683
28	144	JANDA-328, T2-12		77.42	12.87	0.74	0.04	0.02	0.47	0.05	4.10	4.28	99.99	0.9676
29	278	PICO-68, T38-2		76.25	12.69	0.78	0.03	0.06	0.41	0.06	3.98	4.75	99.01	0.9676
30	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9674

Annotations to sample OL92-1019:

2. Bishop ash bed from Sexton Canyon, S. flank Ventura Avenue Anticline, Ventura Co., Calif.
3. Very thin (1-4 mm) ash bed in Padre Juan Canyon, W. of Ventura River, N. flank Ventura Avenue anticline, Ventura Co., Calif. One of the Glass Mountain ash beds.
4. Bishop ash bed (?) from W. side Coxcomb Mts., Mojave Desert, Calif. Coll. by James Calzia (Merriam and Bischoff, 1975).
5. Glass Mt. D ash bed, near Pitas Point, W. of Ventura River, S. flank Ventura Avenue anticline, Ventura Co., Calif.
6. Bailey ash bed, W. of Ventura River, N. Flank of the Ventura Avenue anticline, Ventura Co., Calif.
7. Disseminated, reworked (Bishop-Glass Mt.) tephra in Sherman Lake, central Calif., core at 2.17 m. Coll. by Lisa Wells.
8. Bishop ash bed (?) in Fish Lake Valley, W.-central Nev. Coll. by Marith Reheis.
9. Same as 6 (above).
10. Bishop ash bed from Arches National Park, S. Utah.
11. Bishop ash bed (?) from near Darwin, E.-central Calif. Coll. by D. R. Harden.

Sample OL92-1020

Listing of 30 closest matches for COMP. NO. 2936 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2936	OL92-1020 T272-2 JEOL	3/3/93	74.27	14.09	1.39	0.17	0.03	0.91	0.21	3.83	5.10	100.00	1.0000
2	3003	JY-92-14 T278-9	5/3/93	74.47	14.01	1.33	0.16	0.04	0.89	0.19	3.72	5.18	99.99	0.9804
3	3002	JY-92-13 T277-8	5/3/93	74.44	14.14	1.32	0.17	0.04	0.88	0.20	3.71	5.11	100.01	0.9796
4	2224	RVS-BL-1 T184-6	2/28/89	74.42	14.43	1.37	0.18	0.03	0.94	0.21	3.53	4.88	99.99	0.9678
5	2252	T188-1 256-M	5/9/89	75.27	13.24	1.49	0.23	0.02	0.90	0.24	3.83	4.78	100.00	0.9643
6	2538	BEC-4 R224-4	4/22/91	75.41	13.91	1.35	0.10	0.04	0.90	0.09	3.85	4.36	100.01	0.9637
7	2537	BEC-3 T224-3	4/22/91	75.55	13.84	1.35	0.08	0.04	0.89	0.08	3.81	4.36	100.00	0.9607
8	992	RC-13		75.28	13.63	1.31	0.17	0.04	0.86	0.19	3.71	4.81	100.00	0.9589
9	3050	68-16-2378		75.18	13.58	1.52	0.24	0.04	0.89	0.13	3.41	5.01	100.00	0.9528
10	586	PICO-160, T49-1	12/09/82	75.23	13.69	1.60	0.08	0.04	0.90	0.10	3.79	4.63	100.06	0.9523
11	1961	WL-4-21 (49.16M) T162-15	5/15/88	73.96	14.24	1.33	0.19	0.06	0.87	0.23	4.36	4.76	100.00	0.9517
12	522	CL-06663, T56-1	07/01/83	75.45	13.60	1.26	0.15	0.03	0.94	0.19	3.54	4.84	100.00	0.9496
13	2758	BEC-3 T250-2	2/26/92	75.73	13.30	1.37	0.10	0.04	0.90	0.07	4.10	4.39	100.00	0.9490
14	492	758-373, T18-2		74.92	13.58	1.51	0.15	0.00	0.82	0.19	3.59	5.24	100.00	0.9479
15	3049	68-16-2360		74.88	13.98	1.55	0.33	0.04	0.93	0.13	3.27	4.88	99.99	0.9450
16	1073	61284-14-ASW OBSIDIAN T77-3	7/30/84	74.84	13.98	1.31	0.12	0.04	0.98	0.27	4.07	4.38	99.99	0.9426
17	2409	89B474 T208-1	5/24/90	74.60	13.76	1.82	0.12	0.03	0.92	0.17	3.76	4.83	100.01	0.9423
18	1592	MOD-6 T130-2	9/19/86	76.26	12.71	1.33	0.20	0.03	0.86	0.27	3.66	4.67	99.99	0.9415
19	2703	LM-UBC T245-4	11/27/91	76.32	13.24	1.30	0.09	0.04	0.89	0.08	3.69	4.36	100.01	0.9407
20	1762	OD-ECQM-E1-54 CM T139-9	5/28/87	73.75	14.44	1.35	0.08	0.05	0.75	0.12	4.14	5.34	100.02	0.9407
21	521	CL-0662(100-200), T60-12	08/16/83	75.65	13.59	1.26	0.15	0.04	0.95	0.16	3.50	4.69	99.99	0.9407
22	1765	OD-QWP-2-15 CM T139-6	5/28/87	74.37	13.94	1.54	0.09	0.06	0.73	0.14	4.03	5.10	100.00	0.9405
23	2403	MGP-16 T206-6	5/15/90	76.07	12.95	1.33	0.21	0.03	0.84	0.27	3.54	4.77	100.01	0.9392
24	1946	AV52-TW T155-6	5/15/88	74.95	13.54	1.20	0.19	0.04	0.76	0.30	3.85	5.17	100.00	0.9386
25	2329	FLV-87-HT T192-6	6/1/89	75.68	13.42	1.25	0.21	0.05	0.85	0.23	3.61	4.70	100.00	0.9385
26	2262	T189-3 1351-M	5/9/89	75.83	13.30	1.31	0.18	0.02	0.80	0.19	3.77	4.59	99.99	0.9382
27	1464	ZALTIPAN 14 T115-7	1/27/86	74.30	14.00	1.40	0.13	0.06	0.66	0.15	4.15	5.17	100.02	0.9368
28	299	PR, T25-5		74.63	13.86	1.53	0.16	0.07	0.81	0.19	4.11	4.64	100.00	0.9365
29	1602	MOD-19 T130-13	9/19/86	75.78	12.86	1.21	0.20	0.02	0.79	0.28	3.84	5.01	99.99	0.9352
30	2407	TULELAKE SAMPLE 694 T207-3	5/15/90	75.11	13.79	1.43	0.13	0.04	0.72	0.17	3.98	4.65	100.02	0.9341

Annotations to sample OL92-1020:

2, 3 .Ash beds from Mohawk Valley, N. Sierra Nevada, N. Calif., undated and in undefined stratigraphic context.

4. Tephra layer (tuff) from Borrego Badlands, W. of Salton Sea, S. Calif. Coll. by R. V. Sharp.

5. Scarface obsidian, Medicine Lake Volcano, N. Calif., K-Ar date of 320 ka (written commun., J. M. Donnelly-Nolan, 1989). Not a good match with respect to SiO_2, Al_2O_3, Fe_2O_3, and MgO.

6 through 11. Not good matches with respect to several oxides.

Sample OL92-1021

Listing of 30 closest matches for COMP. NO. 2939 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	1.0000
2	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9947
3	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9937
4	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9909
5	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9899
6	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9896
7	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9887
8	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9885
9	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9866
10	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9830
11	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9823
12	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9821
13	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9817
14	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9811
15	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9803
16	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9791
17	2480	FLV-130-WP T218-1	11/19/90	77.39	12.93	0.73	0.05	0.03	0.45	0.08	3.80	4.55	100.01	0.9784
18	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9781
19	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9780
20	2481	FLV-133B-O T218-2	11/19/90	77.40	12.93	0.72	0.03	0.03	0.44	0.06	3.69	4.71	100.01	0.9780
21	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9779
22	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9769
23	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9766
24	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9763
25	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9762
26	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9753
27	577	LCB-1, T52-8	03/25/83	77.37	12.62	0.74	0.04	0.04	0.43	0.06	4.04	4.65	99.99	0.9750
28	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9746
29	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9746
30	1305	TRENCH *8 (B) BULK T100-15	7/2/85	77.07	12.78	0.71	0.06	0.08	0.45	0.12	3.70	5.04	100.01	0.9744

Annotations to samples OL92-1021 through OL92-1030:

The annotations to these samples are grouped together, because this set of samples represents a chemically and petrographically homogenous set of layers within a 16-m-thick interval at the base of Owens Lake core OL92. This interval represents either an initial coarse airfall ash plus multiple reworked tephra layers derived from a single large eruption, or multiple airfall and reworked ash beds from an eruptive episode of short duration. Specific correlative layers from other sites, where the identity, age or stratigraphic context of the layers are known are the following:

66W5. Bishop ash bed from Onion Creek, E. Utah. Overlies Bruhes-Matuyama reversal, underlies Lava Creek B ash bed (Izett, 1981; Colman and others, 19__).

BT-7. Basal part of the Bishop Tuff ash-flow unit immediately overlying the basal air-fall pumice, same locality as BT-8 (above).

BT-8. The proximal Bishop airfall pumice bed from the Insulating Aggregates Quarry, 11 mi N. of Bishop, E.-central Calif. A laser-fusion $^{40}Ar/^{39}Ar$ date on sanidine grains from this locality is 0.761 ±0.007 Ma (Sarna-Wojcicki and Pringle; 1992).

BT-14. Replicate sample from same unit as BT-8 (above).

D77-2D. Bishop ash bed (?) from Clayton Valley, W.-central Nev., core at 175.25 m depth. Coll. by Joseph Davis.

FLV-57-CS. Ash of Glass Mountain, northeastern Fish Lake Valley, W.-central Nev.

FLV-130-WP. Bishop ash bed near Westgard Pass, White Mountains, E.-central Calif.

FLV-SP-2, -3. Ash-flow tuff of the Silver Peak Range, ~6 Ma. Generally similar in glass chemical composition to the Bishop Tuf and ash bed, but not good match with respect to MnO and TiO2.

FLV-VH-5A, -5B. Volcano Hills, N. Fish Lake Valley. From a set of ash-flow and air-fall tuffs of undetermined age. Similar to Bishop Tuff and tephra layers of Glass Mountain, but MnO and TiO2 are significantly different (close to twice the concentration) than the latter units.

FRIANT 9A. Reworked ash of the Bishop ash bed at the California Minerals Quarry near Friant, central Calif. This ash closely overlies primary air-fall ash layers of the Bishop ash bed.

LCB-1. Ash bed from Last Chance Bench, Beaver Basin, W.-central Utah. Locality of M. Machette (Izett and others, 1988).

O.L. 858.5. Disseminated, reworked (?) Bishop ash bed (?) at 261.66 m in old Owens Lake core.

PICO-5. Bailey ash bed, W. side Ventura River, S. flank Ventura Avenue anticline, Ventura Co., Calif.

PICO-73. Bailey ash bed, Canada del Diablo, W. of Ventura River, N. flank Ventura Avenue anticline, Ventura Co., Calif.

PICO-107A. Bailey ash bed SW of South Mountain, Ventura Co., Calif.

Annotations to samples OL92-1021 through 1030 (continued):

PICO-108. Bailey ash bed. Same locality as PICO-107A (above).

PICO-141. Bishop ash bed, Sexton Canyon, E. of Ventura River, S. side of Ventura Avenue anticline, Ventura Co., Calif.

PICO-152. Glass Mountain (G?) ash bed, near Padre Juan Canyon, W. of Ventura River, S. side Ventura Avenue anticline, Ventura Co., Calif.

TECO-7. Glass Mountain (D?) ash bed, ~10 m below Bishop ash bed, near Shoshone, N. end of Lake Tecopa.

TECO-10. Glass Mountain (D?) ash bed, ~9-10 m below Bishop ash bed, near Shoshone, N. end of Lake Tecopa.

TECO-28A, -28B. Bishop ash bed near Shoshone, N. end of Lake Tecopa (Bed "B" of Shapard and Gude, 1968)..

TECO-29. Ash of Glass Mountain (G?), near Shoshone, N. end of Lake Tecopa.

TECO-30B-2. Thin layer of reworked Bishop ash within Lava Creek B ash bed (ash bed "A" of Shepard and Gude, 1968), near Shoshone, N . end of Lake Tecopa.

TL-111. Tephra layer from the Saugus Formation near Saugus, Calif. Identified as the Bishop ash bed on the basis of chemistry, normal magnetization, and close stratigraphic position above reversal to reversed polarity, identified as the Brunhes Normal-Matuyama Reversed Chron boundary.

YJC-1. Coarse air-fall Bishop pumice in quarry near head of Yellowjacket Canyon, east of Long Valley, E.-central Calif.

Sample OL92-1022

Listing of 30 closest matches for COMP. NO. 2946 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	1.0000
2	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9945
3	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9937
4	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9880
5	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9873
6	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9865
7	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9864
8	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9850
9	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9849
10	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9849
11	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9831
12	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9826
13	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9825
14	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9823
15	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9810
16	577	LCB-1, T52-8	03/25/83	77.37	12.62	0.74	0.04	0.04	0.43	0.06	4.04	4.65	99.99	0.9805
17	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9803
18	2480	FLV-130-WP T218-1	11/19/90	77.39	12.93	0.73	0.05	0.03	0.45	0.08	3.80	4.55	100.01	0.9803
19	31	BT-7, T20-1		77.54	12.60	0.76	0.03	0.03	0.45	0.05	3.86	4.66	99.98	0.9799
20	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9798
21	449	66W5, T5-7		77.59	12.74	0.74	0.03	0.05	0.45	0.07	3.88	4.44	99.99	0.9791
22	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9785
23	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9784
24	274	PICO-39A(2), T20-6		77.47	12.75	0.75	0.03	0.04	0.46	0.05	3.95	4.49	99.99	0.9784
25	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9781
26	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9780
27	452	81BO51, T35-5		76.52	12.77	0.74	0.04	0.02	0.46	0.07	3.67	4.72	99.01	0.9773
28	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9771
29	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9771
30	273	PICO-39A(1), T8-6		77.32	12.99	0.75	0.04	0.05	0.46	0.05	3.90	4.44	100.00	0.9769

Sample OL92-1023

Listing of 30 closest matches for COMP. NO. 2947 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	1.0000
2	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9972
3	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9910
4	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9897
5	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9896
6	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9865
7	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9850
8	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9849
9	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9825
10	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9797
11	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9794
12	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9792
13	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9783
14	2655	UWB-19 T238-2	10/16/91	77.50	12.68	0.71	0.06	0.04	0.46	0.11	3.72	4.71	99.99	0.9771
15	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9770
16	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9767
17	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9758
18	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9755
19	1280	PICO-5 BULK 200SEC CTS T20-5	7/1/85	77.46	12.51	0.70	0.03	0.07	0.45	0.07	3.76	4.96	100.01	0.9751
20	1276	PICO-5 (2) BULK T20-5	7/1/85	77.43	12.56	0.70	0.03	0.07	0.45	0.06	3.74	4.96	100.00	0.9750
21	1022	O.L. 858.5 T75-9	6/23/84	77.43	12.68	0.68	0.04	0.04	0.44	0.05	3.80	4.85	100.01	0.9743
22	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9743
23	2546	UCSB-FS-89-4 T225-4	4/22/91	77.17	12.75	0.73	0.05	0.04	0.48	0.08	3.83	4.88	100.01	0.9742
24	2079	CRAW-88-2D2 T172-9	9/28/88	77.61	12.69	0.70	0.03	0.04	0.47	0.08	3.64	4.76	100.02	0.9742
25	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9736
26	1989	WL-5-24 (90.23m) T165-3	5/22/88	77.51	12.44	0.70	0.03	0.06	0.47	0.10	3.73	4.96	100.00	0.9729
27	2549	UCSB-FS-89-8-5 T225-7	4/22/91	77.32	12.70	0.63	0.02	0.04	0.47	0.06	3.95	4.81	100.00	0.9729
28	2077	CRAW-88-1A T172-7	9/28/88	77.72	12.63	0.70	0.03	0.04	0.47	0.04	3.71	4.65	99.99	0.9723
29	1305	TRENCH *8 (B) BULK T100-15	7/2/85	77.07	12.78	0.71	0.06	0.08	0.45	0.12	3.70	5.04	100.01	0.9720
30	2219	KRL-880828-N T181B-7	1/23/89	77.35	12.96	0.71	0.03	0.03	0.46	0.07	3.48	4.90	99.99	0.9720

Sample OL92-1024

Listing of 30 closest matches for COMP. NO. 2940 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	1.0000
2	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9897
3	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9892
4	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9888
5	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9885
6	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9866
7	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9861
8	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9854
9	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9842
10	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9828
11	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9824
12	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9823
13	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9815
14	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9812
15	1022	O.L. 858.5 T75-9	6/23/84	77.43	12.68	0.68	0.04	0.04	0.44	0.05	3.80	4.85	100.01	0.9800
16	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9782
17	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9762
18	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9753
19	577	LCB-1, T52-8	03/25/83	77.37	12.62	0.74	0.04	0.04	0.43	0.06	4.04	4.65	99.99	0.9744
20	2985	POG2B11 T276-5	4/7/93	77.07	12.73	0.67	0.04	0.08	0.44	0.09	3.76	4.94	99.82	0.9744
21	2006	FLV-57-CS T166-7	7/19/88	77.34	12.71	0.69	0.02	0.04	0.44	0.07	3.69	4.98	99.98	0.9741
22	1683	R-86-Y1 T134-5	11/25/86	77.78	12.52	0.70	0.04	0.04	0.44	0.05	3.75	4.68	100.00	0.9741
23	2481	FLV-133B-O T218-2	11/19/90	77.40	12.93	0.72	0.03	0.03	0.44	0.06	3.69	4.71	100.01	0.9741
24	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9736
25	1280	PICO-5 BULK 200SEC CTS T20-5	7/1/85	77.46	12.51	0.70	0.03	0.07	0.45	0.07	3.76	4.96	100.01	0.9735
26	1276	PICO-5 (2) BULK T20-5	7/1/85	77.43	12.56	0.70	0.03	0.07	0.45	0.06	3.74	4.96	100.00	0.9734
27	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9725
28	2500	FLV-SP-3 T220-1	1/31/91	77.18	12.76	0.73	0.07	0.07	0.44	0.09	3.71	4.95	100.00	0.9724
29	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9722
30	34	BT-11A1, T13-6		77.55	12.72	0.69	0.03	0.04	0.43	0.06	3.69	4.78	99.99	0.9719

Sample OL92-1025

Listing of 30 closest matches for COMP. NO. 2941 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	1.0000
2	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9915
3	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9830
4	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9828
5	2985	POG2B11 T276-5	4/7/93	77.07	12.73	0.67	0.04	0.08	0.44	0.09	3.76	4.94	99.82	0.9826
6	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9825
7	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9825
8	1022	O.L. 858.5 T75-9	6/23/84	77.43	12.68	0.68	0.04	0.04	0.44	0.05	3.80	4.85	100.01	0.9823
9	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9821
10	1280	PICO-5 BULK 200SEC CTS T20-5	7/1/85	77.46	12.51	0.70	0.03	0.07	0.45	0.07	3.76	4.96	100.01	0.9810
11	1276	PICO-5 (2) BULK T20-5	7/1/85	77.43	12.56	0.70	0.03	0.07	0.45	0.06	3.74	4.96	100.00	0.9808
12	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9797
13	2006	FLV-57-CS T166-7	7/19/88	77.34	12.71	0.69	0.02	0.04	0.44	0.07	3.69	4.98	99.98	0.9788
14	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9784
15	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9784
16	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9780
17	1305	TRENCH *8 (B) BULK T100-15	7/2/85	77.07	12.78	0.71	0.06	0.08	0.45	0.12	3.70	5.04	100.01	0.9778
18	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9771
19	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9771
20	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9769
21	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9766
22	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9754
23	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9737
24	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9724
25	2500	FLV-SP-3 T220-1	1/31/91	77.18	12.76	0.73	0.07	0.07	0.44	0.09	3.71	4.95	100.00	0.9720
26	1989	WL-5-24 (90.23m) T165-3	5/22/88	77.51	12.44	0.70	0.03	0.06	0.47	0.10	3.73	4.96	100.00	0.9716
27	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9711
28	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9701
29	2549	UCSB-FS-89-8-5 T225-7	4/22/91	77.32	12.70	0.63	0.02	0.04	0.47	0.06	3.95	4.81	100.00	0.9696
30	34	BT-11A1, T13-6		77.55	12.72	0.69	0.03	0.04	0.43	0.06	3.69	4.78	99.99	0.9694

Sample OL92-1026

Listing of 30 closest matches for COMP. NO. 2942 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	1.0000
2	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9915
3	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9910
4	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9898
5	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9895
6	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9892
7	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9887
8	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9849
9	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9833
10	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9826
11	1022	O.L. 858.5 T75-9	6/23/84	77.43	12.68	0.68	0.04	0.04	0.44	0.05	3.80	4.85	100.01	0.9818
12	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9808
13	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9800
14	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9798
15	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9797
16	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9797
17	1280	PICO-5 BULK 200SEC CTS T20-5	7/1/85	77.46	12.51	0.70	0.03	0.07	0.45	0.07	3.76	4.96	100.01	0.9793
18	1276	PICO-5 (2) BULK T20-5	7/1/85	77.43	12.56	0.70	0.03	0.07	0.45	0.06	3.74	4.96	100.00	0.9792
19	2985	POG2B11 T276-5	4/7/93	77.07	12.73	0.67	0.04	0.08	0.44	0.09	3.76	4.94	99.82	0.9775
20	2006	FLV-57-CS T166-7	7/19/88	77.34	12.71	0.69	0.02	0.04	0.44	0.07	3.69	4.98	99.98	0.9772
21	1305	TRENCH *8 (B) BULK T100-15	7/2/85	77.07	12.78	0.71	0.06	0.08	0.45	0.12	3.70	5.04	100.01	0.9762
22	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9753
23	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9752
24	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9744
25	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9739
26	34	BT-11A1, T13-6		77.55	12.72	0.69	0.03	0.04	0.43	0.06	3.69	4.78	99.99	0.9738
27	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9725
28	2480	FLV-130-WP T218-1	11/19/90	77.39	12.93	0.73	0.05	0.03	0.45	0.08	3.80	4.55	100.01	0.9719
29	2549	UCSB-FS-89-8-5 T225-7	4/22/91	77.32	12.70	0.63	0.02	0.04	0.47	0.06	3.95	4.81	100.00	0.9718
30	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9715

Sample OL92-1027 Major Mode

Listing of 30 closest matches for COMP. NO. 2943 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	1.0000
2	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9972
3	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9909
4	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9898
5	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9888
6	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9865
7	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9864
8	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9861
9	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9830
10	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9803
11	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9801
12	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9786
13	2655	UWB-19 T238-2	10/16/91	77.50	12.68	0.71	0.06	0.04	0.46	0.11	3.72	4.71	99.99	0.9779
14	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9779
15	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9777
16	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9777
17	2079	CRAW-88-2D2 T172-9	9/28/88	77.61	12.69	0.70	0.03	0.04	0.47	0.08	3.64	4.76	100.02	0.9750
18	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9747
19	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9745
20	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9744
21	1280	PICO-5 BULK 200SEC CTS T20-5	7/1/85	77.46	12.51	0.70	0.03	0.07	0.45	0.07	3.76	4.96	100.01	0.9740
22	1276	PICO-5 (2) BULK T20-5	7/1/85	77.43	12.56	0.70	0.03	0.07	0.45	0.06	3.74	4.96	100.00	0.9739
23	1022	O.L. 858.5 T75-9	6/23/84	77.43	12.68	0.68	0.04	0.04	0.44	0.05	3.80	4.85	100.01	0.9732
24	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9732
25	2077	CRAW-88-1A T172-7	9/28/88	77.72	12.63	0.70	0.03	0.04	0.47	0.04	3.71	4.65	99.99	0.9731
26	2549	UCSB-FS-89-8-5 T225-7	4/22/91	77.32	12.70	0.63	0.02	0.04	0.47	0.06	3.95	4.81	100.00	0.9731
27	2546	UCSB-FS-89-4 T225-4	4/22/91	77.17	12.75	0.73	0.05	0.04	0.48	0.08	3.83	4.88	100.01	0.9731
28	274	PICO-39A(2), T20-6		77.47	12.75	0.75	0.03	0.04	0.46	0.05	3.95	4.49	99.99	0.9721
29	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9718
30	1989	WL-5-24 (90.23m) T165-3	5/22/88	77.51	12.44	0.70	0.03	0.06	0.47	0.10	3.73	4.96	100.00	0.9718

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Sample 0L92-1027 Minor Mode

Listing of 30 closest matches for COMP. NO. 2944 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2944	OL92-1027 MIN T273-7 JEOL	3/3/93	76.52	12.90	0.80	0.04	0.05	0.44	0.06	4.10	5.11	100.02	1.0000
2	2759	ET-CFD-1 T250-3	2/26/92	77.07	12.60	0.80	0.04	0.04	0.46	0.09	3.95	4.95	100.00	0.9764
3	384	TECO-29, T17-6		76.68	13.12	0.81	0.04	0.04	0.43	0.07	3.85	4.96	100.00	0.9760
4	382	TECO-28A, T17-4		76.74	13.09	0.81	0.03	0.04	0.43	0.06	3.85	4.94	99.99	0.9756
5	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9725
6	295	PICO-152, T39-1		76.98	12.97	0.79	0.03	0.06	0.42	0.05	3.89	4.80	99.99	0.9698
7	377	TECO-10, T17-1		76.77	13.09	0.78	0.04	0.03	0.42	0.08	3.78	5.01	100.00	0.9690
8	383	TECO-28B, T17-5		77.00	12.89	0.75	0.04	0.03	0.43	0.06	3.80	5.00	100.00	0.9688
9	1729	WEB-2 T137-11	4/21/87	77.44	12.50	0.80	0.05	0.06	0.43	0.04	3.69	4.99	100.00	0.9685
10	279	PICO-73, T39-3		77.29	12.83	0.79	0.03	0.04	0.45	0.06	4.03	4.48	100.00	0.9683
11	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9680
12	375	TECO-7, T14-2		77.09	12.90	0.81	0.03	0.05	0.42	0.06	3.75	4.89	100.00	0.9677
13	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9673
14	2898	FLV-1.3 T267-3	10/27/92	76.99	12.40	0.74	0.06	0.07	0.44	0.09	3.92	5.29	100.00	0.9670
15	26	BT-1, T2-13		77.32	12.91	0.80	0.03	0.03	0.43	0.05	3.85	4.57	99.99	0.9666
16	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9662
17	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9662
18	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9660
19	2086	CRAW-88-3F T173-1	10/6/88	76.98	12.97	0.83	0.04	0.06	0.45	0.08	3.82	4.77	100.00	0.9659
20	2926	BT-2 T62-15 JEOL	2/24/93	77.27	12.90	0.79	0.03	0.03	0.43	0.06	3.68	4.81	100.00	0.9657
21	719	LD-70		77.20	12.92	0.79	0.04	0.04	0.43	0.07	3.60	4.91	100.00	0.9656
22	201	LD-70, T3,4		77.22	12.91	0.79	0.04	0.04	0.43	0.07	3.58	4.93	100.01	0.9655
23	278	PICO-68, T38-2		76.25	12.69	0.78	0.03	0.06	0.41	0.06	3.98	4.75	99.01	0.9645
24	2912	FLV-7.6 T269-4	11/16/92	77.53	12.29	0.77	0.06	0.07	0.43	0.11	3.93	4.83	100.02	0.9639
25	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9637
26	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9637
27	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9634
28	3098	BT-14 T289-1	9/24/93	77.21	12.78	0.75	0.03	0.04	0.43	0.06	3.77	4.92	99.99	0.9631
29	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9630
30	380	TECO-24, T17-3		76.58	13.07	0.76	0.03	0.03	0.44	0.07	3.65	5.37	100.00	0.9630

Sample OL92-1028 Major Mode

Listing of 30 closest matches for COMP. NO. 2945 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	1.0000
2	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9947
3	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9945
4	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9895
5	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9875
6	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9873
7	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9865
8	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9865
9	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9861
10	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9848
11	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9841
12	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9831
13	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9827
14	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9825
15	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9816
16	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9810
17	2480	FLV-130-WP T218-1	11/19/90	77.39	12.93	0.73	0.05	0.03	0.45	0.08	3.80	4.55	100.01	0.9810
18	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9809
19	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9794
20	2546	UCSB-FS-89-4 T225-4	4/22/91	77.17	12.75	0.73	0.05	0.04	0.48	0.08	3.83	4.88	100.01	0.9792
21	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9790
22	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9788
23	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9788
24	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9788
25	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9788
26	2500	FLV-SP-3 T220-1	1/31/91	77.18	12.76	0.73	0.07	0.07	0.44	0.09	3.71	4.95	100.00	0.9787
27	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9787
28	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9778
29	2910	FLV-7.4 T269-2	11/16/92	77.62	12.29	0.74	0.04	0.06	0.46	0.09	3.82	4.88	100.00	0.9765
30	31	BT-7, T20-1		77.54	12.60	0.76	0.03	0.03	0.45	0.05	3.86	4.66	99.98	0.9761

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Sample OL92-1028 Minor Mode

Listing of 30 closest matches for COMP. NO. 2948 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	1.0000
2	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9899
3	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9866
4	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9861
5	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9850
6	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9850
7	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9848
8	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9833
9	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9819
10	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9772
11	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9769
12	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9767
13	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9740
14	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9735
15	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9729
16	2480	FLV-130-WP T218-1	11/19/90	77.39	12.93	0.73	0.05	0.03	0.45	0.08	3.80	4.55	100.01	0.9726
17	2655	UWB-19 T238-2	10/16/91	77.50	12.68	0.71	0.06	0.04	0.46	0.11	3.72	4.71	99.99	0.9725
18	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9725
19	577	LCB-1, T52-8	03/25/83	77.37	12.62	0.74	0.04	0.04	0.43	0.06	4.04	4.65	99.99	0.9725
20	2545	UCSB-FS-89-3-4DE T225-3	4/22/91	77.22	12.69	0.76	0.03	0.04	0.46	0.07	3.96	4.78	100.01	0.9725
21	2481	FLV-133B-O T218-2	11/19/90	77.40	12.93	0.72	0.03	0.03	0.44	0.06	3.69	4.71	100.01	0.9723
22	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9718
23	2710	FLV-195-BC T246-4	12/12/91	77.39	12.52	0.73	0.05	0.04	0.48	0.05	3.99	4.76	100.01	0.9715
24	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9713
25	1805	R-1-87 T143-6	6/24/87	77.52	12.67	0.75	0.03	0.03	0.45	0.05	3.93	4.58	100.01	0.9711
26	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9705
27	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9695
28	1305	TRENCH *8 (B) BULK T100-15	7/2/85	77.07	12.78	0.71	0.06	0.08	0.45	0.12	3.70	5.04	100.01	0.9693
29	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9684
30	2463	SN-7 T215-4	9/25/90	77.71	12.73	0.71	0.03	0.02	0.44	0.06	3.81	4.48	99.99	0.9682

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Sample OL92-1029

Listing of 30 closest matches for COMP. NO. 2937 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	1.0000
2	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9844
3	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9842
4	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9842
5	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9811
6	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9810
7	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9805
8	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	0.9802
9	288	PICO-108, T39-5		77.01	12.81	0.73	0.03	0.04	0.42	0.07	3.81	5.07	99.99	0.9801
10	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9797
11	293	PICO-141, T39-7		77.29	12.84	0.73	0.03	0.02	0.42	0.07	3.68	4.91	99.99	0.9796
12	295	PICO-152, T39-1		76.98	12.97	0.79	0.03	0.06	0.42	0.05	3.89	4.80	99.99	0.9789
13	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9787
14	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9783
15	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9777
16	2943	OL92-1027 MAJ T273-7 JEOL	3/3/93	76.94	13.00	0.70	0.03	0.03	0.46	0.05	3.99	4.80	100.00	0.9777
17	1024	M1493-100 T75-11	6/23/84	77.53	12.50	0.74	0.03	0.07	0.41	0.04	3.88	4.80	100.00	0.9774
18	1275	BT-7 (2) BULK T20-1	7/1/85	77.63	12.48	0.74	0.03	0.05	0.42	0.07	3.87	4.71	100.00	0.9774
19	2948	OL92-1028 MIN T273-8 JEOL	3/3/93	76.73	13.16	0.71	0.04	0.01	0.45	0.07	4.08	4.75	100.00	0.9772
20	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9771
21	2947	OL92-1023 T273-3 JEOL	3/3/93	76.96	12.93	0.70	0.03	0.04	0.46	0.05	4.01	4.83	100.01	0.9770
22	27	BT-1A, T13-3		77.53	12.65	0.74	0.03	0.04	0.42	0.06	3.71	4.81	99.99	0.9764
23	38	BT-11C1, T13-10		77.71	12.59	0.72	0.03	0.04	0.42	0.06	3.67	4.76	100.00	0.9763
24	2084	CRAW-88-3D T172-14	10/6/88	77.45	12.81	0.72	0.03	0.05	0.40	0.04	3.88	4.62	100.00	0.9758
25	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9757
26	662	BT-1C, T62-10	08/26/83	77.47	12.75	0.73	0.03	0.03	0.43	0.07	3.77	4.72	100.00	0.9756
27	33	BT-8(2), T20-2		77.48	12.68	0.71	0.03	0.02	0.45	0.06	3.85	4.72	100.00	0.9754
28	2539	FLV-SP-1 T224-5	4/22/91	76.87	12.99	0.71	0.04	0.08	0.41	0.10	3.67	5.13	100.00	0.9753
29	2930	LW-SL3.1.92 T271-2 2SH JEOL	2/24/92	77.23	12.93	0.77	0.03	0.03	0.42	0.08	3.89	4.60	99.98	0.9748
30	383	TECO-28B, T17-5		77.00	12.89	0.75	0.04	0.03	0.43	0.06	3.80	5.00	100.00	0.9748

Sample OL92-1030

Listing of 30 closest matches for COMP. NO. 2938 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 12/12/93

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2938	OL92-1030 T272-4 JEOL	3/3/93	76.94	12.91	0.74	0.04	0.03	0.44	0.07	3.90	4.93	100.00	1.0000
2	2522	FLV-VH-5A T222-2	4/2/91	77.14	12.75	0.72	0.04	0.07	0.44	0.11	3.89	4.85	100.01	0.9899
3	387	TECO-30B-2, T17-9		76.88	13.08	0.74	0.03	0.04	0.44	0.07	3.75	4.98	100.01	0.9896
4	2945	OL92-1028 MAJ T273-8 JEOL	3/3/93	76.89	12.97	0.73	0.04	0.04	0.45	0.06	3.97	4.85	100.00	0.9875
5	2946	OL92-1022 T273-2 JEOL	3/3/93	76.95	12.95	0.74	0.03	0.03	0.45	0.07	3.99	4.79	100.00	0.9873
6	383	TECO-28B, T17-5		77.00	12.89	0.75	0.04	0.03	0.43	0.06	3.80	5.00	100.00	0.9870
7	2500	FLV-SP-3 T220-1	1/31/91	77.18	12.76	0.73	0.07	0.07	0.44	0.09	3.71	4.95	100.00	0.9865
8	3098	BT-14 T289-1	9/24/93	77.21	12.78	0.75	0.03	0.04	0.43	0.06	3.77	4.92	99.99	0.9858
9	1030	FRIANT 9A T74-4	6/22/84	77.42	12.57	0.71	0.03	0.00	0.44	0.07	3.86	4.91	100.01	0.9854
10	1893	YJC-1-87 T150-11	11/9/87	77.28	12.91	0.73	0.04	0.05	0.44	0.07	3.74	4.75	100.01	0.9841
11	396	TL-111, T46-2		77.24	12.85	0.75	0.04	0.01	0.45	0.07	3.81	4.78	100.00	0.9837
12	2573	FLV-160-MI T227-7	6/13/91	77.28	12.87	0.75	0.02	0.08	0.44	0.06	3.93	4.58	100.01	0.9834
13	287	PICO-107A, T39-4		77.09	12.73	0.77	0.03	0.04	0.46	0.08	3.89	4.91	100.00	0.9825
14	2939	OL92-1021 T273-1 JEOL	3/3/93	76.91	13.00	0.72	0.03	0.03	0.45	0.06	4.00	4.81	100.01	0.9823
15	2940	OL92-1024 T273-4 JEOL	3/3/93	76.86	13.00	0.70	0.03	0.03	0.44	0.05	4.04	4.85	100.00	0.9812
16	1279	BT-7 BULK 200SEC CTS T20-1	7/1/85	77.57	12.48	0.73	0.02	0.05	0.43	0.07	3.88	4.78	100.01	0.9811
17	2898	FLV-1.3 T267-3	10/27/92	76.99	12.40	0.74	0.06	0.07	0.44	0.09	3.92	5.29	100.00	0.9811
18	65	D77-2D, T31-6		77.39	12.66	0.73	0.03	0.05	0.45	0.07	3.72	4.89	99.99	0.9808
19	2540	FLV-SP-2 T224-6	4/22/91	76.79	13.07	0.71	0.05	0.07	0.44	0.10	3.73	5.02	99.98	0.9806
20	2927	LRSW T271-1 JEOL	2/24/93	77.33	12.89	0.73	0.03	0.03	0.43	0.07	3.82	4.66	99.99	0.9803
21	288	PICO-108, T39-5		77.01	12.81	0.73	0.03	0.04	0.42	0.07	3.81	5.07	99.99	0.9803
22	2937	OL92-1029 T273-3 JEOL	3/3/93	76.92	13.06	0.71	0.03	0.04	0.42	0.05	3.92	4.85	100.00	0.9802
23	2942	OL92-1026 T273-6 JEOL	3/3/93	76.96	12.93	0.69	0.03	0.03	0.45	0.08	3.97	4.87	100.01	0.9798
24	2941	OL92-1025	3/3/93	76.86	12.99	0.68	0.04	0.02	0.45	0.08	3.92	4.96	100.00	0.9797
25	2382	FLV-136-WP T203-6	4/16/90	77.86	12.35	0.74	0.03	0.04	0.44	0.08	3.90	4.57	100.01	0.9786
26	293	PICO-141, T39-7		77.29	12.84	0.73	0.03	0.02	0.42	0.07	3.68	4.91	99.99	0.9784
27	2910	FLV-7.4 T269-2	11/16/92	77.62	12.29	0.74	0.04	0.06	0.46	0.09	3.82	4.88	100.00	0.9782
28	662	BT-1C, T62-10	08/26/83	77.47	12.75	0.73	0.03	0.03	0.43	0.07	3.77	4.72	100.00	0.9781
29	2481	FLV-133B-O T218-2	11/19/90	77.40	12.93	0.72	0.03	0.03	0.44	0.06	3.69	4.71	100.01	0.9778
30	2523	FLV-VH-5B T222-3	4/2/91	77.29	12.69	0.70	0.05	0.07	0.43	0.10	3.85	4.82	100.00	0.9778

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

AMS RADIOCARBON DATES ON SEDIMENTS FROM OWENS LAKE DRILL HOLE OL-92

by

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INTRODUCTION

The Owens River system consisted of a chain of pluvial lakes occupying a succession of closed basins in southeastern California. The lakes were supplied primarily by the Owens River which drains the eastern side of the Sierra Nevada, and during historic times Owens Lake has been the terminus of the system. During extreme dry periods (interglacials), Owens Lake was saline, alkaline, and biologically highly-productive. During extreme wet periods (glacials), in contrast, the lake was flushed, overflowing with fresh water, and relatively unproductive. To obtain a record of variations in runoff, three 7.6 -cm diameter cores were drilled in Owens Lake in the late spring of 1992. The three cores extend from 0.00 to 7.16 m (OL-923), 5.49 to 61.37 m (OL-92-1) and 61.26 to 322.86 m (OL-92-2), together representing about 800 kyr of sedimentation (Smith, 1993). We report here on results of radiocarbon analyses of carbonates and humates from the upper 31 m of the section to place the upper part of the core in temporal context. Our results indicate coherent and linear progression of dates with depth down to 23 m and 30 kyr. Scatter of results below this depth indicate that the practical limit of radiocarbon dating in this core is about 30 kyrs.

STRATIGRAPHY AND SAMPLING PROCEDURES

The Bishop Tuff, well-dated at 759 kyrs (Sarna and Pringle, 1992) was encountered at 309 m in the core (Sarna et al, 1993) indicating an overall average sedimentation rate of about 40 cm/kyr. Correcting for less compaction in the upper part of the core, we estimated the practical limit of about 35 kyr for radiocarbon dating occurs at about 30 m depth, and limited our sampling down core to this level. Samples were taken from cores 1 and 3 of OL-92 series. OL-92-1 was drilled by rotary drilling down to 61 m. Because the top 5.5 m were disturbed by the drilling, OL-92-3, essentially a pushed-in gravity core, was taken immediately adjacent to the drilling pad to provide a high resolution sampling of the top-most 7 m of the section. This latter core (OL-92-3)was driven from a back hoe-excavated 3.5 m pit to a total depth of 7.16 m below the surface. The upper-most stratigraphy as exposed in the pit and in the two cores (Smith, 1993) is as follows (present surface = 0): 0-0.94m artificial fill; 0.94-1.3 m historic salt bed ; 1.32 m - 5.16 m oolitic sand; 5.16 m to bottom of core silty clay with occasional thin sand beds. The salt bed was deposited between 1912 and 1921 as a consequence of the artificial desiccation of the lake due to the diversion of the Owens River by the City of Los Angeles (Smith, 1993). Thus, the natural section in the time range of interest is characterized by a 3.8 m bed of oolitic sand, presumably forming up to historic time, overlaying silty clays. The contact between the oolitic sands and silty clays is sharp and abrupt and represents the most striking lithologic change in the entire core. In fact, oolitic sands are absent throughout the rest of the section.

We took 8 samples of the oolites from depths between 3.72 and 5.12 m from OL-92-3, and 12 samples of silty clay from depths between 5.23 and 7.11 m from OL-92-3, and from depths between 7.21 and 31.13 m from OL-92-1. Correlation of beds between OL-92-1 and OL-92-3 based on lithology and on measured depth was straightforward and unambiguous. Each sample consisted of about 50 cc of wet sediment and represented about 3 cm of section. In addition, we took two samples of silty clay sediment from considerably deeper in the core, beyond the limit of radiocarbon dating in order to asses the ^{14}C background and contamination limits for dating this material. These samples were taken at depths of 36.1 m (ca. 50 kyrs) and 55.1 m (ca. 80 kyrs).

EXTRACTIONS AND TARGET PREPARATION

The humate fraction of the organic material was extracted from the silty clays by suspending the samples in 200 mls of 1N NaOH solution in capped polyethylene bottles held in a 70°C oven overnight. The coffee-colored supernate was then separated from the residual solids by filtering. The supernate was then titrated to pH 5 with 3N HCl and the resulting precipitate ("humate fraction") was collected on filter paper, rinsed with distilled water and air-dried. Air-dried humate yields ranged from 12 to 200 mg, more-or-less in proportion to the bulk organic content of each sediment sample. Humates were combusted to CO_2 in sealed evacuated silica tubes using CuO, Cu and Ag.

Oolite samples were cleaned, weighed, and acidified with 10% HCl in vacuum. The resulting CO_2 was dried by passing through an oxygen flow-combustion train, using hot platinum as a catalyst and trapping water and SO_2. The CO_2 gas volumes for oolites and humates were measured and admitted to graphitizers designed for AMS target preparation (Vogel et al, 1985). These small-volume units were charged with 400 Torr of CO_2 and 900 Torr of H_2. Heating overnight in the presence of iron and zinc catalysts at 675° C produced sufficient graphite to be pressed into targets for the Lawrence Livermore accelerator. All reactions were carried to completion to eliminate isotope fractionation due to processing. Replicate targets were made of 4 oolite samples and one humate sample evaluate contamination during target preparation and to evaluate precision.

For the two "infinitely old" control samples, targets were prepared of the "total organic", "humate" and "humin" fractions to determine the viability of the CuO-Cu-Ag procedure described above. For the total-organic fraction, a decalcified sediment-sample was combusted. The humate fraction was the NaOH extractable fraction from another aliquot, separated out as above, and the humin fraction was the solid residue after NaOH extraction. Graphite targets were prepared as above. Targets were analyzed at the Center for Accelerator Mass Spectroscopy (CAMS) of the Lawrence Livermore Laboratory by John Southon.

RESULTS

Results for the samples from the top 31 m are given in Table 1 and Figure 1. Results from the two deeper samples are shown in Table 2. Dates are based on the Libby half-life (5568 yr), using an assumed $\delta^{13}C$ of -5‰ for the oolites and -15‰ for the organic fractions. No attempt has been made to calibrate the results to absolute years (e.g. Bard, et al., 1990). Counting errors on individual samples are generally on the order of ±2% or less. Replicates on the 5 samples for which duplicate targets were prepared agreed within counting error for two of the oolite samples (4.8 m and 5.02 m) and between 5 and 6% for the other two oolite samples and the single humate (3.82 m, 4.29 m and 31.13 m). Results on the "infinite" samples indicate a probable limiting age of between 30 and 35 kyrs (Table 2). For the 36 m sample, three replicate analyses of the total-organic fraction yielded dates from 25 to 27 kyr, while the corresponding humate yielded 30 kyr, and the humin 32 kyr. Similarly, the total organics for the 55 m sample yielded dates from 35.0 to 35.7 kyrs, the humate 38, and the humin 37. Targets made from infinitely old calcite yielded dates of 43.5 kyr while that of infinitely old coal yielded 35 kyr (unpublished data of U.S.G.S. Reston radiocarbon laboratory), indicating contamination levels introduced during sample processing of carbonates and organic matter and the ideal dating limits. The results from the 55m sample are at this limit, whereas those at 36 m are considerable younger. Thus, we conclude that the practical limit for dating humates from the Owens core is about 30 kyr, about the same as encountered in radiocarbon analyses of organic material extracted from other lake sediments (i.e., Robinson et al, 1988; Thompson et al, 1990). This somewhat low limit is probably due to the relative ease of contamination of the plastic and porous-wet sediment by the circulating drilling mud that entrains and slurries younger sediments from the side wall of the hole in the upper parts of the section.

Results on samples younger than the limit of 30 kyrs are relatively coherent, and represent two linear trends with an apparent hiatus between 5100 and 8300 yrs bp (Table 1, Fig. 1). The twelve dates on the oolites, which span only 1.25 m of section (3.72 to 5.02 m) define a linear trend which projects to a zero age at 1.5 m depth. This depth is essentially that of the base of the historic salt layer (1.3 m), a result which adds considerable confidence to the dates. The magnitude of the reservoir effect on the dates (low initial $^{14}C/C$ ratios in lake water), based on the detailed analysis of Benson (1993) for nearby Walker Lake, should be on the order of 200 years and certainly less than 500 yrs.

The dates on the humate extracts likewise result in a linear trend, except for the three samples from 12.97 to 15.32 m. Reexamination of this interval in the core indicated clearly that this section is slumped. The character of this slumped sediment in texture, mottling, color, and bedding is identical to that found above in the section between 8 to 9 m where the dates would plot exactly on the trend. The deepest samples at 23.27 m and at 31.13 m all give dates of 30 to 32 kyrs bp, essentially at the practical limit as indicated by the deeper control samples. Thus, we are left with a coherent trend in the humates beginning at the base of the oolites at 8200 yrs to a date of 25,400 yrs at 23.27 m. The apparent sedimentation rate of the oolites is 70 cm/kyr and that of the silty clay is 83 cm/kyr. The contact between the oolites and the silty clays is abrupt, the bedding apparently conformable, and there is no evidence of pedogenesis at the top of the silty clay. We interpret the offset between the two trends as a disconformity, possibly caused by a period of complete desiccation of the lake followed by wind deflation of pre-existing sediments, or, alternatively, a sublacustrine slumping away of part of the section. The linear trend of the humate dates projects to zero age at +2 m. Thus, because the true zero-age of the section is at -1.3 meters (base of the salt), the amount of missing section represented by the disconformity is about 3.3 m.

Deeper in the core, there is no evidence of a significant change in sedimentological conditions as might be expected for the Pleistocene/Holocene transition, between 10,000 to 14,000 yrs. Rather the significant change in lake conditions seems to have occurred only after 8200 yrs.

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Table 1

AMS Radiocarbon dates from carbonates and organic matter
from sediments from drill hole OL-92, Owens Lake, CA

depth[1], m	material	CAMS[2] No.	^{14}C date yrs B.P.
3.72	oolites	4662-B	3320±70
3.82	"	6317-R	4080±70
"	"	6318-R	4280±70
4.02	"	4663-B	3390±70
4.29	"	6319-R	4130±60
"	"	6320-R	4400±60
4.65	"	6316-R	4660±100
4.80	"	6314-R	5300±70
"	"	6315-R	5310±70
5.02	"	6326-R	5010±80
"	"	6327-R	5010±100
5.12	"	4664-B	5090±80
5.23	humate	6310-R	8280±120
5.27	"	4672-B	8930±70
5.99	"	4675-B	9980±70
7.11	"	4657-B	11,140±70
7.21	"	4671-B	11,360±70
10.45	"	4659-B	15,880±80
12.63	"	4674-B	13,490±80
12.97	"	6313-B	11,990±150
15.32	"	4658-B	12,570±70
18.31	"	4661-B	25,370±160
23.27	"	4673-B	30,310±310
31.13	"	6311-R	32,320±1780
"	"	6312-R	30,670±1420

1 Ditto marks (") under sample depth refer to analyses of replicate targets made from the same sample.

2 Analyzed at the Center for Accelerator Mass Spectroscopy (CAMS) of the Lawrence Livermore Laboratory by John Southon. -B = graphite target prepared at Institute of Arctic and Alpine Research ^{14}C laboratory. -R = graphite target prepared at U.S.G.S. Reston ^{14}C laboratory.

Table 2

AMS Radiocarbon dates on various organic fractions from two sediment samples from drill hole OL-92, Owens Lake, taken from depths below radiocarbon dating limit‡

depth and approx. age	Fraction	CAMS No.	^{14}C date yrs B.P.
36 m, 50 kyrs			
	total organics	6923-B	27,470±110
	"	6924-B	26,580±110
	"	7562-B	25,370±290
	humate	6928-B	29,550±190
	humin	6926-B	31,760±180
55m, 80kyrs			
	total organics	6921-B	35,030±150
	"	7563-B	35,190±990
	"	6922-B	36,730±130
	humate	6927-B	38,430±170
	humin	6925-B	36,730±240

‡ Extractions and preparation of graphite targets carried out at Institute of Arctic and Alpine Research ^{14}C laboratory. Samples were analyzed at the Center for Accelerator Mass Spectroscopy (CAMS) of the Lawrence Livermore Laboratory by John Southon.

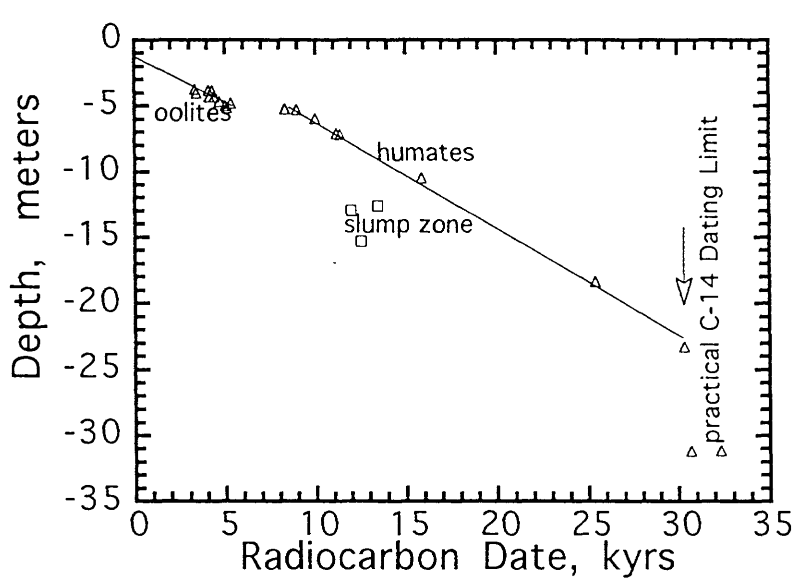

Figure 1
AMS radiocarbon dates on sediments (oolites and humate extrations) from Owens Lake Drill Hole OL-92. Symbol size is about twice the actual counting error for each sample.

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AGE-DEPTH RELATIONS FOR THE SEDIMENT COLUMN AT OWENS LAKE, CALIFORNIA: OL-92 DRILL HOLE

by

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ABSTRACT

The average mass accumulation rate of sediments above Bishop Ash (304 m) in Owens Lake drill hole OL-92, calculated from pore-water content, bulk density, and apparent accumulation rate, is 51.4 $g/cm^2/kyr$. A similar calculation for the top 24 meters with radiocarbon control results in 52.4 $g/cm^2/kyr$, remarkably close to the calculated rate for the entire core. An age-depth curve for the entire core was constructed using radiocarbon control from the top of the core and extrapolating to the Bishop Ash (758 kyr, 304 m depth) after correcting for compaction using the pore water data. The curve is based on the apparent constancy of the rate of sediment-mass accumulation over the extrapolation.

INTRODUCTION

During the spring of 1992, a 323 m core was recovered from Owens Lake in order to obtain a record of climate history and natural climate variation (Smith, 1993). In historic time, throughout the Holocene, and during other dry periods of the past (interglacials), Owens Lake was saline and alkaline and produced $CaCO_3$-rich sediments. During extreme wet periods (glacials), in contrast, the lake was flushed and overflowing with fresh water and produced sediments lacking $CaCO_3$. The present study attempts to construct an age-depth curve for the core in order to place oscillations of climate-controlled sediment parameters in chronological context.

Chronological control on the core consists of radiocarbon dates for the top 25 meters (Bischoff et al 1993 a), and the identification of the Bishop Ash as at 304 meters (Sarna-Wojcicki et al, 1993), the identification of the Brunhes-Matuyama paleomagnetic reversal at 320 meters and a series of 11 paleomagnetic excursion-events between 20 and 269 m (Glen et al, 1993). These results show that the age versus depth relationship is not linear. I found that the mass-accumulation rate (*MAR*, $g/cm^2/kyr$), however, was essentially the same for the portion of the core with radiocarbon control and for the entire core down to the Bishop Ash. If the *MAR* is indeed constant throughout the core, it allows for construction of a continuous age-depth curve down to the Bishop Ash. The age to any given depth can be calculated by estimating the mass of solids for various segments progressively down the core, using the measured pore-water content to estimate the masses of solid sediment. By this procedure starting from the top and extrapolating only from the radiocarbon data using the constant MAR assumption, the estimated age at the depth of the Bishop Ash was found to be within 10 kyrs of its true absolute age of 758 kyrs. The resulting age-depth relationship is derived independently of the paleomagnetic results, but when compared with the latter, it shows remarkable agreement. In what follows, I detail how the *MAR* age-depth curve was calculated and present a table of age-depth data useful for placing geochemical, sedimentological, and biological parameters of the core in a chronological context.

CALCULATING MASS-ACCUMULATION RATE

The calculation of *MAR* is based on radiocarbon ages at the top of the core, the age of the Bishop Ash near the bottom, pore-water content and salinity, and grain-density measurements of the sediments. Sarna-Wojcicki et al (1993) report the top of the Bishop Ash at 303.9 in OL-92, the age of which is 758±2 kyrs (Pringle and Sarna-Wojcicki et al, 1993). This translates to an average sedimentation rate (*SR*) of 40.1 cm/kyr (Fig.3).

AMS radiocarbon dates for the top 24 meters (Fig. 1) are reported by Bischoff et al (1993a). The dates on extracted organic material show a simple linear progression with depth starting from below the capping oolite at 6 m down to about 24 m. Below 24 m the dates scatter, indicating the practical radiocarbon limit is about 30 kyrs, about the same as encountered in radiocarbon analyses of organic material extracted from other lake sediments (i.e., Robinson et al, 1988; Thompson et al, 1990). These results translate to an *SR* of 83.0 cm/kyr in radiocarbon years, or 78.8 cm/kyr in absolute years using the calibration of Mazud et al (1991), a rate almost twice that for the entire segment of the core from near the surface to the Bishop Ash (Fig. 3). The next step is to calculate and compare the average *MAR* for the two segments by correcting for the water content using bulk density estimates. Manheim et al (1974) have shown that bulk densities of marine sediments are most accurately determined from separate measurements of pore-water content, salinity, and grain density. Pore-water content (wt. % H_2O) and salinity were determined for 120 samples from OL-92 taken every 2 to 3 m (Bischoff et al,1993b). The water content varies very erratically but generally decreases down the core, while the salinity varies in a smoother pattern consisting of a single cycle reflecting the overriding effects of ionic diffusion (Fig. 2). Grain densities were determined via gas-comparison pycnometer on six composite samples of sediment from various parts of the core which had been previously rinsed of pore-water salts and dried. The results are reported in Bischoff et al (1993c) and show the grain density to be extremely uniform at 2.63±0.05 g/cc. Such uniformity is expected (Manheim et al, 1974) considering the narrow density range of the constituent minerals: calcite (2.72g/cc), quartz (2.65g/cc), feldspar (2.6-2.75g/cc) and clay minerals (2.6-2.9 g/cc). Thus, in what follows, the density of the solids, ρ_s, is taken as a constant 2.63g/cc, and variations in bulk density are attributable to, and calculated from, pore-water content and salinity. The method of calculation is outlined below. First, the mass accumulation rate is given by:

$$MAR = zW_s/t = SR \cdot W_s \qquad (1)$$

where W_s is the mass of dry sediment per unit volume of wet sediment, z is the thickness of the sediment , and t is the time of accumulation. I first separately calculate W_s for the radiocarbon segment (6 to 24 m) and for the Bishop Ash segment (6 to 304 m) from bulk density considerations, and then calculate MAR by multiplying each W_s by its respective SR.
Bulk density is given by

$$\rho_b = X_s\rho_s + X_{pw}\rho_{pw} = (1-X_{pw})\,\rho_s + X_{pw}\rho_{pw} \qquad (2)$$

where ρ is density, X is weight-fraction and subscript b refers to bulk, s to solids and pw to pore water.

The weight of solids in 1 cc of wet sediment (W_s) is simply the weight-fraction of the solids times the bulk density:

$$W_s = X_s\rho_b = (1-X_{pw})\rho_b \qquad (3)$$

Substituting from (2)

$$W_s = (1-X_{pw})[(1-X_{pw})\,\rho_s + X_{pw}\rho_{pw}\,] \qquad (4)$$

Rearranging:

$$W_s = \rho_s + X_{pw}^2(\rho_s + \rho_{pw}\,) - X_{pw}(2\rho_s + \rho_{pw}\,) \qquad (5)$$

To calculate W_s from parameters that were actually measured, expressions are needed for X_{pw} and ρ_{pw} in terms of measured pore-water content, X_{H_2O}, and measured salinity, x_{sal}, where X_{H_2O} is the weight fraction of H_2O in the bulk sample, and x_{sal} is the weight-fraction of salt in the pore-water. X_{pw} is related to these variables by:

$$X_{pw} = X_{H_2O} + [X_{H_2O}\,x_{sal}/(1-x_{sal})] \qquad (6)$$

The density of the pore-water is primarily a function of its salinity, approximated by that for seawater (Sverdrup et al, 1942):

$$\rho_{pw} = 1 + 0.8\,x_{sal} \qquad (7)$$

Averaged values for pore-water content and salinity for the two segments are given in Table 1, from which respective average W_s is calculated using equations (5), (6), and (7). I then calculate average-MAR for each segment from values in Table 1 as follows.

6 to 24 m : $MAR = SR \cdot W_s = (78.8\ \text{cm/kyr})(0.665\ \text{g/cm}^3) = 52.4\ \text{g/cm}^2\text{/kyr}$ (8)

6 to 304 m: $MAR = SR \cdot W_s = (40.1\ \text{cm/kyr})(1.282\text{g/cm}^3) = 51.4\ \text{g/cm}^2\text{/kyr}$ (9)

The agreement of average MAR for the two segments is remarkable. Such agreement was unexpected, particularly because the 6 to 24 m segment represents primarily maximum glacial conditions while the 6 to 309 m segment encompasses several glacial and interglacial cycles through which rates of *MAR* might be expected to vary. The next step is to construct a time-depth curve for the core down to the Bishop Ash based on the constant value for *MAR* and test for the reasonableness of the curve against independent criteria.

CALCULATION OF THE TIME-DEPTH CURVE

The time for accumulation of any segment of sediment of thickness z with average solid content of Ws and average mass-accumulation rate of *MAR* is

$$t = zW_S/MAR \tag{10}$$

Taking *MAR* as constant and recognizing that W_S varies widely:

$$t = \frac{1}{MAR}\int_0^z W_s dz \tag{11}$$

and substituting from (5)

$$t = \frac{1}{MAR}\int_0^z [\rho_s + X_{pw}^2(\rho_s + \rho_{pw}) - X_{pw}(2\rho_s + \rho_{pw})]dz \tag{12}$$

If X_{pw} could be expressed as an integrable function of depth such as a polynomial, it could be substituted into (5), and then (12) could be integrated to yield a general expression for t as a function of z. Unfortunately, as shown in Fig. 2, X_{H2O} (and therefore X_{pw}) varies erratically down the core and is not amenable to a polynomial fit. Therefore, I divide the core into small separate segments and use the technique of finite sums to estimate the age to any given depth:

$$t = \frac{1}{MAR}\sum_0^n W_{s_i} z_i \tag{13}$$

I subdivided the core into fifteen parcels, calculated an average W_S from the average pore-water content and salinity for each parcel, and therefrom calculated the time of accumulation for each from equation (1). The time to any given depth is then calculated from (13). Fifteen segments divides the core into approximately 20 m parcels, each of which is represented by 5 to 10 pore-water analyses. The resolution of the process could be increased by taking progressively smaller intervals, and based on the limiting number of pore-water samples. the number of parcels for the finite sum could be extended to 120 parcels. At increasingly smaller intervals, however, the assumption of constant MAR becomes less tenable and little is gained in precision. For the purposes of the present study, 15 parcels were broken out with boundaries taken at major changes in pore-water content (Fig. 2). Parameters for each of the 15 segments are listed in Table 2 with the calculated time span for each and a list of cumulative age to the bottom of each segment.

RESULTS

The plot of cumulative age versus depth from the model (Fig. 4) is generally smooth, but has some irregularities between 200 and 300 meters where the massive sandy units interbed with fine-grained sediments (Smith, 1993). The points were fit by cubic spline (moving 3-point polynomial) which reproduces each of the 15 derived ages within ±0.1 kyr. An expanded table of ages versus depth (Table 3) was then generated from the cubic spline fit using, as independent variable, the mid-point depths of the 85 channel samples used in the geochemical study (Bischoff et al, 1993c). This table is the primary product of the exercise, and it is recommended for use in interpolating the age for any given depth in OL-92. The age-depth curve in Fig. 4 can also be described by a polynomial, albeit less accurately:

$$t = 11.83 + 0.37425m + 0.022243m^2 - 0.0001354m^3 + 4.5397\times10^{-7}m^4 - 5.7878\times10^{-10}m^5 \tag{14}$$

where t is in kyrs, m is in meters below the surface and is valid for $6 \leq m \leq 304$. The polynomial reproduces the derived ages within ±5 kyrs for 0 to 200 m and within ±10 kyrs for the lower 200 to 300 m.

DISCUSSION

The reasonableness of the constant *MAR* model can now be evaluated via comparison with the paleomagnetic data. Fig. 5 shows the *MAR*-derived age-depth plot on which are superimposed the 11 paleomagnetic excursions between the Bishop Ash and the surface, as recognized by Glen et al (1993). The identification of these excursions was made assuming that the section was continuous, and, therefore, was somewhat tentative. Constraints on the ages of the excursions, as shown by the error bars on Fig. 5, varies widely, from very close for some to rather broad for others (see Champion et al, 1988). Nevertheless, the *MAR* plot passes close to, or exactly on, the proposed age of each and all of the excursions in what might otherwise appear to be a hand-drawn curve fit through the excursion points. In fact, the excursion data appear to provide no additional control, and therefore, cause no modification of the derived position of the age-depth curve. These results, independently derived, confirm the identification of the excursions, and actually provides them with improved age control. The comparison clearly validates the constant *MAR* model, and confirms the continuity and integrity of the sedimentary section.

The age-depth curve can then be used to provide chronological control on other measured/observed parameters on the core. For example, the age-depth curve provides independent constraint on the ages of two ash layers found in core OL-92. Sarna-Wojcicki et al (1993) identified a tephra layer at 50.7 m which he correlates to one he previously found in sediments of Walker Lake, Nevada (previously estimated at ca 80 to 90 kyr) for which the present results indicate an age of 74.3 kyr. They also identified the Dibekulewe Ash at 224.2 m (only broadly constrained between 410 and 665 kyr) for which the present results indicates an age of 500.2 kyrs.

Variations in climatically controlled variables can also now be put in a chronological framework to allow regional and worldwide comparisons and correlations. For example, the variations in wt. % $CaCO_3$ in the sediments over the past 300 kyrs is shown along with the SPECMAP (Imbrie et al 1984) $\delta^{18}O$ variations believed to represent variations in Northern-Hemisphere ice-volumes in Fig. 6. Interglacial conditions are characterized by high $CaCO_3$ contents of closed-lake conditions, and glacial conditions by low $CaCO_3$ content of lake flushing. The $CaCO_3$ oscillations generally track and correlate with those of SPECMAP. For example, the abrupt warming event which marks the onset of the penultimate interglacial (Termination II) is clearly seen in Fig. 6 by the abrupt increase in $CaCO_3$ content occurring at 117 kyr. According to SPECMAP estimate this event occurs at 128 kyrs. This 10 kyr difference reflects either the error in the age-depth model (i.e., 10% error), or alternatively, a real time-lag between changes in Northern Hemisphere ice-volumes and the manifestation of local climate change in lake geochemistry and sedimentology. Modifying the age-depth curve to coincide with the SPECMAP timing of Termination II, however, would require adjusting the curve to beyond that accomodated by the error bars of the Fram Strass and Blake paleomagnetic excursions of Glen et al (1993). Therefore, I conclude that the age-depth curve is accurate, which leads to the conclusion that rapid changes from glacial to interglacial conditions at Owns Lake occurred at about 117 kyr, a full 10 kyr later than the collapse of the polar ice sheet.

The constant MAR age-depth model obviously works rather well. Why this should be is rather puzzling. Firstly, its success confirms that the section is continuous and that no significant gaps occur in the record. Intuition would suggest, however, that accumulation rates would vary rather significantly between glacial and interglacial conditions. Interglacial conditions are characterized by abundant deposition of $CaCO_3$, and glacial conditions by abundant deposition of mechanically transported silts and sands. That bulk *MAR* has remained relatively constant through the glacial/interglacial cycles can only mean that the increased sediment supply during the high run-off of glacial times is balanced by increased size of the depositional area, and vice-versa during interglacials.

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Table 1
Averaged parameters (weighted) from Owens Lake sediments in drill hole OL-92 used for calculating mass-sedimetation rates

Averages for entire core to Bishop Tuff (6-304 m):

SR (sedimentation rate) = 40.1 cm/kyr
X_{H2O} (pore water content) = 0.372
x_{sal} (pore water salinity) = 0.0027
ρ_s (grain density) = 2.63g /cm^3
ρ_b (bulk density) = 2.01 g/cm^3
$CaCO_3$ content = 12.5 wt %

MAR (mass sedimentation rate) = 51.4 g/cm^2/kyr

Averages for pre-Holocene radiocarbon-dated segment (6-24 m):

SR (sedimentation rate) = 78.8 cm/kyr
X_{H2O} (pore water content) = 0.548
x_{sal} (pore water salinity) = 0.00093
ρ_s (grain density) = 2.63 g/cm^3
ρ_b (bulk density) = 1.68 g/cm^3
$CaCO_3$ content = 8.4 wt %

MAR (mass sedimentation rate) = 52.4g/cm^2/kyr

Table 2
Parameters of sediment intervals from Owens Lake drill hole OL-92 used to calculate accumulation times and age to base of intervals from model of constant accumulation rate. Pore water content and salinity are averaged for each interval from Bischoff et al (1993b).

m to base of interval	interval thickness m (*z*)	X_{H20}	x_{sal} (x100)	ρ_{pw} g/cc	ρ_b g/cc	*zWs* kg/cm^2	kyrs in interval	kyrs to base of interval
16.0	10.00	0.551	9.30	1.07	1.74	0.66	12.6	23.6
33.6	17.60	0.552	1.60	1.01	1.78	1.33	25.4	49.0
58.8	25.20	0.551	1.30	1.01	1.78	1.92	37.4	86.4
77.8	19.00	0.456	1.94	1.02	1.94	1.91	37.2	123.6
102.2	24.40	0.384	2.73	1.02	2.07	2.94	57.3	180.9
117.0	14.80	0.348	3.50	1.03	2.13	1.94	37.7	218.6
134.5	17.50	0.389	3.94	1.03	2.06	2.07	40.2	258.7
147.3	12.80	0.392	4.22	1.03	2.05	1.50	29.1	287.9
174.8	27.50	0.286	4.58	1.04	2.24	4.11	80.0	367.9
195.0	20.20	0.330	3.62	1.03	2.16	2.76	53.8	421.6
225.3	30.30	0.329	1.43	1.01	2.17	4.21	81.9	503.6
262.1	36.77	0.201	1.68	1.01	2.39	6.73	130.9	634.5
279.1	17.08	0.297	1.23	1.01	2.23	2.56	49.8	684.2
291.8	12.65	0.446	0.71	1.01	1.97	1.33	25.8	710.0
306.0	14.20	0.338	0.60	1.00	2.16	1.95	37.8	748.0

Table 3
Age-depth relations for Owens Lake core OL-92 based on model of constant accumulation rate. Ages were calculated for each depth from the cubic spline fit to 15 age-depth points from table 2.

meters	kyrs
7.0	12.6
9.0	16.0
12.7	20.8
18.1	26.6
23.3	31.9
26.3	36.2
32.7	47.4
35.4	52.1
38.4	56.8
41.5	61.4
44.6	65.8
47.1	69.2
49.9	73.2
53.9	78.8
56.7	83.1
59.8	88.1
62.7	93.1
65.6	98.4
68.5	104.1
71.8	110.9
75.5	118.5
78.0	124.0
81.1	130.9
84.1	137.6
87.2	144.6
90.3	151.7
93.3	158.9
95.8	165.1
99.3	173.7
102.3	181.2
110.4	201.9
112.8	208.1
115.7	215.4
117.7	220.3
120.8	227.7
123.4	233.9
125.6	238.8
128.0	244.3
131.1	251.3
133.8	257.3
136.6	263.3
140.5	272.0
143.5	278.8
146.5	285.8
148.9	292.1
153.2	303.6
155.9	311.3
163.8	334.8

meters	kyrs
167.7	346.7
172.8	361.9
176.0	371.3
183.2	391.3
186.3	399.3
189.3	407.0
192.1	414.4
195.1	421.9
196.9	426.5
200.4	435.1
202.9	441.6
208.6	456.1
213.3	468.7
215.7	475.1
220.7	489.6
223.1	496.7
225.7	504.9
235.1	536.5
237.7	545.7
240.6	556.3
245.4	573.8
253.8	604.8
255.3	610.4
267.1	651.5
271.2	664.2
276.6	678.5
279.0	683.8
283.1	691.6
285.2	695.4
288.5	701.8
292.6	712.4
296.2	725.1
299.0	736.2
301.0	744.9
303.0	753.7
305.1	763.0

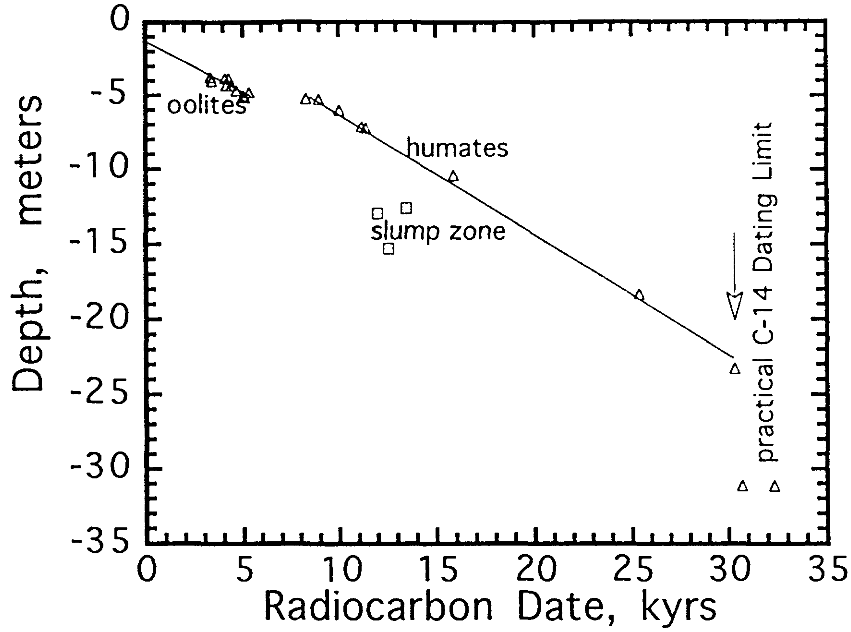

Fig. 1
AMS radiocarbon results on carbonates and extracted organic material (humates) from Owens Lake sediments in drill hole OL-92 from Bischoff et al (1993a).

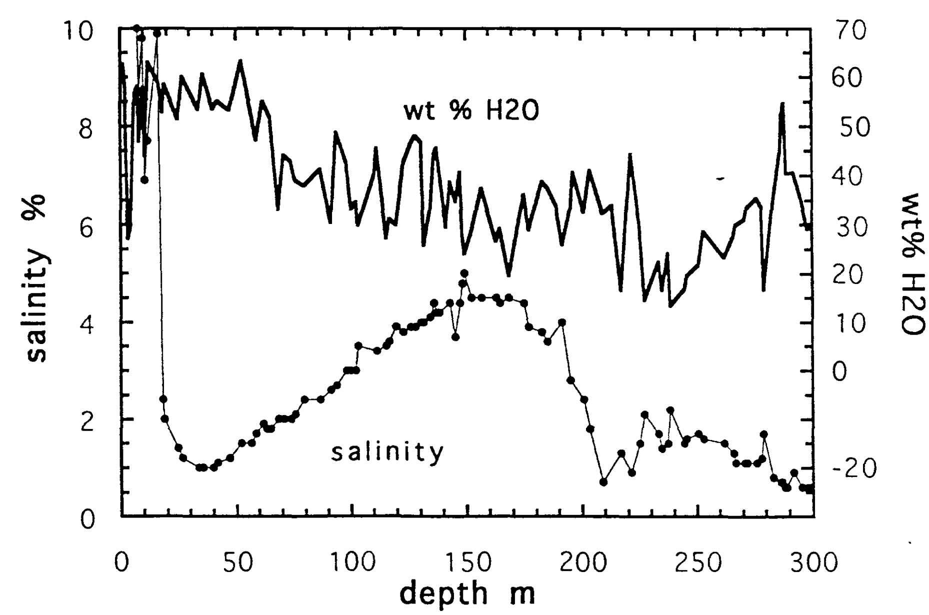

Fig. 2
Pore-water content and salinity in sediments from Owens Lake drill hole OL-92 from Bischoff et al (1993b).

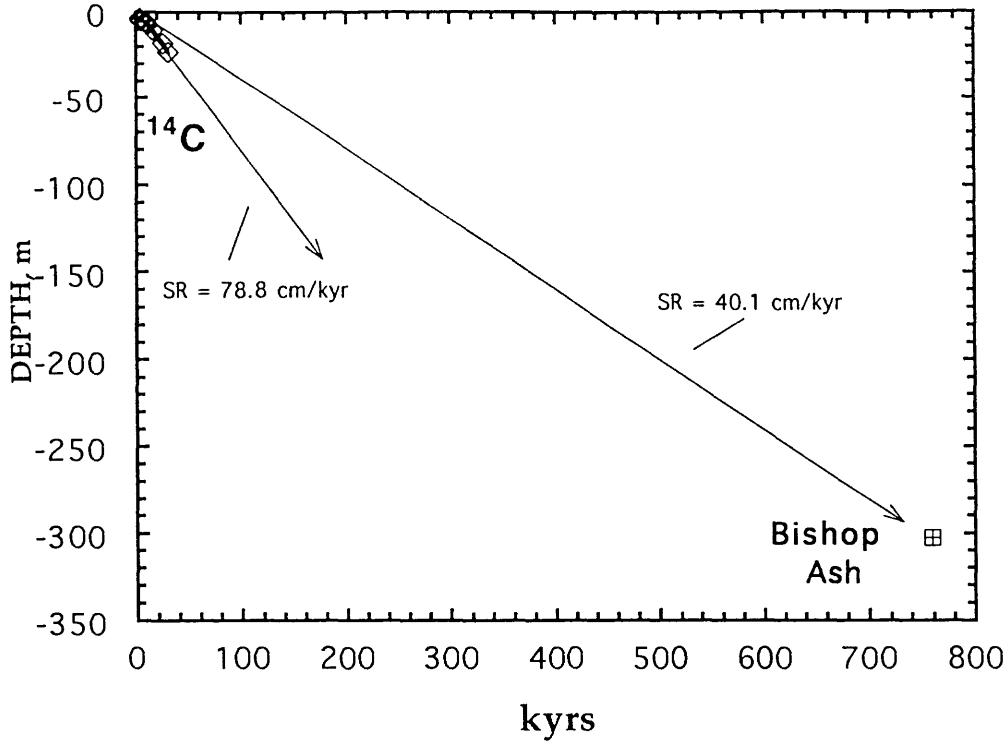

Fig. 3
Radiometric age control on sediments from Owens Lake drill hole OL-92. Radiocarbon dates from 6 to 24 meters from Bischoff et al (1993a). Bishop Ash at 304 m from Sarna et al (1993).

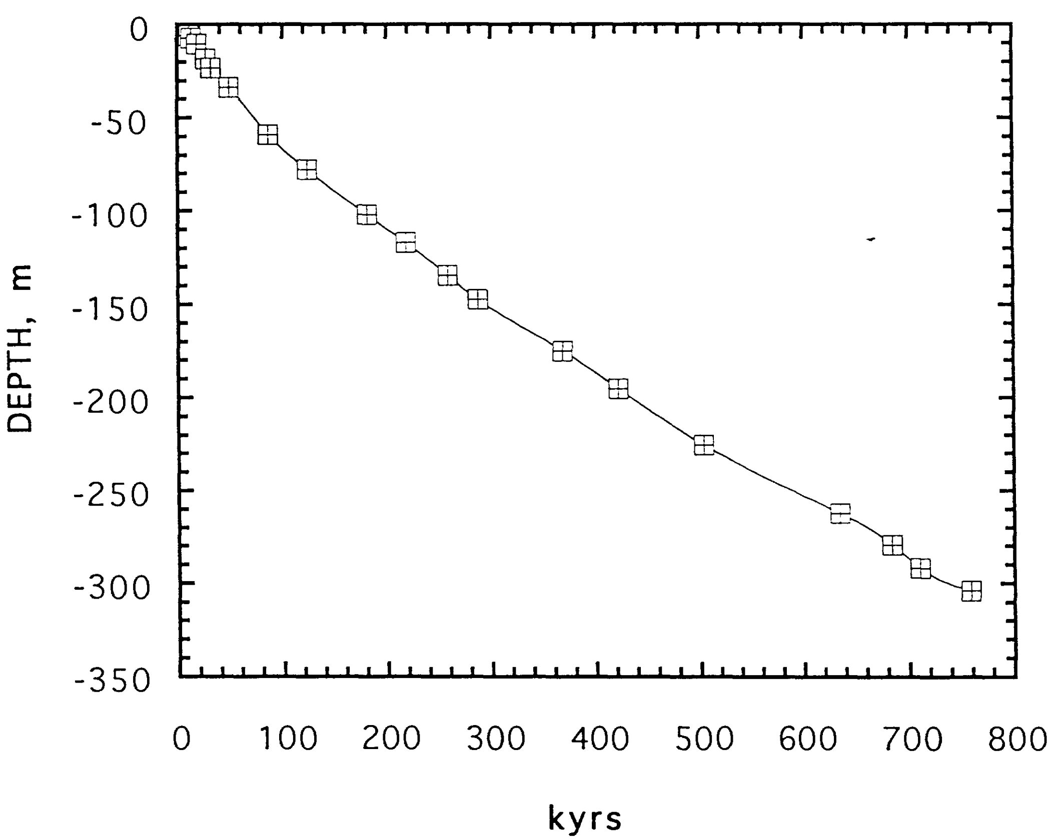

Fig. 4
Age-depth plot of 15 sediment parcels from Owens Lake drill hole OL-92 based on constant mass-accumulation rate model. Data from Table 2. Points are fitted via cubic spline.

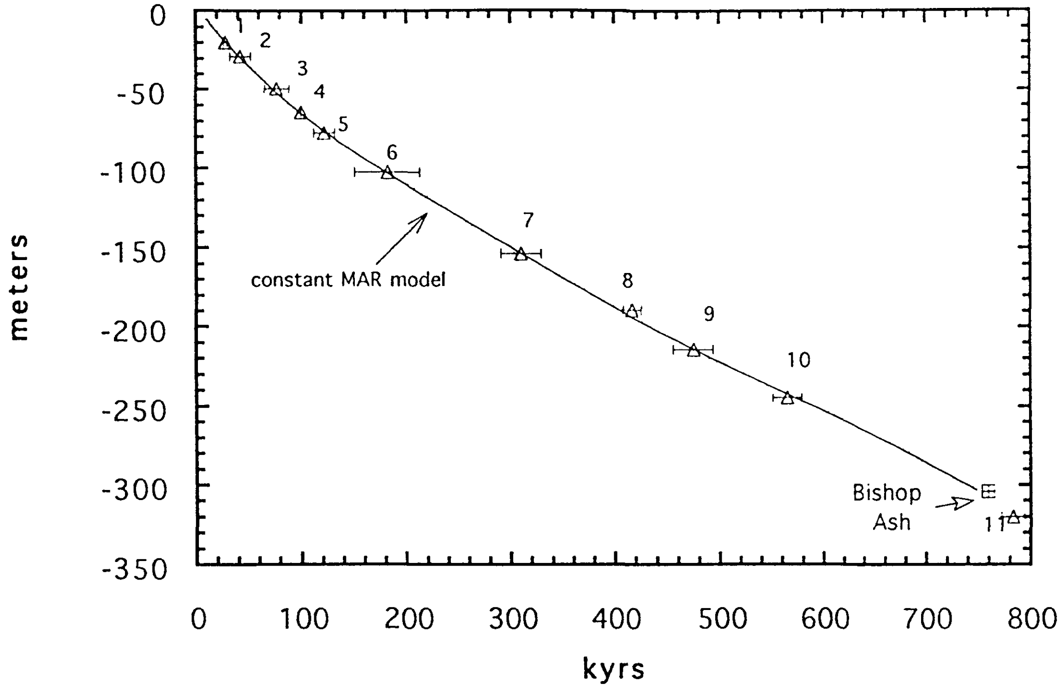

Fig. 5
Age-depth plot from Fig. 3 on which are superimposed 11 paleomagnetic excursions between the Bishop Ash and the surface reported by Glen et al (1993) as follows: 1. Mono Lake, 2. Laschamp, 3. NGS, 4. Fram Strass, 5. Blake, 6. Jamaica/Biwa1, 7. Levantine/Biwa2, 8. Biwa3, 9. Emperor, 10. Big Lost, 11. Brunhes/Matayama. Position of Bishop Ash from Sarna-Wojcicki et al (1993).

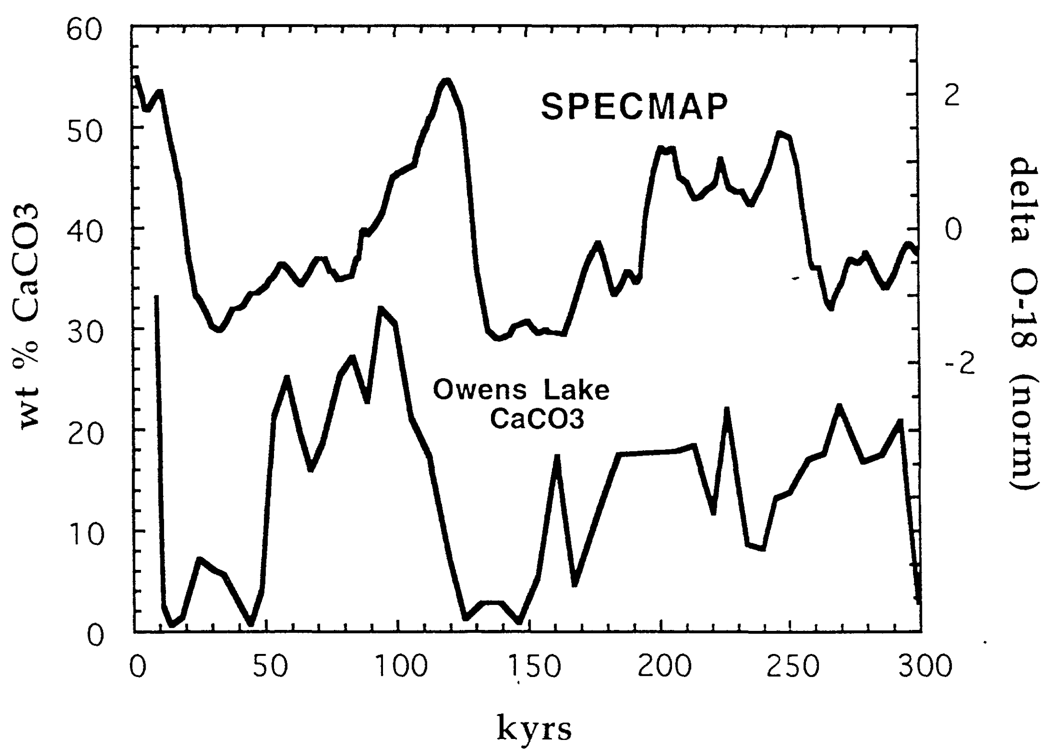

Fig 6
Plot of sediment $CaCO_3$-content versus age from Owens Lake sediments (OL-92 drill hole) as calculated from constant accumulation rate model in OL-92, compared to SPECMAP (Martinson et al, 1984)

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

DIATOMS IN SEDIMENTS

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6.1 Diatoms in sediments

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Denver, Colorado

Introduction

A total of 294 samples (154 samples from core # 1; 129 samples from core # 2 and 11 samples from core # 3) from Owens Lake, Inyo County, California were examined for diatoms to document Quaternary paleolimnological changes of this record.

Methods

Approximately 0.5 cc of dry sample was placed in a 15 ml graduated test tube and covered with about 5 ml concentrated HNO_3. After cessation of $CaCO_3$ reaction, the test tubes were placed in 100° C hot water bath for 30 minutes to dissolve remaining carbonates and related minerals and to oxidize organic matter. When cool, the acid was diluted with distilled water and dissolved substances in the supernatant liquid were decanted following centrifugation. Rinsing, centrifugation and decantation were repeated until all dissolved materials were removed from the processed material. The processed sediment was then allowed to settle in the tubes overnight, and the volume of water-saturated sediment was determined in the graduated tube. The water-saturated sediment was then suspended in 10x its water-saturated volume. Three drops of the diluted suspension were placed in a 50 ml settling dish that contained an 18 mm diameter coverslip. Water was added to the settling dish to re-suspend the sediment-laden drops so the sediment and diatoms could settle evenly over the coverslip and floor of the settling dish (e.g. Battarbee, 1974).

After 3 hours, the water was removed from the settling dish by micro-capillary wicking and the coverslips were allowed to dry. Coverslips were mounted in hyrax, a refractive mounting medium (n = 1.65). Diatoms were counted at 1000x magnification along transects measured by stage micrometer until at least 30 mm of transect were examined or until at least 300 diatoms were counted. Because the water-saturated sediment volumes were all proportionally diluted (10x) and because the same volume (3 drops) of suspended sediment was placed in each settling dish, the diatoms encountered per mm of transect in each sample gives an approximation of diatom concentration in the sample.

The technique can only be approximate for the following reasons: (1) The original samples contain variable amounts of soluble minerals (mostly carbonates) and digestion therefore variably concentrates diatoms. (2) Samples rich in glacial flour, silt, clay, or diatoms behave differently during suspension and delivery to the settling dish so that different amounts of residue may be deposited onto the coverslip. (3) Measured volumes in graduated 15 ml test tubes and by drops from disposable pipettes have inherent inaccuracies. (4) Diatoms are variably fragmented and enumeration techniques discriminate against small fragments. Nevertheless, the variation in numbers of diatoms in the samples is greater than the variability in lithologies and quantification techniques. The results can be considered consistently semi-quantitative and provide a useful measure of diatom concentration.

Diatoms were identified as closely as possible to descriptions of taxa in standard texts or placed in an open nomenclature. However, the diatom flora of the western United States is poorly known, and some taxa from Quaternary deposits of distinctive paleolimnological environments are probably new to science. In some cases such taxa are recorded by "cf." or "aff." on the original worksheets; in other cases they are lumped together with the nearest taxon of similar morphological appearance. Typically diatom preservation is variable and often quite poor in Owens Lake sediment because of breakage and corrosion. The raw counts presented in Appendices 1 and 2 represent whole valves and (or) large (> 40%) fragments of valves. Table 1 provides the provisional species names represented by the coded abbreviations on the spreadsheet

Diatoms may be generally classified into taxa presently living in or preferring fresh (<3‰ tds) and saline (>5‰ tds) waters. Many species found in the cores overlap in their salinity preferences and tolerances, and these guidelines cannot be taken too literally. For example, although most of the taxa considered "fresh" have optima well below 1‰ tds, they may inhabit waters 2 to 3 times more saline. "Saline" taxa, on the other hand, often tolerate (or even prosper in) a broad range of salinities above 5‰ tds, but they may be also present in waters below 5 ‰ tds. Today, the Owens River has a salinity of about 0.2‰ tds (200 ppm), and this salinity level may have been typical of Owens Lake when it was overflowing. The diatoms marked in Table 1 with an asterisk (*) are the more widely distributed taxa of saline waters.

Table 1. Diatom count codes and equivalent taxon

ach = *Achnanthes* (total)
amp-cof = *Amphora coffaeiformis* (*)
amp-oval = *Amphora ovalis*
amp-per = *Amphora perpusilla*
ano-cos = *Anomoeoneis costata* (*)
ast-form = *Asterionella formosa*
au-amb = *Aulacoseira ambigua*
au-gr = *Aulacoseira granulata*
au-isl? = *Aulacoseira islandica* ?
au-sarc = *Aulacoseira subarctica*
au-sol = *Aulacoseira solida*
cal = *Caloneis* (total)
cam-cly = *Campylodiscus clypeus* (*)
cam-smo = *Campylodiscus* sp? a smooth morphotype perhaps related to *Surirella hoffleri.*
chaet = *Chaetoceros muelleri* (usually spores) (*)
coc = *Cocconeis* spp. (total)

(Table 1, cont.)

coc-neot = *Cocconeis neothumensis*
coc-plac = *Cocconeis placentula*
cyc-bod = *Cyclotella bodanica*
cyc-casp = *Cyclotella caspia* (*)
cyc-men = *Cyclotella meneghiniana*
cyc-oce = *Cyclotella ocellata*
cyc-quil = *Cyclotella quillensis* (*)
cymb = *Cymbella* spp. (total)
cyst-opn = *Cyclostephanos* sp. (open center, with loosely packed areolae)
epi = *Epithemia* spp. (total)
fr-brev = *Fragilaria (Pseudostaurosira) brevistriata*
fr-cap = *Fragilaria caupucina*
fr-con = *Fragilaria (Staurosira) construens*
fr-crot = *Fragilaria crotonensis*
fr-lepto = *Fragilaria (Staurosirella) leptostauron*
fr-pin = *Fragilaria (Staurosirella) pinnata*
fr-vau = *Fragilaria vaucheriae*
gom = *Gomphonema* spp. (total)
gyro = *Gyrosigma* spp (total)
hz-am = *Hantzschia amphioxys*
mel-hudt = *Melosira hustedti*
mel-var = *Melosira varians*
nav = *Navicula* spp. (total)
nitz = *Nitzschia* spp. (total)
nz-frust = *Nitzschia frustulum* (*)
nz-mono = *Nitzschia monoensis* (*)
nz-pus = *Nitzschia pusilla* (*)
pin = *Pinnularia* spp (total)
rho-con = *Rhopalodia constricta* (*)
rho-gbr = *Rhopalodia gibberula* (*)
rho-gib = *Rhopalodia gibba*
rhoi = *Rhoicosphenia curvata*
st-ast = *Stephanodiscus asteroides*
st-carc = *Stephanodiscus* sp. cf. *St. carconensis*
st-fn/ecc = *Stephanodiscus* sp. a finely-structured eccentric species
st-min = *Stephanodiscus minutulus* type
st-nia = *Stephanodiscus niagarae*
st-ore = *Stephanodiscus oregonicus*
st-ovecc = *Stephanodiscus* sp. (oval and eccentric form)
st-parv = *Stephanodiscus parvus*
st-10 = *Stephanodiscus* sp. (similar to #10 of Stoermer e.p.). Maybe a *Cyclostephanos* species.

(Table 1, cont.)

sur-str = *Surirella striatula* (*)
sur-ova = *Surirella ovalis* type
syn-acus = *Synedra acus*
syn-maz = *Synedra mazamaensis*
syn-rum = *Synedra rumpens* types
syn-uln = *Synedra ulna*
d/mm = diatom valves per mm of transect
count = total diatom valve count
trav = traverse length in mm

Results

The graphic representation of diatom counts (Figs. 1-18) are plotted against composite stratigraphic sequence based on Owens Lake cores 1, 2, and 3. A minor stratigraphic overlap exists between the base of the uppermost core (7.16 m, Core 3) and the top of underlying Core 1 (5.49 m). The distribution of *Cyclotella ocellata* across the boundary also suggests a potential overlap (Appendix 1). For the stratigraphic plots (Figs. 1-20) the overlapping depths between Cores 1 and 3 have been adjusted to eliminate possible stratigraphic overlap. There appears to be no stratigraphic overlap between the basal sample of Core 1 (61.37 m) and the top sample of Core 2 (61.26 m).

Overall, Figures 1-18 document rapid fluctuations of numbers of individual diatom taxa counted, even over short stratigraphic intervals. Diatom concentration, calculated as the number of all diatom valves encountered per mm of microscope transect (Fig. 19), also varies widely between adjacent samples, particularly in zones where saline diatoms are abundant. Throughout its history, Owens Lake was extraordinarily sensitive to hydrologic and climatic change, sometimes oscillating over short periods of time between a large, through-flowing, freshwater lake and a shallow saline or playa lake. Stratigraphic and paleolimnologic continuity is better developed during periods when the lake was fresh and overflowing than when it was shallow and saline. For example, the most closely spaced samples (e.g. Core 1, 9.5 m to 19.0 m) are about 20 cm (~250 yr) apart (Fig. 20). Within this interval, the concentration of *Asterionella formosa*, a freshwater planktonic diatom, documents cycles of limnological change during the full glacial (15.9 - 25.3 ka) at millennial to sub-millennial scales. Fresh, high-water stages probably reflect more stable limnologic environments that favor nearly continuous deposition rather than short cycles of deposition and erosion characteristic of low and saline lake stages.

It is clear that at least parts of the Owens Lake cores have the potential for high resolution studies of climate change if detailed chronologies can be established.

The diatoms of the Owens Lake core can be organized into ecological groups that have more or less coherent stratigraphic distributions. Five groups have been established (Figs. 21-22).

1. Freshwater planktonic diatoms: all species of *Stephanodiscus*, *Asterionella formosa*, *Fragilaria crotonensis*, *Cyclotella ocellata*, *C.. bodanica*, *Cyclostephanos* species, all *Aulacoseira* species, and most species of *Navicula*.

2. Freshwater benthic diatoms: "*Fragilaria*" species: *Fragilaria brevistriata*, *F. construens*, *F. leptostauron*, and F. *pinnata*.

3. Other Freshwater (mostly benthic) taxa: *Achnanthes*, *Amphora ovalis*, *A. perpusilla*, *Caloneis, Cocconeis*, *Cymbella*, *Epithemia*, *Fragilaria vaucheriae*, *Fragilaria capucina*, *Gomphonema*, *Gyrosigma*, *Hantzschia*, *Melosira*, *Pinnularia*, *Rhoicosphenia curvata*, *Rhopalodia gibba*, *Synedra acus*, *S. mazamaensis*, *S. rumpens*, *S. ulna*.

4. Saline planktonic diatoms: *Chaetoceros muelleri* spores, *Cyclotella caspia*, *C. quillensis*, *C. meneghiniana*.

5. Saline benthic diatoms: *Amphora coffaeiformis*, *Anomoeoneis costata*, *Campylodiscus clypeus*, *Nitzschia frustulum*, *N. monoensis*, *N. pusilla*, *Rhopalodia constricta*, *R. gibberula*, *Surirella hoffleri*, *S. ovalis*, *S. striatula*.

The concentration of freshwater diatoms (Fig. 21) is generally an order of magnitude greater than concentrations of saline diatoms (Fig. 22), probably reflecting poor diatom preservation in saline systems. Alkaline corrosion of biogenic silica, slow deposition rates, and exposure of lake sediments to shallow, high-energy environments probably account for much of the diatom destruction in such habitats. Episodes of high concentrations of saline planktonic diatoms, implying large and possibly deep saline lakes, are rare in the Owens Lake record (Fig. 22); this is in contrast to the paleolimnology of terminal Great Basin lakes such as Walker Lake (Bradbury et al., 1989). Throughout most of its history, Owens Lake apparently freshened when there was sufficient flow in the Owens River.

Peaks of freshwater planktonic diatoms logically correlate with increased flow of the Owens River and probably reflect moister, glacial climates during which Sierran glaciers would expand. Saline planktonic and benthic diatoms most likely correlate with arid, interglacial climates and reduced flow of the Owens River.

Species of *Fragilaria* and other freshwater benthic diatoms have a similar stratigraphic distribution, although benthic *Fragilaria* species dominate below 200 m (Fig. 21). Large concentrations of *Fragilaria* species indicate periods of time when Owens Lake was shallow, but fresh; probably a through-flowing marsh system. It is reasonable to suppose that tectonic rejuvenation of the basin was required to reestablish a lake morphometry suitable for planktonic diatoms, although geomorphic alteration of the Owens sill could also be involved. Perhaps the stratigraphic distribution of *Fragilaria* species documents periods of tectonic quiescence that allowed the Owens basin to nearly fill with sediment and develop persistent shallow-but-fresh marsh environments.

The full paleolimnological interpretation of the diatom stratigraphy of the Owens Lake cores will require integration of ancillary stratigraphic data from pollen, ostracodes, geochemistry and mineralogy coupled with a detailed absolute chronology.

References

Battarbee, R.W., 1973, A new method for the estimation of absolute microfossil numbers, with reference especially to diatoms: Limnology and Oceanography, v. 18, p. 647-653.

Bradbury, J.P., Forester, R.M., and Thompson, R.S., 1989, Late Quaternary paleolimnology of Walker Lake, Nevada: Journal of Paleolimnology, v. 1, p. 249-267.

Figure Captions

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

Figure 19. Diatom concentrations (diatom valves encountered per mm of microscope transect) *versus* depth in the composite Owens Lake core.

Figure 20. Concentrations of *Asterionella formosa* between ~15 and ~25 ka (9.5 to 19.0 m) showing sub-millennial cycles of abundance. This species is a freshwater planktonic diatom that generally lives in water well below 0.7‰ tds. It typically blooms in the spring after ice-out when nutrients, especially Si and light, are abundant. *Asterionella formosa* is a common member of the phytoplankton of Sierran lakes in the Owens Lake drainage. By analogy, its cyclic abundance in Owens Lake during the late Pleistocene could suggest cyclic cool periods with increased precipitation and extension of montane environments to lower elevations.

Figure 21-22. Concentrations of ecological groups of diatoms in the Owens Lake composite core. Figure 21 also plots abundance of benthic *Fragilaria* species which live loosely attached to aquatic plants, rocks, and sediment surfaces in shallow environments (about 2 m) of freshwater lakes and marshes. Deltaic/marsh environments at the head of Pleistocene Owens Lake may have been the principal source of these diatoms. Their abundance at the base of the Owens Lake core suggests a predominance of shallow, riverine environments during this stage of the Owens Lake history.

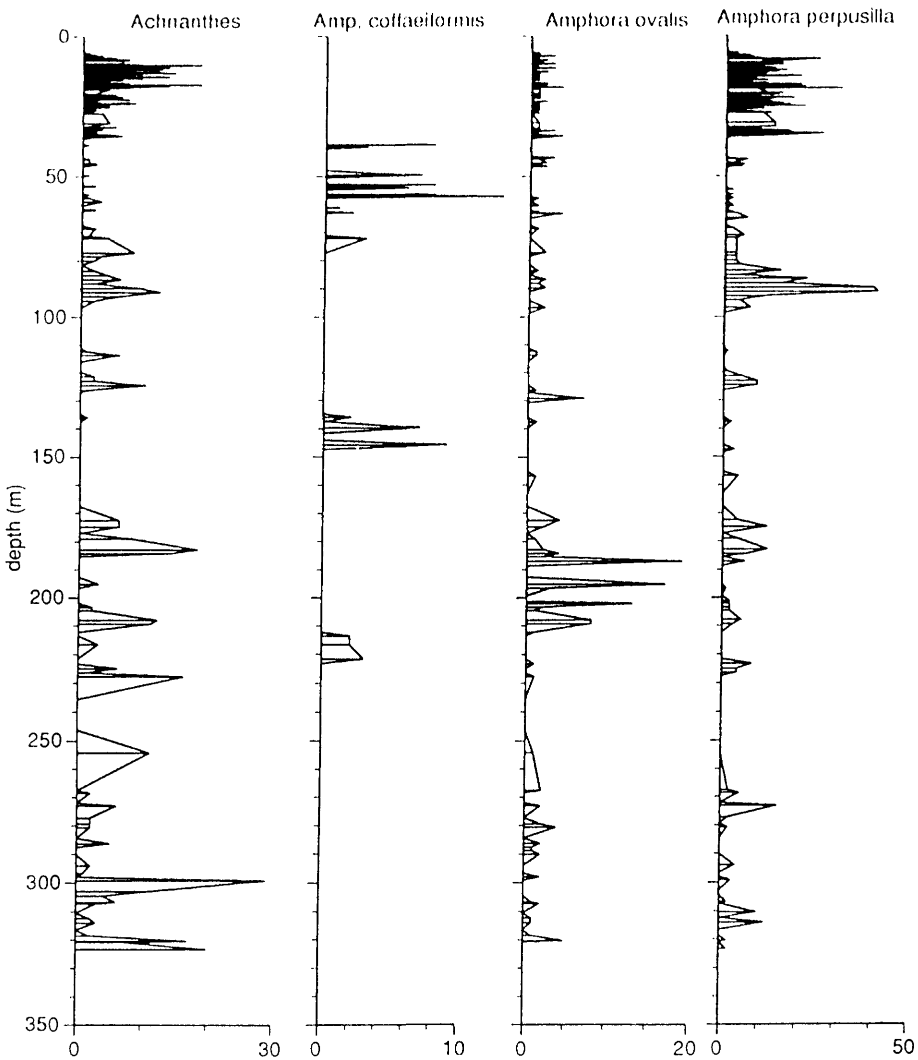

Fig. 1

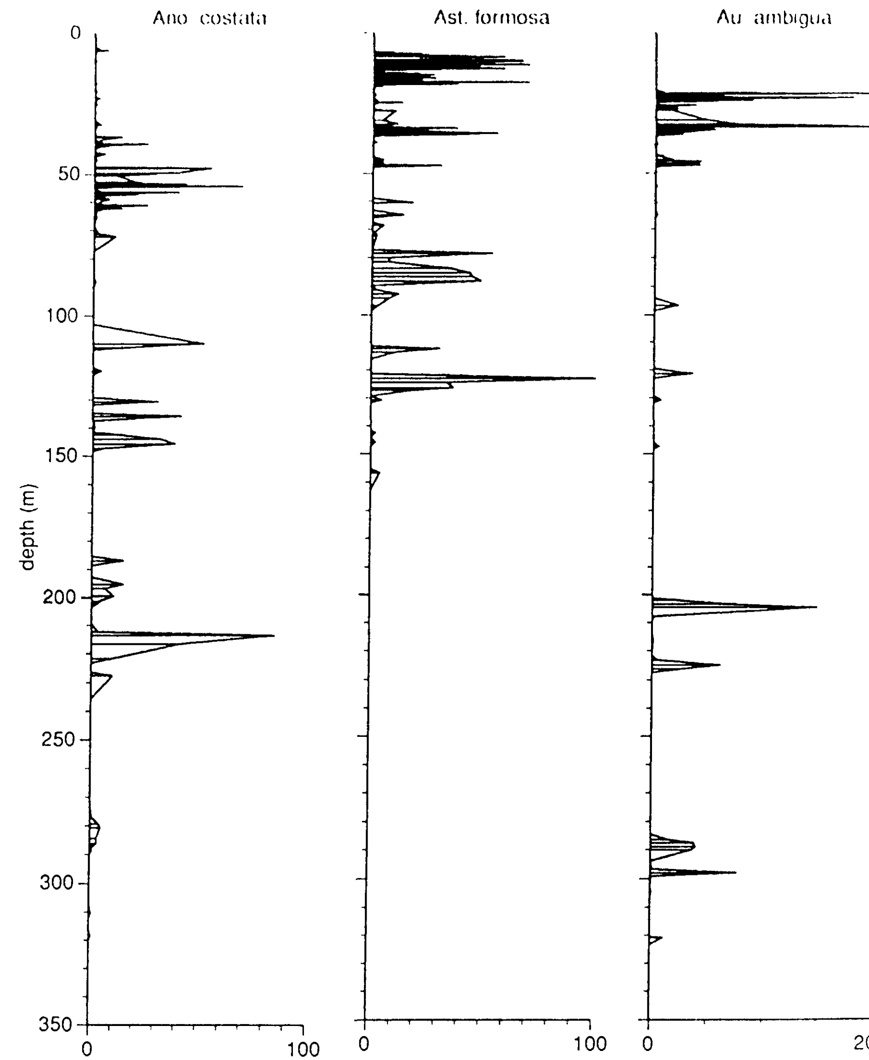

Fig. 2

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

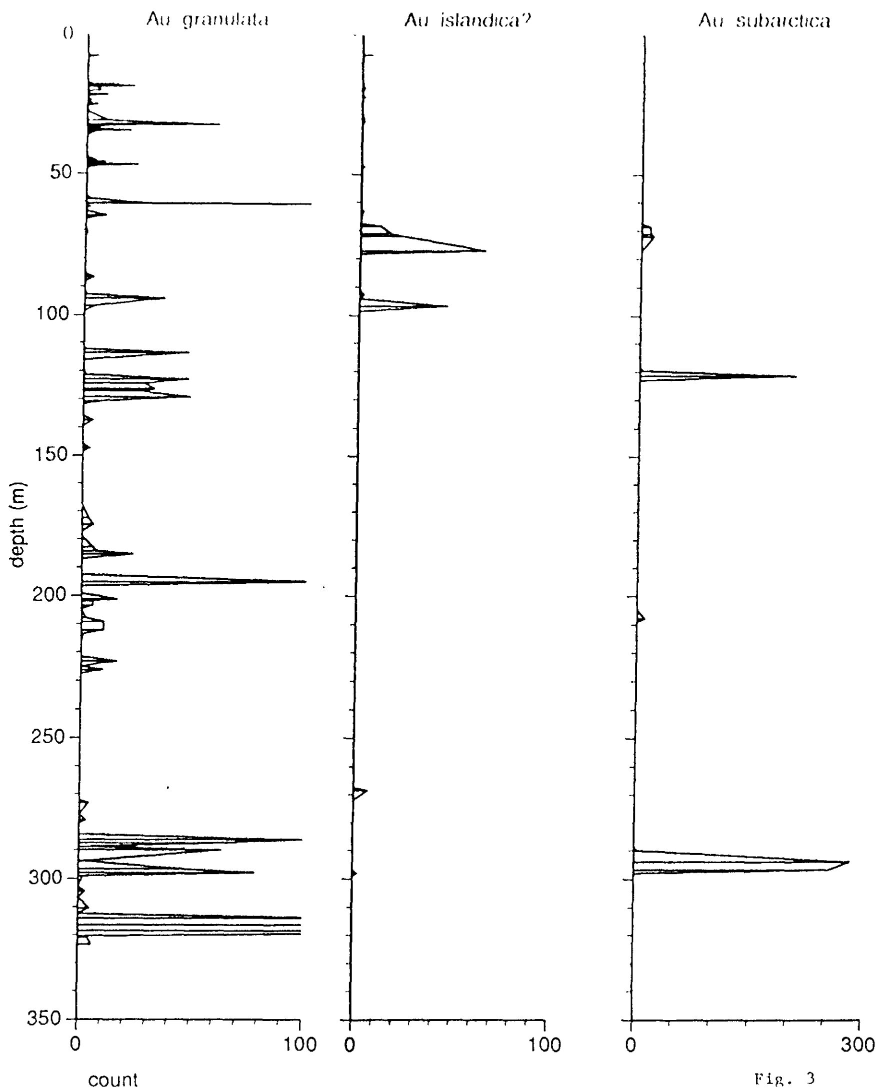

Fig. 3

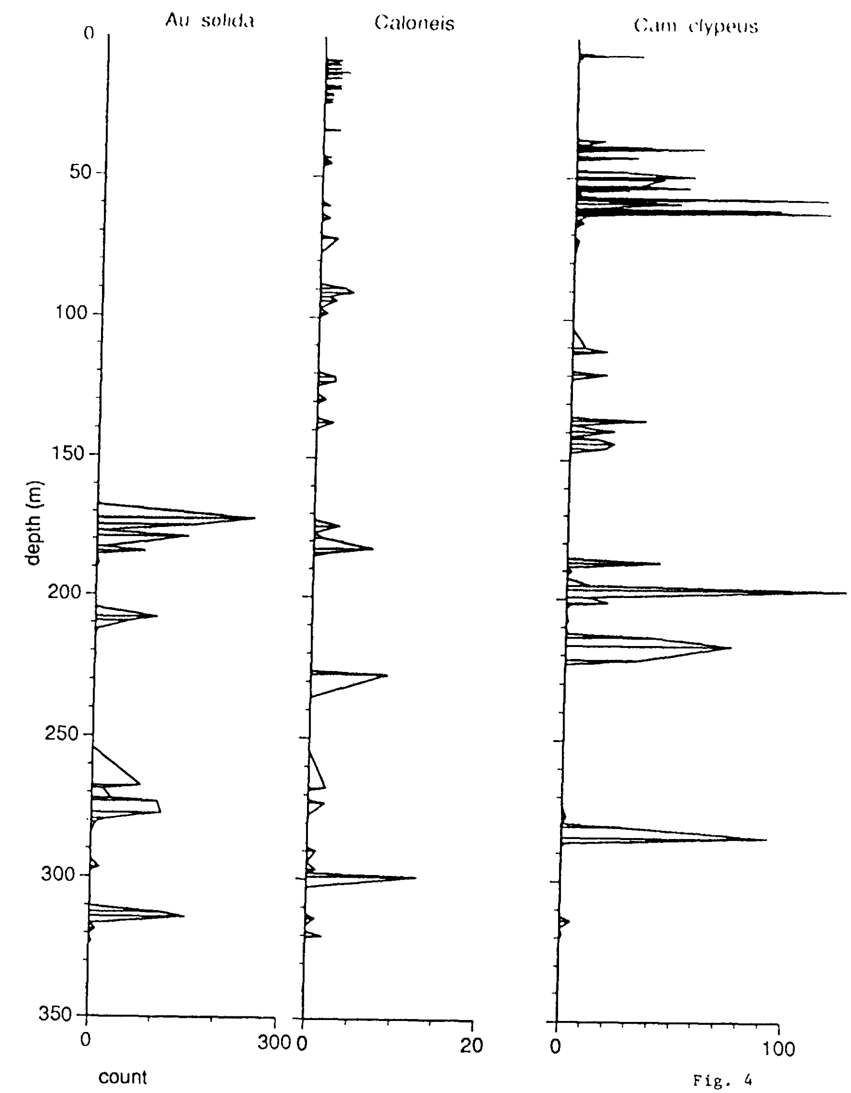

Fig. 4

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

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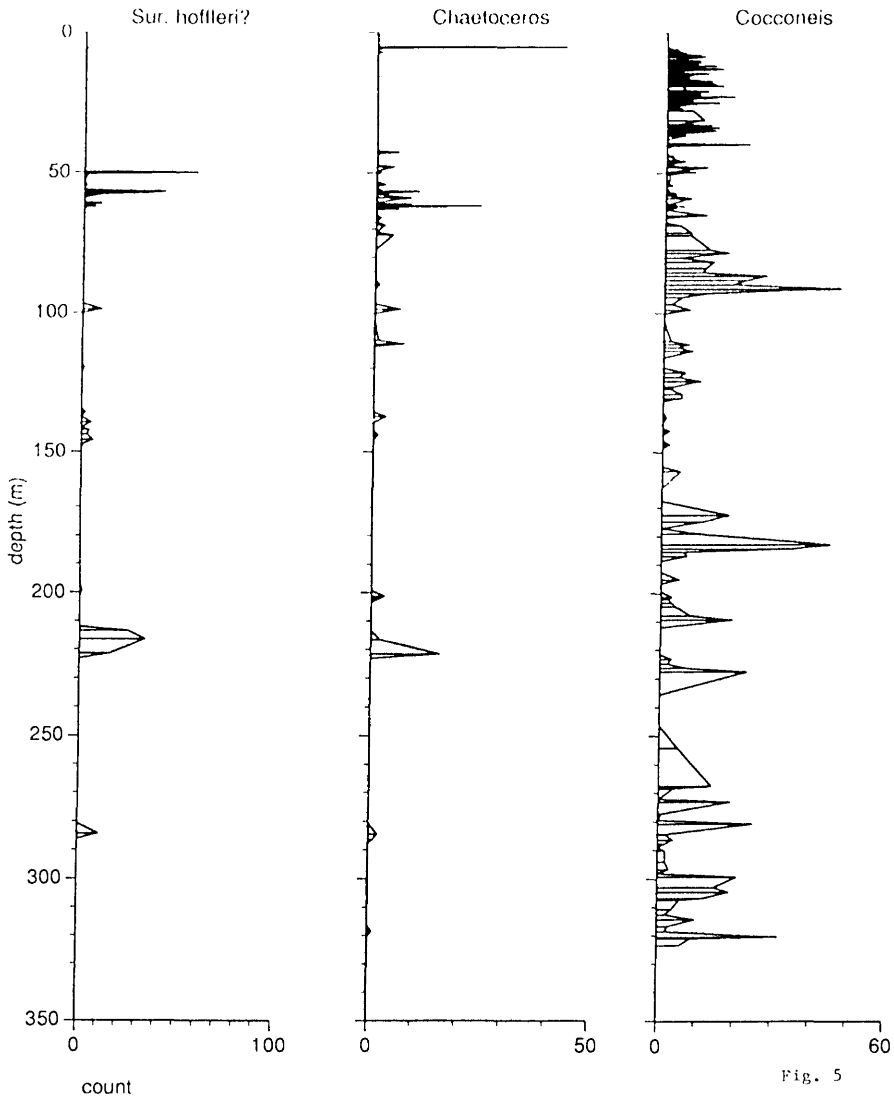


Fig. 5

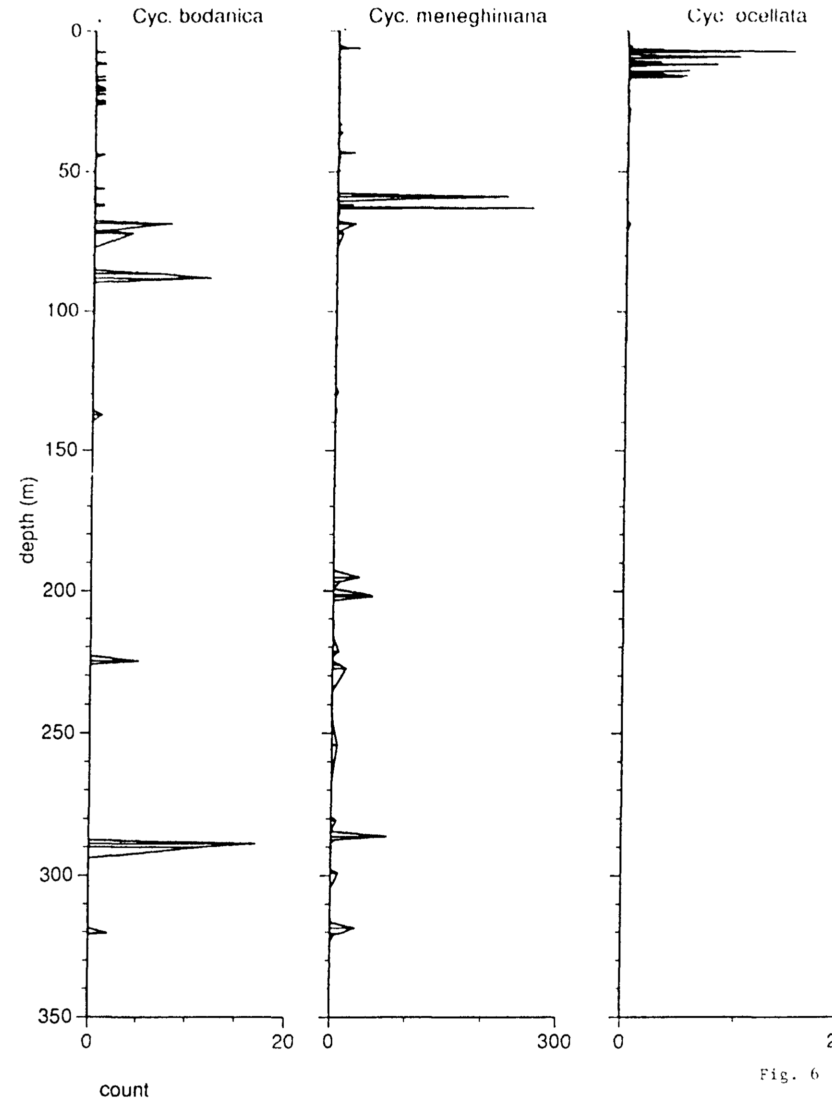
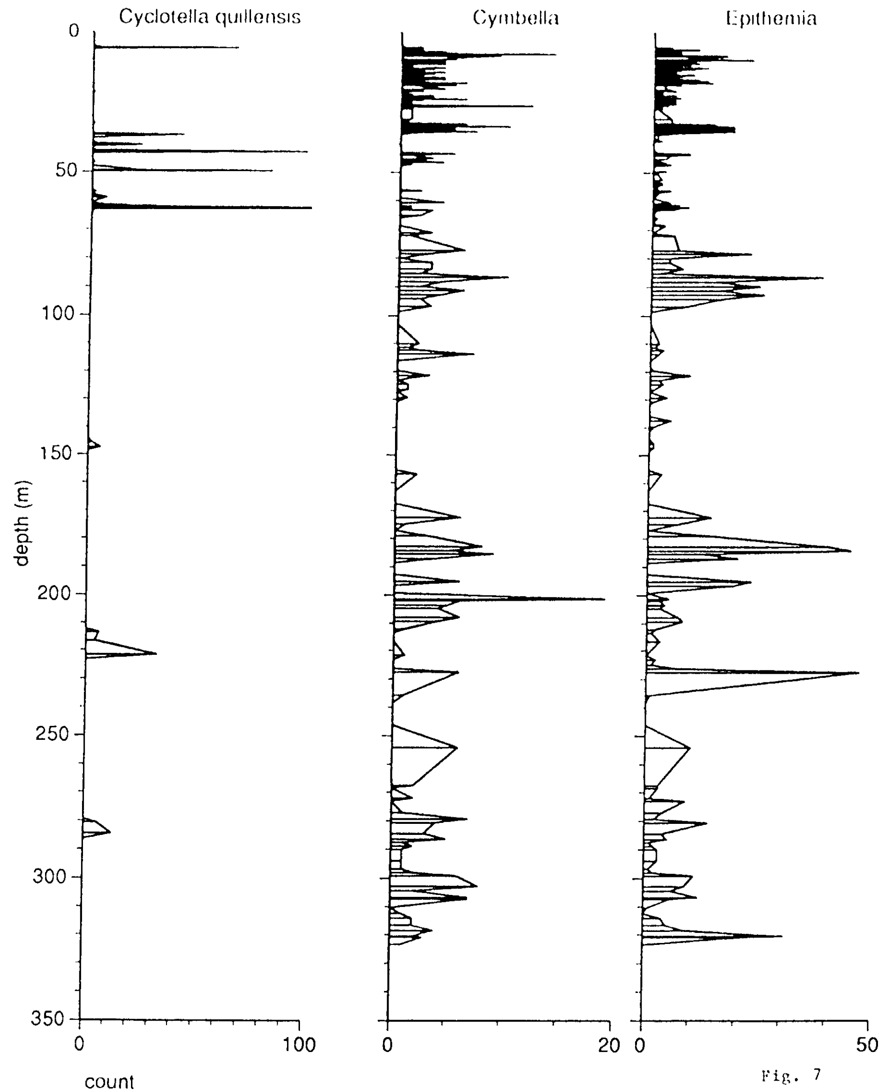
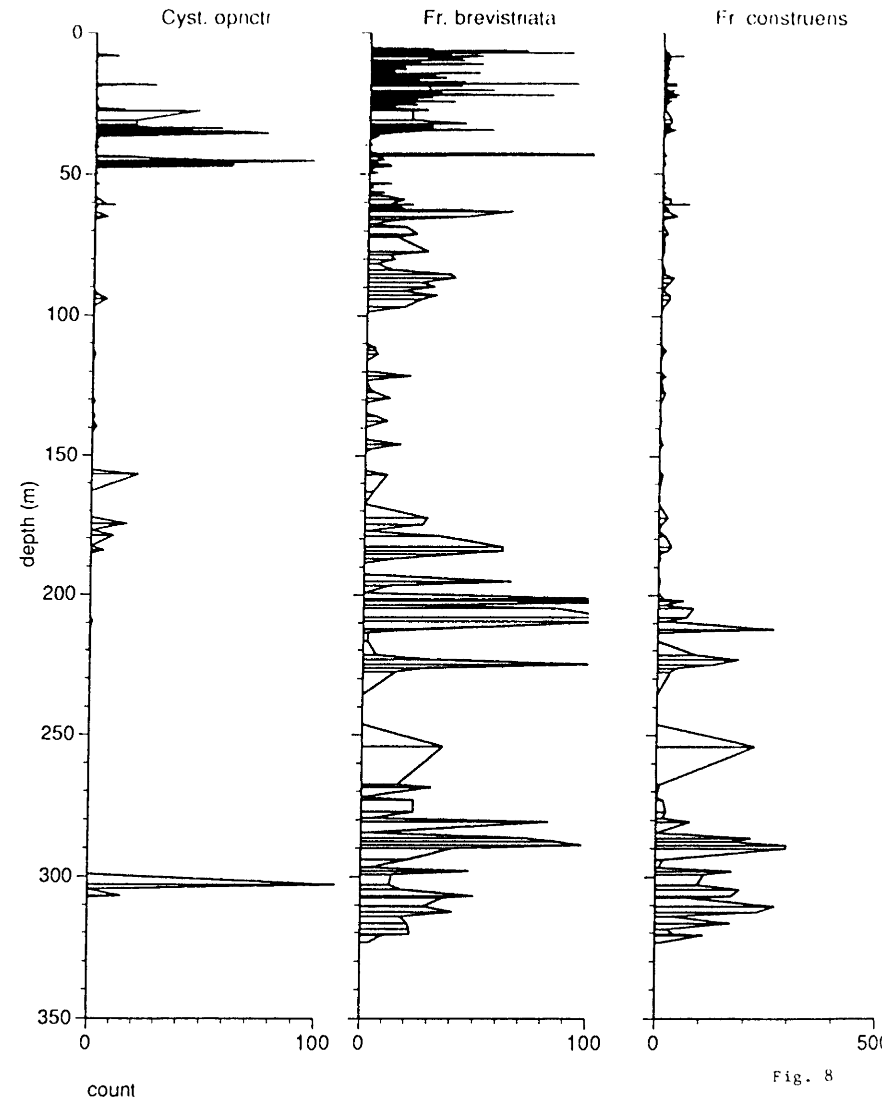


Fig. 6

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.





Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves

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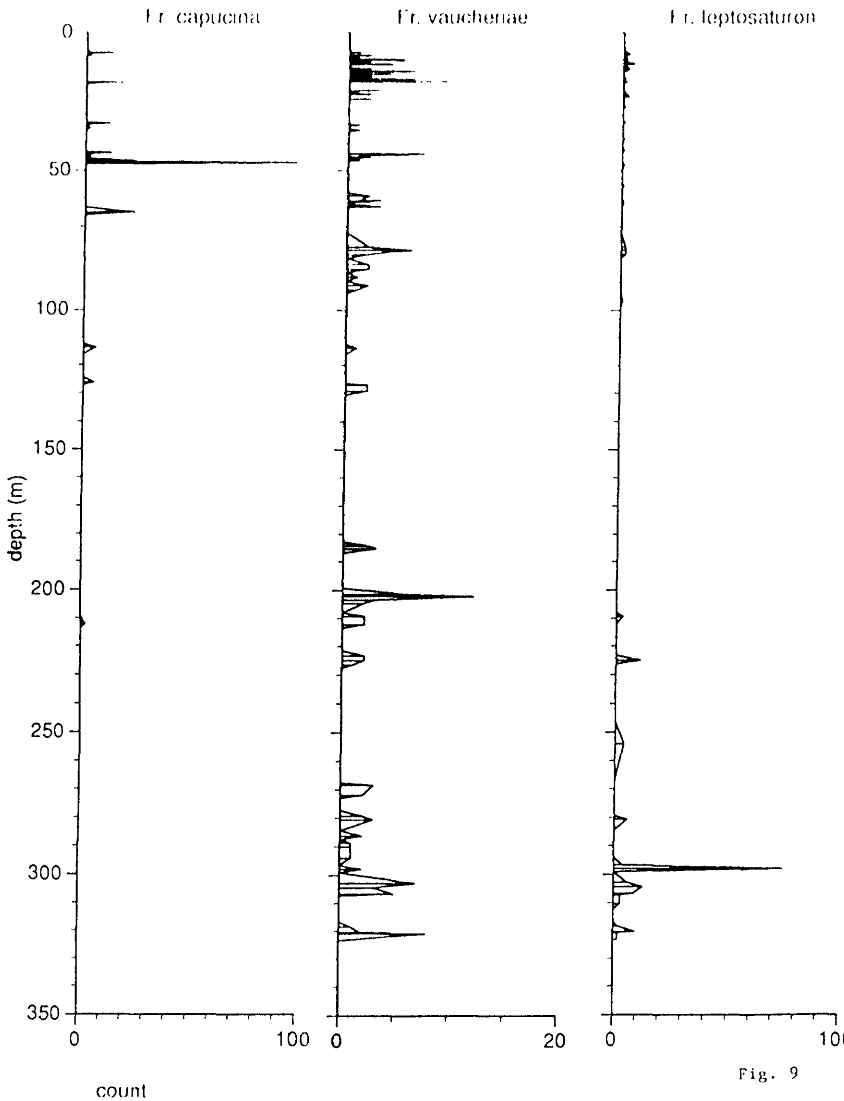

Fig. 9

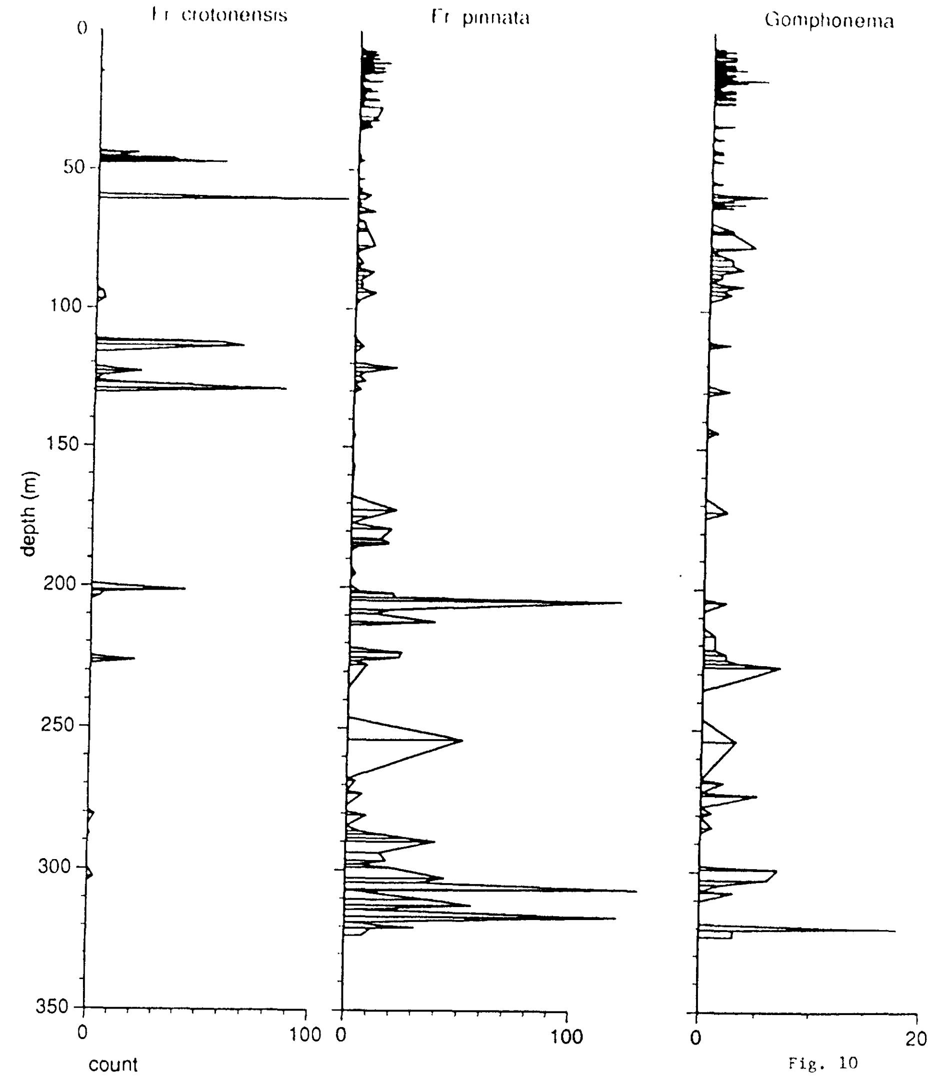

Fig. 10

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

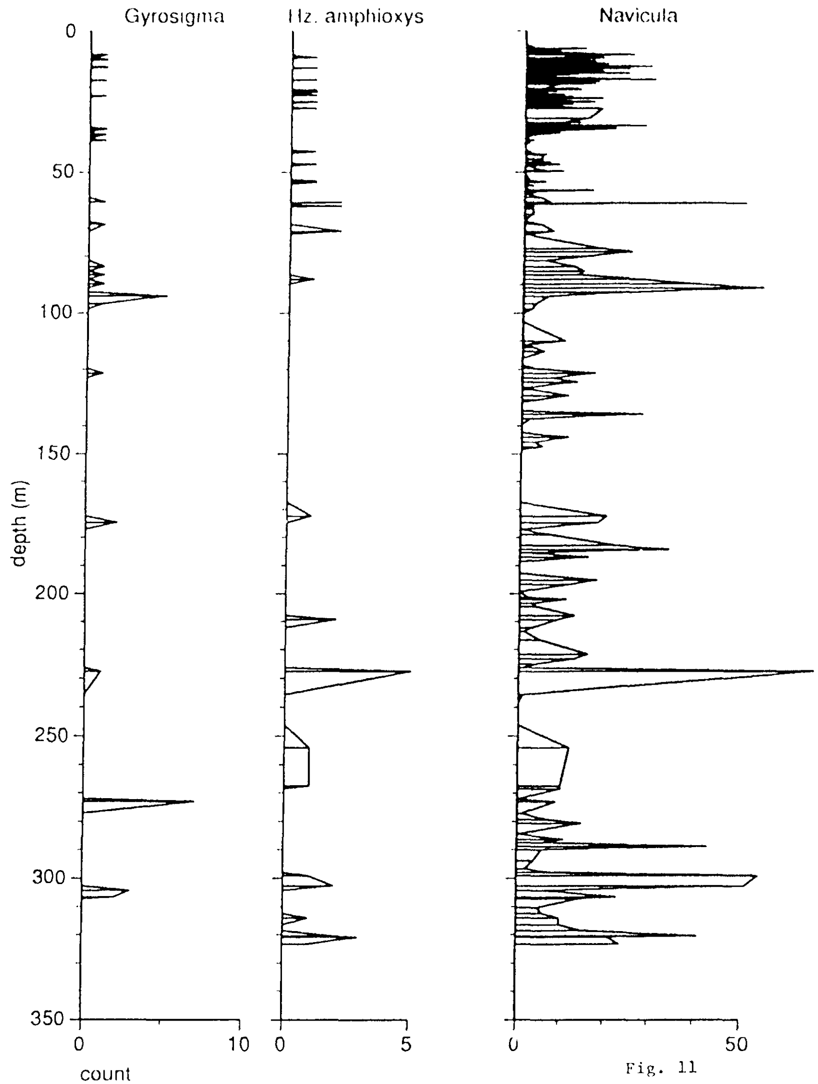

Fig. 11

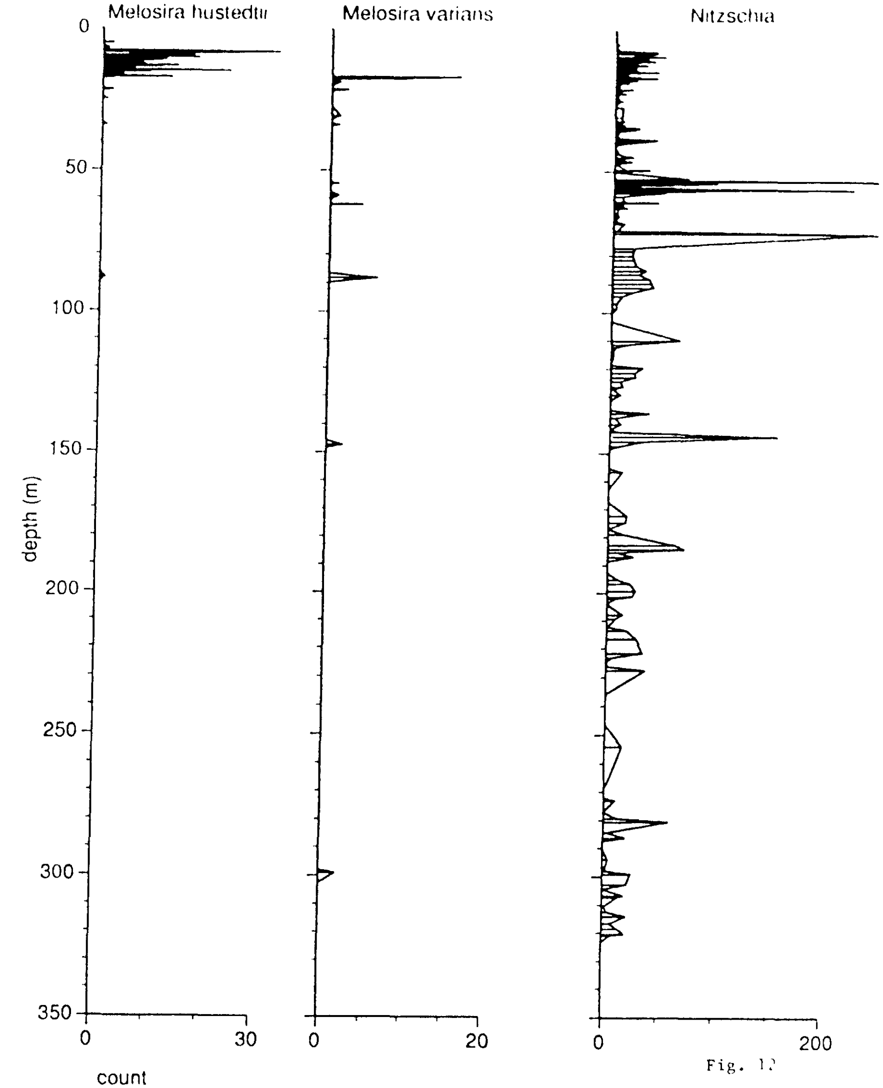

Fig. 12

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

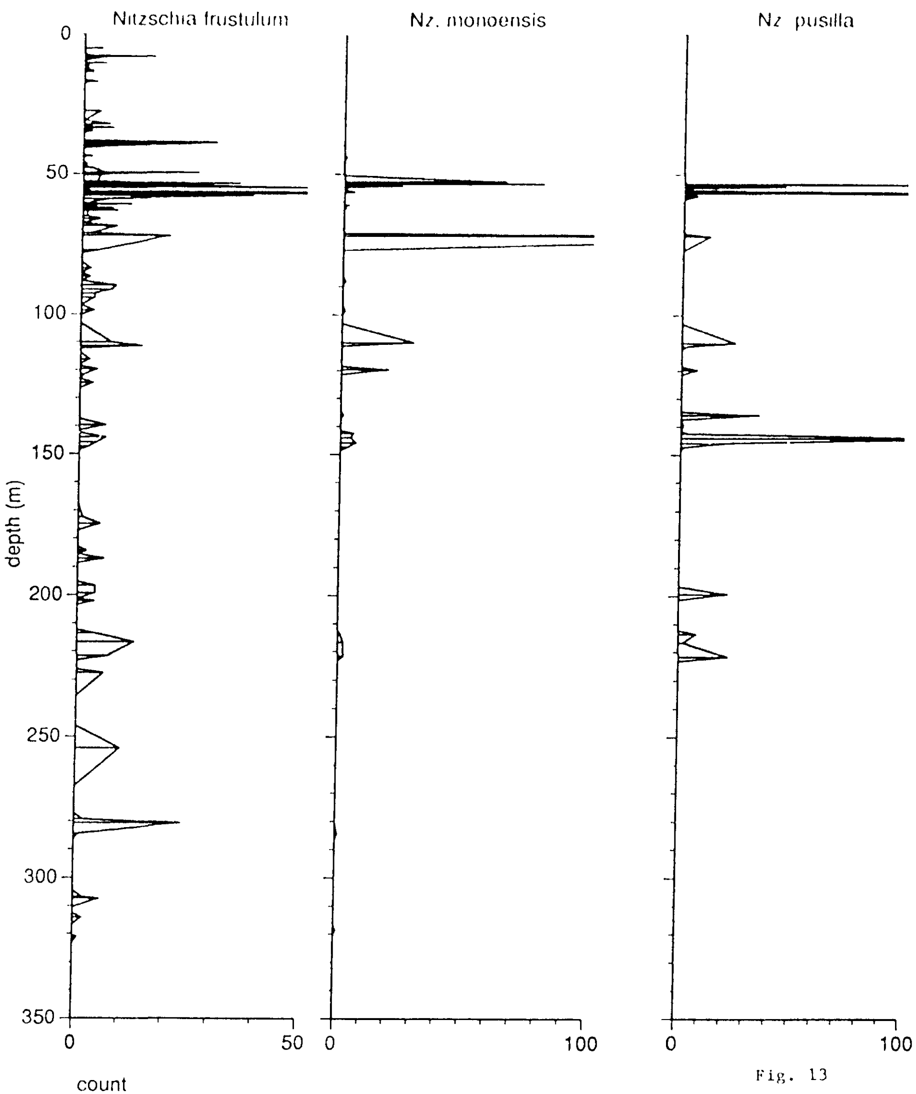

Fig. 13

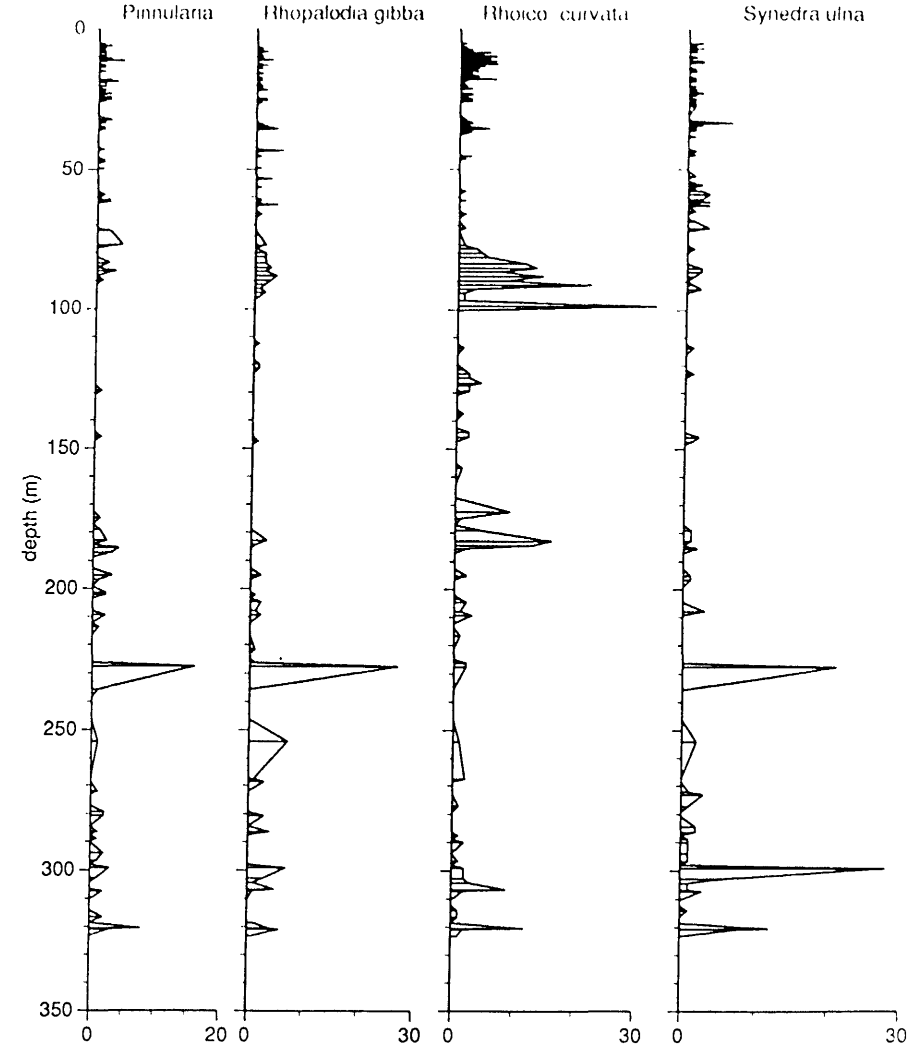

Fig. 14

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

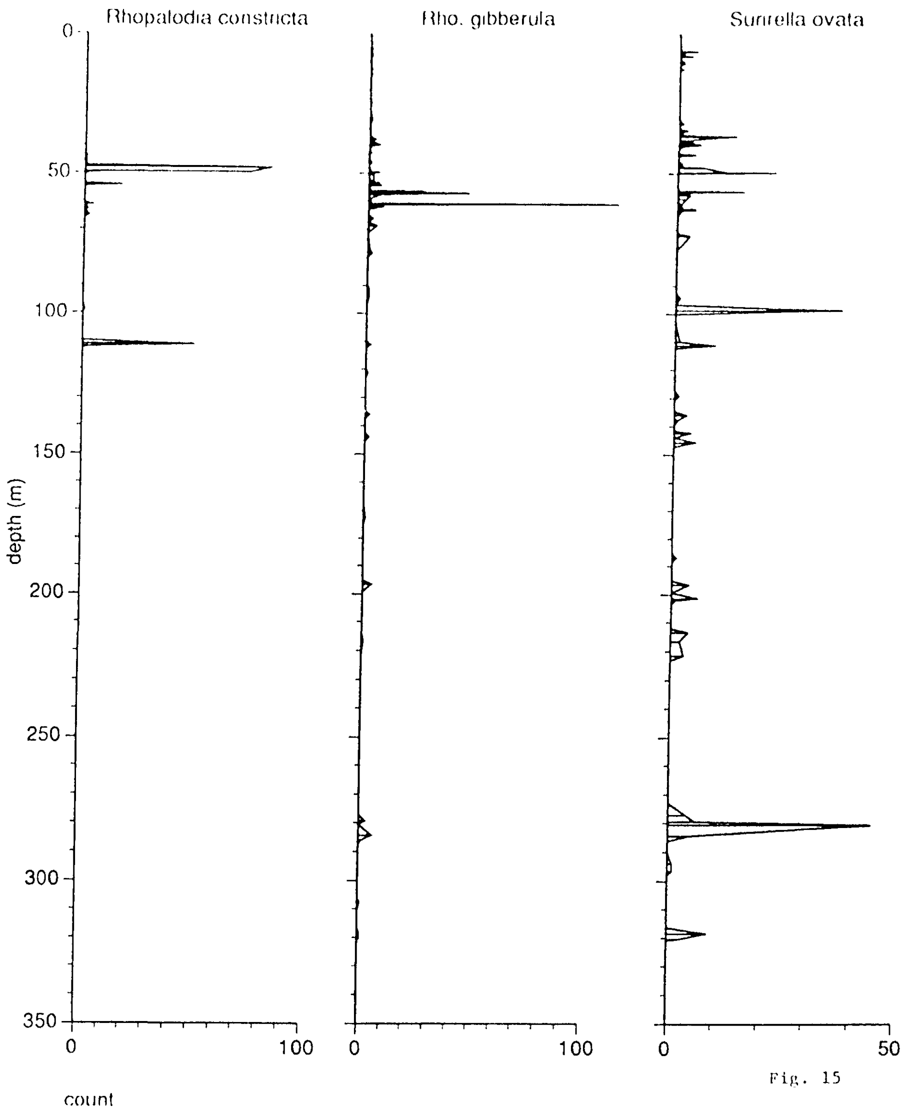

Fig. 15

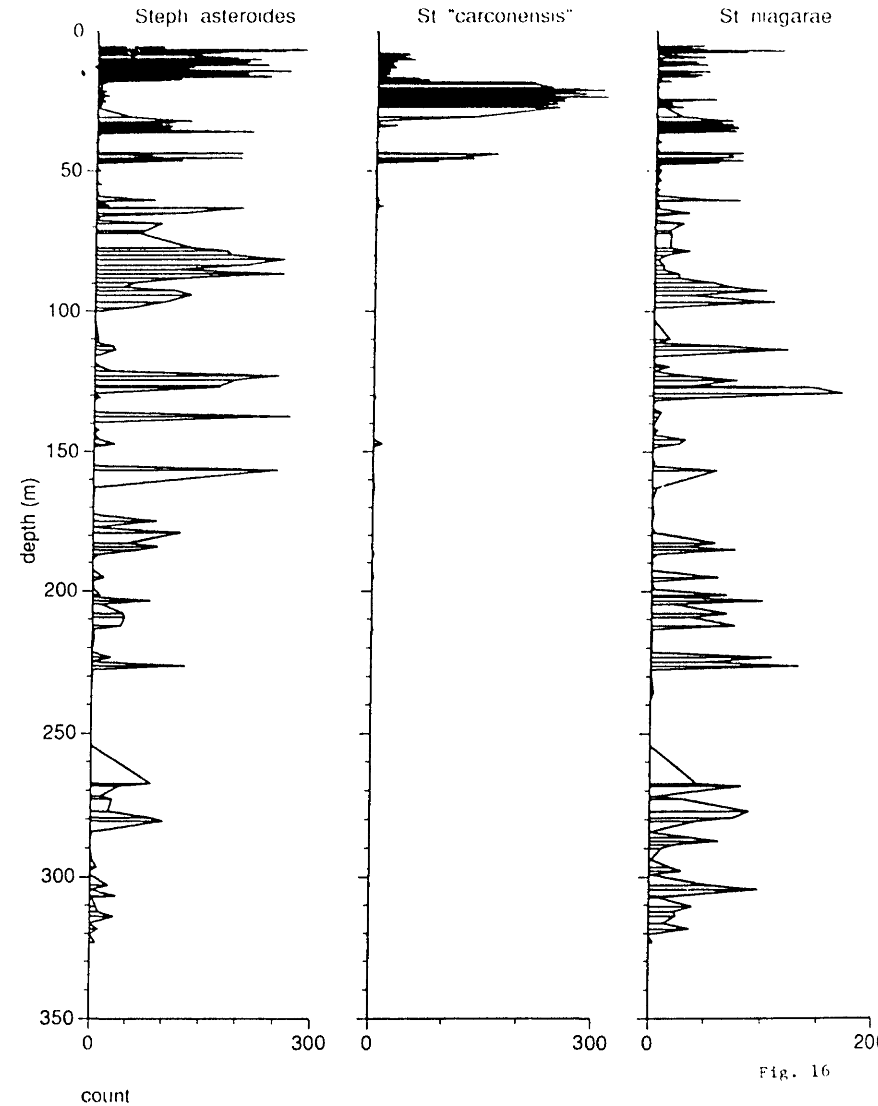

Fig. 16

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

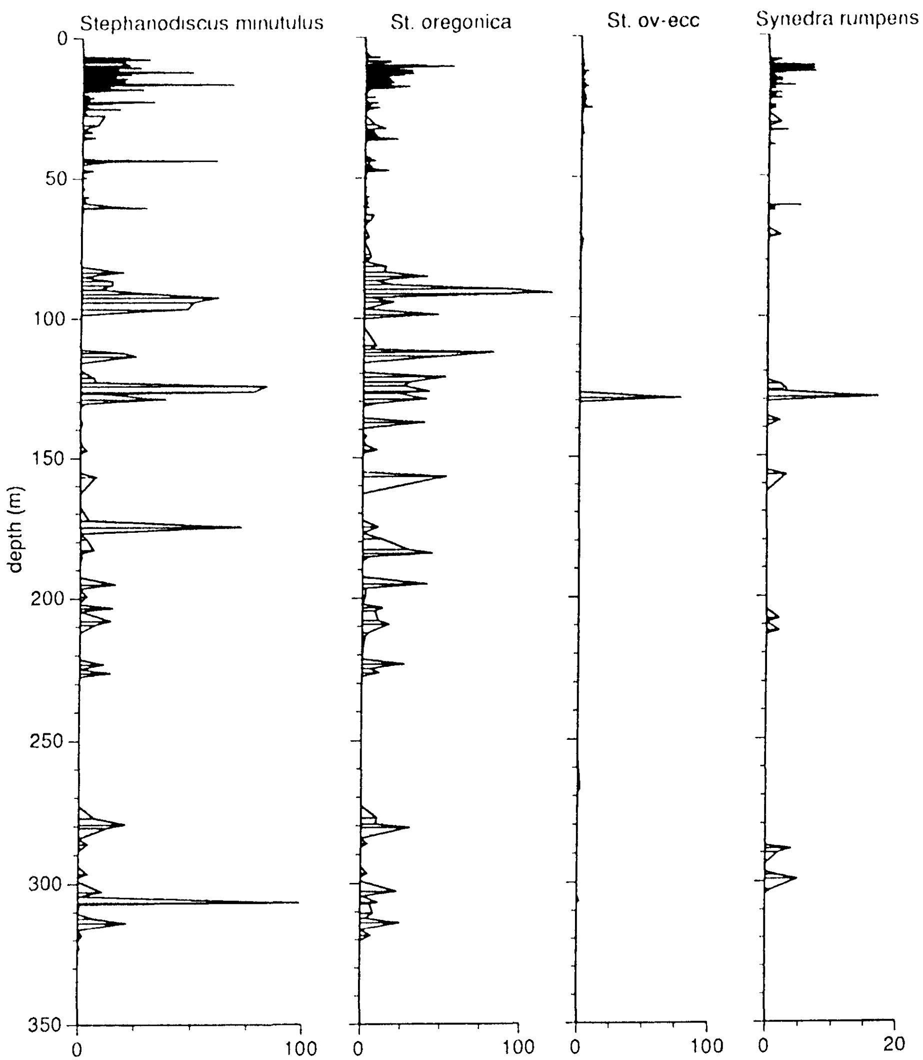

Fig. 17

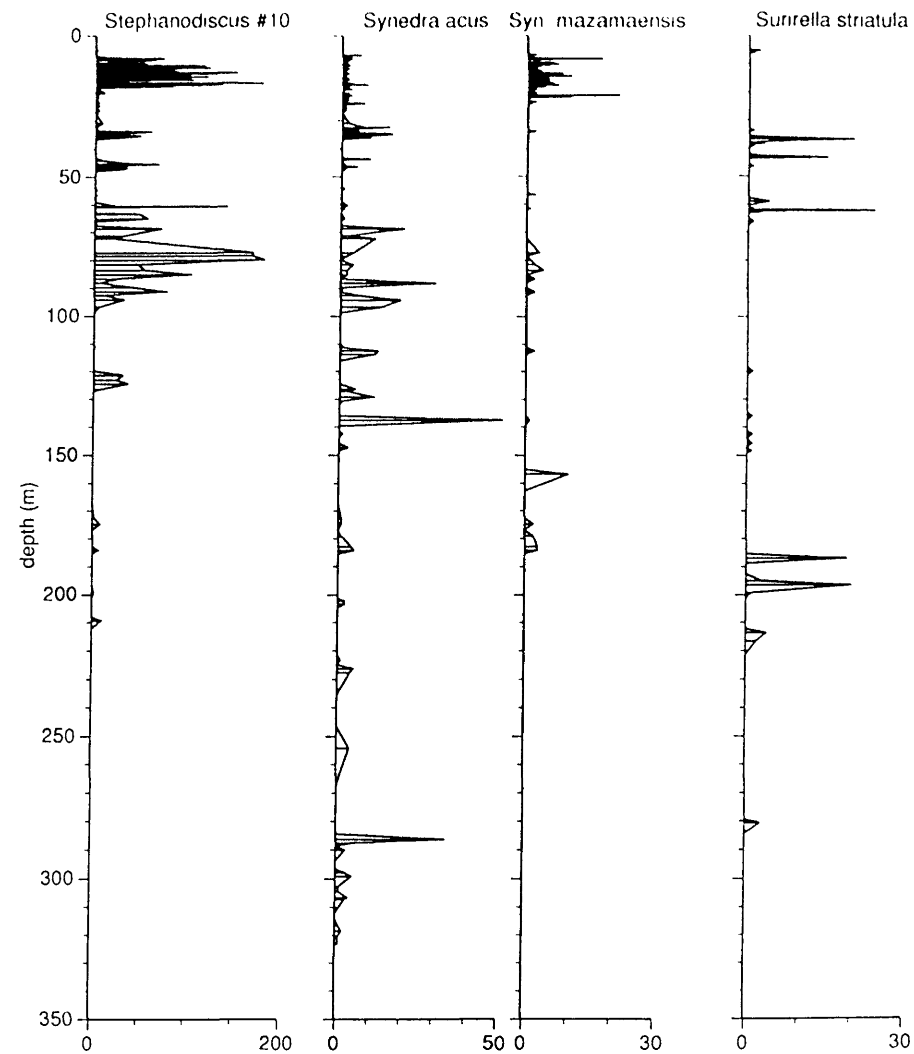

Fig. 18

Figures 1-18 Raw diatom counts versus depth in the composite Owens Lake core, based on analyses of cores 1, 2, and 3. Abscissa represents numbers of valves.

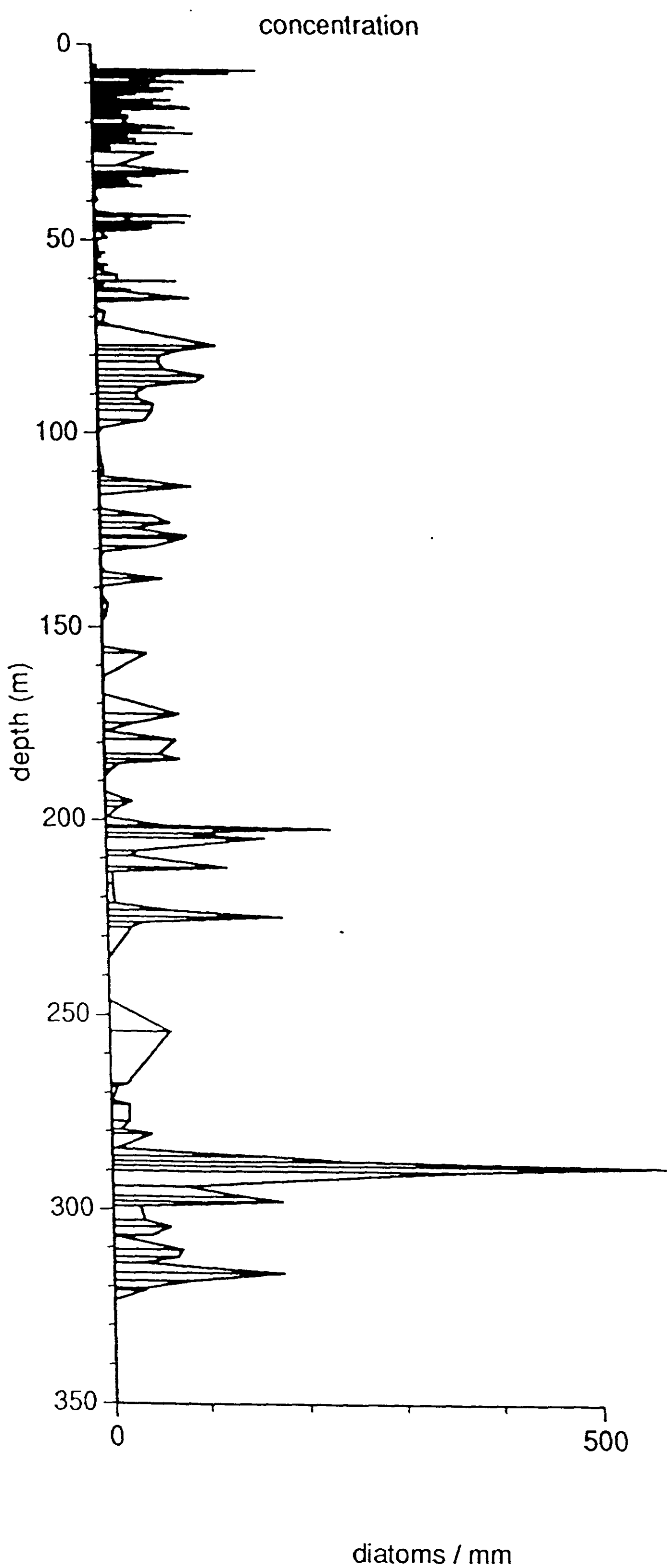

Figure 19. Diatom concentrations (diatom valves encountered per mm of microscope transect) *versus* depth in the composite Owens Lake core.

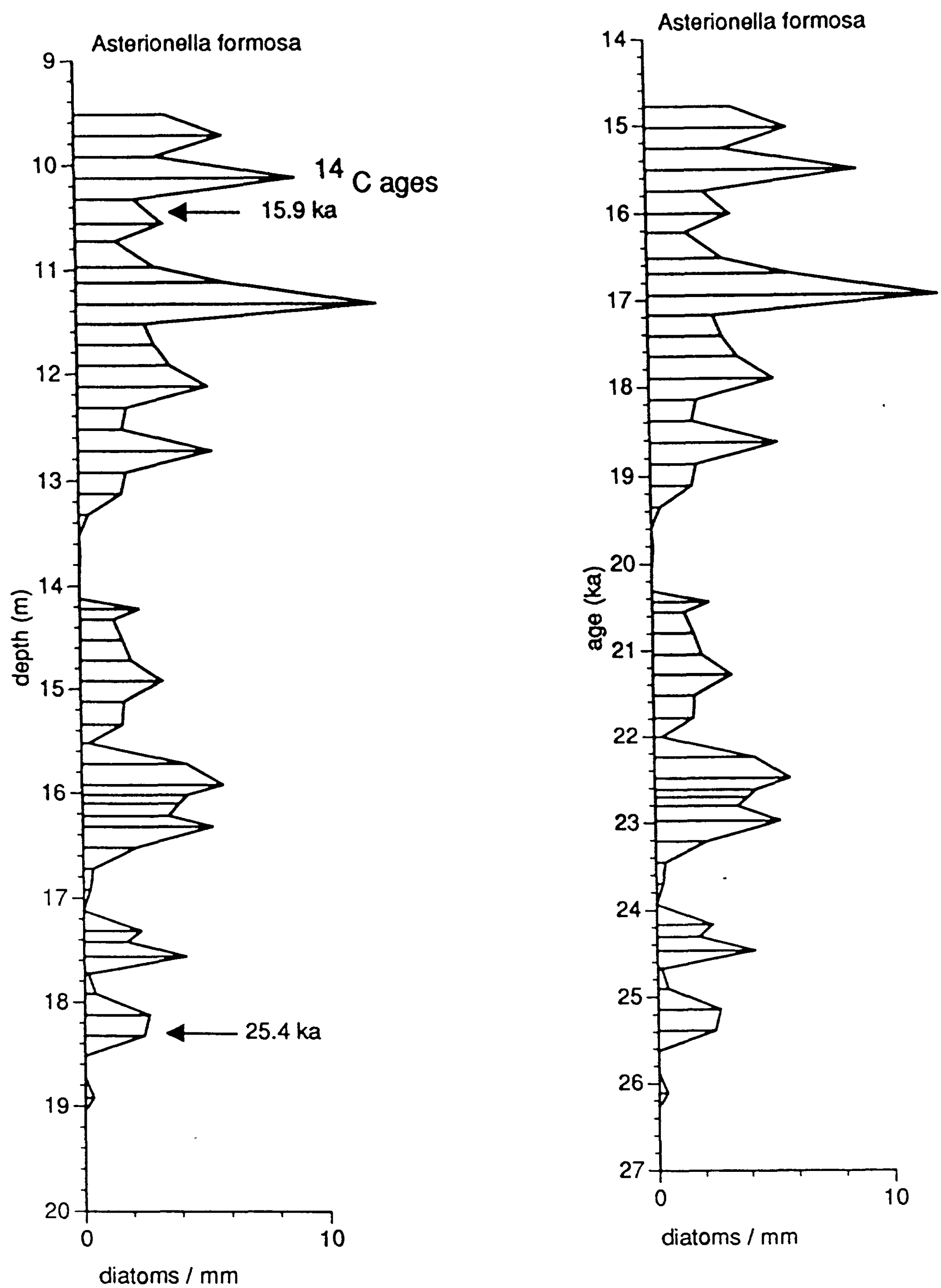

Figure 20. Concentrations of *Asterionella formosa* between ~15 and ~25 ka (9.5 to 19.0 m) showing sub-millennial cycles of abundance. This species is a freshwater planktonic diatom that generally lives in water well below 0.7‰ tds. It typically blooms in the spring after ice-out when nutrients, especially Si and light, are abundant. *Asterionella formosa* is a common member of the phytoplankton of Sierran lakes in the Owens Lake drainage. By analogy, its cyclic abundance in Owens Lake during the late Pleistocene could suggest cyclic cool periods with increased precipitation and extension of montane environments to lower elevations.

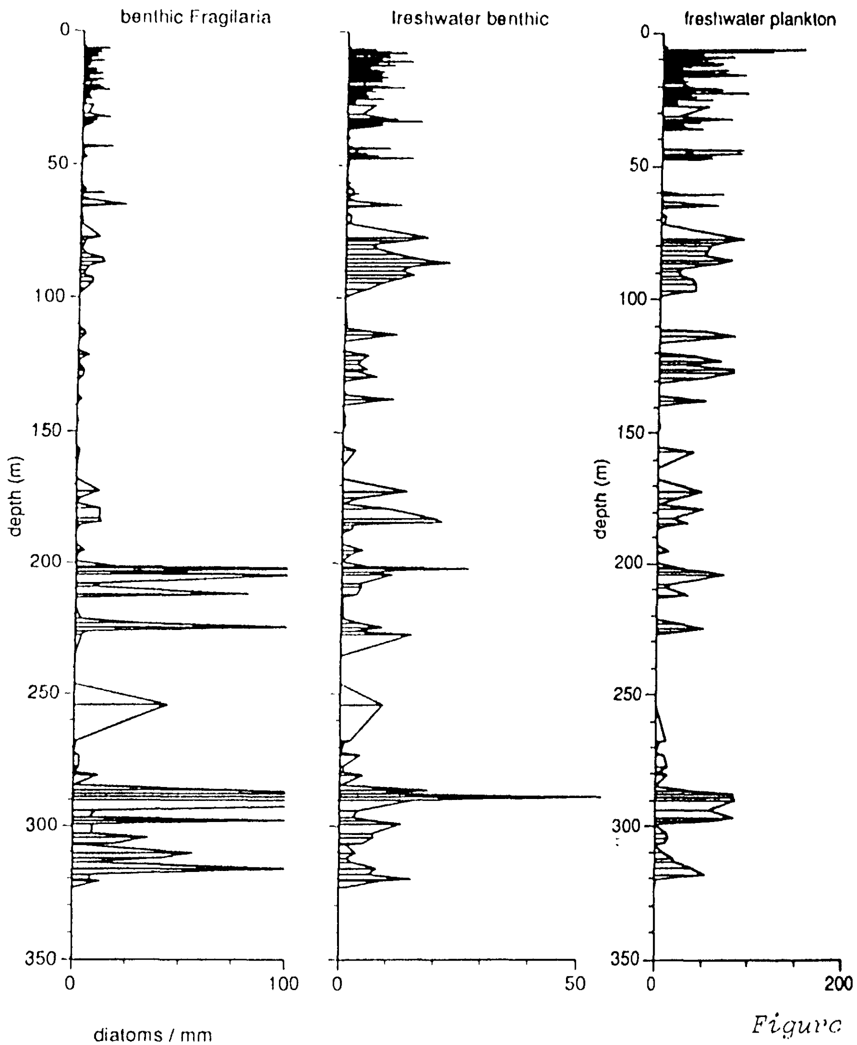

Figure 21

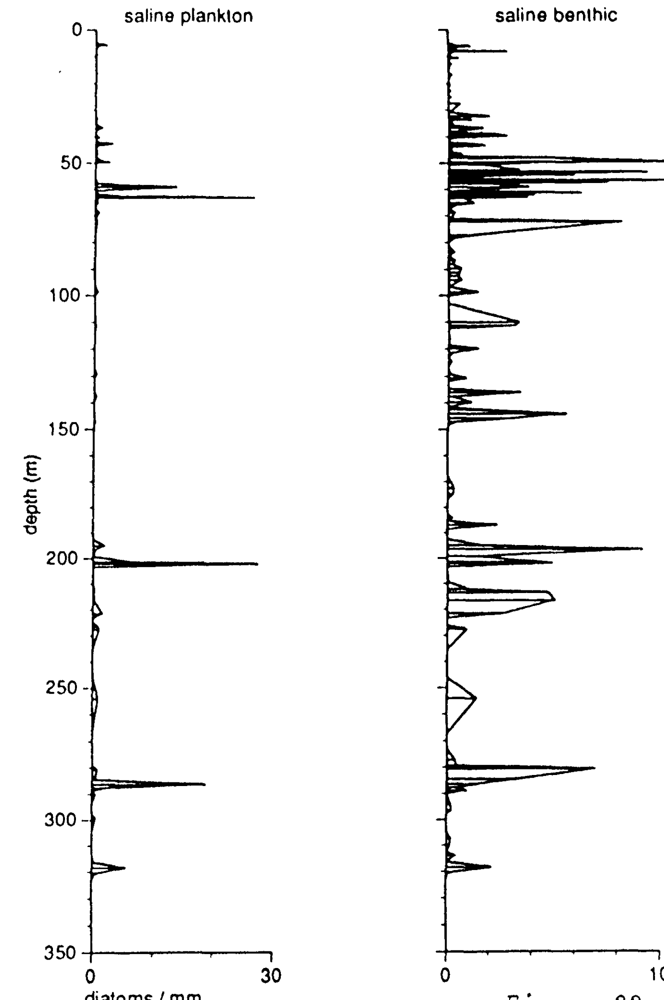

Figure 22

Figure 21-22. Concentrations of ecological groups of diatoms in the Owens Lake composite core. Figure 21 also plots abundance of benthic *Fragilaria* species which live loosely attached to aquatic plants, rocks, and sediment surfaces in shallow environments (about 2 m) of freshwater lakes and marshes. Deltaic/marsh environments at the head of Pleistocene Owens Lake may have been the principal source of these diatoms. Their abundance at the base of the Owens Lake core suggests a predominance of shallow, riverine environments during this stage of the Owens Lake history.

Appendix 1

Appendix 1 lists the raw counts of diatoms in individual samples from Cores OL-92-3, -1, and -2 (in that order). Because of the large numbers of samples and species that are tabulated, these data can not be presented as a "spreadsheet" on a single, text-sized page and remain readable. Instead, on the first 12 pages, which have a heading of "owens #1", the depths headed "z(m)core3" or "z(m)core1" on their left sides, represent segments of a "spreadsheet" for Cores OL-92-3 and OL-92-1; they are designated as Appendix 1A. In that part, pages 1 to 4 (numbers at bottom of each page) represent successively-deeper data tabulated on the left part of this "spreadsheet", pages 5 to 8 represent the middle part, and pages 9 to 12 represent the right part.

The second set of 9 pages, headed "owens #2", are segments of the '"spreadsheet" for Core OL-92-2; they are designated as Appendix 1B. They follow the same format as the first set; pages 1 to 3 represent the left part of the "spreadsheet", pages 4 to 6 the middle part, and pages 7 to 9 represent the right part.

The abbreviations along the tops of these sheets are explained by the data in Table 1.

Appendix 1A

owens #1

z(m)core3	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au-lsl?	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn	epi	fr-brev	fr-cap
5.122	0	0	0	0	0	0	0	0	0	0	1	0	0	0		0	0	0	0	0	0	0	0	0	0
5.282	0	0	0	0	0	0	0	0	0	0	7	0	43	0	0	0	0	0	2	3	2	0	4	6	0
5.522	0	0	0	0	2	0	0	0	0	0	1	0	1	1	0	1	0	9	4	0	0	0	3	28	0
5.722	0	0	0	0	1	0	0	0	0	0	11	1	1	1	0	1	0	0	0	66	0	0	1	6	0
5.922	1	0	1	3	0	0	0	0	0	0	11	0	0	3	1	2	0	0	3	11	2	0	7	23	0
6.122	0	0	0	0	3	0	0	0	0	0	31	0	0	0	0	0	0	28	0	0	1	0	10	11	0
6.322	0	0	0	0	6	0	0	0	0	0	4	0	0	0	0	0	0	5	5	0	0	0	7	70	0
6.522	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	2	0	0	21	0
6.722	1	0	1	2	0	0	0	0	0	0	0	0	0	4	2	1	0	0	22	0	4	0	2	11	0
6.922	3	0	1	6	0	9	0	0	0	0	0	0	0	3	0	3	0	0	18	0	1	0	0	13	1
7.122	0	0	0	2	0	2	0	0	0	0	0	0	0	3	0	2	0	0	60	0	2	0	2	5	0
z(m)core1																									
7.02	0	0	3	7	0	0	0	0	0	0	0	0	1	4	1	3	0	0	38	0	0	0	6	91	0
7.12	1	0	1	7	0	0	0	0	5	0	2	0	0	5	2	3	0	1	30	0	5	0	4	66	0
7.32	2	0	0	3	0	20	0	0	0	0	0	0	0	2	0	2	0	0	91	0	1	0	2	12	0
7.52	0	0	0	4	0	21	0	0	0	0	0	0	0	5	2	3	0	0	149	0	1	2	3	17	12
7.71	5	0	0	7	0	17	0	5	0	0	0	0	0	5	0	5	0	0	0	0	14	7	0	16	0
8.11	1	0	1	10	0	43	0	0	0	0	0	0	0	9	0	9	0	0	1	0	2	10	15	37	0
8.32	7	0	0	15	0	23	0	0	0	2	0	0	0	2	0	2	0	0	0	0	1	0	16	50	2
8.51	6	0	2	25	0	59	0	0	0	2	0	0	0	10	3	7	0	0	0	0	9	0	16	46	0
9.52	6	0	0	9	0	19	0	0	0	1	0	0	0	1	0	1	0	1	100	0	4	0	7	25	0
9.72	2	0	1	13	0	67	0	0	0	0	0	0	0	3	0	3	0	0	13	0	5	0	18	42	0
9.92	8	0	3	15	1	60	0	0	0	0	0	0	0	9	2	6	0	0	0	0	3	0	22	13	0
10.12	9	0	1	6	0	67	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	7	18	0
10.32	18	0	0	15	0	42	0	0	0	0	0	0	0	4	0	4	0	0	0	0	1	0	9	22	0
10.55	9	0	0	12	0	41	0	0	0	0	0	0	0	9	3	6	0	0	0	0	1	0	9	16	0
10.72	10	0	0	6	0	24	0	0	0	0	0	0	0	6	0	6	0	0	3	0	4	0	7	6	0
10.97	2	0	0	2	0	26	0	0	0	0	0	0	0	1	1	0	0	0	30	0	0	0	1	19	0
11.12	13	0	1	10	0	43	0	0	0	0	0	0	0	8	2	6	0	0	12	0	3	0	10	50	0
11.33	12	0	0	8	0	70	0	1	0	0	0	0	0	8	3	4	1	0	7	0	4	0	5	24	0
11.52	3	0	3	13	0	31	0	0	0	2	0	0	0	6	2	3	1	0	3	0	0	0	2	16	0
11.72	12	0	0	9	0	48	0	0	0	1	0	0	0	13	12	1	1	1	3	0	1	0	8	10	0
11.92	4	0	0	6	0	23	0	0	0	0	0	0	0	2	1	1	0	0	76	0	0	0	2	12	0
12.12	2	0	0	0	0	43	0	0	0	0	0	0	0	2	0	2	0	0	80	0	0	0	2	15	0
12.32	5	0	0	16	0	33	0	0	0	0	0	0	0	10	0	8	0	0	13	0	1	0	4	10	0
12.52	5	0	0	4	0	22	0	0	0	0	0	0	0	9	3	6	0	0	16	0	0	0	4	16	0
12.72	12	0	2	14	0	59	0	0	0	0	0	0	0	10	4	6	0	0	3	0	4	0	12	14	0
12.92	6	0	1	13	0	24	0	0	0	3	0	0	0	15	9	6	0	1	0	0	1	0	7	16	0
13.12	14	0	1	7	0	30	0	0	0	0	0	0	0	10	0	9	0	0	1	0	3	0	9	9	0
13.32	1	0	1	11	0	7	0	0	0	0	0	0	0	5	0	4	0	0	0	0	0	0	6	6	0
13.52	9	0	0	10	0	0	0	0	0	2	0	0	0	4	1	3	0	0	0	0	2	0	5	7	0
13.72	7	0	1	5	0	1	0	0	0	0	0	0	0	2	0	2	0	0	0	0	2	0	6	11	0
13.92	6	0	0	2	0	0	0	0	0	0	0	0	0	2	1	1	0	0	1	0	0	0	0	1	0
14.12	7	0	0	8	0	0	0	0	0	0	0	0	0	4	1	3	0	0	0	0	0	0	5	3	0
14.22	3	0	1	7	0	13	0	0	0	0	0	0	0	4	0	4	0	0	55	0	3	0	3	23	0
14.32	3	0	0	4	0	13	0	0	0	0	0	0	0	8	2	3	0	0	49	0	4	0	1	49	0
14.52	13	0	1	20	0	21	0	0	0	0	0	0	0	11	4	7	0	0	3	0	2	0	3	22	0
14.72	4	0	0	9	0	13	0	0	0	0	0	0	0	2	0	2	0	0	31	0	1	0	5	12	0
14.92	8	0	1	6	0	27	0	0	0	2	0	0	0	4	2	2	0	0	18	0	3	0	3	29	0
15.12	9	0	0	5	0	22	0	0	0	1	0	0	0	7	6	1	0	0	1	0	1	0	9	27	0
15.34	4	0	1	5	0	17	0	0	0	0	0	0	0	5	3	2	0	0	34	0	0	0	8	11	0
15.52	3	0	0	8	0	4	0	0	0	0	0	0	0	2	0	2	0	0	15	0	2	0	6	8	0
15.72	6	0	1	5	0	22	0	0	0	0	0	0	0	6	1	5	0	0	41	0	0	0	6	22	0
15.92	3	0	0	11	0	25	0	0	0	0	0	0	0	2	0	2	0	0	46	0	0	0	0	34	0

z(m)core	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au.isl?	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn	epi	fr-brev	fr-cap
16.02	1	0	0	3	0	23	0	0	0	0	0	0	0	2	0	2	0	0	47	0	4	0	2	28	0
16.1	2	0	0	4	0	28	0	0	0	0	0	0	0	3	0	3	0	0	53	0	1	0	2	4	0
16.12	4	0	0	4	0	16	0	0	0	0	0	0	0	3	0	3	1	0	32	0	1	0	1	10	0
16.32	2	0	0	1	0	22	0	0	0	0	0	0	0	3	0	3	0	1	49	0	2	0	2	22	0
16.52	2	0	0	4	0	20	0	0	0	0	0	0	0	7	4	3	0	0	46	0	0	0	2	4	0
16.72	7	0	2	7	0	4	0	0	0	0	0	0	0	6	4	4	0	0	2	0	4	0	10	6	0
16.92	6	0	0	11	0	5	0	0	0	0	0	0	0	9	2	7	0	0	0	0	1	0	8	16	0
17.12	3	0	2	4	0	0	0	0	0	0	0	0	0	12	2	10	0	0	0	0	2	0	7	4	0
17.31	18	0	0	20	0	39	0	0	0	0	0	0	0	9	2	6	0	0	2	0	2	0	12	42	0
17.32	7	0	1	6	0	32	0	1	1	1	0	0	0	6	2	4	0	0	0	0	1	0	4	13	0
17.56	4	0	0	9	0	70	0	2	0	0	0	0	0	6	1	5	1	0	1	0	0	0	5	10	0
17.72	13	0	0	10	0	7	0	1	0	0	0	0	0	4	0	4	0	0	0	0	0	0	4	16	0
17.74	9	0	0	15	0	3	0	0	0	2	0	0	0	3	1	2	0	0	0	0	3	0	2	15	0
17.92	10	0	0	14	1	8	0	14	0	1	1	0	0	6	0	5	0	0	0	0	0	0	5	11	0
18.12	7	0	2	21	0	38	0	0	0	0	0	0	0	13	3	9	0	0	0	0	6	20	13	93	10
18.32	2	0	4	10	0	29	0	6	0	0	0	0	0	8	2	5	0	0	0	0	3	27	2	15	17
18.52	7	0	1	15	0	0	0	21	0	0	0	0	0	7	1	6	0	0	0	0	1	0	1	33	0
18.72	2	0	1	14	0	0	0	18	1	1	0	0	0	7	1	5	0	0	0	0	3	0	3	29	4
18.92	3	0	0	31	0	4	0	10	0	2	0	0	0	15	7	7	0	0	0	0	5	2	6	41	0
19.02	4	0	1	8	0	1	0	4	1	0	0	0	0	4	2	2	0	1	0	0	1	0	2	26	0
20.22	2	0	1	11	0	0	0	6	0	0	0	0	0	5	0	5	1	0	0	0	4	0	3	27	0
20.42	2	0	1	15	1	0	0	0	0	1	0	0	0	8	3	4	0	0	0	0	1	0	4	55	0
20.62	2	0	1	9	0	0	4	0	0	0	0	0	0	8	5	3	0	1	0	0	2	0	3	16	0
20.82	5	0	0	9	0	0	6	0	0	0	0	0	0	11	10	1	0	0	0	0	1	0	2	32	0
21.02	1	0	0	14	1	0	3	0	0	0	0	0	0	8	7	1	0	0	0	0	0	0	5	17	0
21.09	4	0	0	5	0	0	8	0	0	1	0	0	0	7	1	6	0	0	0	0	2	0	0	24	0
21.22	2	0	0	7	0	0	14	0	0	0	0	0	0	2	0	2	1	1	0	0	0	0	0	29	0
21.42	5	0	1	9	0	0	201	0	0	0	0	0	0	7	1	6	0	0	1	1	0	0	1	24	0
21.72	6	0	1	4	0	1	30	9	0	0	0	0	0	9	4	5	0	0	0	0	0	0	2	29	0
22.12	4	0	1	16	0	1	60	0	1	0	0	0	0	5	2	3	0	1	0	0	1	0	1	82	0
22.32	4	0	0	8	0	0	23	0	1	0	0	0	0	5	2	3	0	0	0	0	0	0	1	5	0
22.52	7	0	0	13	0	0	23	0	0	0	0	0	0	6	3	3	1	0	0	0	1	0	5	23	0
22.57	3	0	0	6	0	0	67	0	0	1	0	0	0	5	2	3	0	0	0	0	3	0	1	10	0
22.72	2	0	0	3	1	0	43	0	0	0	0	0	0	18	12	6	0	0	0	0	0	0	3	17	0
22.92	0	0	0	6	2	0	178	0	0	0	0	0	0	4	3	1	0	0	0	0	0	0	1	12	0
23.12	0	0	0	6	2	0	154	0	0	0	0	0	0	12	6	5	0	0	0	0	1	1	3	28	0
23.32	2	0	2	12	0	0	80	0	0	0	0	0	0	7	2	5	0	0	0	0	1	0	3	16	1
23.52	1	0	0	12	0	0	45	2	0	0	0	0	0	5	0	5	0	0	0	0	3	1	6	18	0
23.72	3	0	0	8	0	2	28	0	0	1	0	0	0	6	1	5	0	0	0	0	1	0	3	21	0
23.92	8	0	0	15	1	0	66	0	0	0	0	0	0	7	3	4	0	0	0	0	6	0	3	15	0
24.12	5	0	1	14	0	0	44	0	0	0	0	0	0	4	1	3	0	0	0	0	0	0	2	13	0
24.32	2	0	0	15	0	0	55	0	0	0	0	0	0	2	0	2	0	0	0	0	2	0	1	31	0
24.52	1	0	0	17	0	2	28	0	0	0	0	0	0	7	0	7	0	0	0	0	0	0	5	38	0
24.72	2	0	0	11	0	13	0	2	0	0	0	0	0	6	1	5	1	0	0	0	0	0	1	7	0
24.92	4	0	1	4	0	0	0	0	0	0	0	0	0	14	5	8	0	0	0	0	1	0	3	19	0
25.12	1	0	1	21	1	2	1	5	0	0	0	0	0	5	0	5	0	0	0	0	0	0	5	13	0
25.26	1	0	0	9	1	0	0	3	0	0	0	0	0	8	2	6	0	0	0	0	0	0	2	11	0
25.27	4	0	1	13	0	0	0	3	0	0	1	0	0	8	2	6	1	1	0	0	0	0	1	8	0
25.52	2	0	1	4	0	0	1	2	0	0	0	0	0	2	0	1	0	0	0	0	1	0	4	21	0
25.72	1	0	0	2	0	0	36	0	0	0	0	0	0	5	2	1	0	0	0	0	0	1	5	8	0
25.92	0	0	1	10	0	0	18	0	0	0	0	0	0	3	0	2	1	0	0	0	2	0	3	11	0
26.32	2	0	1	4	0	0	7	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	3	5	0
26.92	1	0	0	5	0	0	20	0	0	0	0	0	0	4	3	1	0	0	0	0	0	13	0	16	0
27.5	1	0	1	12	0	4	12	1	0	0	0	0	0	4	0	2	0	0	0	0	0	10	2	26	0

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z(m)core	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au.isl?	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn	epi	fr-brev	fr-cap
27.56	3	0	0	10	0	10	15	0	0	0	0	0	0	7	1	5	0	0	2	0	1	46	1	19	0
30.92	4	0	1	13	0	4	46	9	1	0	0	0	0	10	5	4	0	0	1	0	1	18	4	19	0
32.31	0	0	1	13	3	11	73	57	0	0	0	0	0	3	0	2	0	0	1	0	0	18	4	43	0
32.32	5	0	0	11	0	8	94	59	0	0	0	0	0	3	0	1	0	0	0	0	2	14	5	27	0
32.72	2	0	1	6	0	0	164	14	0	0	0	0	0	12	5	6	0	0	0	1	6	17	13	15	0
33.32	3	0	1	6	1	8	205	2	0	0	0	0	0	6	0	6	0	3	0	0	4	25	14	28	11
33.68	2	0	3	17	0	38	32	0	0	2	0	0	0	14	4	7	0	0	0	0	10	56	18	28	0
33.92	2	0	1	6	0	3	6	4	0	0	0	0	0	11	1	10	0	0	0	0	3	3	0	4	0
34.52	0	0	0	23	0	19	54	20	0	0	0	0	0	10	5	5	0	1	0	0	5	28	18	55	0
34.92	4	0	1	26	0	25	41	4	0	0	0	0	0	13	1	9	0	1	0	0	2	64	14	25	2
35.53	6	0	4	16	0	56	24	2	0	0	0	0	0	8	0	7	0	0	0	0	7	76	18	11	0
36.12	2	0	2	1	0	36	24	0	0	0	0	0	0	2	1	1	0	8	0	0	1	46	6	4	0
36.72	0	0	0	0	13	0	0	0	0	0	13	0	0	5	0	5	0	2	0	42	0	2	1	4	0
37.92	0	0	0	0	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0
38.51	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38.82	1	8	0	0	0	2	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	1	2	0	0
39.12	0	0	0	0	25	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39.72	0	3	0	0	7	0	2	0	0	0	58	0	0	22	0	22	0	0	0	2	0	0	0	1	0
40.32	0	0	0	0	3	0	0	0	0	0	10	0	0	2	0	2	0	0	0	23	0	1	0	0	0
40.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41.52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42.72	0	0	0	0	5	0	0	0	0	0	28	0	5	0	0	0	0	0	0	98	0	0	1	4	0
43.32	0	0	3	0	2	0	0	0	0	1	9	0	0	0	0	0	0	22	0	0	5	0	8	252	0
43.75	1	0	2	3	0	0	7	0	0	0	0	0	0	2	0	1	0	0	0	0	1	19	8	2	12
43.92	1	0	1	6	0	0	4	0	0	0	0	0	0	1	0	1	1	1	0	0	1	15	4	3	4
45.12	1	0	2	2	1	5	16	4	0	1	0	0	0	3	0	3	0	2	0	0	3	58	3	7	0
45.38	2	0	1	1	0	4	15	2	0	0	0	0	0	3	1	2	0	1	0	0	1	96	1	3	2
45.72	2	0	0	5	0	4	41	8	0	1	0	0	0	5	1	4	0	0	0	0	0	85	0	2	2
46.5	0	0	2	4	0	4	37	8	0	0	0	0	0	2	1	1	0	1	0	1	4	19	3	5	23
46.72	0	0	0	1	0	3	20	23	0	0	0	0	0	1	0	1	0	1	0	0	0	61	1	9	2
47.32	0	0	0	0	0	31	40	5	1	0	0	0	0	1	0	1	0	0	0	0	1	60	4	10	97
47.92	0	0	0	0	55	0	0	0	0	0	22	0	4	11	0	11	0	0	0	0	0	0	0	2	0
49.52	0	6	0	0	40	0	0	0	0	0	54	0	0	0	0	0	0	0	0	25	0	0	0	0	0
49.6	1	7	0	0	18	0	1	0	0	0	46	0	0	8	0	8	0	3	0	82	0	1	3	4	0
49.92	0	4	0	0	29	0	0	0	0	0	33	58	1	4	0	4	0	0	0	0	0	0	0	0	0
50.49	0	0	0	0	10	0	0	0	0	0	40	2	0	1	0	1	0	0	0	0	0	0	1	0	0
52.5	0	0	0	0	19	0	0	0	0	0	29	0	0	1	0	1	0	0	0	0	0	0	2	0	0
53.12	0	8	0	0	23	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53.35	2	1	0	0	43	0	0	0	0	0	52	0	0	1	0	1	0	0	0	0	0	2	0	10	0
53.72	0	2	0	0	10	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0	2	2	0
54.32	0	6	0	0	69	0	0	0	0	0	24	1	2	2	0	2	0	0	0	0	0	0	2	0	0
54.8	0	0	0	2	1	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2	0
54.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55.52	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
56.12	0	0	0	0	4	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	1	0	0
56.5	1	8	0	2	40	0	0	0	0	0	9	15	1	0	0	0	0	0	0	0	2	0	4	7	0
56.72	0	6	0	0	21	0	0	0	0	0	8	42	10	2	0	2	0	0	0	2	0	0	2	2	0
57.32	0	13	0	0	19	0	0	0	0	0	114	32	0	3	0	3	0	0	0	0	0	0	1	3	0
57.76	1	0	1	2	0	0	0	0	0	0	6	10	0	0	0	0	0	0	0	0	0	0	1	8	0
58.95	3	0	0	0	7	0	0	2	0	0	48	0	8	7	0	7	0	227	0	7	0	2	0	16	0
60.52	0	0	1	2	0	18	0	27	0	1	3	0	0	2	2	0	0	0	0	0	4	5	4	9	0

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z(m)core1	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au.isl?	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn	epi	fr-brev	fr-cap
60.63	0	0	0	2	0	0	2	100	0	0	5	0	0	2	2	0	0	0	0	0	1	9	1	20	0
60.72	0	0	0	0	10	0	0	0	0	0	83	5	0	0	0	0	0	0	0	0	0	0	1	5	0
60.92	0	0	0	0	6	0	0	0	0	0	93	9	0	0	0	0	0	0	0	1	0	0	1	2	0
61.12	0	1	0	0	25	0	0	0	0	0	64	8	8	2	0	2	0	0	0	6	0	0	0	7	0

z(m)core3	fr-con	fr-crot	fr-lepto	fr-pln	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhol	st-ast	st-carc	st-min	st-nia	st-ore	st-ovecc	st-10
5.122	0	0	0	0	0	0	0	0	2	0	0	4	4	0	0	0	0	0	0	0	12	1	0	4	0	0	2
5.282	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	64	0	0	43	0	0	0
5.522	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	91	0	0	25	0	0	0
5.722	4	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	28	0	0	21	0	0	0
5.922	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	30	0	0	10	2	0	0
6.122	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
6.322	4	0	0	0	0	0	0	0	0	0	14	0	0	0	0	2	0	0	0	0	25	0	0	20	0	0	0
6.522	5	0	1	2	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	271	0	1	44	2	0	0
6.722	3	0	0	0	0	2	0	0	1	0	5	0	0	0	0	0	0	0	0	0	283	1	10	40	4	1	0
6.922	13	0	0	0	0	1	0	0	1	0	1	2	0	0	0	0	0	0	1	0	272	0	21	69	9	0	0
7.122	8	0	0	0	0	1	0	0	0	0	2	0	0	0	0	1	0	0	0	0	268	0	7	37	9	0	0
z(m)core1																											
7.02	11	0	0	7	1	0	0	0	0	0	3	5	0	0	0	0	0	0	1	0	151	0	7	115	0	0	0
7.12	8	0	2	1	0	0	0	0	1	0	2	1	0	0	0	0	0	1	1	0	254	0	16	65	0	0	0
7.32	1	0	0	2	0	0	0	0	0	0	8	9	0	0	0	0	0	0	1	2	204	0	9	61	0	0	6
7.52	6	0	0	0	0	0	0	0	0	0	5	17	1	0	0	0	0	0	0	1	160	0	8	63	0	0	10
7.71	9	0	3	2	0	1	0	0	0	0	12	38	2	0	0	1	0	0	0	0	177	2	30	81	0	0	8
8.11	18	0	2	6	0	0	0	0	23	0	16	38	16	0	0	0	0	1	1	2	136	44	6	2	0	0	72
8.32	46	0	0	7	2	0	1	0	24	0	12	29	0	0	0	1	0	0	2	2	133	28	19	1	9	0	48
8.51	18	0	0	8	0	2	1	0	33	0	25	38	4	0	0	1	0	0	1	5	114	44	17	0	16	1	63
9.52	7	0	2	2	1	2	0	1	4	0	6	14	0	0	0	1	0	0	0	0	191	3	21	44	2	0	10
9.72	17	0	1	2	5	1	0	0	17	0	18	46	0	0	0	0	0	0	1	6	129	45	15	14	9	0	41
9.92	6	0	2	9	5	2	0	0	14	0	11	22	0	0	0	0	0	0	1	1	132	42	14	2	38	2	54
10.12	4	0	1	4	0	0	1	0	8	0	1	6	0	0	0	0	0	0	1	6	222	25	10	0	14	0	32
10.32	13	0	0	5	2	0	1	0	9	0	3	17	0	0	0	0	0	0	1	2	166	52	12	0	56	0	35
10.55	9	0	0	5	0	1	0	0	18	0	7	30	5	0	0	2	0	0	0	2	127	13	26	1	24	2	116
10.72	0	0	2	2	0	0	0	0	6	0	16	12	0	0	0	1	0	0	0	5	200	16	3	1	17	0	97
10.97	0	0	4	0	0	0	0	0	2	0	6	2	0	0	0	2	0	0	0	0	207	6	16	36	9	0	27
11.12	13	0	5	2	0	0	0	0	12	0	7	29	0	0	0	0	0	0	3	4	156	26	13	15	19	0	23
11.33	0	0	3	14	2	2	0	0	11	0	18	36	0	0	0	4	0	0	0	0	66	16	6	7	16	1	121
11.52	9	0	5	5	4	0	0	0	9	0	11	16	1	0	0	0	0	0	0	6	172	21	15	12	22	0	74
11.72	11	0	0	2	0	1	0	0	9	0	19	14	0	0	0	0	0	0	0	3	124	16	17	6	30	0	70
11.92	5	0	0	6	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	182	2	24	34	15	1	25
12.12	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	232	0	49	46	11	0	7
12.32	4	0	0	6	0	2	0	0	3	0	18	20	1	0	0	0	0	0	0	1	154	23	18	16	19	5	65
12.52	1	0	1	1	0	0	0	0	6	0	11	10	0	0	0	0	0	0	0	6	137	9	25	22	24	0	87
12.72	14	0	2	3	0	0	1	0	8	0	29	29	0	0	0	0	0	1	1	6	123	18	10	3	30	2	66
12.92	10	0	3	8	2	0	1	0	7	0	15	18	2	0	0	1	0	0	0	1	131	24	21	1	27	3	100
13.12	11	0	2	11	0	0	0	1	5	0	24	18	0	0	0	0	0	0	2	3	120	25	21	0	23	2	150
13.32	9	0	0	2	0	3	0	0	14	0	15	13	0	0	0	0	0	0	0	2	112	23	10	0	24	2	125
13.52	8	0	3	2	0	0	0	0	6	0	24	19	2	0	0	1	0	0	0	4	89	15	10	0	20	1	83
13.72	3	0	0	3	0	0	0	0	11	0	13	16	0	0	0	0	0	0	0	1	110	12	15	0	14	2	100
13.92	3	0	0	5	6	1	0	0	3	0	6	13	0	0	0	0	0	0	0	3	142	6	7	0	11	0	74
14.12	4	0	2	6	0	1	0	0	6	0	12	14	0	0	0	0	0	0	1	3	172	17	12	0	12	1	51
14.22	4	0	0	0	0	0	0	0	0	0	5	7	0	0	0	0	0	0	0	1	250	1	10	21	14	0	12
14.32	10	0	0	2	0	0	0	0	2	0	2	7	0	0	0	0	0	0	0	2	262	0	20	30	7	0	11
14.52	7	0	0	12	0	0	0	0	5	0	18	21	0	0	0	0	0	1	0	1	128	18	8	10	16	0	119
14.72	3	2	0	2	2	2	0	0	2	0	3	7	0	0	0	0	0	0	0	1	209	6	11	48	8	0	11
14.92	8	0	0	10	0	1	0	0	6	0	8	17	0	0	0	0	0	0	0	1	177	8	13	11	11	0	68
15.12	13	0	0	7	4	0	0	0	24	0	24	40	0	0	0	1	0	0	0	3	101	11	19	0	10	0	100
15.34	6	0	0	0	2	1	0	0	1	0	5	15	0	0	0	0	0	0	0	0	204	13	10	18	17	3	42
15.52	3	0	0	2	0	2	0	0	9	0	12	12	0	0	0	0	0	0	0	2	195	17	17	14	15	2	103
15.72	2	0	0	4	1	0	0	0	1	0	6	8	0	0	0	0	0	0	0	0	181	10	13	21	14	0	33
15.92	5	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	202	0	18	41	18	1	6

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z(m)core	fr-con	fr-crot	fr-lepto	fr-pin	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhol	st-ast	st-carc	st-min	st-nia	st-ore	st-ovecc	st-10
16.02	10	0	0	2	0	1	0	0	0	0	0	3	0	0	0	0	0	0	1	0	213	4	19	31	11	0	2
16.1	8	0	0	0	2	0	0	0	2	0	7	3	0	0	0	0	0	0	0	1	232	5	22	22	15	0	34
16.12	3	0	0	0	0	0	0	0	4	0	2	3	0	0	0	0	0	0	0	1	229	1	16	12	3	0	12
16.32	9	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	2	236	0	20	37	2	0	0
16.52	5	0	2	2	0	2	0	0	4	0	8	14	0	0	0	0	0	0	0	2	231	7	67	34	3	0	20
16.72	0	0	0	0	6	0	0	0	0	0	16	23	2	0	0	0	0	0	0	3	120	41	19	0	12	2	177
16.92	7	0	0	0	1	2	0	0	2	0	11	9	0	0	0	0	0	0	0	3	91	57	12	0	16	2	68
17.12	1	0	0	2	2	4	0	0	4	16	20	26	3	0	0	0	0	0	0	2	106	28	12	2	16	3	134
17.31	2	0	0	2	2	5	0	0	13	13	30	39	0	0	0	0	0	0	0	3	82	38	10	4	23	2	65
17.32	0	0	0	3	1	0	0	1	0	0	5	6	1	0	0	0	0	0	0	2	114	70	10	0	28	0	133
17.56	2	0	0	4	0	0	1	0	1	1	8	19	0	0	0	0	0	0	1	1	110	20	5	1	22	5	70
17.72	6	0	1	2	3	0	0	0	2	10	12	12	0	0	0	0	0	0	0	0	93	46	2	1	12	2	68
17.74	4	0	0	0	0	0	0	0	0	9	8	7	0	0	0	0	0	0	0	1	58	37	0	0	5	3	49
17.92	0	0	2	0	9	0	0	0	0	3	6	14	0	0	0	0	0	0	0	6	85	49	3	0	18	2	82
18.12	30	0	3	11	0	3	0	0	0	0	17	20	0	0	0	2	0	0	1	2	8	69	17	12	6	3	39
18.32	7	0	0	0	0	1	0	0	0	0	10	8	0	0	0	0	0	0	0	1	6	200	27	13	3	2	9
18.52	7	0	0	1	0	1	0	0	0	0	5	7	0	0	0	1	0	0	1	0	12	215	15	0	2	1	2
18.72	19	0	0	0	0	0	0	0	0	0	16	2	0	0	0	3	0	0	0	1	9	211	9	0	2	1	2
18.92	29	0	0	1	0	0	0	0	0	0	13	12	0	0	0	1	0	0	0	0	6	204	7	0	1	1	4
19.02	7	0	0	0	0	1	0	0	0	1	8	5	0	0	0	1	0	0	0	0	5	215	0	0	1	1	2
20.22	4	0	0	2	0	0	0	0	0	0	4	2	0	0	0	1	0	0	1	1	6	239	0	1	0	2	9
20.42	11	0	0	0	0	0	0	0	0	0	12	4	0	0	0	0	0	0	1	1	5	219	3	2	0	1	2
20.62	25	0	0	5	0	2	0	0	0	0	11	1	0	0	0	0	0	0	0	0	2	240	0	1	0	1	2
20.82	11	0	0	0	0	2	0	1	0	0	13	1	0	0	0	0	0	0	1	0	2	281	0	0	1	3	0
21.02	11	0	0	2	0	1	0	0	0	0	4	4	0	0	0	0	0	0	0	0	5	284	2	1	0	3	0
21.09	3	0	0	3	3	0	0	0	0	0	7	5	0	0	0	0	0	0	1	0	4	208	4	0	6	2	
21.22	21	0	0	0	0	0	0	0	0	0	7	16	0	0	0	0	0	0	1	2	0	307	5	0	0	3	0
21.42	5	0	1	3	0	1	0	1	0	0	7	7	0	0	0	1	0	0	0	1	12	153	0	0	0	1	0
21.72	24	0	0	8	0	2	0	1	2	2	1	4	0	0	0	1	0	0	2	0	10	267	3	0	0	0	2
22.12	36	0	0	2	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	227	3	0	0	2	0
22.32	15	0	2	2	0	0	0	0	0	0	4	5	0	0	0	0	0	0		0	4	264	1	0	0	4	2
22.52	12	0	0	0	2	1	0	0	0	0	9	4	0	0	0	0	0	0	0	0	8	283	0	0	0	1	0
22.57	8	0	0	2	0	0	0	0		0	2	0	0	0	0	1	0	0	0	0	9	261	2	0	2	1	
22.72	9	0	0	3	0	1	0	0	0	0	5	10	0	0	0	0	0	0	0	0	6	230	32	0	1	0	0
22.92	5	0	0	0	0	0	0	1	0	0	4	1	0	0	0	1	0	0	0	0	2	139	4	1	0	0	1
23.12	29	0	3	2	0	2	1	0	0	0	7	0	0	0	0	2	0	0	0	2	16	129	1	0	8	3	0
23.32	15	0	1	2	0	0	0	0	0	0	11	3	0	0	0	0	0	0	0	2	9	217	13	0	1	0	2
23.52	9	0	3	0	0	0	0	0	0	0	10	1	0	0	0	0	0	0	0	2	10	250	0	0	4	1	3
23.72	8	0	0	2	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	1	3	312	2	0	1	3	2
23.92	10	0	0	2	0	2	0	0	0	0	18	1	0	0	0	0	0	0	0	0	8	251	0	2	3	2	0
24.12	9	0	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	1	3	257	0	0	0	0	0
24.32	7	0	0	0	2	0	0	0	0	0	6	2	0	0	0	2	0	0	0	0	7	255	0	2	0	2	2
24.52	20	0	0	8	0	0	0	0	0	0	7	4	0	0	0	0	0	0	0	1	5	231	3	38	0	0	0
24.72	4	0	0	3	0	0	0	0	0	0	6	1	0	0	0	0	0	1	0	1	8	208	1	54	2	4	4
24.92	6	0	0	9	0	0	0	0	1	0	11	2	0	0	0	1	0	0	2	2	10	166	4	31	9	2	2
25.12	8	0	0	3	0	0	0	1	0	0	10	2	0	0	0	1	0	0	0	2	11	241	4	32	4	8	1
25.26	12	0	1	0	0	2	0	1		0	16	1	0	0	0	2	0	0	1	0	3	255	17	9	3	3	0
25.27	5	0	0	3	0	0	0	1	0	0	5	7	0	0	0	0	0	0	0	0	11	232	5	22	5	2	0
25.52	3	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	2	0	8	188	1	10	0	1	0
25.72	3	0	0	0	0	2	0	0	0	0	3	1	0	0	0	1	0	0	0	0	5	168	1	7	2	0	0
25.92	3	0	0	2	0	0	0	0	0	0	11	2	0	0	0	0	0	0	0	2	3	212	0	7	1	0	1
26.32	7	0	0	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	0	5	245	0	14	0	1	4
26.92	4	0	1	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	4	214	2	11	0	1	0
27.5	3	0	1	6	0	0	0	1	0	0	12	0	0	0	0	0	0	0	0	0	2	208	0	24	0	0	2

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z(m)core	fr-con	fr-crot	fr-lepto	fr-pin	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhoi	st-ast	st-carc	st-min	st-nia	st-ore	st-ovecc	st-10
27.56	5	0	0	10	0	0	0	0	0	0	18	7	4	0	0	0	0	0	0	0	0	249	10	7	0	0	0
30.92	19	0	0	8	0	0	0	0	0	1	15	6	0	0	0	0	0	1	0	0	47	135	7	24	6	0	7
32.31	18	0	0	6	0	0	0	0	0	0	9	6	6	0	0	2	0	0	0	1	129	2	1	69	13	1	1
32.32	10	0	0	9	0	0	0	0	0	0	13	9	0	0	0	2	0	0	0	0	92	5	1	51	8	0	0
32.72	14	0	1	4	0	0	0	0	0	0	5	3	0	0	0	1	0	0	0	1	107	2	0	50	2	0	0
33.32	12	0	0	4	0	0	0	0	0	0	7	2	0	0	0	1	0	0	0	2	61	0	4	60	6	1	2
33.68	15	0	0	5	1	2	0	0	0	0	28	9	7	0	0	0	0	0	1	2	56	0	4	69	5	0	20
33.92	8	0	0	2	0	1	0	0	1	1	11	3	0	0	0	0	0	0	1	1	102	28	0	7	6	1	60
34.52	28	0	0	6	0	0	1	0	0	0	19	17	0	0	0	0	0	0	2	1	101	1	0	73	7	2	22
34.92	24	0	0	5	0	0	1	0	0	0	21	23	2	0	0	1	0	0	2	2	88	0	0	73	7	0	26
35.53	12	0	0	2	1	0	0	0	0	0	5	16	0	0	0	1	0	0	4	5	100	0	6	28	9	0	48
36.12	2	0	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0	1	213	2	0	72	21	0	25
36.72	4	0	0	0	0	0	1	0	0	0	3	3	0	0	0	0	0	0	0	2	5	0	0	1	1	0	0
37.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0
38.51	0	0	0	0	0	1	0	0	0	0	0	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38.82	1	0	1	0	0	0	1	0	0	0	2	33	29	0	0	0	0	1	0	0	3	0	0	2	0	0	0
39.12	0	0	0	0	0	0	0	0	0	0	0	39	30	0	0	0	0	3	0	0	0	0	0	0	0	0	0
39.72	1	0	0	0	0	0	0	0	0	0	1	28	21	0	0	0	0	5	0	0	1	0	0	5	0	0	0
40.32	0	0	0	0	0	0	0	0	0	0	0	9	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0
40.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
41.52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42.72	2	0	1	0	0	1	0	1	0	0	1	2	0	0	0	1	0	1	0	0	1	0	0	2	3	0	0
43.32	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	2	0	7	3	2	0	0
43.75	9	11	0	0	0	1	0	0	0	0	5	5	2	0	0	0	1	0	1	0	199	50	60	79	7	0	5
43.92	1	18	0	0	7	0	0	0	0	0	4	2	0	1	0	0	1	0	0	0	39	165	13	65	3	0	5
45.12	0	8	0	1	0	0	0	0	0	0	4	17	0	0	0	0	0	0	0	0	90	116	0	70	2	0	37
45.38	2	4	0	0	2	0	0	0	0	0	4	5	0	0	0	0	1	0	1	2	198	4	0	40	3	0	68
45.72	2	33	0	1	0	0	0	0	0	0	1	6	0	0	0	0	0	1	0	0	70	133	0	24	5	0	37
46.5	6	36	0	0	1	1	0	0	0	0	6	10	1	0	0	1	1	1	0	1	117	3	0	79	0	0	16
46.72	5	35	0	3	0	0	0	0	0	0	1	16	0	0	0	1	0	0	0	0	83	84	0	35	7	0	34
47.32	2	58	0	1	0	0	0	1	0	0	8	1	0	0	0	1	0	0	0	0	1	1	5	57	15	0	30
47.92	0	0	1	0	0	0	0	0	0	0	0	3	2	0	0	0	83	0	0	0	0	0	0	4	1	0	0
49.52	0	0	0	0	0	0	0	0	0	0	5	11	5	0	0	0	74	1	0	0	2	0	0	1	0	0	0
49.6	0	0	0	0	0	0	0	0	0	0	9	33	26	0	0	1	9	5	1	0	6	0	2	6	0	0	0
49.92	0	0	0	0	0	0	0	0	0	0	0	12	7	0	0	0	2	2	0	0	2	0	0	1	1	0	0
50.49	1	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	2	0	0	0	0	0	4	0	0	0
52.5	1	0	0	0	0	0	0	0	0	0	1	69	3	65	0	0	0	2	0	0	1	0	0	1	0	0	0
53.12	4	0	0	0	0	0	0	1	0	0	1	49	14	32	0	0	0	0	0	0	0	1	0	5	0	0	0
53.35	4	0	0	3	0	0	0	1	0	0	5	245	35	80	117	0	0	5	3	0	0	0	0	4	1	0	0
53.72	2	0	0	0	0	0	0	1	0	0	0	32	17	2	12	0	0	1	0	0	1	0	1	4	0	0	0
54.32	0	0	0	0	0	1	0	0	0	0	0	95	18	23	45	0	17	6	0	0	0	0	0	1	0	0	0
54.8	3	0	0	0	0	0	0	0	0	1	2	50	50	0	0	0	3	0	0	0	8	2	0	2	1	0	2
54.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55.52	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
56.12	1	0	0	0	0	0	0	0	0	0	1	119	2	2	115	0	0	1	0	0	0	0	0	1	0	0	0
56.5	3	0	0	0	0	0	0	0	0	0	16	222	66	4	123	0	0	26	1	0	0	2	0	1	0	0	2
56.72	6	0	0	2	0	0	0	0	0	0	3	92	72	0	1	0	0	7	0	0	1	0	3	4	3	0	0
57.32	0	0	0	1	0	0	0	0	0	0	2	49	36	0	2	0	0	46	0	0	1	0	0	2	0	0	0
57.76	3	0	0	0	0	0	0	0	0	0	0	46	38	0	6	0	0	6	0	1	1	0	1	0	1	0	0
58.95	19	0	0	6	2	5	0	0	0	1	4	8	6	0	0	1	0	1	0	0	4	0	2	4	2	0	0
60.52	16	112	0	3	1	0	1	0	0	0	6	9	0	0	0	0	0	1	0	0	81	4	21	57	0	0	23

z(m)core	fr-con	fr-crot	fr-lepto	fr-pin	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhol	st-ast	st-carc	st-min	st-nia	st-ore	st-ovecc	st-10
60.63	60	78	1	3	3	2	0	0	0	0	3	6	4	0	0	0	0	0	1	0	56	0	29	77	3	0	141
60.72	1	0	0	0	2	0	0	2	0	0	1	12	11	0	0	0	0	15	1	0	2	0	0	1	0	0	0
60.92	0	0	1	0	0	0	0	0	0	0	7	2	1	0	0	2	2	33	0	0	0	0	0	3	0	0	0
61.12	0	0	0	0	2	0	0	0	0	0	50	41	3	2	0	1	1	113	0	1	1	0	0	0	0	0	0

z(m)core3	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
5.122	0	0	0	0	0	0	0.8	26	34
5.282	2	0	0	0	0	2	5.3	184	35
5.522	2	0	0	0	0	1	4.9	174	35.6
5.722	0	0	0	0	0	0	4	143	35.6
5.922	1	0	0	0	0	1	3.3	116	34.8
6.122	1	3	0	0	0	0	2.5	90	35.4
6.322	0	4	0	0	0	0	4.7	169	36
6.522	0	0	0	0	0	1	170	391	2.3
6.722	0	0	0	2	0	0	97.8	391	4
6.922	0	0	6	0	0	0	73.9	458	6.2
7.122	0	0	1	0	0	1	92	414	4.5
z(m)core1									
7.02	0	0	0	0	0	1	33.4	454	13.6
7.12	0	1	2	1	0	2	47.1	485	10.3
7.32	0	0	3	0	0	0	123.1	443	3.6
7.52	0	0	0	0	0	1	142.3	498	3.5
7.71	0	0	0	0	0	1	42.9	472	11
8.11	0	3	2	5	0	1	72.9	510	7
8.32	0	0	3	17	0	1	29.5	516	17.5
8.51	0	0	2	3	2	0	32.1	561	17.5
9.52	0	0	1	1	0	0	95.9	489	5.1
9.72	0	1	0	6	0	0	49.6	546	11
9.92	0	0	1	0	0	1	27.9	503	18
10.12	0	0	1	7	0	1	60.9	451	7.4
10.32	0	0	2	3	3	1	28.8	496	17.2
10.55	0	1	2	5	5	0	44.6	509	11.4
10.72	0	1	1	0	7	0	32.1	466	14.5
10.97	0	0	1	3	2	0	50.6	405	8
11.12	0	0	0	2	4	0	73.1	512	7
11.33	0	0	0	0	5	0	84.9	484	5.7
11.52	0	0	0	2	4	2	43.6	480	11
11.72	0	0	2	2	7	2	29.9	449	15
11.92	0	0	0	1	3	0	74.7	448	6
12.12	0	0	0	0	0	2	82.4	499	8
12.32	0	0	1	3	0	0	28	457	16.3
12.52	0	0	1	3	0	0	35.8	430	12
12.72	0	1	0	1	7	0	45.8	490	10.7
12.92	0	0	0	0	7	0	38.9	475	12.2
13.12	0	0	0	3	5	0	31.4	533	17
13.32	0	0	2	8	2	0	24.1	417	17.3
13.52	0	0	0	1	2	0	18.8	334	17.8
13.72	0	0	1	0	0	0	21	347	16.5
13.92	0	0	1	2	0	0	17.5	302	17.3
14.12	0	0	1	0	0	1	20.2	358	17.7
14.22	0	0	0	0	0	0	82.5	437	5.3
14.32	0	0	0	10	0	1	52.2	501	9.6
14.52	0	0	1	2	1	0	39.6	475	12
14.72	0	0	0	0	0	0	64	397	6.2
14.92	0	0	0	4	0	0	56.3	450	8
15.12	0	0	2	4	2	1	36.9	458	12.4
15.34	0	0	1	5	0	1	43.5	435	10
15.52	0	0	2	3	2	0	36.5	475	13
15.72	0	0	0	3	2	0	77.1	393	5.1
15.92	0	0	0	5	0	0	100	430	4.3

z(m)core	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
16.02	0	0	1	0	0	0	78.5	416	5.3
16.1	0	0	1	0	2	0	65.3	457	7
16.12	0	0	1	0	0	0	82.6	372	4.5
16.32	0	0	0	0	1	0	101.5	416	4.1
16.52	0	0	1	0	0	0	54.6	491	9
16.72	0	0	3	5	0	0	50.7	492	9.7
16.92	0	0	3	6	1	0	20.7	361	17.4
17.12	0	0	3	2	0	0	25.8	439	17
17.31	0	0	8	2	0	1	30.6	496	16.2
17.32	0	0	4	5	2	0	26.4	468	17.7
17.56	0	0	0	7	0	0	23.6	390	16.5
17.72	0	0	2	0	4	0	19.2	340	17.7
17.74	0	0	1	0	4	0	14.4	245	17
17.92	0	0	2	3	0	1	20.7	373	18
18.12	0	0	1	4	0	0	35.3	498	14.1
18.32	0	0	0	3	0	0	38.3	448	11.7
18.52	0	0	0	0	0	0	21.9	372	17
18.72	0	0	0	0	0	1	32.1	376	11.7
18.92	0	0	3	0	1	0	38.4	419	10.9
19.02	0	0	0	2	0	0	30.6	306	10
20.22	0	0	0	0	0	0	37.6	338	9
20.42	0	0	2	2	2	1	45.4	363	8
20.62	0	0	1	0	0	0	49.3	345	7
20.82	0	0	0	0	0	0	75.7	386	5.1
21.02	0	0	3	0	0	0	41.7	375	9
21.09	0	0	0	21	0	0	76.2	320	4.2
21.22	0	0	0	13	1	0	86.3	440	5.1
21.42	0	0	0	2	0	1	36.3	450	12.4
21.72	0	0	2	10	0	1	48.9	440	9
22.12	0	0	1	0	0	0	50.3	463	9.2
22.32	0	0	1	0	2	1	32.3	355	11
22.52	0	0	1	0	0	1	28.8	403	14
22.57	0	0	0	0	0	0	104.3	386	3.7
22.72	0	0	2	0	0	2	29.7	395	13.3
22.92	0	0	0	0	0	0	28.1	365	13
23.12	0	0	1	0	0	2	24	427	17.8
23.32	0	0	1	0	0	0	26.6	413	15.5
23.52	0	0	1	2	0	1	37.4	393	10.5
23.72	0	0	1	0	0	1	24.6	419	17
23.92	0	0	7	0	0	0	26.3	448	17
24.12	0	0	3	1	0	0	46	368	8
24.32	0	0	0	0	0	0	33.6	400	11.9
24.52	0	0	0	0	0	0	24.2	423	17.5
24.72	0	0	1	0	1	0	20.6	351	17
24.92	0	0	1	0	0	1	17.8	309	17.4
25.12	0	0	1	0	0	1	23.7	388	16.4
25.26	0	0	0	0	0	0	67.2	363	5.4
25.27	0	0	0	0	0	0	20.2	346	17.1
25.52	0	0	0	0	1	0	15.1	263	17.4
25.72	0	0	0	0	0	0	10.4	258	24.7
25.92	0	0	1	0	1	1	14.7	300	20.4
26.32	0	0	1	0	0	0	18.4	317	17.2
26.92	0	0	0	0	0	1	17.7	307	17.3
27.5	0	0	0	0	0	1	18.6	334	18

z(m)core~~7~~1	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
27.56	0	0	0	0	0	1	64.7	427	6.6
30.92	0	0	2	0	2	0	25	437	17.5
32.31	0	1	7	0	0	0	99.4	497	5
32.32	0	0	15	0	0	0	44.7	447	10
32.72	0	0	5	0	0	1	89.8	449	5
33.32	0	0	5	0	0	4	45.8	495	10.8
33.68	1	0	2	0	3	6	65.4	458	7
33.92	0	0	1	2	0	0	16.3	287	17.6
34.52	0	2	14	0	0	2	32.4	551	17
34.92	0	1	16	0	0	1	37.5	525	14
35.53	0	0	8	0	0	1	34.8	484	14
36.12	6	1	9	0	0	1	51	510	10
36.72	20	13	0	0	0	0	4	139	35
37.92	1	3	0	0	0	0	0.5	16	35
38.51	3	3	0	0	0	1	0.9	31	35
38.82	0	0	0	0	1	0	2.7	95	35
39.12	1	4	0	0	0	0	2.5	89	35
39.72	0	5	0	0	0	0	4.1	142	35
40.32	0	1	0	0	0	0	1.5	51	35
40.92	0	0	0	0	0	0	0	0	35
40.96	0	0	0	0	0	0	0	1	36
41.52	0	0	0	0	0	0	0	0	35
41.79	0	0	0	0	0	0	0	0	36
42.12	0	0	0	0	0	0	0	0	35
42.72	3	0	0	0	0	0	4.6	161	35
43.32	15	4	0	0	0	1	20.8	353	17
43.75	0	0	9	0	0	1	100.4	502	5
43.92	0	0	0	0	0	0	29.5	384	13
45.12	0	0	0	0	0	1	40	480	12
45.38	0	0	1	0	0	0	94.4	472	5
45.72	0	0	0	0	0	0	59.5	476	8
46.5	1	1	5	0	0	0	50.3	402	8
46.72	0	0	1	0	0	0	61	427	7
47.32	0	0	1	0	0	0	53.6	434	8.1
47.92	0	6	0	0	0	0	5.6	192	34
49.52	0	11	0	0	0	0	13.3	232	17.5
49.6	0	22	0	0	0	0	8.1	283	34.9
49.92	0	0	0	0	0	0	4.3	151	35
50.49	0	0	0	0	0	0	1.8	63	35
52.5	0	0	0	0	0	1	3.7	129	35
53.12	0	0	0	0	0	0	3.8	133	35
53.35	0	0	0	0	0	0	10.9	387	35.6
53.72	0	0	0	0	0	0	1.9	67	35
54.32	0	0	1	0	0	0	6.6	230	35
54.8	0	0	0	0	0	1	2.5	84	34
54.92	0	0	0	0	0	0	0	0	35
55.52	0	0	0	0	0	2	0.2	7	35
56.12	0	0	0	0	0	1	3.8	133	35
56.5	0	15	0	2	0	0	13.5	383	28.3
56.72	0	1	0	0	0	1	6.2	222	35.7
57.32	0	0	0	0	0	0	8.3	289	34.8
57.76	0	3	0	0	0	2	2.7	96	35
58.95	4	2	0	0	0	3	22.6	398	17.6
60.52	0	1	2	0	0	2	23.2	418	18

z(m)core~~X~~ 1	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
60.63	0	0	0	0	5	0	84.3	624	7.4
60.72	0	0	0	0	0	0	1	143	36
60.92	0	0	0	0	0	0	4.6	165	36
61.12	0	1	0	0	0	1	9.6	332	34.7

Appendix 1B

depth	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au-isl?	au-sarc	au-sol	cal	cam-cly	cam-smo	chael	coc	coc-neot	coc-plac	cyc-bod	cyc-casp	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn
81.31	0	0	0	1	9	0	0	0	0	0	0	0	14	0	0	3	0	3	0	0	0	0	3	0	0
61.52	0	0	0	0	2	0	0	0	0	0	0	0	97	1	1	1	0	1	0	0	0	0	17	0	1
61.72	0	0	0	0	4	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	6	0	0
61.73	2	0	0	0	2	0	0	2	0	0	0	0	44	0	24	5	0	5	1	0	21	0	28	1	0
61.92	0	0	0	0	7	0	0	0	0	0	0	0	115	0	1	1	0	1	0	0	0	0	31	1	0
62.12	2	0	0	0	8	0	0	0	0	0	0	0	92	6	16	2	0	2	0	0	2	0	37	1	0
62.32	0	0	0	0	13	0	0	0	0	0	0	0	77	1	3	3	0	3	1	0	0	0	141	1	0
62.52	0	0	1	2	2	0	0	0	0	0	0	0	28	1	2	0	0	0	0	0	0	0	234	1	0
62.96	0	2	0	0	3	0	0	0	0	0	0	0	17	0	5	2	2	0	0	0	261	0	4	0	0
63.19	0	0	4	3	1	0	0	0	1	0	0	0	6	0	0	1	0	1	0	0	1	0	1	3	0
64.94	0	0	0	6	1	14	2	9	0	0	0	1	1	0	0	11	8	1	0	0	2	0	0	2	6
65.94	0	0	0	0	1	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0
67.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68.59	2	0	1	2	0	5	0	0	10	12	0	0	0	0	2	4	1	3	8	0	25	3	0	0	0
71.06	1	0	0	5	2	1	0	1	15	13	0	0	0	0	0	7	2	2	1	0	4	0	0	3	0
72.06	4	3	0	3	10	2	0	0	21	17	0	2	2	0	4	7	1	6	4	0	8	0	0	1	0
77.16	6	0	2	3	0	0	0	0	64	0	0	0	0	0	0	12	2	10	0	0	0	0	0	6	0
78.39	3	0	0	3	0	54	0	0	0	0	0	0	0	0	0	17	8	9	0	0	0	0	0	3	0
79.9	2	0	0	3	0	8	0	0	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0	0	0
81.42	0	0	0	4	0	7	0	0	0	0	0	0	0	0	0	13	0	10	0	0	0	0	0	3	0
83.55	2	0	1	15	0	35	0	0	0	0	0	0	0	0	0	11	1	9	0	0	0	0	0	3	0
85.17	4	0	0	4	0	44	0	0	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0	2	0
86.55	6	0	2	22	0	45	0	4	0	0	0	0	0	0	0	27	2	23	7	0	0	0	0	10	0
86.06	2	0	1	15	1	49	0	0	0	0	0	0	0	0	0	22	5	15	12	0	0	0	0	4	0
89.65	9	0	2	40	0	0	0	0	0	0	0	3	0	0	1	18	7	11	0	0	0	0	0	2	0
91.17	12	0	0	41	0	2	0	0	0	0	0	4	0	0	0	47	13	29	0	0	0	0	0	6	0
92.6	6	0	0	11	0	12	0	1	2	0	0	1	0	0	0	12	1	11	0	0	0	0	0	4	2
94.12	2	0	0	4	0	8	0	36	0	0	0	2	0	0	0	5	0	5	0	0	0	0	0	2	6
96.66	0	0	2	7	0	3	22	5	45	0	0	0	0	0	0	2	2	0	0	0	0	0	0	3	0
98.64	0	0	0	0	0	0	0	0	0	0	0	1	0	10	6	7	0	7	0	15	0	0	0	0	0
100.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109.96	0	0	0	0	52	0	0	0	0	0	0	0	6	0	1	2	0	2	0	0	1	1	0	2	0
111.24	0	0	0	0	19	0	0	0	0	0	0	0	16	0	7	7	0	7	0	0	0	0	0	1	0
112.33	1	0	1	1	0	31	0	1	0	0	0	0	0	0	0	4	0	4	0	0	1	0	0	2	0
113.64	6	0	1	0	0	11	0	47	0	0	0	0	0	0	0	8	0	8	0	0	0	0	0	7	1
116.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117.91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119.65	0	0	0	1	4	0	1	0	0	4	0	0	16	1	0	0	0	0	0	0	0	0	0	0	0
121.32	2	0	0	5	0	0	35	1	0	206	0	2	0	0	0	6	1	5	0	0	0	0	0	3	0
122.95	2	0	0	9	0	100	0	47	0	0	0	2	0	0	0	4	0	4	0	0	0	0	0	0	0
124.44	10	0	0	9	0	34	0	27	0	0	0	0	0	0	0	10	2	4	0	0	0	0	0	1	0
126.31	1	0	1	0	0	37	0	32	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	1	0
127.17	0	0	0	0	0	20	0	25	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
129.18	0	0	7	0	0	0	0	48	0	0	0	1	0	0	0	5	3	2	0	0	4	0	0	1	0
130.62	0	0	0	0	31	5	7	9	0	0	0	0	0	0	0	5	2	3	0	0	1	0	0	0	1
131.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135.85	1	2	0	0	42	0	0	0	0	0	0	0	34	2	0	0	0	0	0	0	2	0	0	0	1
137.43	0	0	1	2	0	0	0	4	0	0	0	2	0	0	3	1	0	1	1	0	0	0	0	0	0
139.54	0	7	0	0	1	0	0	0	0	0	0	0	20	5	0	0	0	0	0	0	0	0	0	0	2

depth	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au-isl?	au-sarc	au-sol	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-casp	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn
141.42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142.29	0	0	0	0	12	2	0	0	0	0	0	0	13	4	0	2	0	0	0	0	0	0	0	0	0
145.91	0	0	0	0	32	0	0	0	0	0	0	0	20	3	1	0	0	0	0	0	0	0	0	0	0
145.69	0	9	0	0	39	2	0	0	0	0	0	0	16	6	0	0	0	0	0	0	0	0	2	0	0
147.24	0	0	0	3	5	0	5	3	0	0	0	0	0	1	0	2	0	2	0	0	0	0	6	0	0
148.43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156.71	0	0	1	4	0	4	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	0	2	21
162.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172.43	6	0	4	4	0	0	0	3	0	0	250	0	0	0	0	18	0	16	0	0	0	0	0	6	0
174.76	6	0	2	12	0	0	0	5	0	0	162	3	0	0	0	11	4	7	0	0	0	0	0	1	16
177.05	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	8	0	1	4	0	0	0	0	0	0	146	1	0	0	0	10	3	7	0	0	0	0	0	3	10
182.79	18	0	2	12	0	0	0	5	0	0	12	7	0	0	0	45	18	19	0	0	0	0	0	8	0
184.18	14	0	4	7	0	0	0	6	0	0	77	2	0	0	0	35	28	6	0	0	0	0	0	5	6
185.34	0	0	2	0	0	0	0	23	0	0	0	0	0	0	0	8	0	6	0	0	0	0	0	9	0
186.92	0	0	19	6	15	0	0	0	0	1	2	0	42	0	0	7	0	6	0	0	1	0	0	4	0
188.63	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190.15	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
191.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195.08	3	0	17	0	15	0	0	103	0	0	0	0	11	0	0	5	0	5	0	0	35	0	0	6	0
196.54	0	0	3	1	6	0	0	0	0	0	0	0	126	0	0	0	0	0	0	0	9	0	0	0	0
199.29	0	0	0	0	10	0	0	0	0	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0
201.3	0	0	0	2	4	0	0	16	0	0	0	0	19	0	3	3	0	3	0	0	45	0	0	19	0
202.05	0	0	13	2	3	0	20	5	0	0	0	0	2	0	2	2	0	2	0	0	53	0	0	6	0
203.4	2	0	2	2	0	0	66	5	0	0	0	0	0	0	0	3	0	3	0	0	1	0	0	5	0
204.6	2	0	1	2	0	0	148	0	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0	4	0
207.89	12	0	8	5	0	0	2	2	0	10	99	0	1	0	0	8	0	4	0	0	0	0	0	6	0
209.26	11	0	8	3	0	0	0	10	0	0	55	0	0	0	0	19	5	9	0	0	0	0	0	4	1
212.14	0	0	1	0	3	0	0	10	0	0	5	0	1	0	0	0	0	0	0	0	1	0	0	1	0
213.49	0	2	0	0	85	0	0	1	0	0	2	0	39	25	0	0	0	0	0	0	0	0	6	0	0
216.52	3	2	0	0	42	0	1	0	0	0	0	0	75	34	2	0	0	0	0	0	0	0	4	0	0
221.48	0	3	0	0	10	0	0	0	0	0	1	0	34	16	16	0	0	0	0	0	8	0	33	1	0
223.17	0	0	1	8	0	0	5	16	0	0	0	0	0	0	0	3	0	2	0	0	1	0	0	0	0
224.84	6	0	0	4	0	0	61	0	0	0	0	0	0	0	0	2	0	2	5	0	0	0	0	0	0
226.26	1	0	0	4	0	0	28	10	0	0	0	0	0	0	0	7	0	7	0	0	10	0	0	0	0
227.54	16	0	1	0	10	0	0	0	0	0	0	9	0	0	0	23	0	23	0	0	18	0	0	6	0
235.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
238.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
241.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
246.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
254.1	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	1	4	0	0	7	0	0	6	0
267.53	0	0	2	2	0	0	0	0	0	0	78	2	0	0	0	14	8	6	0	0	0	0	0	2	0
268.43	2	0	0	5	0	0	0	0	7	0	18	0	0	0	0	4	2	2	0	0	0	0	0	0	0
271.98	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	2	0
273	6	0	2	15	0	0	0	4	0	0	105	2	0	0	0	19	13	6	0	0	0	0	0	0	0
277.15	2	0	0	2	1	0	0	0	0	0	111	0	2	0	0	1	1	0	0	0	0	0	0	1	0
279.3	2	0	2	0	4	0	0	3	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	7	0
280.59	2	0	4	2	5	0	0	0	0	0	8	0	28	0	0	25	22	3	0	0	7	0	8	4	0

295

depth	ach	amp-cof	amp-oval	amp-per	ano-cos	ast-form	au-amb	au-gr	au-lsl?	au-sarc	au-sol	cal	cam-cly	cam-smo	chaet	coc	coc-neot	coc-plac	cyc-bod	cyc-casp	cyc-men	cyc-oce	cyc-quil	cymb	cyst-opn
284.34	0	0	0	0	3	0	0	0	0	0	0	0	93	11	2	2	0	2	0	0	0	0	13	3	0
286.25	5	0	2	0	3	0	15	100	0	0	0	0	2	0	1	4	0	4	0	0	75	0	0	5	0
287.5	0	0	1	0	1	0	38	65	0	0	0	0	0	0	0	2	0	2	0	0	5	0	0	1	0
288.74	0	0	1	0	1	0	40	4	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	2	0
290	0	0	2	0	0	0	37	64	0	5	0	1	0	0	0	2	1	1	12	0	1	0	0	1	0
293.9	2	0	0	4	0	0	0	2	0	285	0	0	0	0	0	2	0	1	0	0	0	0	0	1	0
296.6	1	0	0	0	0	0	2	47	0	256	14	1	0	0	0	3	1	2	0	0	0	0	0	1	0
297.93	0	0	2	0	0	0	77	79	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
299.17	29	0	0	3	0	0	1	2	0	0	0	13	0	0	0	21	2	19	0	0	10	0	0	6	0
302.82	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2	11	0	0	4	0	0	8	109
304.41	4	0	0	0	0	0	1	3	0	0	0	0	0	0	0	19	0	19	0	0	0	0	0	2	0
306.64	6	0	1	2	0	0	0	0	0	0	0	0	0	0	0	12	0	12	0	0	0	0	0	7	15
307.24	3	0	2	0	0	0	0	1	0	0	1	0	0	0	0	6	0	6	0	0	0	0	0	7	0
310.37	0	0	0	10	1	0	0	5	0	0	0	0	0	0	0	4	2	2	0	0	0	0	0	0	0
312.33	2	0	1	0	0	0	0	0	0	0	112	0	0	0	0	2	0	2	0	0	0	0	0	1	0
313.97	3	0	1	12	0	0	0	115	0	0	154	1	5	0	0	10	7	3	0	0	0	0	0	2	0
316.45	0	0	0	0	0	0	0	110	0	0	2	0	0	0	0	3	2	1	0	0	1	0	0	2	0
318.45	2	0	1	0	1	0	0	265	0	0	9	0	1	0	1	2	0	2	0	0	33	0	0	4	0
320.36	17	0	5	2	0	0	0	0	0	0	0	2	0	0	0	32	1	31	2	0	15	0	0	2	0
320.86	7	0	0	0	0	0	12	4	0	0	0	0	0	0	0	9	0	9	0	0	6	0	0	3	0
323.28	20	0	0	2	0	0	0	6	0	0	4	0	0	0	0	6	1	5	0	0	0	0	0	1	0

depth	epi	fr-brev	fr-cap	fr-con	fr-crot	fr-lepto	fr-pin	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhoi	st-ast	st-carc	st-fn/ecc	st-min
61.31	6	15	0	4	0	1	1	0	0	0	0	0	0	2	4	3	0	0	0	4	0	1	0	5	0	0	0
61.52	3	8	0	2	0	0	0	0	1	0	0	0	0	2	2	0	0	0	0	0	2	0	0	12	4	0	0
61.72	3	4	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	4	0	0	6	2	0	0
61.73	3	10	0	12	0	0	0	0	3	0	0	0	0	2	3	1	0	0	2	0	4	0	0	6	0	0	0
61.92	3	16	0	6	0	0	0	0	0	0	1	0	0	2	7	3	0	0	0	0	1	0	0	3	0	0	1
62.12	8	5	0	7	0	1	2	0	0	0	2	0	4	1	9	7	1	0	0	1	7	0	0	17	1	0	0
62.32	3	0	0	11	0	0	0	2	1	0	0	0	0	0	5	2	0	0	0	0	3	1	0	16	3	0	0
62.52	6	46	0	15	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	3	4	0	16	10	0	0
62.96	4	24	0	3	0	0	1	3	2	0	0	0	0	1	13	8	0	0	0	2	0	1	0	0	0	0	0
63.19	1	64	0	10	0	0	0	0	0	0	0	0	0	2	4	1	0	0	0	0	0	0	0	201	3	0	0
64.94	0	45	23	34	0	0	8	0	0	0	0	0	0	2	3	1	0	0	0	2	0	0	0	122	0	0	0
65.94	1	15	0	2	0	0	0	0	0	0	0	0	0	1	5	4	0	0	0	0	2	1	1	6	1	0	0
67.49	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
68.59	3	17	0	4	0	0	3	0	0	1	0	0	0	4	10	8	0	0	0	0	4	0	0	91	0	0	0
71.06	0	22	0	12	0	0	4	0	2	0	2	0	0	7	3	2	0	0	0	0	0	0	1	68	1	0	0
72.06	5	13	0	5	0	0	5	0	2	0	0	0	0	0	245	20	207	12	2	0	0	0	0	59	0	0	0
77.16	6	27	0	5	0	2	8	2	4	0	0	0	0	18	20	4	0	0	4	0	1	2	1	131	0	0	0
78.39	22	10	0	2	0	2	4	6	0	0	0	0	0	25	19	0	0	0	0	0	2	0	3	179	0	0	0
79.9	4	12	0	0	0	2	0	2	1	0	0	0	0	15	18	0	0	0	0	0	0	2	4	184	0	0	0
81.42	4	4	0	0	0	0	1	0	2	0	0	0	0	5	20	0	0	0	0	0	0	2	5	257	1	0	0
83.55	7	11	0	7	0	0	3	2	2	1	0	0	0	12	22	2	0	0	2	0	0	2	11	205	0	0	19
85.17	2	37	0	7	0	0	0	2	3	0	0	0	0	14	31	0	0	0	0	0	0	3	13	108	0	0	0
86.55	38	39	0	27	0	0	8	0	1	1	0	0	0	13	24	2	0	0	3	0	0	2	7	256	0	0	14
88.08	14	24	0	19	0	0	5	1	1	0	1	1	6	27	34	0	1	0	0	0	0	4	14	127	0	0	14
89.65	24	30	0	9	0	0	2	0	0	1	0	0	0	39	36	6	0	0	1	0	0	3	8	56	0	0	8
91.17	15	15	0	6	0	0	3	2	3	0	0	0	0	54	38	7	0	0	0	0	1	2	22	38	1	0	34
92.6	25	31	0	19	0	0	2	1	1	0	0	0	0	26	21	3	0	0	0	0	1	1	3	111	0	0	61
94.12	16	24	0	19	3	0	9	0	2	5	0	0	0	6	10	3	0	0	0	0	1	2	1	132	0	0	50
96.66	8	17	0	5	4	1	2	0	0	1	0	0	0	3	4	0	0	0	0	0	0	0	1	95	0	0	47
98.64	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3	1	0	0	1	0	0	33	50	0	0	0
100.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109.96	2	0	0	0	0	0	0	0	0	0	0	0	0	10	63	7	29	24	0	0	0	0	0	5	0	0	0
111.24	1	4	0	6	0	0	1	0	0	0	0	0	0	0	16	14	0	2	0	50	2	0	0	4	0	0	0
112.33	3	4	0	12	57	0	2	0	2	0	0	0	0	3	4	0	0	0	0	0	0	1	0	25	0	0	19
113.64	2	5	6	6	67	0	4	1	0	0	0	0	0	5	2	0	0	0	0	0	0	0	1	28	0	0	25
116.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
117.91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119.65	1	0	0	0	0	0	0	0	0	0	0	0	0	3	30	4	19	7	0	0	0	1	0	8	0	0	2
121.32	9	20	0	11	0	0	19	0	0	1	0	0	0	17	22	1	0	0	0	0	1	1	1	23	0	0	6
122.95	2	0	0	1	21	0	5	0	0	0	0	0	0	7	23	0	0	0	0	0	0	0	2	250	0	0	7
124.44	3	1	0	6	4	0	2	0	0	0	0	0	0	13	9	3	0	0	0	0	0	0	2	194	0	0	83
126.31	1	2	5	7	0	0	5	0	0	0	0	0	0	1	11	0	0	0	0	0	0	0	4	173	0	0	77
127.17	0	4	0	12	14	0	0	2	0	0	0	0	0	3	2	0	0	0	0	0	0	0	2	170	0	0	9
129.18	4	11	0	8	86	0	3	2	2	0	0	0	0	11	9	0	0	0	1	0	0	0	2	0	0	0	38
130.62	1	1	0	3	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	7	2	0	2
131.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135.85	0	5	0	2	0	0	0	0	0	0	0	0	0	28	36	0	1	35	0	0	2	0	0	0	0	0	0
137.43	5	10	0	4	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	1	266	0	0	1
139.54	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	6	0	1	0	0	0	0	0	0	0	0	0

depth	epi	fr-brev	fr-cap	fr-con	fr-crot	fr-lepto	fr-pln	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pln	rho-con	rho-gbr	rho-gib	rhoi	st-ast	st-carc	st-fn/ecc	st-min
141.42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	5	3	0	0	0	0	0	6	0	0	0
143.91	0	0	0	2	0	0	0	0	1	0	0	0	0	11	154	6	4	135	0	0	2	0	2	0	0	0	0
145.69	1	16	0	8	0	0	1	0	0	0	0	0	0	3	33	4	6	21	1	0	0	0	2	8	0	0	1
147.24	1	3	0	0	0	0	0	0	0	0	0	0	2	5	10	2	3	1	0	0	0	1	0	29	12	0	3
148.43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156.71	3	10	0	9	0	0	1	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	1	250	0	0	7
162.89	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0
167.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172.43	14	28	0	21	0	0	20	0	2	0	1	0	0	20	17	1	0	0	0	0	1	0	9	0	0	28	4
174.76	7	26	0	8	0	0	9	0	0	2	0	0	0	18	16	5	0	0	1	0	0	0	1	88	0	50	72
177.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	14	34	0	16	0	0	18	0	0	0	0	0	0	7	14	0	0	0	1	0	0	0	4	120	0	1	3
182.79	40	61	0	29	0	0	13	0	0	0	0	0	0	22	61	0	0	0	2	0	0	3	16	48	0	0	6
184.18	45	61	0	22	0	0	17	2	0	0	0	0	0	34	70	2	0	0	0	0	0	1	13	90	0	0	0
185.34	12	41	0	2	0	0	3	3	0	0	0	0	0	2	9	0	0	0	4	0	0	0	2	63	0	0	1
186.92	20	14	0	5	0	0	0	0	0	0	0	0	0	16	24	6	0	0	3	0	0	0	0	9	3	0	0
188.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195.08	23	65	0	5	0	0	2	0	0	0	0	0	0	18	10	0	0	0	3	0	0	2	2	16	2	0	16
196.54	19	12	0	2	0	0	0	0	0	0	0	0	0	12	21	4	0	0	1	0	4	0	0	0	0	0	0
199.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	4	0	22	0	0	0	0	0	2	0	0	3
201.3	5	117	0	14	43	0	4	6	0	0	0	0	0	2	23	0	0	0	2	0	0	0	0	10	0	0	0
202.05	3	205	0	58	6	0	19	12	0	0	0	0	0	11	8	4	0	0	2	0	0	1	0	0	0	0	0
203.4	4	13	0	12	4	0	20	3	0	0	0	0	0	3	1	0	0	0	0	0	0	0	1	80	0	0	15
204.6	3	86	0	81	0	0	121	2	2	0	0	0	0	4	2	0	0	0	0	0	0	2	2	12	0	0	0
207.89	7	112	0	65	0	0	18	0	0	0	0	0	0	13	14	0	0	0	0	0	0	1	1	42	0	0	14
209.26	8	113	0	18	0	3	11	2	0	0	2	0	0	9	8	0	0	0	2	0	0	2	3	44	0	0	7
212.14	2	25	2	264	0	0	38	2	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	39	0	0	0
213.49	1	2	0	0	0	0	0	0	0	0	0	0	0	1	18	4	1	8	1	0	0	0	0	2	1	0	0
216.52	3	2	0	0	0	0	0	0	1	0	0	0	0	5	27	13	2	2	0	0	1	0	1	4	0	0	0
221.48	0	6	0	87	0	0	0	0	1	0	0	0	0	16	33	7	2	22	0	0	0	1	0	0	0	0	0
223.17	2	30	0	184	0	0	23	2	2	0	0	0	0	13	5	0	0	0	0	0	0	0	0	26	0	0	11
224.84	1	106	0	128	0	11	22	2	2	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
226.26	7	27	0	43	20	0	2	1	3	0	0	0	0	1	2	0	0	0	0	0	0	1	2	128	0	0	14
227.54	47	15	0	30	0	0	8	0	7	1	5	0	0	66	36	6	0	0	16	0	0	27	2	2	0	0	0
235.61	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
238.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
241.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
246.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254.1	10	36	0	223	0	4	51	0	3	0	1	0	0	12	16	10	0	0	1	0	0	7	1	0	0	0	0
267.53	3	16	0	9	0	0	1	0	0	0	1	0	0	10	2	0	0	0	0	0	0	1	2	83	0	0	0
268.43	3	31	0	7	0	0	4	3	2	0	0	0	0	10	0	0	0	0	0	0	0	3	0	39	0	0	0
271.98	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	13	0	0	0
273	9	23	0	16	0	0	7	0	5	7	0	0	0	9	10	0	0	0	0	0	0	0	0	29	0	0	0
277.15	4	23	0	23	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	24	0	0	7
279.3	2	5	0	15	0	0	0	2	1	0	0	0	0	7	12	2	0	0	2	0	3	0	0	82	0	0	21
280.59	14	83	0	77	3	6	9	3	0	0	0	0	0	15	59	24	0	0	2	0	0	3	0	100	0	0	13

depth	epi	fr-brev	fr-cap	fr-con	fr-crot	fr-lepto	fr-pin	fr-vau	gom	gyro	hz-am	mel-hudt	mel-var	nav	nitz	nz-frust	nz-mono	nz-pus	pin	rho-con	rho-gbr	rho-gib	rhoi	st-ast	st-carc	st-fn/ecc	st-min
284.34	4	3	0	2	0	0	0	0	1	0	0	0	0	0	3	1	1	0	0	0	6	0	0	3	0	0	0
286.25	5	73	0	216	0	0	6	2	0	0	0	0	0	11	21	0	0	0	1	0	1	4	0	0	0	0	4
287.5	1	86	0	168	1	0	17	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	2
288.74	2	98	0	296	0	0	27	1	0	0	0	0	0	43	0	0	0	0	1	0	0	0	0	0	0	0	0
290	3	41	0	295	0	0	40	1	0	0	0	0	0	6	0	0	0	0	0	0	0	0	2	0	0	0	0
293.9	3	21	0	18	0	0	15	1	0	0	0	0	0	4	5	0	0	0	2	0	0	0	0	3	0	0	0
296.6	1	4	0	8	0	4	18	0	0	0	0	0	0	2	3	0	0	0	1	0	0	0	1	9	0	0	4
297.93	2	48	0	173	0	75	6	2	0	0	0	0	0	8	3	0	0	0	0	0	0	0	0	0	0	0	0
299.17	11	14	0	109	0	0	20	0	7	0	1	0	2	54	26	0	0	0	3	0	0	7	2	0	0	0	0
302.82	9	13	0	95	3	6	44	7	6	0	2	0	0	51	22	0	0	0	1	0	0	3	2	25	0	0	11
304.41	6	18	0	191	0	13	32	3	2	3	0	0	0	6	0	0	0	0	0	0	0	1	3	2	0	0	0
306.64	12	50	0	171	0	9	130	5	0	2	0	0	0	23	20	2	0	0	0	0	0	5	9	36	0	0	99
307.24	6	37	0	69	0	3	4	0	3	0	0	0	0	15	14	6	0	0	2	0	1	1	2	3	0	0	1
310.37	1	28	0	272	0	3	37	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	9	0	0	0
312.33	0	41	0	231	0	0	56	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	11	0	4	7
313.97	4	18	0	34	0	0	4	0	0	0	1	0	0	10	22	2	0	0	0	0	0	0	1	33	0	0	22
316.45	5	21	0	170	0	0	121	0	0	0	0	0	0	10	7	0	0	0	2	0	0		1	0	0	0	0
318.45	9	22	0	26	0	2	0	1	0	0	0	0	0	15	14	0	1	0	0	0	1	1	0	11	0	0	2
320.36	31	22	0	42	0	10	31	2	18	0	2	0	0	41	21	0	0	0	8	0	1	4	12	0	0	0	0
320.86	22	10	0	109	0	2	12	8	3	0	3	0	0	21	8	1	0	0	3	0	0	6	2	2	0	0	0
323.28	1	4	0	15	0	2	8	0	3	0	1	0	0	24	0	0	0	0	0	0	0	1	1	8	0	0	1

depth	st-nia	st-parv	st-ore	st-ovecc	st-10	sur-sir	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
61.31	3	0	1	0	0	0	0	1	0	1	2	2.5	88	34.8
61.52	2	0	0	0	0	1	1	1	1	0	2	4.6	166	36
61.72	1	0	0	1	0	0	0	0	0	0	3	2.2	75	34.4
61.73	2	0	0	0	1	3	1	0	0	0	2	5.4	190	35
61.92	2	0	0	0	0	19	0	0	0	0	1	6.2	220	35.6
62.12	0	0	1	0	0	24	1	0	0	0	0	7.25	262	36
62.32	2	0	0	0	0	15	1	0	0	1	0	9	315	35
62.52	4	0	1	0	0	3	4	0	0	0	1	22.1	389	17.6
62.96	0	0	0	0	0	2	4	0	0	0	3	36.5	369	10.1
63.19	0	0	6	0	47	0	1	0	0	0	0	29	362	12.5
64.94	31	0	4	0	57	0	0	1	0	0	1	97	388	4
65.94	1	0	2	0	0	1	0	0	0	0	0	1.3	47	35
67.49	0	0	0	0	2	0	0	0	0	0	0	0.1	4	35
68.59	26	0	1	0	72	0	0	20	0	0	1	9.2	340	37
71.06	13	0	3	0	31	0	0	2	0	2	3	6.7	236	35
72.06	15	0	0	2	20	0	3	11	0	0	0	15.8	495	31.4
77.16	14	0	4	0	168	0	0	4	3	0	0	123.3	530	4.3
78.39	32	3	4	0	168	0	0	2	0	0	1	89.2	571	6.4
79.9	11	0	1	0	181	0	0	0	1	0	0	66.3	464	7
81.42	3	0	14	0	46	0	0	4	2	0	0	83.4	406	6.4
83.55	8	0	13	0	54	0	0	2	4	0	0	70	490	7
85.17	8	0	40	0	104	0	0	2	0	0	2	111.5	446	4
86.55	22	0	7	0	25	0	0	0	2	0	2	103.3	630	6.1
88.06	22	11	19	0	7	0	0	30	0	0	1	50.6	516	10.2
89.65	53	0	88	0	39	0	0	1	0	0	0	39.6	503	12.7
91.17	69	0	118	0	78	0	0	0	2	0	1	43.3	624	14.4
92.6	101	0	3	0	11	0	0	6	0	0	2	58.3	484	8.3
94.12	30	0	19	0	32	0	1	19	0	0	0	57.3	458	8
96.66	108	0	0	0	6	0	0	13	0	0	0	48.6	408	8.4
98.64	0	0	47	0	0	0	37	0	0	0	0	4.8	183	36
100.14	0	0	0	0	0	0	0	0	0	0	0	0	0	35
101.59	0	0	0	0	0	0	0	0	0	0	0	0	0	35
103.07	0	0	0	0	0	0	0	0	0	0	0	0	0	35
109.96	14	0	8	0	0	0	1	0	0	0	0	4.8	169	35
111.24	3	0	4	0	1	0	9	1	0	0	0	4.4	153	35
112.33	67	36	82	0	0	0	0	12	2	0	0	56.8	375	6.6
113.64	120	0	55	0	0	0	0	11	0	0	1	96.1	423	4.4
116.04	1	0	0	0	0	0	0	0	0	0	0	0.08	3	36
117.91	0	0	0	0	0	0	0	0	0	0	0	0	0	36
118.48	0	0	0	0	0	0	0	0	0	0	0	0	0	34.2
119.65	14	0	1	0	0	1	0	0	0	0	0	2.5	90	35.8
121.32	0	0	52	0	31	0	0	0	0	0	0	55	495	9
122.95	32	5	30	0	24	0	0	0	0	0	1	73.6	574	7.8
124.44	75	4	25	0	37	0	0	0	0	2	0	32.5	555	17.1
126.31	34	0	42	0	8	0	0	5	0	3	0	90.6	453	5
127.17	142	0	21	0	0	0	0	2	0	2	0	86.8	434	5
129.18	169	0	40	78	0	0	1	11	0	17	0	55.7	501	9
130.62	47	0	9	0	0	0	0	1	0	0	0	3.9	140	35.6
131.74	2	0	0	0	0	0	0	0	0	0	0	0.06	2	35
133.29	0	0	0	0	0	0	0	0	0	0	0	0	0	36
134.61	0	0	0	0	0	0	0	0	0	0	0	0	0	35
135.85	7	0	0	0	0	1	3	0	0	0	0	4.8	168	35
137.43	5	2	39	0	0	0	1	51	1	2	0	64.2	411	6.4
139.64	2	0	0	0	0	0	0	0	0	0	0	1.4	48	35

300

depth	st-nia	st-parv	st-ore	st-ovecc	st-10	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
141.42	0	0	0	0	0	0	0	0	0	0	0	0	0	35
142.29	4	0	2	0	0	1	4	1	0	0	0	1.7	59	34
143.91	0	0	0	0	0	0	0	0	0	0	0	6.3	228	36
145.69	30	0	2	0	0	1	5	0	0	0	2	5.5	191	35
147.24	23	1	9	0	0	0	0	3	0	0	1	3.8	134	35
148.43	3	0	0	0	0	1	0	0	0	0	0	0.1	4	35
149.19	0	0	0	0	0	0	0	0	0	0	0	0	0	35
152.48	0	0	0	0	0	0	0	0	0	0	0	0	0	35
154.06	2	0	0	0	0	0	0	0	0	0	0	0.05	2	36
155.11	0	0	0	0	0	0	0	0	0	0	0	0	0	35
156.71	58	31	53	0	0	0	0	0	10	3	0	45.8	486	10.6
162.89	4	0	0	0	0	0	0	0	0	0	0	0.3	12	36
167.49	0	0	0	0	0	0	0	0	0	0	0	0	0	35
172.43	2	0	0	0	2	0	0	1	0	0	0	79	490	6.2
174.76	0	11	10	0	8	0	0	1	2	0	0	31.8	557	17.5
177.05	0	0	0	0	0	0	0	0	0	0	0	0	1	34
179	3	1	12	0	1	0	0	1	2	0	1	75	448	6
182.79	57	0	29	0	0	0	0	4	3	0	1	57.1	531	9.3
184.18	32	5	44	0	6	0	0	5	3	0	0	79.25	634	8
185.34	75	0	4	0	0	0	0	0	0	0	2	14.7	265	18
188.92	5	0	0	0	0	19	1	0	0	0	0	6.5	221	34
188.63	0	0	0	0	0	0	0	0	0	0	0	0.1	4	35
190.15	1	0	0	0	0	0	0	0	0	0	0	0.09	3	33
191.53	0	0	0	0	0	0	0	0	0	0	0	0.03	1	35
192.61	0	0	0	0	0	0	0	0	0	0	0	0	0	35
195.08	60	0	41	0	0	3	0	0	0	0	1	27.4	480	17.5
196.54	0	0	2	0	0	20	4	0	0	0	1	14.2	252	17.8
199.29	3	0	2	0	2	1	0	0	0	0	0	1.7	60	34.4
201.3	68	2	1	0	0	0	6	0	0	0	0	59.7	418	7
202.05	23	1	0	0	0	0	1	2	0	0	0	231	462	2
203.4	100	0	13	0	0	0	0	2	0	0	0	71.8	359	5
204.6	20	0	8	0	0	0	0	0	0	0	0	164.6	428	2.6
207.89	68	0	10	0	0	0	0	0	0	2	3	32.3	549	17
209.26	36	0	17	0	10	0	0	0	0	0	0	25	437	17.5
212.14	75	0	4	0	0	0	0	0	0	2	0	125.3	501	4
213.49	1	0	2	0	0	4	4	0	0	0	0	5.4	196	36
218.52	1	0	1	0	0	2	2	0	0	0	0	6.2	213	34.4
221.48	1	0	0	0	0	0	3	0	0	0	0	7.9	276	35
223.17	108	0	27	0	0	0	0	1	0	0	0	65.1	508	7.8
224.84	50	0	5	0	0	0	0	0	0	0	0	181.25	435	2.4
226.26	132	1	11	0	0	0	0	5	0	0	0	38.4	461	12
227.54	0	0	0	0	0	0	0	4	0	0	21	24.7	413	16.7
235.61	3	0	0	0	0	0	0	0	0	0	0	0.2	8	35
238.5	0	0	0	0	0	0	0	0	0	0	0	0	0	35
241.7	0	0	0	0	0	0	0	0	0	0	0	0	0	35
246.2	0	0	0	0	0	0	0	0	0	0	0	0	1	35
254.1	0	0	0	0	0	0	0	4	0	0	2	63.2	449	7.1
267.53	42	0	0	2	0	0	0	0	0	0	0	17	297	17.5
268.43	82	0	0	0	0	0	0	0	0	0	0	6.6	236	35.6
271.98	4	0	0	0	0	0	0	0	0	0	1	1.6	58	36
273	30	0	0	0	0	0	0	0	0	0	3	18.4	326	17.7
277.15	89	0	10	0	0	0	4		0	0	1	17.9	317	17.7
279.3	75	0	9	0	0	0	6	0	0	0	0	10	357	35.6
280.59	42	0	31	0	0	3	45	0	0	0	0	41.9	629	15

depth	st-nia	st-parv	st-ore	st-ovecc	st-10	sur-str	sur-ova	syn-acus	syn-maz	syn-rum	syn-uln	d/mm	count	trav
284.34	0	0	0	0	0	0	5	0	0	0	2	4.5	160	35.2
286.25	36	0	4	0	0	0	0	34	0	0	2	161	644	4
287.5	62	0	0	0	0	0	0	5	0	0	0	244.5	489	2
288.74	23	0	0	0	0	0	0	0	0	4	1	567	567	1
290	11	0	0	0	0	0	0	3	0	2	1	370	555	1.5
293.9	2	2	0	0	0	0	1	0	0	0	1	76.4	382	5
296.6	19	3	4	0	0	0	1	0	0	0	1	137.2	422	4.2
297.93	29	0	0	0	0	0	0	3	0	2	0	175.7	527	3
299.17	2	0	0	0	0	0	0	5	0	5	28	28.1	424	15.1
302.82	53	18	23	0	0	0	0	1	0	1	6	32.8	585	17.8
304.41	97	0	1	0	0	0	0	1	0	0	1	60.4	429	7.1
306.64	26	17	11	2	0	0	0	4	0	0	1	39.8	701	17.6
307.24	8	0	6	0	0	0	0	3	0	0	3	6	212	35.2
310.37	39	0	8	0	0	0	0	1	0	0	0	71.7	430	6
312.33	23	0	3	0	0	0	0	0	0	0	0	67.6	548	8.1
313.97	24	3	25	0	0	0	0	0	0	0	1	30.5	525	17.2
318.45	13	0	0	0	0	0	0	1	0	0	0	176.3	529	3
318.45	37	1	7	0	0	0	9	2	0	0	0	82.3	494	6
320.36	0	0	0	0	0	0	3	1	0	0	12	34.2	424	12.4
320.86	0	0	0	0	0	0	0	1	0	0	8	31.8	318	10
323.26	4	0	0	0	0	0	0	1	0	0	0	3.2	113	35

U.S. DEPARTMENT OF THE INTERIOR
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OSTRACODES PRESENT IN SEDIMENTS

by

Clair Carter

U.S. Geological Survey
Menlo Park, California 94025

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ABSTRACT

One-hundred forty-three samples were taken from the 323.28m Owens Lake core and processed for ostracodes. The fauna consists mainly of *Limnocythere ceriotuberosa* Delorme, *L. sappaensis* Staplin, *Candona* aff. *C. caudata*, and, above 96.66m, *Cytherissa lacustris* (Sars).

SAMPLING AND PROCESSING PROCEDURES

The core was sampled for ostracodes at intervals of approximately 1 to 3 meters, depending on the presence of suitable lithologies: sandy beds are less likely to yield ostracodes than are finer grained sediments. Each raw sample was frozen, thawed and placed in a beaker to which approximately 300ml of hot water and a rounded teaspoon of baking soda were added. After cooling, about 2 tablespoons of Calgon were added and the sample was allowed to sit for 24 hours. It was then wet sieved under a shower type flow over a 100 mesh seive and the resulting residue was allowed to air dry. Each sample was dry seived and the resulting size fractions were examined for adult carapaces and valves, which were picked onto standard paleontological slides.

DATA AND DISCUSSION

Results are presented in Tables 1 and 2. An ostracode carapace consists of two valves that frequently become separated after the animal's death. Therefore the numbers under the species names represent whole adult carapaces or the equivalent in single valves (one right valve and one left valve = one adult carapace). Many samples contained only juveniles of one or more species and these instances are represented on Table 2 by the letter j.

Limnocythere ceriotuberosa Delorme is still found very commonly in western North America; presently it occurs from eastern Washington and northern California through Nevada, into southern Colorado and the central prairies north to the Canadian prairies (Forester, 1985). It lives in fresh and saline lakes (total dissolved solids (TDS) range ~300mg/l to 30g/l) (Delorme, 1989) exhibiting the seasonal variability in temperature and water chemistry common to semi-arid and arid regions (Forester, 1991). It is more common in alkaline-saline lakes north of the frostline (it probably requires, or at least can tolerate, cold water) but can survive seasonal temperatures above 20° C (Forester, 1991).

Limnocythere sappaensis Staplin has a modern distribution pattern the same as *L. ceriotuberosa* but also extends south into central Mexico (Forester, 1985). It requires alkaline-enriched, calcium-depleted saline waters, becoming less common as TDS and chemical composition approach fresh water (Forester, 1991). It is able to thrive in a wide range of temperatures and salinities and might be described as a halobiont taxon (R.M. Forester, oral commun., 1993).

Cytherissa lacustris (Sars) lives only in very fresh-water, cold, stenotopic (single habitat), boreal forest lakes (Delorme, 1989; Forester, 1991). It prefers water temperatures below 20° C and perhaps below 15° C (Forester, 1991), although it has been found in waters ranging in temperature between 3.7° and 23.0° C (Delorme, 1978).

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Table 1. Ostracodes from Owens Lake Core, OL-92-1

Drive	Slug	Depth	Weight	Candona	L.cerio.	C.lacust.	L.sappaen	fish	diatoms	Limno A
6	A	5.59	12.0						X	
7	A	7.59	14.0					X	X	
8	B	9.83	13.4							
11	B	17.84	11.4	6	3	24				
12	A	21.09	14.4					X		
13	B	22.57	11.6					X		
14	A	25.26	16.4					X		
14	B	27.56	12.9	3	7	1		X	X	
17	A	32.31	13.0					X	X	
17	B	33.68	14.2	1	1			X	X	1
19	B	38.82	12.4				46	X	X	
20	A	40.96	16.5				45			
21	A	43.75	14.4					X	X	
21	B	45.38	16.3					X	X	
22	A	46.50	17.6					X	X	
23	A	49.60	17.6		11		24		X	
25	A	53.35	17.2						X	
25	B	54.80	11.1				18			
26	A	56.50	18.7				17		X	
26	B	57.76	16.4		10		15		X	
27	A	58.95	14.5		12			X	X	
27	B	60.63	13.4		16		1	X	X	

EXPLANATION:

Depth in meters, weight in grams

Candona = _Candona_ aff. _C_. _caudata_

L.cerio. = _Limnocythere_ _ceriotuberosa_ Delorme

C.lacust. = _Cytherissa_ _lacustris_ (Sars)

L.sappaen. = _Limnocythere_ _sappaensis_ Staplin

fish = fish bones, teeth, scales

Table 2.

Ostracodes from Owens Lake Core, OL-92-2

Drive	Slug	Depth	Weight	L.cerio	L.sappa	C."cauda"	L.cf.brad	Limno A	C.lacust	Limno sp	Hetero	CandonaA	Limno B	Limno C	Limno D	fish	diatoms	plants	other
1	A	61.73	18.2	4	1	j											x	x	
1	B	62.96	12.5	31												x	x		
2	A	64.94	15	3		j										x	x		
2	B	65.94	13.5		j												x		
3	A	67.49	12.9																
3	B	68.59	24	j		1													
4	A	71.06	16.4		1	j													
4	B	72.26	30.9	8	j		5												
7	A	77.16	22.5														x		
7	B	78.39	24.5	j		1?													
8	A	70.9	24.5			1?		10											
8	B	81.42	18.9			4		11	2										
9	A	83.55	17.1			3		23	4	2									
9	B	85.17	20	j		6		27	7	1								x	
10	A	86.55	17.4	j		1		2	3										
10	B	88.06	22.5	j		1		j	2	1							x		
11	A	89.65	19.9			5		j	2	1							x		molluscs
11	B	91.17	17.7			2		2	7	2							x		molluscs
12	A	92.6	13.1	6		6		1	10	1									
12	B	94.12	17.9			18			15							x	x	x	
14	A	96.66	16	2		-4			j									x	
15	A	98.64	19.6	85															
15	B	100.14	19.4		7													x	
16	A	101.59	23.6	j	1													x	
16	B	103.07	25.4	j	-3	1													m.o.
22	A	109.96	18.8	j	j														
22	B	111.24	18.8		8												x		
23	A	112.33	20.7			j										x			
23	B	113.64	19.4			j												x	
25	A	116.04	26.2	28	1													x	
26	A	117.41	30.8		7													x	
26	B	118.48	18.7		4													x	
27	A	119.65	22.8		j	j												x	
27	B	121.32	20															x	
28	A	122.95	25.1			?												x	
28	B	124.44	22.2															x	
28	C	126.31	22.3			?													
29	A	127.17	21.4			?										x			
29	B	129.18	26.1	j		-4										x		x	
30	A	130.62	15.8		1														
31	A	131.74	25.2		6													x	
31	B	133.29	20	j	j	?												x	
31	C	134.61	24		55						x							x	
32	A	135.85	20	2		j											x		
32	B	137.43	15.8	5		-8												x	
33	A	139.54	20		21												x	x	
33	B	141.42	22.2	j							x							x	
34	A	142.29	16.6		j														
34	B	143.91	23	4	3						x						x	x	
35	A	145.69	24.2	j	2	j											x		
35	B	147.24	16.3		3														
36	A	148.43	21.8															x	
37	A	149.19	31.7	4	1							j						x	
39	A	152.48	23.7			j													
39	B	154.06	26	j		j													
40	A	155.11	19	j		j													
40	B	156.71	19.2	j		-4										x	x	x	
44	A	162.89	18.2	181	22	12													m.o.
47	A	167.49	31.9																
51	A	172.43	31.6															x	
52	A	174.76	26.3													x		x	
53	A	177.05	22.1			j						j	j	j			x	x	
54	A	179	26.6															x	
55	A	182.79	20			j						1	1?	j		x			
55	B	184.18	20.6			-8						3?	j	8				x	
56	A	185.34	23.5									-6?				x	x	x	
56	B	186.92	28		8	9?									222	x		x	
57	A	188.63	23	j	2														
57	B	190.15	34		-6														
58	A	191.53	36	5	1	-7	8				x	2?							Ca tubes
58	B	192.61	27.2																
59	A	195.08	28.1		1	12							2	47	82	x		x	molluscs
59	B	196.54	22.3		j	j								1		x	x		
60	A	199.29	17.5		13														
60	B	201.3	37.2		j	9	2						2	-5		x		x	molluscs
60	C	202.02	22			-6				j				j		x		x	molluscs
61	A	203.4	20.4													x		x	
61	B	204.6	28.5													x			
63	A	207.89	23.5	j		j												x	
64	A	209.26	16.1	j		j		3					j					x	
65/66	A	212.41	15.2	j		1										x	x	x	
65/66	B	213.49	21.6		j												x		
66	C	216.52	21.4		7						x						x	x	Ca tubes
69	A	221.48	31.5	j	1		j				x						x		
70	A	223.17	16.3			j	j											x	
70	B	224.84	ns																
71	A	226.26	30.5			6						j	2			x		x	molluscs
71	B	227.54	ns																
81	A	235.61	24																
82	A	238.5	35.2															x	
83	A	241.7	30.3															x	
85	A	246.2	17.1																
88	A	254.1	30.1																
93	A	267.53	28.4																
94	A	268.43	33.3																
95	A	271.98	26																
95	B	273	20.9																
97	A	277.15	21.5	j		j	41											x	
98	A	279.3	14.6	11	2		120					j						x	
99	A	280.59	29.8	31	j							j				x		x	insect?
100	A	284.34	25.9	13	j							j				x			
100	B	286.25	20.7									j				x		x	molluscs
100	C	287.5	16.8									j				x		x	
101	A	288.74	26.4													x			
101	B	290	24													x			
102	B	293.9	21.4													x			
103	A	296.6	51															x	
103	B	297.93	27.4													x			
104	A	299.17	19.7															x	
104	C	302.82	25.1													x		x	
105	A	304.41	19.3													x		x	
105	C	306.64	30.9																
106	A	307.24	17.9																
106	C	310.37	25.1													x			
107	A	312.33	17.4	9								j				x			
107	B	313.97	21.8	6		9										x			molluscs
108	A	316.45	24.8			-3						j				x			
108	B	318.36	23.6	j	j							j				x	x		molluscs, char
109	A	320.36	23.2																molluscs
109	B	320.86	18.7															x	
110		323.28	25.4																

EXPLANATION:

Depth in meters, weight in grams
L.cerio=*Limnocythere ceriotuberosa* Delorme
L.sappa=*Limnocythere sappaensis* Staplin
C."cauda"=*Candona* aff. *C. caudata*
L.cf.brad=*Limnocythere* cf. *L. bradburyi*
Limno A=*Limnocythere* sp. A

C.lacust=*Cytherissa lacustris* Sars
Limno sp.=*Limnocythere* spp.
Hetero=*Heterocypris* sp.
CandonaA=*Candona* sp. A
Limno B=*Limnocythere* sp. B
Limno C=*Limnocythere* sp. C

Limno D=*Limnocythere* sp. D
fish=fish bones, teeth, scales
diatoms=mainly *Campylodiscus* sp.
plants=fragments of plant material
molluscs include gastropods, pelecypods
m.o.=cladocerans

j=juveniles
x=present, not counted
ns=no sample
char=charophytes

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U.S. DEPARTMENT OF THE INTERIOR
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IDENTIFICATION OF MOLLUSCA FROM CORE OL-92-2, OWENS LAKE, CALIFORNIA

by

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Introduction

Thirty two samples from core OL-92-2, Owens Lake, California, were examined for fossil mollusks. Six taxa of mollusca were recorded, consisting of four gastropods and two pelecypods; these are listed in table 1, below. Amnicola sp. cf. A. limosa and Amnicola sp. are probably the same, and are included here as representing a single taxon, i.e. the genus. In addition, numerous Ostracoda were noted in several of the samples, but are not included in this analysis. The listing of the samples in table 2 follows depth, which is generally the same order as the list of samples provided by the U.S.G.S.

TABLE 1. FAUNAL LIST

Gastropoda
- Amnicola sp. cf. A. limosa
- ?Amnicola sp.
- Helisoma (Carinifex) newberryi (Lea)
- Hydrobia sp.
- Valvata sp. cf. V. sincera Say

Pelecypoda
- Pisidium sp. cf. P. compressum Prime
- Anodonta sp. indet.

In most instances, the shells were fragmented and rarely complete, identification was made by examination of several fragments of similar individuals under binocular microscope at 10X to 40X magnification. All samples were conserved as shipped, with a minimal amount of destructive analysis, in order to preserve them for future studies. Table 2 below gives the listing of taxa from each sample, and is organized by sample number, slug, drive, and depth.

TABLE 2: LISTING OF FAUNA BY SAMPLE

Sample no.	Drive no.	Slug no.	Depth (m)	Description
801	16	A	100.90	Small shell of Helisoma (Carinifex) newberryi; unidentifiable shell fragments; partial interanl casts.

Sample no.	Drive no.	Slug no.	Depth (m)	Description
802	56	B	186.71	External mold of Helisoma (Carinifex) sp.; abundant Pisidium sp. cf. P. compressum; abundant miscellaneous unidentifiable shell fragments; abundant ostracoda. Several of the Pisidium speciments with both valves, indicating in situ preservation with no post-mortem transport.
803	59	B	195.14	Helisoma (Carinifex) newberryi; miscellaneous unidentifiable shell fragmets.
804	59	B	195.70-195.72	Shell fragments of Pisidium; unidentifiable shell fragments.
810	62	A	206.60-206.78	Nacreous shell fragments, probably of Anodonta.
811	63	A	207.49-207.53	Miscellaneous shell fragments, undetermined; some nacreous fragments probably referable to Anodonta sp.
813	63	A	207.91-207.96	Abundant small fragments of nacreous shell, probably Anodonta.
814	63	A	208.29	Pisidium sp. undetermined.
815	62	A	208.39	Single fragment of ?Anodonta sp.
816 A-B	64	B	210.13	A: Anodonta sp. B: Anodonta sp.
817	64	B	210.15	Pisidium sp. cf. P. compressum; nacreous shell fragments of Anodonta sp.; single broken shell of Helisoma (Carinifex) sp.
819	66	B	213.54	?Helisoma (Carinifex) sp undet.; miscellaneous shell fragments; ostracoda.
820	66	B	214.05	Abundant Pisidium compressum; ? Amnicola sp.; ostracoda.
821	67	A	216.93-217.01	Helisoma (Carinifex) newberryi; Pisidium sp. undet., unidentified shell fragments.
823	71	A	225.73-225.96	Unidentified gastroped shell fragments, exhibiting distortion from pressure. One specimen of first 1 1/2 volutions of ?Helisoma. sp.

Sample no.	Drive no.	Slug no.	Depth (m)	Description
824	71	B	226.41-226.48	Valvata sp. cf. V. sincera; ?Amnicola sp. Remnants of color banding noted on Valvata. Shell fragments of large (>1 cm) gastroped not identifiable.
828 A-E	100	A	284.24	A: Nacreous shell fragments of ?Anodonta; small, undetermined gastroped; ostracoda. B: Nacreous shell fragments of ?Anodonta; miscellaneous unidentifiable gastroped shell fragments; ostracoda. C: Hydrobia sp. D: Large nacreous shell fragments of Anodonta sp.; Hydrobia sp.; ostracoda. E: Hydrobia sp.
829	100	B	284.64	Unidentifiable gastroped shell fragments.
850	106	C	309.49	Nacreous shell fragments of Anodonta sp.
851 A-B	107	A	310.25	A: Nacreous shell fragments of ?Anodonta; unidentifiable fragments of gastroped. B: Shell fragments of a sphaeriid pelecypod assignable to ?Pisidium sp.; nacreous fragments of ?Anodonta; miscellaneous unidentified gastroped shell fragments.
852 A-B	107	A	310.40	A: Pisidium sp. undet.; Hydrobia sp.; nacreous shell fragments of ?Anodonta sp. B: Hydrobia sp.; nacreous shell fragments of ?Anodonta.
855	107	B	312.92	Nacreous shell fragments, ?Anodonta sp.; Amnicola sp. cf. A. limosa; unidentified fragments of larger gastropod.
---	107	B	313.97	Fragments of Pisidium sp. undet.
856 A-B	108	A	314.75	A: Nacreous shell fragments of ?Anodonta; Hydrobia sp., commonly present. B: Hydrobia sp.; abundant nacreous shell fragments of ?Anodonta; ostracoda.
---	108	B	318.36	Hydrobia sp. undet.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OWENS LAKE CORE OL92 FISH REMAINS

by

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Open-File Report 93-683

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6.4 OWENS LAKE CORE OL92 FISH REMAINS

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Only half of the fragments submitted from the core OL92 could be identified, partly because that part of the Great Basin has such a sparse fish fauna. The most common fish then (also a common fish now) was the Tui chub, Gila (Siphateles) bicolor. This fish has distinctive asymmetrical-centered and round shield shaped scales, usually 2-4 mm in diameter as adults with strong radii in one field. Sucker (Catostomidae) scales are larger, with radii in the anterior and posterior fields of a more symmetrical scale. Two genera are possible, but I can't narrow it down from the material. A complete skull bone of a baby catostomid was found.

The surprise was the presence of what appear to be trout and whitefish scales, distinctive in the lack of radii. The trout and whitefish indicate more water and (or) lower temperatures, when they are present. The Gila bicolor are about the same size and growth rates as those in Pyramid lake today. None of the scales bear enough information to say more about stratigraphy or paleoenvironments.

I found no otoliths. There is one tiny bird, mouse, or shrew bone.

Depth (m)	Identified and unidentified remains
199.80	Gila bicolor scale, 4-5 yr old
200.96	Unidentified scale, fragment
206.64	Gila bicolor, scales in good condition
203.10	Catostomid scale, ca. 4 mm
204.27	Gila bicolor scale; unidentified fragments
221.48	Bird bone? ?Catostomid scale; Gila bicolor scale
285.74	Catostomid scales; unidentified bones; cyprinid cleithrum?
286.56	Catostomid scales; Gila bicolor tooth
286.81	? Coregonine scale, 4.5 mm, ovoid, no radii; tooth fragment?
287.19	? Salmonid scale; cyprinid vertebra; unidentified bone, scale; pyrite
287.68	Gila bicolor scales; ?Catostomid bone
288.14	Scale fragments without radii; salmonid?
288.91	Unidentified fragments
291.72	Unidentified fragment
295.50	Two 2.5 mm Gila bicolor scales
296.23	Ovoid salmonid scale without radii, 3-4 mm
296.86	Gila bicolor scale, 2.5 mm; unidentified fragments, catostomid tooth?
302.67	Unidentified tooth; large catostomid scale
302.90	Large catostomid scale

307.15	Unidentified fragments
308.40	Wood and pumice; unidentified fragments
308.99	Catostomid scales, 2-3 mm
315.62	Left frontal 3.8 X 5.2 mm of small catostomid with fontanelle
184.68	Gila bicolor scale, 4.5 mm, 4 + yr old; fish = ca. 1' long
184.39	Gila bicolor scale; giant centric diatoms?

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Macroscopic Organic Material from Owens Lake Core

by

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MACROSCOPIC ORGANIC MATERIAL FROM OWENS LAKE CORE

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The results of my analyses of the samples from Searles Lake core OL92-2, identified in the field as macroscopic organic(?) material, are listed below. The procedures for examination were those that we use to identify macrobotanical materials from packrat middens and archaelogical contexts, particularly those we have developed to identify carbonized wood and charcoal. Each specimen was examined under a Wild-Heerbrugg stereo-microscope at 60X to 500X using a combination of directed, tungsten-halogen and diffuse tungsten light sources. Larger specimens were fractured to reveal fresh surfaces.

In all cases there was a lack of critically diagnostic morphological characteristics that would allow identification beyond "Plantae". These are chiefly organized cellular patterns in cross-sections of the larger pieces of wood, and features such as attachment scars or scales on the smaller fragments. This may be attributable to the compression that the specimens have undergone, and (or) to the distinctive chemical environment of the sediments.

Sample number (and depth, in meters)	
812 (207.99)	Fragments of organic material; black to very dark reddish brown; largest fragment ca. 5 x 8 mm; cellular structure obscured; organization of material varies from planar to amorphous; diagnostic surface features absent. **Determination:** Plantae, vascular plant, possible root fragment.
825 (237.57)	Fragments of organic material; black to very dark reddish brown; largest fragment ca. 4 x 3 mm; includes linear impression in clay ca. 12 x 10 mm; cellular structure obscured but organized in planar fashion; diagnostic surface features absent. **Determination:** Plantae, possible vascular plant fragment.
826 (240.82)	Single, linear fragment; black to very dark brown; ca. 12 x 1.5 mm; cellular structure not evident; diagnostic surface features absent; compressed; patterned surface (large, pseudo-reticulate) likely the result of compression and desiccation: possible node evident on one end. **Determination:** Plantae, vascular plant root or twig.
844 (305.70)	Large, cuboid clasts; ca. 2 x 4 cm; very dark brown to reddish brown; freshly fractured exterior reveals tracheid-like linear structures that may represent cellular organization; cross-section fracture (perpendicular to above structures) shows overlapping planar structures ca. 1 x 3 mm, no rings, rays, or pores are revealed. **Determination:** This is an enigmatic specimen. Initially determined to be inorganic, it likely represents highly compressed wood: Plantae, vascular plant wood.

845 (306.02) Linear organic fragments (2); largest ca. 1 x 4 mm; black; cellular structure not evident; diagnostic surface features absent.
Determination: ?Plantae

848 (308.76) Disseminated organic fragments in clay matrix, largest 0.5 x 2 mm; black to yellowish brown; cellular structure not evident; diagnostic surface features absent.
Determination: Indeterminate, finely comminuted organic debris.

853 (310.73) Organic fragments (2), largest 2 x 3 mm; black to reddish brown; fracturing reveals distinct ray tracheids on radial aspect; cross-section fracture, however, reveals no rays, pores, or cellular structure; presence of rings equivocal.
Determination: Plantae, vascular plant wood, highly compressed.

854 (312.15) Organic fragments (2), largest 12 x 12 mm; black to reddish brown; fracturing reveals obscure ray tracheids in radial aspect; cross-section fracture fails to reveal rays, pores, or cellular structure; presence of rings equivocal.
Determination: Plantae, vascular plant wood, highly compressed.

859 (320.34) Dark gray, tabular fragments (4), largest 5 x 8 mm; linear structure revealed along long axis, possible tracheids; cross-section fractures reveals no structure; patterned, pseudo-reticulate surface evident on one fragment.
Determination: ?Plantae

U.S.. DEPARTMENT OF THE INTERIOR
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POLLEN PRESENT IN CORES OL-92-1, 2 AND -3

by

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INTRODUCTION

This chapter presents preliminary pollen data for the two upper subsections of the Owens Lake core and for the top 1.46 meters of OL-92-2 for an overall depth range of 5.52 m to 62.72 m. Samples from the surface to 7.16 m are from core OL-92-3, from 5.49 m to 61.37 m from core OL-92-1, and from 61.26 m to 62.72 m from core OL-92-2. The initial sampling sought to retrieve an estimated ~150,000 years of record, based on an assumed constant sedimentation rate of 41 cm 1000 yr^{-1}, calculated from the basal date of ~800 ka. This assumption was unjustified. According to the newly dated sedimentation rate (Bishoff, 1993), the upper ~90 m dates to over 151 ka at 1671 y m^{-1}. Therefore at least 27.5 more meters from OL-92-2 needs to be sampled to acquire the complete period of time.

The planned research will analyse the pollen, spores, and algal colonies in order to reconstruct the vegetation history of the southern Owens Valley region, including the Sierra Nevada and Inyo Mountains, during the past two full glacial cycles, beginning with the last glacial maximum ($\delta^{18}O$ isotope Stage 6). Charcoal is also counted for a potential fire history.

The projected result of the investigation is an empirical model of the response of vegetation to long-term climate change. The study area is sensitive to climate change because it has high biodiversity, is on the ecotone between the Mojave and Great Basin deserts, and is influenced by three major seasonal air masses.

Three main research outputs are planned: (1) a high resolution vegetation history spanning the past ~150 ka will be compiled from the pollen record at intervals of ~300-700 years; (2) the historic covariance of vegetation and climate will be modeled using modern analogs and such statistical methods as squared chord distance and response surfaces; (3) and inferences about the nature of vegetation-climate dynamics on a local and regional scale will be derivied.

No interpretation of the pollen diagram is given at this time.

SAMPLING PROCEDURES

The three core subsections have been sampled from the surface to 7.16 m (OL-92-3), from 5.49 m to 61.37 m (OL-92-1), and from 61.26 m to 62.72 m (OL-92-2). Samples were taken from the split core at 20 cm intervals and at 1 cm depths below the split surface, with a volume range of 2-5 cm^3. In a few instances, where the core was disturbed from previous sampling, the sample interval and depth were adjusted to no more than 5 cm and 2 cm, respectively. Each sample was trimmed of external sediments adjacent to the plastic core liner in order to prevent contamination from any vertical displacement of material during coring operations and placed in a Nasco

"WHIRL-PAK" plastic bag and stored at a temperature of approximately 5°C. Sampling begins at a depth of 3.52m from the modern playa surface, the assumed former surface of the lake sediments beneath the historic salt layer. A total of 285 samples was taken, including four duplicates to account for disturbance.

LABORATORY PROCEDURES

Pretreatment

A 1 cm^3 fraction of each sample was placed in a 50 ml plastic test tube with deionized water. A small amount of ALCONOX (a phosphate detergent) was added and the sample was shaken vigorously in order to disperse the fine clays. The sample was then poured into a 500 ml Nalgene beaker to which 50 ml of 10% HCl was added to further disaggregate the sediments and hydrolyze the carbonates. Two tablets containing ~12,077-13,900 each *Lycopodium* spores were also added as a tracer to determine pollen concentration. The sample was then swirled and screened through a 149 μm mesh screen into a 50 ml Nalgene test tube and repeatedly centrifuged and decanted until the entire beaker volume was concentrated in the tube. The residue sediments on the screen were washed into a petri dish and examined for minerals, plant tissue, rootlets and other plant parts, unidentified organic material, and charcoal fragments.

Extraction

Extraction procedures began with acidification of each sample by adding 10 ml of concentrated HCl and thoroughly mixing; any remaining carbonates were thus removed. This was followed by diluting the sample with 30 ml of deionized water, stirring, centrifuging and decanting. (Centrifuging and decanting were done between each of the following steps.) The sample was then neutralized with a hot water rinse.

To remove silicates, concentrated (48%) HF was added to near the top of each 50 ml tube, which was either left to stand overnight or placed in a boiling water bath for at least one hour. The sample was then neutralized by a hot water rinse and transferred to a 15 ml Pyrex test tube. A second concentrated HCl step was sometimes inserted here to remove silica colloids.

Cellulose and cellulose derivatives were digested with an acetolysis mixture of one part H_2SO_4 to nine parts acetic anhydride. The sample was first dehydrated with 5 ml glacial acetic acid. It was then stirred and acetolized by adding 5 ml acetic anhydride with a volumetric dispenser, followed by the addition of 0.55 ml H_2SO_4 with a volumetric pipette and mixed. This makes H^+ available for bonding between acetate and cellulose, synthesizing rayon. Another series of glacial acetic acid (to dissolve the rayon) and water rinses completes this step.

Humic acids were then removed by a 10% KOH solution in a ~2 minute hot water bath, followed by several hot water rinses until the remaining solution is clear and colorless.

The sample was then stained with safranin, rinsed with water, and transferred to 1 dram shell vials, after which several drops of glycerol were added.

COUNTING

After a small portion of a sample was mounted on a slide, the pollen, spores, algae, and charcoal were counted by systematically scanning along a transect across the cover slip, from edge to edge, with a Leitz binocular microscope at a magnification of 450X. For positive identification of difficult taxa, oil immersion at 1000X was used. Identification of unfamiliar types was assisted by published keys, microphotographs and slide reference collections at the University of Arizona and in possession of the author. Unknown taxa were described and photographed for future reference.

A minimum of 300 non-aquatic pollen grains were counted and no less than 100 non-*Pinus* pollen when the abundance of that taxon was extremely high. The bladders of many pine pollens were separated from the body by mechanical damage. These isolated bladders or single bladders still connected to the body were, therefore, counted as one-half of a pollen grain. Fungal spores (except the functionally significant *Sporomiella,*counted to the sample total) and algae were counted to a minimum of 100 individuals or colonies or until one *Lycopodium* tracer spore was encountered; a ratio of the taxon to the tracer was then calculated, to be multiplied by the total tracer count.

Charcoal abundance was calculated as the total concentration per cm^3, according to the equation:

$$\frac{\text{Total } Lycopodium \text{ spores x number of charcoal grains counted}}{\text{Number of } Lycopodium \text{ spores counted}} = \text{Total number of}$$

charcoal grains in a sample (Stockmarr, 1974).

Only charcoal fragments greater than 2 μm were counted due to the difficulty of identifying and tracking smaller fragments. Care was taken not to misidentify cubic pyrite crystals as charcoal.

Pediastrum colonies also suffered mechanical damage. A system was devised to count broken colonies according to the observed fractions, 2/3, 1/2, 1/4 to 1/3, or <1/4.

RESULTS

The core subsections have been surveyed to a depth of 62.72 m. A preliminary total of 70 terrestrial and aquatic pollen taxa, two types of *Botryococcus* sp. , and four types of

Pediastrum sp. algae have been identified from 34 samples. This includes undifferentiated *Pinus*, white pine (haploxylon), yellow pine (diploxylon), *Pinus longaeva*, and *Pinus monophylla.* Preservation for all samples counted is generally good, with a range from excellent to poor. Indeterminate grains are usually deteriorated or obscured by detritus. Deterioration mostly takes the form of mechanical breakage, bending, and crumpling resulting from transportation or diagenesis and degradation (that is, thinning of the exine) by oxidation. Grains are rarely corroded, that is, the exine perforated or etched by microbial activity (Moore, Webb and Collinson, 1991).

Variables

The pollen sum includes terrestrial, riparian, indeterminate, and unknown pollen types. Percentages of aquatics, algae, and spores were calculated outside the pollen sum because of the significant number and variability of these taxa. Charcoal was calculated as total concentration per cm^3. All the variables are listed in Table 1.

TABLE 1.--*Variables in the summary data set*

VarCode	VarName
T	*Lycopodium* (Exotic club-moss spore used as tracer)
A	*Abies* (true firs)
P	*Pinus*, undifferentiated (pines)
Ph	*Pinus*, haploxylon (white pines)
Pd	*Pinus*, diploxylon (yellow pines)
Pm	*Pinus monophylla* (single leaf pinyon pine)
Tm	*Tsuga* (hemlock)
S	*Sequoiadendron* (giant sequoia)
J	*Juniperus*
DF	*Pseudotsuga* type (Douglas fir)
Q	*Quercus* (oaks)
E	*Shepherdia*(buffalo berry)
p	*Populus* (cottonwood or aspen)
B	*Betula* (birch)
Bb	*Berberis* type (barberry)
$C	*Chrysolepis Castanea*-type

F	*Fraxinus*-type
$S	*Salix* (willow)
$E	*Ephedra* (joint fir)
C	Cheno-Am. (Chenopodiaceae-*Amaranthus*)
Sa	*Sarcobatus* (greasewood)
CP	*Cercocarpus Purshia* type
$P	*Prunus*
$R	Rhamnaceae
At	*Artemisia*, sec. *Tridentatae* (sagebrush)
AS	*Artemisia spinescens* (bud sage)
Am	*Ambrosia* type
L	*Larrea tridentata* (creosote bush)
Aq	*Aquilegia* type (columbine)
Ti	*Tidestromia*
Cy	Caryophyllaceae
Er	Eriogonum (buckwheat)
M	Malvaceae (mallow)
Bs	Brassicaceae
Sx	*Saxifraga* type
R	Rosaceae , undifferentiated
FL	Fabaceae, *Lupinus* type
FM	Fabaceae, Mimusoideae
FP	Fabaceae, cf. *Psorothamnus*
$F	Fabaceae, undifferentiated
O	Onagraceae
Oe	*Oenothera* type (evening primrose)
Pv	*Primula veris* type (primrose)
Ap	Apiaceae

So	*Solanum* type
Sl	Solanaceae undifferentiated
Ly	*Lycium* (wolfberry)
Mm	*Mimulus guttatus* type (monkey flower)
$L	*Leptodactylon* type
G	*Gilia -Langloisia* type
Ct	*Castilleja* type (Indian paintbrush)
La	Lamiaceae
As	Asteraceae, undifferentiated high-spine
Lg	Liguliflorae
Mu	Musticeae
Po	Poaceae (grasses)
Al	Amaryllidaceae, *Allium* type (wild onion)
Fr	*Fritillaria* type
Ty	*Typha latifolia* (cattail)[1]
TS	*Typha-Sparganium* (cattail and burreed)[1]
Pt	*Potamogeton* (pondweed)[1]
CY	Cyperaceae (sedges)[1]
Le	*Lemna* type (duckweed)[1]
I	*Isoetes* (quillwort)[1]
Eq	*Equisetum* type[1]
Bg	*Botryococcus* A[1]
	Botryococcus B[1]
Pe	*Pediastrum boryanum* type[1]
	Pediastrum Kawraiskyi type[1]
	Pediastrum simplex type[1]
	Pediastrum integrum type[1]
	Pediastrum, undifferentiated[1]

Sp	*Sporormiella*[1]
Fg	Undifferentiated spores[1]
X	Indeterminate and unknown
Ch	Charcoal[1]

[1] Type exluded from pollen sum

A few of the more important taxa are defined as follows:

***Abies* (firs)** This pollen type probably represents either *Abies concolor* (white fir) or *A. magnifica* (red fir), the two species of firs of the eastern Sierra Nevada upper montane forest, which collectively have an upper elevation range of ~3100 m.

***Pinus* (pines)** When orientation and preservation permit, recognition of several attributes identify pine pollen to at least four subgeneric categories. The presence or absence of verrucae on the leptoma (the thin exine on the distal side of the body from which the pollen tube emerges) classifies pine pollen as haploxylon (white pines) or diploxylon (yellow pines), respectively. If the length of the grain is greater than 70 µm, the haploxylon type may include the mixed subalpine woodland species *Pinus monticola* (western white pine), *P. balfouriana* (foxtail pine), *P. albicaulis* (whitebark pine), and *P. flexilis* (limber pine), of the Sierra Nevada, and *P. flexilis* and *P. longaeva* (bristlecone pine) of the White-Inyo Mountains. *P. lambertiana* (sugar pine) may rarely be represented from the midmontane forest of the west slope. Grains <70 µm long with bladders (saccae) less than 30 µm are classified as *P. monophylla* (single-leaf pinyon) after the system of Jacobs (1985). Diploxylon grains probably represent *P. jeffreyi* (Jeffrey pine) and *P. contorta* var. *murrayana* (lodgepole pine) of the eastern Sierra lower montane forest or these pines plus *P. ponderosa* from westside forests. Pine pollen is very widely dispersed because of the abundant production and the buoyancy provided by the saccate design and so is usually overrepresented in most western United States pollen diagrams.

***Tsuga* (hemlock)** The attributes of this type readily identify it as *T. mertensiana* (mountain hemlock). This conifer is a component of the mixed subalpine woodland up to timberline at 3500 m. It is rare in Owens Lake sediments.

***Sequoiadendron* (giant sequoia)** *Sequoiadendron giganteum* is now limited to a few groves with high water tables in the mixed conifer forest of the west side at elevations of 825-2700 m. This rare type is differentiated from other TCT (Taxodiaceae, Cupressaceae, and Taxaceae) pollen by the prominent papilla.

***Juniperus* (juniper)** Juniper pollen probably includes *J. occidentalis* var *australis* (a variety of western juniper) and *J. osteosperma* (Utah juniper) of the Sierra Nevada and

White-Inyo Mountains and possibly *J. communis* of high elevations (1900-3400 m). Other TCT pollen could be uncommonly misidentified as juniper, such as *Sequoiadendron* with obscured or missing papilla or an occasional *Calocedrus decurrens* (incense cedar) grain from the west slope.

***Psuedotsuga* type (Douglas fir)** This must remain a tentative identification. At present the species is restricted to the west slope of the Sierra Nevada below 2200 m and north of 37°N latitude (Griffin and Critchfield, 1972). The pollen grains observed in the Owens Lake core are about 62 μm, smaller than modern *Pseudotsuga* reference specimens ($\bar{x}$=95 μm) and smaller according to the pollen key of Kapp (1969) which reports a range of ~110 to 115 μm. The size is closer to *Larix* (larch) (reference specimens, $\bar{x}$=70 μm; or Kapp's range of 60-90 μm). The closest species of larch (*Larix occidentalis*), however, grows in the Cascade forests of Washington and Oregon (Barbour and Billings, 1988) which makes its presence in the southern Sierra Nevada a biogeographic anomaly, even during the Wisconsin. This pollen type, whatever its taxonomic identity, is rare.

***Quercus* (oak)** Today three species of oak (*Quercus kelloggii, Q. wislizenii*, and *Q. chrysolepis*) grow in Owens Valley and a few eastern canyons of the Sierra Nevada. The fossil pollen may represent one or more of these local species or grains that may have been windborne across the crest from the west slope. The taxon is rare in the Owens Lake core.

***Shepherdia* (buffaloberry)** *Shepherdia argentea* is now distributed widely in scattered stands in southern California, and with denser coverage in the northern plains of the Dakotas, Montana, and Canada (Little, 1976). In the Sierra Nevada isolated stands have been observed in Pine Creek canyon and the Mono Basin north of Owens Valley. *Shepherdia* pollen is occasional in the core sediments.

Populus This taxon may be represented by either two species of cottonwood or quaking aspen. *Populus fremontii* (Fremont cottonwood) and *P. balsamifera* spp. *trichocarpa* (black cottonwood) are riparian species growing throughout California and locally in the Owens Lake basin. *P. tremuloides* (quaking aspen) is widespread in the eastside Sierra Nevada, growing in cloned stands along streamsides and on moist slopes in a variety of habitats between 1800 and 3000 m (Hickman, 1993). This pollen type does not preserve well and is uncommon in Owens Lake sediments

Two other riparian taxa identified throughout the core are***Salix*** (willow) and ***Betula*** (birch) . *Salix* is much more common and represents several possible species of willow, including *S. goodingii, S. exigua, S. lasiolepis*, and *S. lutea. Betula occidentalis* (water birch) is the most abundant birch species in the eastern Sierra, producing thick stands in association with willow, cottonwood and aspen although its pollen is rare.

***Ephedra* (joint fir)**. Also called Mormon tea, this shrubby gymnosperm is an associate of lower elevation xeric plant communities from creosote bush and sagebrush shrub to pinyon-juniper woodland. The infrequent pollen probably represents *E. nevadensis* and *E. viridis* but, since it is a long distance traveler, other species from without the region may also be represented.

Chenopodeaceae-*Amaranthus* (Cheno-Am). The polyporate pollen of the large chenopod family and the genus *Amaranthus* (both belong to the order Caryophyllales) are indistinguishable with a light microscope. Cheno-Am pollen from the core most likely belongs to the various halophytes composing the shadscale scrub and salt desert communities surrounding Owens Lake and growing along the axis of Owens Valley. Representative species include *Atriplex canescens* (fourwing saltbush), *A. confertifolia* (shadscale), *A. parryi*, and *A. polycarpa,* among others; *Krascheninnikovia lanata* (winterfat), *Grayia spinosa* (hop-sage), *Kochia americana* (gray molly), *Suaeda calceoliformis* (sea-blite), *Allenrolfea occidentalis* (iodine bush) and various species of *Chenopodium.*

***Sarcobatus vermiculatus* (greasewood).** Greasewood pollen is one of the few types identifiable to species. This halophyte presently grows around the shorelines of Owens Lake with a free water table about 1 m deep.

***Cercocarpus*-Purshia type.** Rosaeae pollen belonging to this category is similar to that produced by: *Cercocarpus ledifolius* and *C. intricatus*, two species of mountain mahogany growing on the slopes of the White-Inyo Mountains and Sierra Nevada between 1200 and 3000 m; *Purshia tridentata* and *P. mexicana*, shrubs of the pinyon-juniper woodland and sagebrush shrub; and *Coleogyne ramosissima*, the dominant species of the blackbrush shrub community growing along the west side of the southern Owens Valley below the sagebrush shrub community. Blackbrush is an indicator of the Great Basin and Mohave Desert ecotone.

***Artemisia,* section *Tridentatae* (sagebrush)** Among the several species of sagebrush represented by this pollen type those common to the Owens Valley region are *Artemisia tridentata, A. nova*, and *A. arbuscula. Artemisia* grows as a dominant in sagebrush steppe along the west side of Owens Valley and as an associate of the pinyon-juniper woodlands of the lower slopes of the Sierra Nevada eastern escarpment, and in the White-Inyo and Coso Mountains.

Ambrosia type It is assumed that this short-spined, wind-blown, Asteraceae pollen type primarily represents *Ambrosia dumosa* (bur-sage) the major associate of the creosote bush series (*Larrea tridentata-A. dumosa* community) of the Mojave Desert. This community grows on the alluvial fans along the east side of the southern Owens Valley and to the east and south of Owens Lake. The pollen type may be used as an indicator of the community but with discretion since, according to the packrat midden record, *A. dumosa* dissassociated from creosote bush in response to effective climate change at the last glacial termination and preceeded creostote bush during the migration of the series into its northernmost range (Spaulding, 1990).

Aquatic Pollen This category comprises hydrophytes formerly growing around the lakeshore, along the Owens River channel, and in associated wetlands. The very large Cyperaceae family is represented by one pollen type. It includes mostly *Carex* sp. (sedge) and *Scirpus* sp. Typha latifolia (cattail) is identified to species by the distinctive pollen tetrad. *Typha-Sparganium* is undifferentiated from the warm climate *Typha domingensis*, broken tetrads of *T. latifolia*, and the genus *Sparganium* (bur-reed) although the pollen type is probably *Typha* since bur-reed in the Owens Lake region is presently known only from the high Sierra Nevada.

Algae Tentative identification of the four types of *Pediastrum* colonies to species is based on the key by Prescott (1962). *P. simplex* type has the highest frequency but all taxa are periodically abundant throughout the core. There are two types of *Botryococcus*, which I have termed gracile (Type A) and robust (Type B). Type A is smaller with apparently thinner cell walls than Type B.

Sporormiella Spores of the dung fungus *Sporormiella* sp. have been discussed by Davis (1986). They are commonly found in the dung of domestic and wild herbivores and have been found in historic sediments subsequent to the introduction of horses and cattle to North America, although they are absent during the rest of the Holocene. Prior to ~11,000 years BP they are abundant in late-glacial sediments. The significance of *Sporormiella* to Pleistocene paleoecology is that it may indicate the presence of megafauna when other evidence is lacking. The spore is rare but occasional in Owens Lake.

Preliminary Pollen Diagram

Eric Grimm's Tilia Software Package was used to enter the data, calculate percentages, and plot the diagram (Fig 1a, b). Charcoal is given as abundance per cm^3. Only selected taxa and charcoal have been plotted. The raw pollen, spore, algae, and charcoal counts are given in Table 2.

The top and bottom of the diagram plots samples from a depth of 5.92 m to 62.72 m, which have been given extrapolated dates of approximately 10.9 ka to 93.8 ka, respectively. Based on the sedimentation rate (Bischoff, 1993) the 20 cm sample interval for the proposed complete analysis is ~336.2 years. The solid black curve diagrams the actual percentages; the shaded silhouette is a 10% exaggeration to clarify the rarer taxa.

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Table 2.--Raw Counts, OL-92

Depth in meters	5.5	5.9	6.3	8.3	12.7
Tracer Lycopodium	129.0	144.0	140.0	280.0	211.0
Abies	1.0	4.0	4.0	1.0	1.0
Pinus undiff.	113.0	45.0	129.0	77.0	39.0
Pinus haploxylon	5.0	44.0	3.0	17.0	18.0
Pinus diploxylon	11.0	20.0	12.0	6.0	11.0
Pinus monophylla	3.0	20.0	6.0	10.0	13.0
Tsuga mertensiana	0.0	0.0	0.0	0.0	2.0
Sequoiadendron	0.0	0.0	0.0	0.0	0.0
Juniperus	14.0	4.0	16.0	100.0	166.0
Pseudotsuga type	0.0	0.0	0.0	0.0	0.0
Quercus	0.0	0.0	0.0	1.0	0.0
Shepherdia	0.0	0.0	1.0	0.0	1.0
Populus	1.0	4.0	1.0	4.0	1.0
Betula	0.0	1.0	0.0	1.0	0.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	0.0	0.0	0.0	0.0	0.0
Salix	3.0	0.0	2.0	16.0	6.0
Ephedra	8.0	2.0	6.0	1.0	0.0
Chenopodiaceae-Amaranthus	43.0	49.0	35.0	25.0	18.0
Sarcobatus	4.0	4.0	1.0	6.0	7.0
Cercocarpus-Purshia type	14.0	22.0	7.0	2.0	3.0
Prunus	0.0	0.0	0.0	0.0	1.0
Rhamnaceae	0.0	0.0	0.0	0.0	0.0
Artemisia tridentatae	34.0	29.0	36.0	13.0	20.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	24.0	35.0	21.0	0.0	0.0
Larrea tridentata	0.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	1.0	0.0	0.0	0.0
Tidestromia	0.0	1.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	1.0	0.0
Eriogonum	0.0	4.0	0.0	4.0	2.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	0.0	1.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	0.0	1.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	0.0	0.0
Lupinus type	0.0	0.0	0.0	6.0	3.0
Psorothamnus type	2.0	0.0	6.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	1.0	0.0	1.0	0.0	0.0
Onagraceae	0.0	0.0	0.0	0.0	0.0
Oenothera type	1.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	1.0	0.0	0.0	0.0
Solanaceae	1.0	0.0	1.0	1.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	1.0	0.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	15.0	15.0	12.0	11.0	4.0
Liguliflorae	1.0	0.0	0.0	0.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	6.0	8.0	5.0	10.0	4.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	1.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	3.0	0.0	0.0	0.0	0.0
Typha-Sparganium	0.0	10.0	0.0	4.0	1.0
Potamogeton	7.0	0.0	4.0	0.0	0.0
Cyperaceae	14.0	15.0	6.0	30.0	18.0
Equisetum	2.0	0.0	3.0	0.0	0.0
Lemna type	0.0	3.0	0.0	0.0	0.0
Isoetes	0.0	1.0	0.0	0.0	0.0
Botryococcus undiff.	239.0	349.0	222.0	798.0	1484.0
Pediastrum undiff.	6450.0	3550.0	4667.0	12.0	28.0
Sporormiella	1.0	0.0	0.0	5.0	9.0
Undiff. spores	243.0	153.0	99.0	1077.0	728.0
Indeterminate	11.0	9.0	9.0	34.0	17.0
Unknown 1	7.0	1.0	0.0	4.0	1.0
Unknown 2	0.0	1.0	0.0	0.0	2.0
Unknown 3	0.0	0.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	4563000.0	900000.0	3159000.0	56893.0	313200

Table 2.--Raw Counts, OL-92

Depth in meters	15.3	17.3	21.3	25.1	27.5
Tracer Lycopodium	218.0	306.0	89.0	144.0	118.0
Abies	4.0	1.0	0.0	1.0	2.0
Pinus undiff.	49.0	35.0	52.0	58.0	68.0
Pinus haploxylon	26.0	14.0	23.0	22.0	25.0
Pinus diploxylon	9.0	9.0	6.0	7.0	11.0
Pinus monophylla	24.0	16.0	12.0	20.0	18.0
Tsuga mertensiana	4.0	1.0	2.0	2.0	0.0
Sequoiadendron	0.0	0.0	0.0	0.0	2.0
Juniperus	108.0	122.0	98.0	74.0	120.0
Pseudotsuga type	0.0	0.0	0.0	0.0	0.0
Quercus	1.0	0.0	0.0	0.0	1.0
Shepherdia	1.0	2.0	1.0	0.0	1.0
Populus	0.0	0.0	0.0	1.0	1.0
Betula	0.0	0.0	0.0	0.0	3.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	1.0	0.0
Fraxinus type	0.0	0.0	0.0	0.0	0.0
Salix	10.0	17.0	6.0	7.0	7.0
Ephedra	0.0	1.0	0.0	0.0	4.0
Chenopodiaceae-Amaranthus	28.0	21.0	22.0	19.0	16.0
Sarcobatus	2.0	10.0	10.0	10.0	6.0
Cercocarpus-Purshia type	4.0	1.0	3.0	3.0	3.0
Prunus	0.0	0.0	0.0	0.0	0.0
Rhamnaceae	0.0	0.0	0.0	0.0	0.0
Artemisia tridentatae	38.0	27.0	64.0	76.0	66.0
Artemisia spinescens	0.0	1.0	0.0	0.0	0.0
Ambrosia type	11.0	2.0	2.0	1.0	1.0
Larrea tridentata	0.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	2.0	3.0	1.0	1.0	1.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	0.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	0.0	0.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	0.0	0.0
Lupinus type	2.0	1.0	0.0	0.0	1.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	1.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	0.0	0.0	0.0	0.0	0.0
Onagraceae	0.0	0.0	0.0	0.0	0.0
Oenothera type	0.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	1.0
Solanaceae	0.0	0.0	0.0	0.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	1.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	13.0	16.0	10.0	12.0	9.0
Liguliflorae	0.0	1.0	0.0	0.0	0.0
Musticeae	0.0	2.0	0.0	0.0	0.0
Poaceae	3.0	16.0	0.0	1.0	1.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	0.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	4.0	0.0	0.0	0.0	0.0
Typha-Sparganium	0.0	0.0	0.0	0.0	0.0
Potamogeton	0.0	5.0	7.0	3.0	5.0
Cyperaceae	39.0	22.0	24.0	18.0	16.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	0.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	237.0	3.0	266.0	294.0	29.0
Pediastrum undiff.	606.0	2.0	1978.0	2400.0	8.0
Sporormiella	4.0	2.0	5.0	1.0	0.0
Undiff. spores	545.0	746.0	685.0	300.0	328.0
Indeterminate	17.0	21.0	4.0	6.0	12.0
Unknown 1	1.0	1.0	0.0	1.0	0.0
Unknown 2	0.0	4.0	0.0	0.0	0.0
Unknown 3	0.0	2.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	1350000.0	2700000.0	300034.0	750000.0	270000

Table 2.--Raw Counts, OL-92

Depth in meters	32.7	35.5	39.5	41.9	45.1
Tracer Lycopodium	89.0	209.0	436.0	92.0	109.0
Abies	2.0	0.0	0.0	8.0	5.0
Pinus undiff.	114.0	138.0	79.0	122.0	170.0
Pinus haploxylon	13.0	17.0	13.0	13.0	3.0
Pinus diploxylon	4.0	13.0	6.0	22.0	2.0
Pinus monophylla	10.0	13.0	9.0	9.0	9.0
Tsuga mertensiana	2.0	0.0	1.0	0.0	0.0
Sequoiadendron	0.0	1.0	1.0	0.0	0.0
Juniperus	57.0	105.0	100.0	40.0	33.0
Pseudotsuga type	0.0	0.0	0.0	0.0	0.0
Quercus	0.0	0.0	0.0	1.0	1.0
Shepherdia	2.0	3.0	3.0	0.0	2.0
Populus	3.0	0.0	1.0	1.0	0.0
Betula	3.0	0.0	0.0	1.0	2.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	1.0	0.0	0.0	0.0	0.0
Salix	6.0	8.0	2.0	2.0	4.0
Ephedra	1.0	0.0	8.0	3.0	0.0
Chenopodiaceae-Amaranthus	19.0	12.0	11.0	42.0	22.0
Sarcobatus	6.0	2.0	10.0	0.0	6.0
Cercocarpus-Purshia type	4.0	1.0	0.0	11.0	6.0
Prunus	0.0	0.0	0.0	0.0	0.0
Rhamnaceae	0.0	0.0	0.0	0.0	0.0
Artemisia tridentatae	59.0	23.0	58.0	19.0	53.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	6.0	3.0	0.0	10.0	9.0
Larrea tridentata	0.0	0.0	0.0	0.0	1.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	0.0	3.0	0.0	1.0	0.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	0.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	0.0	1.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	0.0	0.0
Lupinus type	0.0	0.0	0.0	0.0	0.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	0.0	0.0	0.0	0.0	1.0
Onagraceae	0.0	0.0	0.0	1.0	0.0
Oenothera type	0.0	0.0	0.0	0.0	4.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	0.0
Solanaceae	0.0	0.0	1.0	0.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	0.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	8.0	14.0	18.0	0.0	4.0
Liguliflorae	0.0	0.0	0.0	0.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	2.0	2.0	1.0	0.0	0.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	0.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	0.0	1.0	0.0	0.0	0.0
Typha-Sparganium	1.0	0.0	0.0	0.0	0.0
Potamogeton	1.0	0.0	0.0	0.0	0.0
Cyperaceae	11.0	16.0	17.0	12.0	2.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	1.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	175.0	100.0	8.0	6.0	574.0
Pediastrum undiff.	424.0	317.0	1.0	8.0	2422.0
Sporormiella	0.0	0.0	2.0	0.0	0.0
Undiff. spores	297.0	498.0	226.0	219.0	176.0
Indeterminate	13.0	18.0	21.0	16.0	7.0
Unknown 1	0.0	0.0	1.0	1.0	0.0
Unknown 2	0.0	0.0	0.0	0.0	0.0
Unknown 3	0.0	0.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	850652.0	540000.0	385741.0	675000.0	806593.0

Table 2.--Raw Counts, OL-92

Depth in meters	46.7	47.3	47.9	49.5	49.9
Tracer Lycopodium	131.0	168.0	106.0	202.0	183.0
Abies	1.0	2.0	6.0	3.0	2.0
Pinus undiff.	146.0	127.0	179.0	190.0	159.0
Pinus haploxylon	4.0	2.0	6.0	13.0	6.0
Pinus diploxylon	4.0	3.0	2.0	3.0	5.0
Pinus monophylla	2.0	3.0	6.0	13.0	11.0
Tsuga mertensiana	1.0	1.0	0.0	0.0	1.0
Sequoiadendron	0.0	0.0	0.0	1.0	1.0
Juniperus	61.0	69.0	62.0	61.0	60.0
Pseudotsuga type	2.0	3.0	1.0	0.0	3.0
Quercus	0.0	0.0	1.0	0.0	1.0
Shepherdia	2.0	2.0	0.0	0.0	0.0
Populus	1.0	1.0	0.0	0.0	0.0
Betula	1.0	2.0	2.0	0.0	0.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	0.0	0.0	0.0	0.0	0.0
Salix	4.0	5.0	1.0	0.0	1.0
Ephedra	0.0	3.0	0.0	1.0	0.0
Chenopodiaceae-Amaranthus	20.0	17.0	14.0	17.0	19.0
Sarcobatus	19.0	19.0	9.0	12.0	8.0
Cercocarpus-Purshia type	3.0	5.0	2.0	3.0	4.0
Prunus	0.0	0.0	0.0	0.0	0.0
Rhamnaceae	0.0	0.0	0.0	0.0	0.0
Artemisia tridentatae	34.0	55.0	29.0	30.0	18.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	12.0	7.0	2.0	0.0	5.0
Larrea tridentata	1.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	1.0	0.0	0.0	0.0	3.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	0.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	0.0	0.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	0.0	1.0
Lupinus type	0.0	3.0	0.0	0.0	0.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	1.0	0.0	0.0	0.0	0.0
Onagraceae	0.0	0.0	0.0	0.0	0.0
Oenothera type	0.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	1.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	0.0
Solanaceae	0.0	0.0	0.0	0.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	1.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	0.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	10.0	10.0	6.0	5.0	11.0
Liguliflorae	1.0	0.0	0.0	0.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	1.0	1.0	1.0	0.0	3.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	0.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	1.0	2.0	1.0	2.0	1.0
Typha-Sparganium	0.0	0.0	0.0	0.0	0.0
Potamogeton	4.0	0.0	4.0	0.0	0.0
Cyperaceae	5.0	27.0	11.0	37.0	10.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	0.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	728.0	692.0	1.0	22.0	4.0
Pediastrum undiff.	1456.0	16800.0	1.0	0.0	0.0
Sporormiella	0.0	0.0	0.0	2.0	1.0
Undiff. spores	193.0	292.0	184.0	249.0	496.0
Indeterminate	18.0	15.0	18.0	15.0	16.0
Unknown 1	1.0	1.0	1.0	0.0	0.0
Unknown 2	0.0	0.0	0.0	0.0	0.0
Unknown 3	0.0	0.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	5251400.09801000.01597200.02420000.01701				

Table 2.--Raw Counts, OL-92

Depth in meters	50.5	52.5	53.1	53.7	54.3
Tracer Lycopodium	152.0	196.0	150.0	204.0	141.0
Abies	6.0	4.0	5.0	3.0	9.0
Pinus undiff.	118.0	136.0	127.0	113.0	175.0
Pinus haploxylon	3.0	6.0	3.0	11.0	6.0
Pinus diploxylon	4.0	2.0	2.0	7.0	5.0
Pinus monophylla	12.0	10.0	6.0	8.0	5.0
Tsuga mertensiana	0.0	2.0	1.0	1.0	1.0
Sequoiadendron	0.0	1.0	1.0	2.0	0.0
Juniperus	45.0	70.0	58.0	78.0	56.0
Pseudotsuga type	1.0	5.0	1.0	0.0	0.0
Quercus	0.0	1.0	1.0	0.0	1.0
Shepherdia	0.0	0.0	0.0	1.0	0.0
Populus	2.0	2.0	6.0	0.0	4.0
Betula	1.0	0.0	0.0	0.0	1.0
Berberis type	1.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	0.0	0.0	0.0	0.0	0.0
Salix	0.0	0.0	4.0	1.0	2.0
Ephedra	3.0	5.0	4.0	1.0	0.0
Chenopodiaceae-Amaranthus	43.0	25.0	40.0	32.0	30.0
Sarcobatus	17.0	8.0	16.0	10.0	6.0
Cercocarpus-Purshia type	7.0	4.0	6.0	2.0	5.0
Prunus	0.0	0.0	0.0	0.0	0.0
Rhamnaceae	0.0	0.0	1.0	1.0	0.0
Artemisia tridentatae	32.0	23.0	23.0	32.0	18.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	2.0	2.0	4.0	3.0	5.0
Larrea tridentata	0.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	0.0	3.0	1.0	1.0	0.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	1.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	1.0	0.0	0.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	0.0	0.0
Lupinus type	0.0	0.0	0.0	0.0	0.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	1.0	1.0	0.0	0.0	1.0
Onagraceae	0.0	0.0	0.0	0.0	0.0
Oenothera type	0.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	0.0
Solanaceae	0.0	0.0	0.0	0.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	0.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	13.0	9.0	6.0	5.0	7.0
Liguliflorae	0.0	0.0	0.0	1.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	0.0	0.0	1.0	0.0	0.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	0.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	0.0	0.0	0.0	0.0	1.0
Typha-Sparganium	0.0	0.0	0.0	0.0	0.0
Potamogeton	0.0	1.0	0.0	1.0	0.0
Cyperaceae	19.0	20.0	22.0	24.0	13.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	0.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	2.0	2.0	0.0	2.0	1.0
Pediastrum undiff.	2.0	0.0	0.0	1.0	1.0
Sporormiella	1.0	0.0	1.0	1.0	0.0
Undiff. spores	224.0	296.0	290.0	276.0	220.0
Indeterminate	20.0	16.0	27.0	11.0	12.0
Unknown 1	1.0	0.0	1.0	0.0	2.0
Unknown 2	0.0	0.0	0.0	0.0	0.0
Unknown 3	0.0	0.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	4235000.08155400.03000800.01210000.04864				

Table 2.--Raw Counts, OL-92

Depth in meters	54.9	55.5	56.1	56.7	57.3
Tracer Lycopodium	116.0	178.0	116.0	67.0	155.0
Abies	8.0	5.0	7.0	3.0	5.0
Pinus undiff.	141.0	189.0	168.0	164.0	289.0
Pinus haploxylon	10.0	8.0	5.0	10.0	8.0
Pinus diploxylon	2.0	7.0	2.0	3.0	4.0
Pinus monophylla	9.0	6.0	5.0	6.0	7.0
Tsuga mertensiana	0.0	0.0	0.0	0.0	0.0
Sequoiadendron	0.0	0.0	0.0	0.0	0.0
Juniperus	30.0	32.0	39.0	36.0	23.0
Pseudotsuga type	0.0	0.0	0.0	0.0	0.0
Quercus	0.0	0.0	0.0	0.0	0.0
Shepherdia	0.0	0.0	0.0	0.0	0.0
Populus	0.0	3.0	1.0	1.0	0.0
Betula	0.0	0.0	0.0	0.0	0.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	0.0	0.0	0.0	0.0	0.0
Salix	0.0	1.0	0.0	0.0	3.0
Ephedra	1.0	0.0	2.0	2.0	0.0
Chenopodiaceae-Amaranthus	84.0	28.0	43.0	48.0	26.0
Sarcobatus	3.0	2.0	5.0	4.0	0.0
Cercocarpus-Purshia type	6.0	0.0	0.0	3.0	6.0
Prunus	0.0	0.0	1.0	0.0	0.0
Rhamnaceae	0.0	0.0	0.0	1.0	0.0
Artemisia tridentatae	11.0	18.0	10.0	22.0	9.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	15.0	8.0	7.0	4.0	6.0
Larrea tridentata	0.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	0.0	1.0	0.0	0.0	1.0
Malvaceae	0.0	0.0	0.0	0.0	0.0
Brassicaceae	0.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	1.0	0.0	0.0
Rosaceae undiff.	0.0	0.0	0.0	1.0	0.0
Lupinus type	0.0	0.0	0.0	0.0	0.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	1.0	0.0	0.0	0.0	0.0
Onagraceae	1.0	0.0	0.0	0.0	1.0
Oenothera type	0.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	0.0
Solanaceae	0.0	0.0	0.0	0.0	0.0
Solanum type	0.0	0.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	1.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	1.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	0.0	0.0
Castilleja type	0.0	0.0	0.0	0.0	1.0
Lamiaceae	0.0	1.0	0.0	0.0	0.0
Asteraceae undiff. high spine	8.0	6.0	7.0	1.0	4.0
Liguliflorae	0.0	0.0	0.0	0.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	0.0	0.0	0.0	0.0	0.0
Amaryllidaceae Allium type	0.0	0.0	1.0	0.0	0.0
Fritillaria type	0.0	0.0	0.0	0.0	0.0
Typha latifolia	0.0	1.0	0.0	0.0	0.0
Typha-Sparganium	0.0	0.0	0.0	0.0	0.0
Potamogeton	0.0	0.0	0.0	0.0	0.0
Cyperaceae	4.0	14.0	16.0	8.0	3.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	0.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	0.0	0.0	0.0	0.0	1.0
Pediastrum undiff.	0.0	0.0	0.0	0.0	0.0
Sporormiella	0.0	4.0	1.0	0.0	0.0
Undiff. spores	143.0	280.0	223.0	152.0	129.0
Indeterminate	22.0	9.0	19.0	26.0	18.0
Unknown 1	0.0	1.0	1.0	1.0	1.0
Unknown 2	0.0	0.0	1.0	0.0	0.0
Unknown 3	0.0	0.0	0.0	0.0	0.0
Unknown 4	0.0	0.0	0.0	0.0	0.0
Charcoal	6993800.0	1805347.0	3388000.0	7260000.0	1210

Table 2.--Raw Counts, OL-92

Depth in meters	60.5	61.1	61.5	62.1	62.7
Tracer Lycopodium	165.0	214.0	188.0	102.0	68.0
Abies	1.0	3.0	2.0	3.0	3.0
Pinus undiff.	118.0	176.0	202.0	173.0	129.0
Pinus haploxylon	5.0	8.0	7.0	9.0	9.0
Pinus diploxylon	8.0	12.0	8.0	2.0	6.0
Pinus monophylla	3.0	8.0	7.0	12.0	3.0
Tsuga mertensiana	0.0	2.0	0.0	1.0	0.0
Sequoiadendron	0.0	0.0	0.0	0.0	0.0
Juniperus	44.0	33.0	31.0	17.0	46.0
Pseudotsuga type	0.0	0.0	0.0	0.0	0.0
Quercus	0.0	0.0	0.0	0.0	0.0
Shepherdia	1.0	0.0	0.0	0.0	0.0
Populus	0.0	0.0	3.0	0.0	3.0
Betula	0.0	0.0	0.0	0.0	0.0
Berberis type	0.0	0.0	0.0	0.0	0.0
Chrysolepis-Castanea type	0.0	0.0	0.0	0.0	0.0
Fraxinus type	0.0	0.0	1.0	0.0	0.0
Salix	10.0	2.0	2.0	0.0	2.0
Ephedra	0.0	5.0	1.0	1.0	4.0
Chenopodiaceae-Amaranthus	43.0	59.0	31.0	22.0	42.0
Sarcobatus	9.0	4.0	5.0	1.0	4.0
Cercocarpus-Purshia type	5.0	6.0	6.0	6.0	12.0
Prunus	0.0	0.0	0.0	0.0	2.0
Rhamnaceae	0.0	0.0	0.0	0.0	0.0
Artemisia tridentatae	36.0	33.0	21.0	35.0	41.0
Artemisia spinescens	0.0	0.0	0.0	0.0	0.0
Ambrosia type	10.0	15.0	8.0	17.0	14.0
Larrea tridentata	0.0	0.0	0.0	0.0	0.0
Aquilegia type	0.0	0.0	0.0	0.0	0.0
Tidestromia	0.0	0.0	0.0	0.0	0.0
Caryophyllaceae	0.0	0.0	0.0	0.0	0.0
Eriogonum	0.0	1.0	1.0	1.0	0.0
Malvaceae	0.0	0.0	1.0	0.0	0.0
Brassicaceae	0.0	0.0	0.0	0.0	0.0
Saxifraga type	0.0	0.0	0.0	0.0	0.0
Rosaceae undiff.	0.0	1.0	0.0	0.0	0.0
Lupinus type	0.0	1.0	0.0	1.0	0.0
Psorothamnus type	0.0	0.0	0.0	0.0	0.0
Mimusoideae	0.0	0.0	0.0	0.0	0.0
Fabaceae undiff.	0.0	3.0	0.0	0.0	0.0
Onagraceae	0.0	0.0	0.0	0.0	0.0
Oenothera type	1.0	0.0	0.0	0.0	0.0
Primula veris type	0.0	0.0	0.0	0.0	0.0
Apiaceae	0.0	0.0	0.0	0.0	0.0
Solanaceae	0.0	0.0	0.0	0.0	0.0
Solanum type	0.0	1.0	0.0	0.0	0.0
Lycium (?)	0.0	0.0	0.0	0.0	0.0
Mimulus guttatus type	0.0	0.0	0.0	0.0	0.0
Leptodactylon type	0.0	0.0	0.0	0.0	0.0
Gilia-Langloisia type	0.0	0.0	0.0	0.0	0.0
Castilleja type	1.0	0.0	0.0	0.0	0.0
Lamiaceae	0.0	0.0	0.0	0.0	0.0
Asteraceae undiff. high spine	14.0	9.0	9.0	8.0	8.0
Liguliflorae	0.0	0.0	0.0	0.0	0.0
Musticeae	0.0	0.0	0.0	0.0	0.0
Poaceae	7.0	0.0	1.0	4.0	0.0
Amaryllidaceae Allium type	0.0	0.0	0.0	0.0	0.0
Fritillaria type	0.0	1.0	0.0	0.0	0.0
Typha latifolia	3.0	1.0	0.0	0.0	0.0
Typha-Sparganium	0.0	0.0	0.0	0.0	0.0
Potamogeton	5.0	0.0	2.0	1.0	1.0
Cyperaceae	15.0	11.0	13.0	12.0	12.0
Equisetum	0.0	0.0	0.0	0.0	0.0
Lemna type	0.0	0.0	0.0	0.0	0.0
Isoetes	0.0	0.0	0.0	0.0	0.0
Botryococcus undiff.	220.0	3.0	0.0	128.0	379.0
Pediastrum undiff.	1833.0	2.0	3.0	13.0	219.0
Sporormiella	0.0	0.0	0.0	0.0	0.0
Undiff. spores	611.0	268.0	165.0	123.0	219.0
Indeterminate	18.0	20.0	13.0	12.0	20.0
Unknown 1	1.0	0.0	1.0	0.0	0.0
Unknown 2	2.0	0.0	0.0	0.0	0.0
Unknown 3	3.0	0.0	0.0	0.0	0.0
Unknown 4	2.0	0.0	0.0	0.0	0.0
Charcoal	9720000.02700000.04050000.04914000.09001				

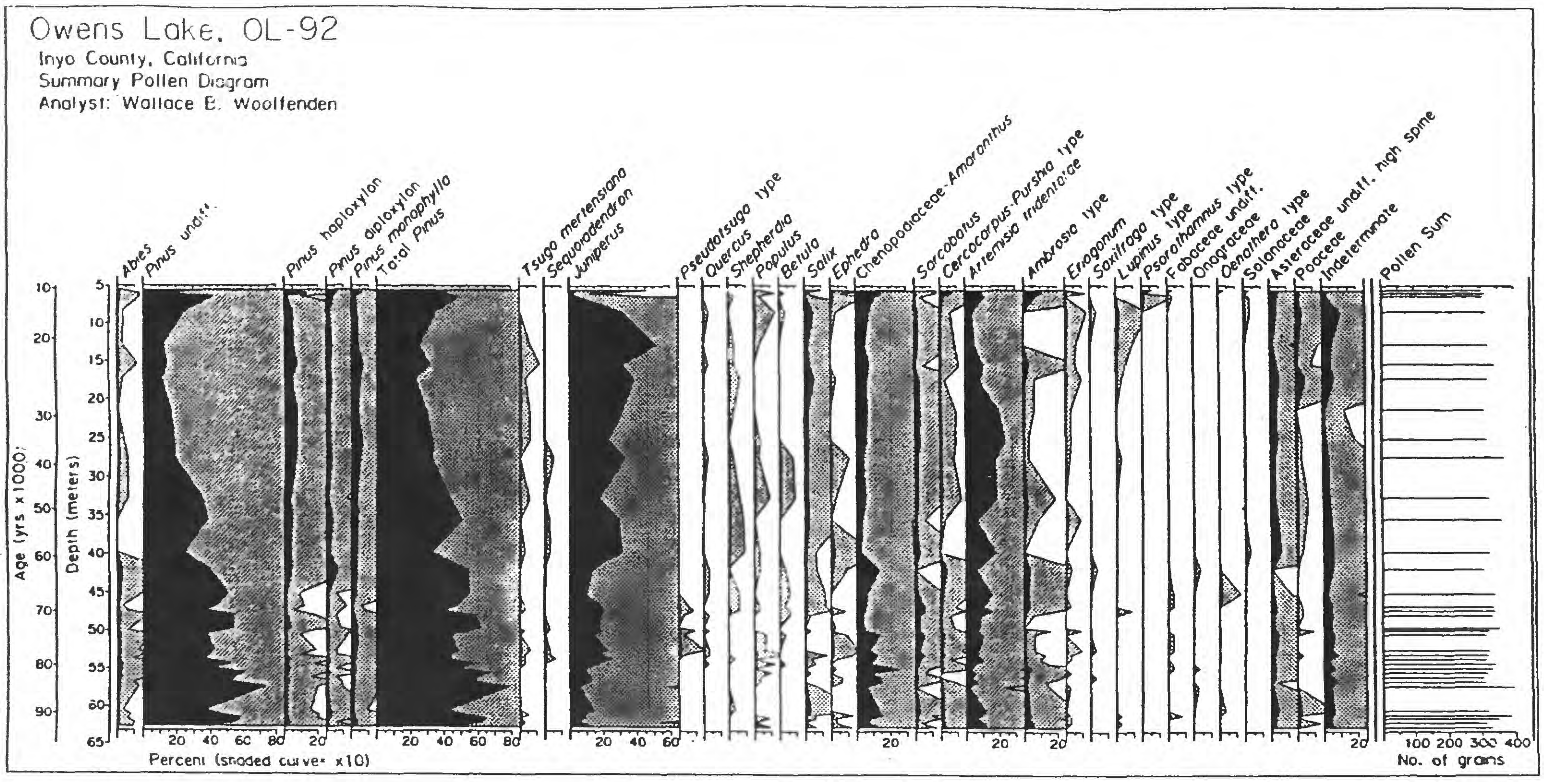

Figure 1a.--Summary pollen diagram: terrestrial pollen.

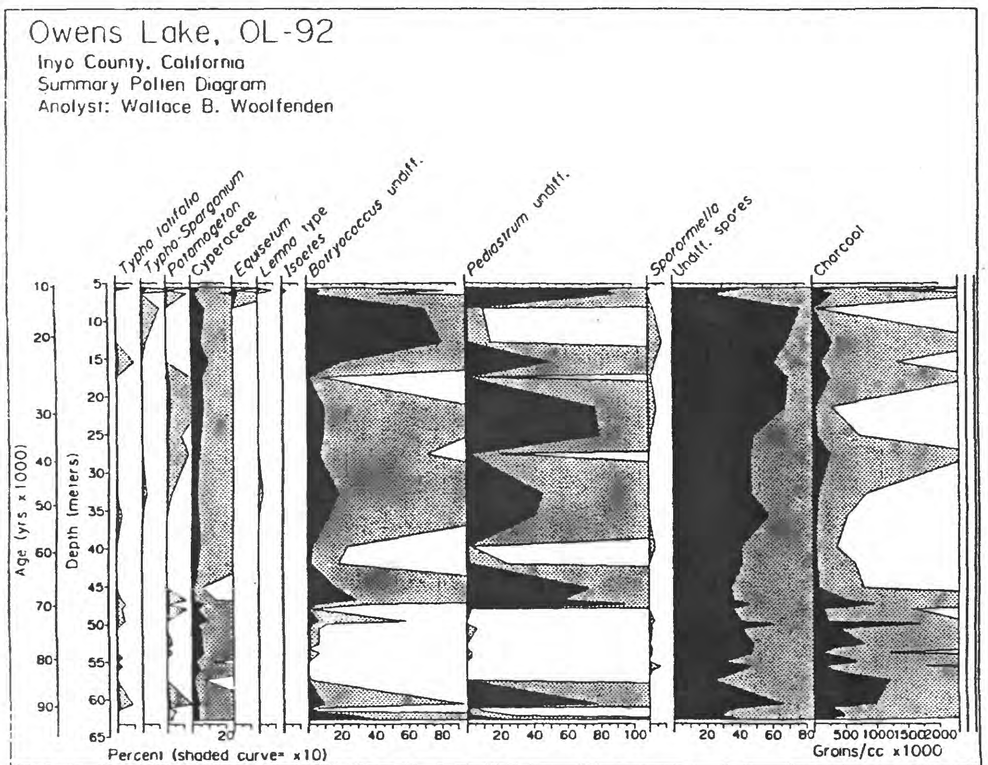

Figure 1b.--Summary pollen diagram: aquatics, algae, spores, and charcoal concentration.

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Continental-marine correlation of Late Pleistocene climate change: Census of palynomorphs from core OL-92, Owens Lake, California

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Open-File Report 93-683

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INTRODUCTION

The initial palynomorph census obtained from core OL-92 indicates the presence of a nearly continuous record of pollen assemblages through approximately 320 meters of lake sediments from Owens Lake, Inyo County, southeastern California. The sediments recovered range in age from present day to approximately 0.8 Ma, i.e., the entire Brunhes polarity chron and the uppermost portion of the Matuyama polarity chron (Smith, this volume; Glen et al., this volume). Preliminary palynological results suggest a high correlation of the terrestrial fossil record to $\delta^{18}O$ isotope curves derived from marine core analyses. Core OL-92 therefore has potential to become an important baseline record for correlating climate change in terrestrial and marine environments through the Late Cenozoic.

This study had four purposes: 1) to assess the quality and continuity of the palynomorph record in core OL-92, 2) to determine the core's potential for providing a high resolution signal of climate change for the southern California Basin and Range through the Late Cenozoic, on the basis of its fossil pollen, 3) to correlate this terrestrial climate change record with high resolution marine cores through the same temporal interval, and 4) to create a statistically significant pollen database for comparison with coeval Late Cenozoic long terrestrial records across the western U.S. Preliminary conclusions are discussed here; detailed analyses of the pollen assemblages from these core samples will be presented at a later date.

LOCATION

The field location and a detailed core log of OL-92 are noted in Smith (this volume). The core was sited at approximately 36^0 22'50"N, 117^0 57'40" W, in Owens Valley, at the southwestern end of Owens Lake (Figure 1A).

PROVENANCE

The palynological record preserved in the core sediments represents a regional vegetational record of the Owens Valley watershed, derived in large part from the eastern flank of the southern Sierra Nevada (John Muir Wilderness Area and Inyo National Forests) and the western flank of the Inyo Mountains (including part of the Inyo National Forest)(Figure 1A). Drainages from these two areas combine in the valley to form the south-flowing Owens River that presently terminates in Owens Lake at the southern end of the valley. To the southwest of the core site Ash Creek drains approximately 7400 ft. of vertical relief above lake level on the eastern flank of Muah Mountain. To the northwest of the core site

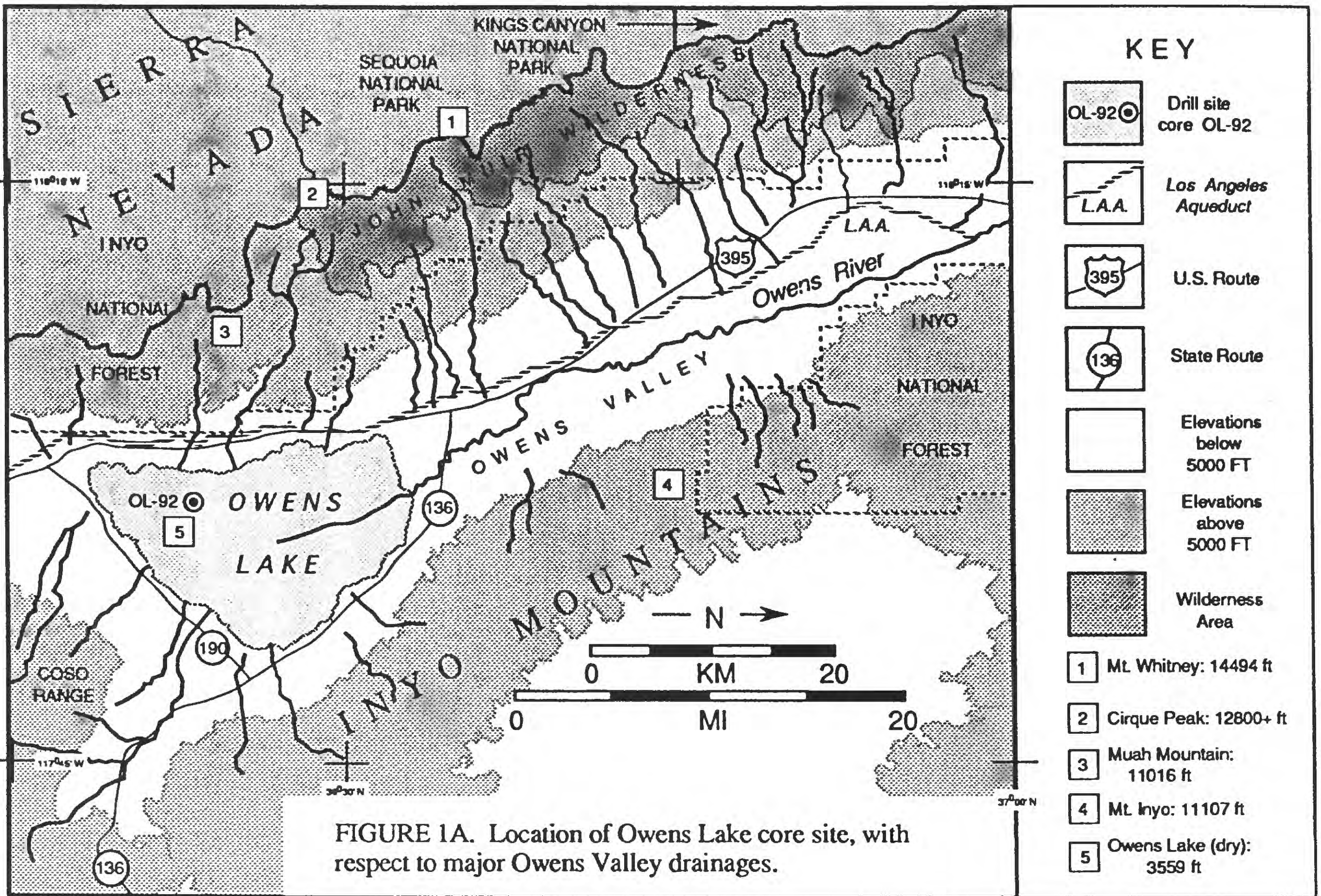


FIGURE 1A. Location of Owens Lake core site, with respect to major Owens Valley drainages.

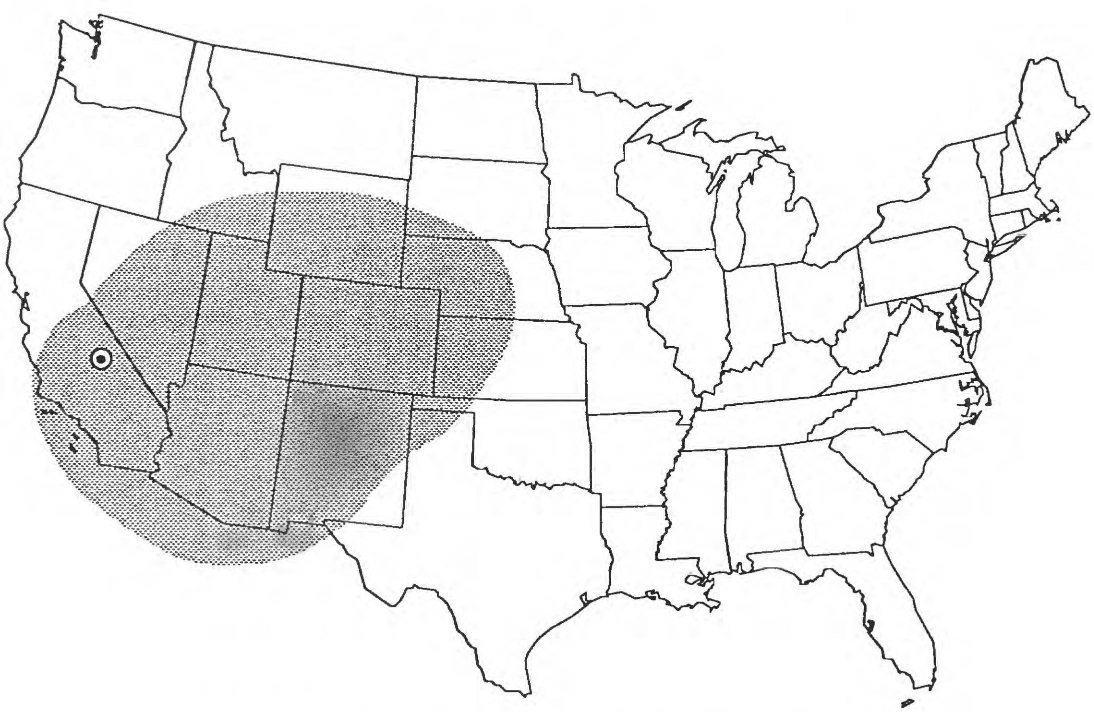


FIGURE 1B. Inferred extent of Middle Pleistocene Bishop Ash Modified from Izett et al. (1988). Core site (this study) noted.

Cottonwood Creek drains nearly 9300 ft. of vertical relief above lake level on the eastern flank of Cirque Peak and the southern flank of Wonoga Peak.

AGE CALIBRATION

The pollen record of Owens Lake core OL-92 is especially valuable for climate change research because it can be calibrated for age by several independent means. First, coring at 309.1-308.5 m depth penetrated a tephra marker bed, the Bishop Ash (primary ashfall). This tephra unit is geographically widespread from California to Kansas (Izett et al., 1988; Figure 1B) and has been dated radiometrically at an absolute age of 0.78 ± 0.02 Ma (Izett and Obradovich, 1991), on the basis of ^{40}Ar-^{39}Ar laser fusion analysis of the sanidine component of the tuff. Second, the Brunhes-Matuyama polarity chron boundary likely was penetrated just below the tuff, in our sample depth interval 309.1-312.33 m (see discussion, below). Izett and Obradovich (1991) back-calculated the Brunhes-Matuyama chron boundary at approximately 0.79 Ma, on the basis of inferred deposition rates for other lake cores in the western region that also recorded the tuff and polarity datums. They noted that their age estimate corroborated ages that were previously derived independently by oxygen isotope analyses (Shackleton et al., 1990) and astronomical calculations (Johnson, 1982). Third, Bischoff et al. (this volume) calculated age/depth relationships for the core on the basis of ^{14}C isotope ages (upper part of core) and on ^{40}Ar-^{39}Ar laser fusion analyses of the Bishop Ash (Izett and Obradovich, 1991) in the lower part of the core.

MATERIALS AND METHODS

This study was a reconnaisance-scale palynological census of the OL-92 interval 21.09-323.28 m depth. Fine resolution pollen analysis of the core interval 0-60 m is in progress by researchers at the University of Arizona (Woolfenden, this volume), and the pollen assemblage dataset through the 0-20 m depth interval is not included in this report. Both reconnaissance and fine scale sampling were done through the depth interval 20-60 m, to permit comparison of results of the two sampling scales. The sampling interval for the pollen assemblages presented in this report (138 samples) is noted in Figure 2 and Tables 2-3, and correlates directly with samples obtained for diatom analyses (Bradbury, this volume). For pollen extraction, approximately 2-5 grams of sediment were decalcified with 20% HCl and demineralized with 52% HF (in a fume hood) until the mineral fraction was disaggregated. Strew slides of neutral pH residue were made to identify incompletely disaggregated samples. Samples of silt-sand then were acidified in 2% HCl and centrifuged in an aqueous solution of zinc chloride (s.g. 2.0) for specific gravity separation. Undigested or clay-rich samples were retreated in HCl, HF, or were winnowed of clay before specific gravity separation. Clay removal was accomplished by centrifugation of mud in a dilute low-sudsing detergent (surfactant). (For specific procedures see Litwin and Andrle, 1992). The residual organic fraction was isolated by the specific gravity separation mentioned above. Palynomorphs also were recaptured from the clay-rich supernatant fraction by vacuum-filtering with an 8 µm nylon filter. These were rinsed in HCl and combined with the other palynomorph fraction. Melted glycerine jelly was added to the recombined palynomorph fraction for permanent microscope slide preparation.

TABULATION

Minimum census counts of 200 specimens were made from each sample where possible (total dataset of ~28,600 specimens). Forty two taxa and census categories (combinations of taxa) were identified. Pollen identifications mostly were made to generic level and in several cases to family level. Conifer pollen frequently was encountered as broken specimens in these preparations. To correct this we counted isolated sacci as half-specimens and did not count isolated corpi. The subtotal of broken grains was added to counts of complete conifer pollen grains for a final sum. All identifiable taxa were coded

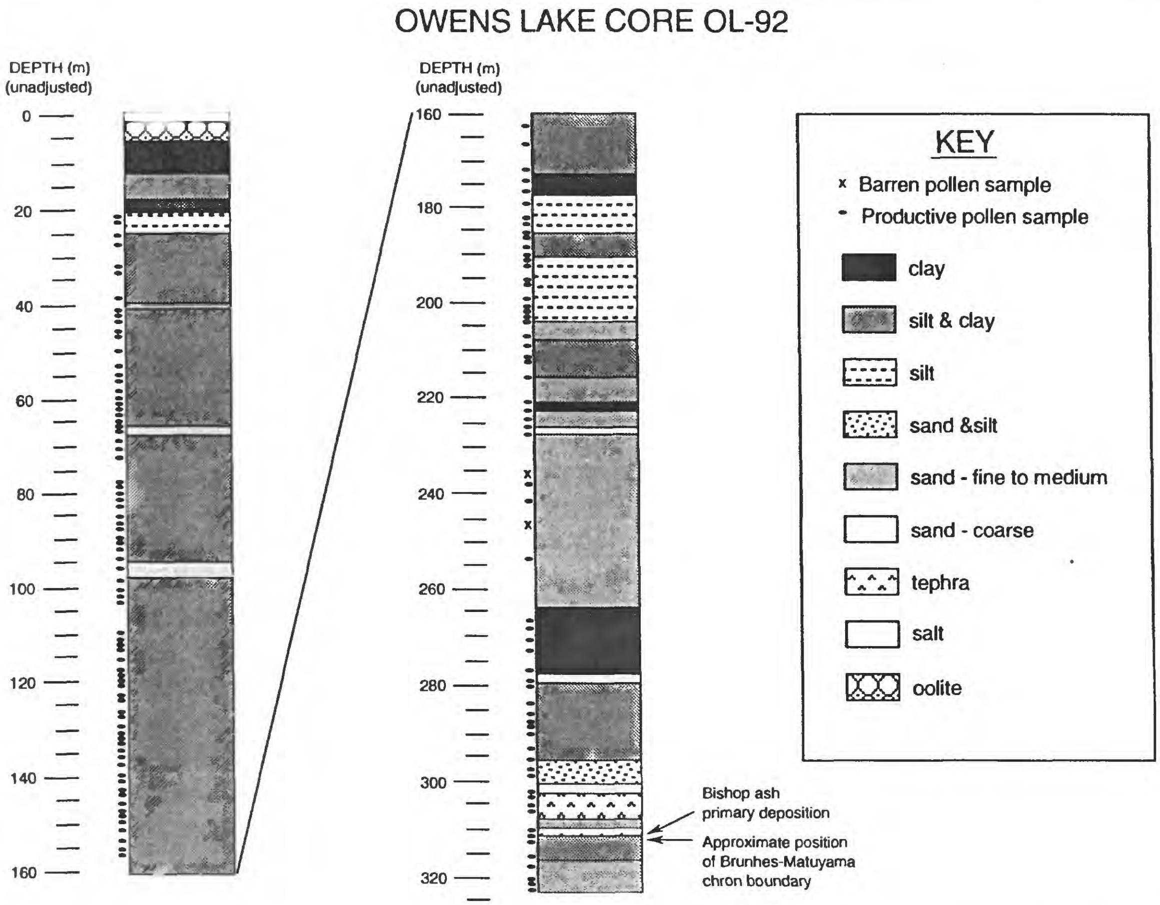


FIGURE 2. Palynomorph sample intervals and generalized lithologic log

TABLE 1. CENSUS CODES AND IDENTIFICATION CATEGORIES

CODE	GENUS (FAMILY)	COMMON NAME
ABIES	*Abies*	firs
ALNUS	*Alnus*	alders
ARTEM	*Artemisia*	sagebrush
ARTMD		"*Artemisia*-like"pollen
AZOLL	*Azolla*	water fern
BETUL	*Betula*	birches
BOTR	*Botryococcus*	alga
CASTA	*Chrysolepis, Lithocarpus*	chinquapin, tanbark oak
CH-AM	Chenopodiaceae + Amaranthaceae	goosefoot and pigweed families
COMP-SS	Compositae	daisy family (short-spined pollen)
COMP-LS	Compositae	daisy family (long-spined pollen)
COMP-LG	Compositae	daisy family ("Liguliflorae"-type)
CORYL	*Corylus*	hazelnuts
CYPER	Cyperaceae	sedge
EPH-NEV	*Ephedra nevadensis*	ephedra
EPH-TOR	*Ephedra torreyana*	ephedra
EPH-SP	*Ephedra*	ephedra (species indeterminate)
ERICA	Ericaceae	heaths, laurels
FUNGI		fungal spores
GRAMI	Gramineae	grasses
JUGLA	*Juglans*	walnut
LYCOP	*Lycopodium*	clubmosses (in part)
MENYA	*Menyanthes*	bog plants (Family Menyanthaceae)
NUPHAR	*Nuphar*	emergent aquatics (Bull-head lily, pond lily, etc.)
NYMPH	Nymphaeaceae	water lilies (undifferentiated)
ONAG	Onagraceae	evening primrose family
PEDIA	*Pediastrum*	alga
PICEA	*Picea*	spruce
PINUS	*Pinus*	pines
POL-PER	*Polygonum, persicaria* type	buckwheat (smartweed)
PSEUD	*Pseudotsuga*	Douglas fir
QUER	*Quercus*	oaks
SALIX	*Salix*	willows
SARCO	*Sarcobatus*	greasewood
SELAG	*Selaginella*	clubmosses (in part)
SHEPH	*Shepherdia*	buffaloberry
TCT	Taxodiaceae-Cupressaceae-Taxaceae	cypresses, incense-cedar, redwoods and junipers
TSUG-MER	*Tsuga mertensiana*	hemlock
TYPH-SPAR	*Typha / Sparganium*	cat-tails and burr-reeds
UK-ANG		unknown flowering plants
UK-SPO		unknown lower vascular plants
UK-UND		unknown palynomorph (undifferentiated)

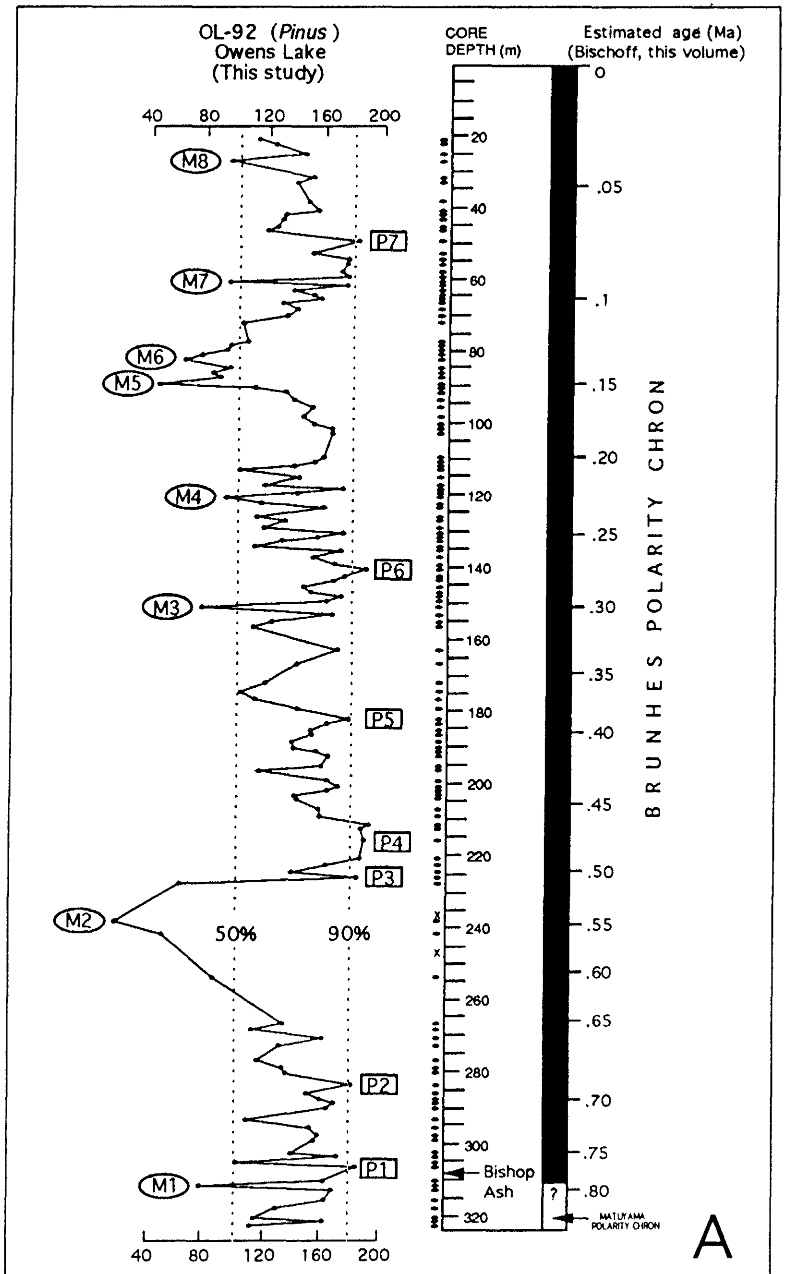
for census (Table 1). Census figures are presented in Tables 2a and 2b. All counts below 208 m depth were normalized to 200 specimens (Table 2b) before preliminary climatic trends were interpreted. Original preparations from which these census data were compiled are reposited at the U.S. Geological Survey (Reston, VA).

DISCUSSION

The initial pollen analyses indicate that the Owens Lake core OL-92 preserves a high quality, nearly continuous terrestrial vegetational record from the Owens Valley watershed that spans the past 0.8 Ma. A high rate of change was noted for individual taxon frequencies and for assemblage diversities. We attribute this in part to our relatively low sampling density, and in part to the presence of a high resolution climate signal. Figure 3A illustrates the curve for pines (genus *Pinus*, including all species) plotted against core depth (unit depth), with ages assigned on the basis of the age/depth values calculated by Bischoff et al. (this volume). We used *Pinus* relative frequency to test for response to changes in temperature and precipitation associated with glacial and interglacial events because it was the dominant element in our long terrestrial record, because the genus is known to be a prodigous producer of pollen, and because its relative frequency had a high rate of change. Relative frequencies below 50% and above 90% were chosen for initial comparison (minima M1-M8 and peak abundances P1-P7, Figure 3A) to known climatic shifts. The deep sea $\delta^{18}O$ isotope curve of Ruddiman et al. (1989) from Site 607 (North Atlantic Ocean) was chosen as a good approximate glacial/interglacial record for comparison to the *Pinus* curve of Core OL-92. The age/depth values in Figure 3A then were transposed and the *Pinus* curve was replotted (Figure 3B) so that preliminary comparison could be made between the *Pinus* and $\delta^{18}O$ curves at the same scale (as a tentative estimate of unit time).

The initial results indicate that the pollen record for the pines shows a strong positive correlation with each of the marine oxygen-isotope Stages for this time interval. The stratigraphic interval examined for this report probably correlates with $\delta^{18}O$ isotope Stages 2 (base of 1?) to 22 (23?). The *Pinus* minima M8-M1 appear to correspond to isotope stages 2, 4, 6 (~M6 + M5), 8, 10, 14, and 22?, respectively. The *Pinus* peak abundances P7-P1 appear to coincide with isotope stages 3, 9, 11, 13 (~P4 + P3), 18?, and 21?, respectively. With the exception of P2, peak abundances of *Pinus* appeared to be coincident with interglacial intervals, and minima appeared to be coincident with glacial intervals. Additionally, there is preliminary evidence that the pollen curves at least in some cases have the capability to resolve substage equivalents within the isotopic record (Figure 3B, compare the isotopic and pollen excursions for isotope Stage 7). Both convergent and divergent intervals are present in the pollen curve, with respect to the isotopic trends. Presently we suspect that convergent trends ("in phase" intervals) may represent larger scale vegetational response to climatic change, and that divergent trends ("out of phase" intervals) may represent geographically localized terrestrial response, forest disequilibrium, or artifacts of our sampling interval and/or density. Some response lag may be present in parts of the pollen curve (Figure 3B); this may be real or an artifact. Vegetational leads or lags, with respect to glacial and interglacial trends, will be able to be established more conclusively once radiometric and paleomagnetic studies are finished, and calibration of core Ol-92 is finalized.

In both plots (Figure 3A and Figure 3B) the pollen curve appears to exhibit two general signal frequencies. The shorter of these frequencies may correspond to a 41,000 year orbital cycle, and the longer of these to a 100,000 year orbital cycle. If this is true, the *Pinus* curve (in particular) may



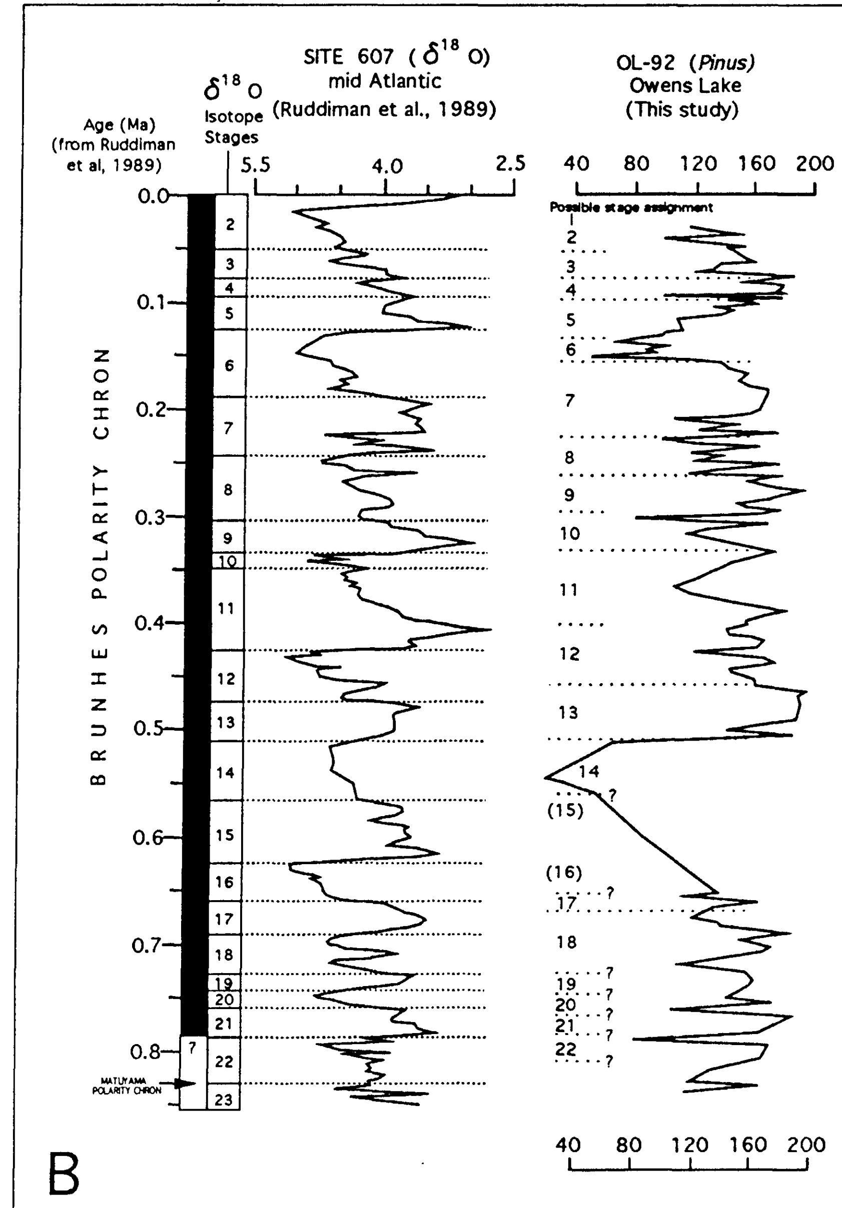


Figure 3. *Pinus* relative frequency plots. A.) Relative frequency vs. unit depth for core OL-92. Minima and maxima (values below 50% and above 90%, respectively) are labelled, and sample depths are noted. Age values shown are from Bischoff et al. (this volume). B.) Relative frequency vs. oxygen isotope curve of Ruddiman et al. (1989). *Pinus* curve was rescaled to tentative estimate of unit time, to enhance comparison with the isotope curve trends and enable preliminary correlation. Possible placements for oxygen isotope stage boundaries are shown (assigned on the basis of all pollen data in this report, not exclusively *Pinus*). Short bars indicate more tentative boundary placements. Age values for pollen curve derived from suggested age/depth values of Bischoff et al. (this volume).

provide terrestrial evidence that the periodicity shift from the Matuyama chron (dominantly a 41,000 year frequency) to the Brunhes chron (dominantly a 100,000 year frequency) may not have occurred before the beginning of the Brunhes chron. This polarity shift was noted in marine records by Ruddiman et al. (1989). Additionally, the pollen records may suggest some overprinting of the shorter cycle on the longer through much of the Late Cenozoic.

Once the OL-92 pollen dataset is resolved more finely (i.e., with a closer sampling interval), it may permit a direct comparison to other exceptionally long terrestrial records such as those at Clear Lake (Adam et al., 1981; Adam, 1988a, 1988b) and at Tule Lake (Adam et al., 1989), and direct comparison to Pacific marine records, such as those by Heusser and Shackleton (1979), Adam (1988b), Gardner et al. (1988), and Heusser and Heusser (1990). Although these results are preliminary, they do suggest that the terrestrial vegetational record preserved in the sediments of Core Ol-92 shows marked response to climatic shifts, and has the ability to be correlated to the deep sea $\delta^{18}O$ isotopic record.

CURRENT WORK

Our current studies focus on testing the response of our other census categories (and combinations of them) for the OL-92 record. Ultimately, we hope to correlate our pollen record with other long terrestrial records, such as the Tule Lake and Clear Lake records, and to test the practical limits of resolution in several depth intervals of core OL-92, in order to determine the resolution level of climatic response in the fossil floral record. We would like to determine the heterogeneity in resolution potential through core OL-92, as we do not expect glacial and interglacial resolution potentials necessarily to be equivalent. Results of these studies will be presented elsewhere, but initial results of testing this model to the Brunhes chron pollen record at Tule Lake tentatively suggest that we can resolve each of the equivalent isotope stages where sampling density and pollen recovery were sufficient.

CONCLUSIONS

Initial analyses of the long terrestrial pollen record of Owens Lake core OL-92 suggest the following conclusions. First, the potential for examining high resolution climate change through the Late Cenozoic appears to be excellent, as recorded in the fossil palynomorph record in sediments of Owens Lake and previously studied western U.S. long terrestrial records. This potential for the Owens Lake pollen record is enhanced by independent age controls (radiometric and paleomagnetic datums) that exist in parts of the cored interval and which permit a high quality age calibration for its fossil vegetational record. Second, correlation of the OL-92 pollen record with high resolution deep sea cores as far back as the Brunhes-Matuyama chron boundary appears to be feasible, and oxygen-isotope Stages 2(1?)-22(23?) tentatively were identified in this core. Fluctuations in floral diversity were noted through the sample interval, but probable causative factors were not established. We only note that diversity in any sample was in part inversely correlated with *Pinus* frequency, and that our studies on this topic are in progress. Lastly, we believe the palynomorph record at Owens Lake appears to have high potential for calibrating geographically separated Late Cenozoic long terrestrial records and for correlating marine and terrestrial Late Cenozoic climate change in the western U.S., through the Brunhes-Matuyama chron boundary.

ACKNOWLEDGEMENTS

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TABLE 2A. FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE, CALIFORNIA: CORES OL-92-1 & OL-92-2

DEPTH	ABIES	ALNUS	ARTEM	ARTMD	AZOLL	BETUL	CASTA	CH-AM	COMP-SS	COMP-LS	COMP-LG	CORYL	CYPER	EPH-NEV
8747(21.09m)	0	0	15	4	0	0	0	9	1	5	0	0	5	2
8749(22.57m)	1	0	7	1	0	0	0	5	0	2	0	0	3	2
8751(25.26m)	2	0	7	1	0	0	0	3	1	1	0	0	3	0
8753(27.56m)	2	0	13	2	0	0	0	5	2	2	0	0	5	0
8755(32.31m)	1	0	9	2	0	1	0	5	2	2	0	0	1	0
8757(33.68m)	1	0	12	1	0	0	0	2	1	4	0	0	3	0
8759(38.82m)	0	0	9	2	0	0	0	8	3	0	0	0	2	1
8761(40.96m)	2	0	8	1	0	0	0	4	1	4	0	0	1	2
8763(41.79m)	5	0	3	3	0	0	0	5	2	4	0	0	1	4
8765(43.75m)	3	0	13	6	0	1	0	5	3	0	0	0	4	1
8767(45.38m)	2	0	20	3	0	0	0	5	1	1	1	0	3	0
8769(46.50m)	1	0	6	3	0	0	0	10	1	1	0	0	5	0
8771(49.60m)	2	0	0	0	0	0	0	6	0	0	1	0	2	0
8773(53.35m)	4	0	1	1	0	0	0	13	3	0	0	0	2	1
8775(54.80m)	1	0	1	0	0	0	0	7	1	0	0	0	0	0
8777(56.50m)	3	0	0	2	0	0	0	0	1	3	0	0	0	1
8779(57.76m)	2	0	2	2	0	1	0	5	1	0	0	0	0	1
8781(58.95m)	7	0	0	0	0	1	0	4	1	0	0	0	0	0
8783(60.63m)	1	1	15	2	0	0	0	18	11	1	1	0	4	3
8785(61.73m)	1	0	1	1	0	0	0	1	3	0	0	0	1	2
8787(62.96m)	5	0	3	2	0	0	0	38	0	0	0	0	1	0
8789(64.94m)	3	0	11	3	0	0	0	2	1	0	0	0	0	0
8791(65.94m)	5	0	2	3	0	0	0	8	1	1	0	0	0	2
8793(67.49m)	4	0	7	7	0	0	0	11	2	2	1	0	2	1
8795(68.59m)	10	0	3	6	0	0	0	4	6	1	0	0	0	2
8797(71.06m)	5	0	1	1	0	0	0	7	4	0	1	0	3	3
8799(72.26m)	5	0	8	2	0	0	0	26	3	0	1	0	18	2
8801(77.16m)	3	0	3	0	0	0	0	3	1	3	0	0	7	0
8803(78.39m)	2	1	2	0	0	0	0	6	2	1	0	0	6	0
8805(79.90m)	1	0	0	3	0	0	0	1	2	0	0	0	3	0
8807(81.42m)	0	0	1	1	0	0	1	8	6	0	0	0	4	0
8809(83.55m)	2	1	2	1	0	0	1	5	3	5	0	0	2	1
8811(85.17m)	4	0	4	1	0	0	0	5	4	3	0	1	1	0
8813(86.55m)	3	0	2	0	0	0	0	6	0	1	0	0	12	0
8815(88.06m)	2	0	7	2	0	0	0	8	4	3	0	0	5	0
8817(89.65m)	2	0	1	0	0	0	0	1	7	2	4	0	4	1
8819(91.17m)	4	0	1	2	0	0	0	6	2	3	0	0	2	2
8821(92.60m)	5	0	2	3	0	0	0	3	1	2	0	0	0	0
8823(94.12m)	2	0	14	5	0	0	0	9	0	0	0	0	5	0
8825(96.66m)	3	0	4	0	0	0	0	8	1	0	0	0	0	0
8827(98.64m)	4	0	4	2	0	0	0	5	1	0	0	0	0	6
8829(100.14m)	4	0	2	2	0	0	0	4	0	0	1	0	1	2
8831(101.59m)	2	0	0	0	0	0	0	5	3	2	0	0	1	2
8833(103.07m)	4	0	0	5	0	0	0	2	1	1	0	0	2	1
8835(109.96m)	6	0	3	0	0	0	0	8	2	1	0	0	1	2
8837(111.24m)	6	0	7	1	0	0	0	7	0	0	0	0	1	2
8839(112.33m)	4	0	6	5	0	1	0	8	6	3	0	1	5	1

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	EPII-TOR	EPII-SP	ERICA	GRAMI	JUGLA	?LARIX	LYCOP	MENYA	NUPHAR	NYMPH	ONAG	PICEA	PINUS	POL-PER
8747(21.09m)	1	0	0	1	0	1	0	1	0	0	0	1	116	0
8749(22.57m)	0	0	0	0	0	1	0	0	0	0	0	0	128	0
8751(25.26m)	1	0	0	1	0	0	0	0	0	1	0	0	149	0
8753(27.56m)	0	0	0	3	0	0	0	1	0	0	0	0	98	0
8755(32.31m)	0	0	0	0	0	0	0	0	0	0	0	2	153	0
8757(33.68m)	0	0	0	1	0	0	0	0	0	0	0	0	142	0
8759(38.82m)	0	0	0	0	0	0	0	0	0	0	0	0	151	0
8761(40.96m)	0	0	0	0	0	1	0	0	0	0	0	0	159	0
8763(41.79m)	0	0	0	0	0	0	0	0	0	0	0	0	135	0
8765(43.75m)	0	0	1	0	0	0	0	0	0	1	0	0	133	0
8767(45.38m)	0	0	0	1	0	0	0	0	0	1	0	0	129	0
8769(46.50m)	0	0	0	0	0	0	0	0	0	1	0	0	122	0
8771(49.60m)	0	0	0	0	0	0	0	0	0	0	0	0	186	0
8773(53.35m)	0	0	0	0	0	0	0	0	0	0	0	1	154	0
8775(54.80m)	0	0	0	0	0	0	0	0	0	0	0	0	179	0
8777(56.50m)	0	0	0	0	0	0	0	0	0	1	0	2	178	0
8779(57.76m)	0	0	0	1	0	0	0	0	0	0	1	0	174	0
8781(58.95m)	0	0	0	0	0	0	0	0	0	0	1	0	179	0
8783(60.63m)	0	0	0	5	0	0	0	0	0	0	0	1	97	0
8785(61.73m)	0	0	0	0	0	0	0	0	0	0	1	0	178	0
8787(62.96m)	0	0	0	0	0	0	0	0	0	0	0	0	141	0
8789(64.94m)	0	0	0	0	0	0	0	0	0	0	0	0	154	0
8791(65.94m)	0	0	0	1	0	0	1	0	0	0	0	0	160	0
8793(67.49m)	0	0	0	0	0	0	0	0	0	0	0	0	133	0
8795(68.59m)	1	0	0	0	0	0	0	0	0	0	0	2	144	0
8797(71.06m)	0	0	0	0	0	0	0	0	0	0	1	0	137	0
8799(72.26m)	0	0	0	1	0	0	0	0	0	0	0	0	107	0
8801(77.16m)	1	0	0	0	0	0	0	0	0	0	0	0	109	0
8803(78.39m)	0	0	0	0	0	0	0	0	0	0	0	0	98	0
8805(79.90m)	0	0	0	5	0	0	0	0	0	0	0	0	95	0
8807(81.42m)	0	0	0	2	0	0	0	0	0	0	0	0	78	0
8809(83.55m)	0	0	0	2	0	0	0	0	0	0	0	0	66	0
8811(85.17m)	0	0	0	2	0	1	0	0	0	0	1	0	98	0
8813(86.55m)	0	0	0	2	0	2	0	0	0	0	0	0	85	0
8815(88.06m)	0	0	0	1	0	0	0	0	0	0	0	0	90	0
8817(89.65m)	1	0	0	1	0	0	0	0	0	0	0	0	48	1
8819(91.17m)	1	0	0	1	0	0	0	0	0	0	0	1	114	0
8821(92.60m)	0	0	0	0	0	0	0	0	2	0	0	0	136	0
8823(94.12m)	0	0	0	0	0	0	0	0	0	0	0	0	142	1
8825(96.66m)	0	0	0	0	0	1	0	0	0	0	1	0	154	0
8827(98.64m)	0	0	0	0	0	0	0	0	0	0	0	0	149	0
8829(100.14m)	0	0	0	0	0	0	0	0	0	0	0	0	156	0
8831(101.59m)	0	0	0	0	0	0	0	0	0	0	0	0	169	0
8833(103.07m)	0	0	0	0	0	0	0	0	0	0	0	0	169	0
8835(109.96m)	0	0	0	0	0	0	0	0	0	0	0	0	162	0
8837(111.24m)	0	0	0	0	0	0	0	0	0	0	1	0	157	0
8839(112.33m)	0	0	0	0	1	0	0	0	0	0	0	0	142	0

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	QUER	SALIX	SARCO	SELAG	SHEPH	TCT	TSUG-MER	TYPH/SPAR	UK-ANG	UK-SPO	UK-UND	TOTAL COUNT
8747(21.09m)	0	3	3	0	0	25	0	4	2	0	1	200
8749(22.57m)	1	0	2	0	1	7	4	9	7	0	19	200
8751(25.26m)	4	1	2	0	0	9	3	9	2	0	0	200
8753(27.56m)	5	1	3	0	1	47	1	0	6	1	2	200
8755(32.31m)	1	0	0	0	0	16	0	4	0	0	1	200
8757(33.68m)	0	2	2	0	1	18	0	0	9	0	1	200
8759(38.82m)	5	0	0	0	0	14	2	0	0	0	3	200
8761(40.96m)	1	0	1	0	0	11	3	0	0	0	1	200
8763(41.79m)	3	0	0	0	1	17	4	4	0	0	9	200
8765(43.75m)	5	0	2	0	0	7	1	1	1	0	12	200
8767(45.38m)	5	2	1	0	3	14	1	0	1	1	5	200
8769(46.50m)	6	6	8	0	0	18	1	4	4	0	3	200
8771(49.60m)	0	0	0	0	0	2	1	0	0	0	0	200
8773(53.35m)	2	5	0	0	0	8	2	0	2	0	1	200
8775(54.80m)	0	0	2	0	0	4	0	0	1	1	3	200
8777(56.50m)	1	0	0	0	0	8	0	0	0	0	0	200
8779(57.76m)	0	1	0	0	0	5	2	0	0	0	2	200
8781(58.95m)	1	0	0	0	0	4	2	0	0	0	0	200
8783(60.63m)	4	1	3	0	0	25	1	0	0	0	6	200
8785(61.73m)	2	0	0	0	0	3	2	0	3	0	1	200
8787(62.96m)	1	1	1	0	0	2	2	0	1	0	2	200
8789(64.94m)	1	1	1	0	1	11	0	0	1	0	10	200
8791(65.94m)	1	0	0	0	0	7	2	0	1	0	5	200
8793(67.49m)	1	0	0	0	1	17	0	0	4	1	6	200
8795(68.59m)	2	0	1	0	0	12	2	0	2	1	1	200
8797(71.06m)	2	16	0	0	0	5	3	0	8	1	2	200
8799(72.26m)	10	2	0	0	0	5	2	0	4	0	4	200
8801(77.16m)	2	2	3	0	7	45	4	0	1	2	4	200
8803(78.39m)	3	0	0	0	4	67	4	0	4	0	0	200
8805(79.90m)	8	2	0	0	2	65	2	0	2	0	9	200
8807(81.42m)	4	0	0	0	5	75	4	0	4	0	7	200
8809(83.55m)	3	3	3	0	9	66	6	0	5	1	13	200
8811(85.17m)	3	0	6	0	1	47	0	0	8	0	10	200
8813(86.55m)	3	1	3	0	1	63	2	1	2	0	11	200
8815(88.06m)	4	2	5	0	1	54	3	0	1	1	7	200
8817(89.65m)	4	3	5	0	6	87	0	2	6	0	14	200
8819(91.17m)	3	2	1	0	4	37	4	0	3	1	6	200
8821(92.60m)	0	0	2	0	0	32	2	0	3	1	6	200
8823(94.12m)	2	2	1	0	0	2	2	0	1	0	12	200
8825(96.66m)	1	2	2	0	0	17	1	0	3	0	2	200
8827(98.64m)	0	1	2	0	0	15	1	0	5	1	4	200
8829(100.14m)	1	0	1	0	0	18	1	0	2	0	5	200
8831(101.59m)	0	0	0	0	0	5	5	0	2	0	4	200
8833(103.07m)	1	0	2	0	0	5	1	0	1	0	5	200
8835(109.96m)	1	0	0	0	0	6	4	0	1	0	3	200
8837(111.24m)	0	0	0	0	1	5	6	0	2	0	4	200
8839(112.33m)	1	0	1	0	0	5	2	1	1	0	6	200

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	ABIES	ALNUS	ARTEM	ARTMD	AZOLL	BETUL	CASTA	CH-AM	COMP-SS	COMP-LS	COMP-LG	CORYL	CYPER	EPH-NEV
8841(113.64m)	3	0	11	6	0	1	0	14	3	2	0	1	5	0
8843(116.04m)	2	0	2	2	0	0	0	4	1	2	0	0	2	6
8845(117.91m)	1	0	3	0	0	0	0	15	8	1	0	0	2	5
8847(118.48m)	7	0	0	0	0	0	0	0	0	0	0	0	2	0
8849(119.65m)	1	0	2	0	0	0	0	6	4	0	0	0	0	0
8851(121.32m)	5	0	7	1	0	0	0	5	1	1	0	0	4	1
8853(122.95m)	2	0	5	0	0	0	0	1	0	1	0	0	1	0
8855(124.44m)	2	0	5	0	0	0	0	5	1	3	0	0	1	0
8857(126.31m)	5	1	21	5	0	0	0	5	3	0	0	0	0	1
8859(127.17m)	6	0	3	7	0	0	0	6	18	1	0	0	1	0
8861(129.18m)	6	0	2	8	0	0	0	2	23	1	0	0	0	1
8863(130.62m)	4	0	2	0	0	0	0	2	0	3	0	0	1	0
8865(131.74m)	4	0	1	1	0	0	0	4	2	2	0	0	0	1
8867(133.29m)	0	0	1	0	0	0	0	3	1	3	0	0	6	2
8869(134.61m)	2	0	5	3	0	0	0	10	9	0	1	0	3	3
8871(135.85m)	4	0	4	0	0	0	0	4	0	1	0	0	1	0
8873(137.43m)	5	0	12	0	0	0	0	3	3	0	0	0	7	0
8875(139.54m)	5	0	1	0	0	0	0	4	0	0	0	0	0	2
8877(141.42m)	3	0	0	0	0	0	0	0	0	0	0	0	0	0
8879(142.29m)	3	0	2	1	0	0	0	4	1	0	0	0	1	0
8881(143.91m)	2	0	0	0	0	0	0	6	1	2	0	0	1	0
8883(145.69m)	2	0	5	2	0	0	0	6	1	1	0	0	1	0
8885(147.24m)	2	0	4	3	0	0	0	8	2	0	0	0	1	4
8887(148.43m)	0	0	0	1	0	0	0	3	0	1	0	1	2	0
8889(149.19m)	3	0	0	0	0	0	0	0	1	0	0	0	0	0
8891(152.48m)	0	0	4	2	0	0	0	6	5	0	0	0	1	0
8893(154.06m)	4	0	1	1	0	0	0	0	1	1	0	0	0	0
8895(155.11m)	4	1	7	2	0	0	0	2	1	2	0	0	1	0
8897(156.71m)	4	1	17	1	0	0	0	11	2	1	2	2	1	0
8899(162.89m)	2	1	2	0	0	0	0	3	0	0	0	0	3	1
8901(167.49m)	4	2	7	3	0	0	0	5	4	0	0	0	0	3
8903(172.43m)	4	0	5	0	0	0	0	5	2	1	0	0	3	0
8905(174.76m)	1	1	6	3	0	0	0	4	1	1	1	0	1	1
8907(177.05m)	4	0	4	1	0	0	0	1	3	2	0	0	1	0
8909(179.00m)	5	0	3	1	0	0	0	3	1	1	0	0	0	0
8911(182.79m)	3	0	0	0	0	0	0	0	0	0	0	0	0	0
8913(184.18m)	3	1	4	2	0	0	0	1	0	1	0	0	0	1
8915(185.34m)	3	0	9	5	0	0	0	8	3	1	0	0	0	1
8917(186.92m)	2	1	3	3	0	0	0	3	3	3	0	0	1	2
8919(188.63m)	0	0	9	4	0	0	0	7	1	1	0	0	1	3
8921(190.15m)	4	1	1	0	0	0	0	7	0	1	0	0	2	0
8923(191.53m)	2	1	0	0	0	0	0	0	1	0	0	0	2	0
8925(192.61m)	4	0	0	0	0	0	0	4	2	0	0	0	3	1
8927(195.08m)	2	1	6	0	0	0	0	3	3	0	0	0	0	0
8929(196.54m)	2	1	3	3	0	0	0	3	4	3	0	0	2	1
8931(199.29m)	0	1	1	0	0	0	0	3	1	0	0	0	3	0
8933(201.30m)	9	0	0	2	1	0	0	4	2	1	0	0	1	0

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	EPH-TOR	EPH-SP	ERICA	GRAMI	JUGLA	?LARIX	LYCOP	MENYA	NUPHAR	NYMPH	ONAG	PICEA	PINUS	POL-PER
8841(113.64m)	0	0	0	2	0	1	0	0	0	0	0	1	104	0
8843(116.04m)	0	0	0	1	0	0	0	0	0	0	0	0	145	0
8845(117.91m)	3	0	0	0	0	0	0	0	0	1	0	0	122	0
8847(118.48m)	0	0	0	0	0	0	0	0	0	0	0	0	177	0
8849(119.65m)	1	0	0	0	0	0	0	0	0	0	0	3	144	0
8851(121.32m)	0	0	0	0	0	0	0	0	1	0	0	0	96	0
8853(122.95m)	0	0	0	0	0	0	0	0	0	0	0	0	120	0
8855(124.44m)	0	0	0	0	0	1	0	0	0	0	0	0	163	0
8857(126.31m)	0	0	0	0	0	0	0	0	1	0	0	1	117	0
8859(127.17m)	0	0	0	0	0	0	0	0	0	0	0	0	137	0
8861(129.18m)	0	0	0	0	0	0	0	0	0	0	0	0	121	0
8863(130.62m)	0	0	0	0	0	0	0	0	0	0	0	0	177	0
8865(131.74m)	0	0	0	0	0	0	0	0	0	0	0	1	159	0
8867(133.29m)	0	0	0	0	0	0	0	0	0	0	0	0	134	0
8869(134.61m)	0	0	0	0	0	0	0	0	0	0	0	1	116	0
8871(135.85m)	0	0	0	0	0	0	0	0	0	0	0	1	174	0
8873(137.43m)	0	0	0	0	0	0	0	0	0	0	0	0	156	0
8875(139.54m)	0	0	0	0	0	0	0	0	0	0	0	0	171	0
8877(141.42m)	0	0	0	0	0	0	0	0	0	0	0	0	192	0
8879(142.29m)	0	0	0	0	0	0	0	0	0	0	0	0	178	0
8881(143.91m)	0	0	0	0	0	0	0	0	0	0	0	0	170	0
8883(145.69m)	0	0	0	0	0	0	0	1	0	0	0	1	149	0
8885(147.24m)	0	0	0	1	0	0	0	0	0	0	0	0	154	0
8887(148.43m)	0	0	0	1	0	0	0	0	0	0	0	0	177	0
8889(149.19m)	0	0	0	0	0	0	0	0	0	0	0	1	166	0
8891(152.48m)	2	0	0	1	0	0	0	0	0	0	0	1	79	0
8893(154.06m)	0	0	0	0	0	0	0	0	0	1	0	2	169	0
8895(155.11m)	0	0	0	0	0	0	0	0	0	0	0	0	128	0
8897(156.71m)	0	0	0	0	0	0	0	0	0	0	0	1	114	0
8899(162.89m)	0	0	0	0	0	0	0	0	0	0	0	0	173	0
8901(167.49m)	0	0	0	0	0	0	0	0	0	0	0	0	145	0
8903(172.43m)	0	0	0	0	0	0	0	0	0	0	0	0	122	0
8905(174.76m)	0	0	0	0	0	0	0	0	0	1	0	0	105	0
8907(177.05m)	0	0	0	0	0	0	0	0	0	0	0	0	116	0
8909(179.00m)	0	0	0	0	0	0	0	0	0	0	1	0	146	0
8911(182.79m)	0	0	0	0	0	0	0	0	0	0	1	1	181	0
8913(184.18m)	0	0	0	0	0	1	0	0	0	0	0	0	166	0
8915(185.34m)	0	0	0	0	0	0	0	0	0	0	0	1	154	0
8917(186.92m)	0	0	0	0	0	0	0	0	0	0	1	0	156	0
8919(188.63m)	0	0	0	0	0	0	0	0	0	0	0	0	141	0
8921(190.15m)	0	0	0	0	0	0	0	0	1	0	0	1	142	0
8923(191.53m)	0	0	0	0	0	0	0	0	0	0	0	1	159	0
8925(192.61m)	0	0	0	0	0	0	0	0	0	0	0	0	168	0
8927(195.08m)	0	0	0	0	0	0	0	0	0	1	0	3	162	0
8929(196.54m)	0	0	0	1	0	0	0	0	0	0	0	0	119	0
8931(199.29m)	0	0	0	1	0	0	0	1	0	0	0	2	167	0
8933(201.30m)	0	0	0	0	0	0	0	0	0	0	0	7	174	0

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	QUER	SALIX	SARCO	SELAG	SHEPH	TCT	TSUG-MER	TYPH/SPAR	UK-ANG	UK-SPO	UK-UND	TOTAL COUNT
8841(113.64m)	2	1	5	0	0	13	6	0	12	0	7	200
8843(116.04m)	6	0	1	0	0	14	2	0	6	0	4	200
8845(117.91m)	1	1	4	0	1	13	1	0	7	0	11	200
8847(118.48m)	1	0	0	0	1	7	1	0	2	1	1	200
8849(119.65m)	1	0	1	0	0	11	4	0	9	0	13	200
8851(121.32m)	1	1	0	0	1	54	5	0	3	2	11	200
8853(122.95m)	0	1	0	0	2	47	1	0	12	0	7	200
8855(124.44m)	0	0	0	0	0	8	3	0	3	0	5	200
8857(126.31m)	1	0	6	0	4	19	1	0	2	0	7	200
8859(127.17m)	1	0	1	0	0	4	1	0	10	0	4	200
8861(129.18m)	2	0	4	0	1	13	6	0	6	0	4	200
8863(130.62m)	0	0	1	0	0	3	2	0	3	0	2	200
8865(131.74m)	2	0	2	0	0	11	1	0	3	0	6	200
8867(133.29m)	1	0	4	0	2	23	2	0	6	0	12	200
8869(134.61m)	4	5	3	0	0	29	1	0	1	0	4	200
8871(135.85m)	1	0	0	0	0	2	1	0	3	2	2	200
8873(137.43m)	2	1	0	0	0	6	1	0	2	0	2	200
8875(139.54m)	0	0	0	0	0	9	1	0	2	0	5	200
8877(141.42m)	0	0	0	0	0	0	2	0	3	0	0	200
8879(142.29m)	1	0	0	0	0	7	1	0	0	0	1	200
8881(143.91m)	2	0	2	0	0	7	1	0	3	0	3	200
8883(145.69m)	0	0	1	0	0	24	2	0	2	0	2	200
8885(147.24m)	2	0	3	0	0	11	4	0	0	0	1	200
8887(148.43m)	0	1	1	0	0	10	1	0	0	0	1	200
8889(149.19m)	0	0	0	0	0	25	1	0	2	0	1	200
8891(152.48m)	1	0	0	0	4	79	1	0	2	1	11	200
8893(154.06m)	1	0	2	0	0	11	3	0	0	0	3	200
8895(155.11m)	4	0	0	0	4	30	4	0	5	0	5	200
8897(156.71m)	2	0	3	0	2	16	6	1	4	0	9	200
8899(162.89m)	0	0	1	0	0	6	0	0	4	0	4	200
8901(167.49m)	2	0	0	0	0	16	2	0	2	1	4	200
8903(172.43m)	1	0	0	0	2	44	2	0	3	1	5	200
8905(174.76m)	3	0	3	0	0	50	0	0	8	0	10	200
8907(177.05m)	1	0	2	0	3	49	1	0	3	1	8	200
8909(179.00m)	1	0	4	0	0	28	0	0	3	1	2	200
8911(182.79m)	2	0	0	0	1	9	2	0	0	0	0	200
8913(184.18m)	5	0	1	0	1	7	0	0	5	0	1	200
8915(185.34m)	3	0	2	0	0	5	3	0	0	0	2	200
8917(186.92m)	1	0	2	0	0	10	2	0	4	0	3	200
8919(188.63m)	0	0	0	0	1	25	1	0	3	0	3	200
8921(190.15m)	0	0	0	0	0	29	1	0	7	0	3	200
8923(191.53m)	0	0	0	0	0	25	1	0	4	0	4	200
8925(192.61m)	0	0	1	0	0	10	0	0	6	1	0	200
8927(195.08m)	2	0	0	0	0	11	2	0	1	0	3	200
8929(196.54m)	2	1	1	0	0	31	3	0	11	0	9	200
8931(199.29m)	1	0	1	0	0	10	0	0	5	1	2	200
8933(201.30m)	0	0	0	0	0	0	0	0	1	0	0	202

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	ABIES	ALNUS	ARTEM	ARTMD	AZOLL	BETUL	CASTA	CH-AM	COMP-SS	COMP-LS	COMP-LG	CORYL	CYPER	EPH-NEV
8935(202.05m)	10	0	0	0	0	0	0	3	2	1	0	0	5	0
8937(203.40m)	1	1	3	1	0	0	0	4	1	0	0	0	1	0
8939(204.60m)	4	1	0	3	0	0	0	4	1	0	0	0	3	0
8941(207.89m)	2	0	0	0	0	0	0	3	2	0	0	0	6	0
8943(209.26m)	6	0	0	0	0	0	0	10	5	4	0	0	0	0
8945(212.14m)	0	0	0	0	0	0	0	3	0	0	0	0	0	0
8947(213.49m)	4	0	1	0	0	0	0	6	1	0	0	0	0	0
8949(216.52m)	2	0	0	0	0	0	0	3	2	0	0	0	1	0
8951(221.48m)	3	0	1	0	0	0	0	5	4	0	0	0	0	0
8953(223.17m)	2	2	0	0	0	0	0	9	1	2	0	0	0	0
8955(224.84m)	2	3	3	0	0	0	0	9	5	3	0	0	14	0
8957(226.26m)	2	0	0	0	0	0	0	3	1	0	0	0	0	0
8959(227.54m)	0	0	1	0	4	0	1	22	3	22	0	0	9	0
8963(238.50m)	1	0	20	8	0	1	0	20	10	9	0	0	19	0
8965(241.70m)	0	0	1	0	0	0	0	21	7	16	0	0	27	0
8969(254.10m)	0	0	1	3	0	0	0	20	1	2	0	0	11	0
8971(267.53m)	2	0	0	2	0	0	0	10	5	6	0	0	1	0
8973(268.43m)	1	0	0	2	0	0	0	8	15	9	0	0	2	0
8975(271.98m)	1	0	3	0	0	0	0	3	3	3	0	0	9	0
8977(273.00m)	1	0	3	0	0	0	0	21	9	11	0	0	3	0
8979(277.15m)	1	0	5	2	0	0	0	27	3	4	0	0	0	0
8981(279.30m)	3	0	9	0	0	0	0	11	3	4	0	0	11	0
8983(280.59m)	4	3	4	2	0	0	0	12	3	11	0	0	3	0
8985(284.34m)	5	0	1	0	0	0	0	3	1	0	0	0	0	0
8987(286.25m)	11	1	2	1	0	0	0	7	7	2	0	0	5	0
8989(287.50m)	7	2	4	1	0	0	0	5	1	0	0	0	2	0
8991(288.74m)	6	0	1	0	0	0	0	8	1	0	0	0	0	0
8993(290.00m)	8	0	0	0	0	0	0	2	2	3	0	0	3	0
8995(293.90m)	1	0	4	0	0	1	0	28	6	3	0	0	8	0
8997(296.60m)	4	0	5	0	0	1	0	11	0	0	0	0	7	0
8999(297.93m)	30	0	0	0	0	0	0	3	2	0	0	0	0	0
9001(299.17m)	3	0	3	0	3	0	0	3	0	1	0	0	12	0
9003(302.82m)	5	0	1	0	0	0	0	6	3	1	0	0	7	0
9005(304.41m)	3	0	0	0	0	0	0	2	0	2	0	0	2	0
9007(306.64m)	0	0	2	2	0	0	0	0	2	4	0	0	0	0
9009(307.24m)	7	0	0	0	0	0	0	0	0	0	0	0	0	0
9011(310.37m)	0	0	1	8	0	0	0	1	2	0	0	0	2	0
9013(312.33m)	2	0	9	30	0	0	0	34	7	1	0	0	4	0
9015(313.97m)	12	1	0	0	0	0	0	3	2	1	0	0	0	0
9017(316.45m)	7	0	0	0	0	0	0	6	2	1	0	0	0	0
9019(318.45m)	14	1	7	0	0	0	1	15	6	0	0	0	0	0
9021(320.36m)	10	0	2	0	0	0	0	3	1	0	2	0	0	0
9023(320.86m)	5	0	2	0	0	0	0	1	0	0	0	0	0	0
9025(323.28m)	1	0	13	1	0	1	0	8	4	0	0	0	0	0

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	EPH-TOR	EPH-SP	ERICA	GRAMI	JUGLA	?LARIX	LYCOP	MENYA	NUPHAR	NYMPH	ONAG	PICEA	PINUS	POL-PER
8935(202.05m)	0	0	0	0	0	0	0	0	0	0	0	6	167	0
8937(203.40m)	0	0	0	1	0	0	0	1	0	1	0	0	143	0
8939(204.60m)	0	0	0	1	0	0	1	0	0	0	0	2	145	0
8941(207.89m)	0	0	0	1	0	0	0	1	0	1	0	2	161	0
8943(209.26m)	0	0	0	1	0	0	0	0	0	0	0	0	209	0
8945(212.14m)	0	0	0	0	0	0	0	0	0	0	0	0	208	0
8947(213.49m)	0	0	0	0	0	0	0	0	0	0	0	0	240	0
8949(216.52m)	0	1	0	0	0	0	0	0	0	0	0	0	210	0
8951(221.48m)	0	0	0	0	0	0	0	0	0	0	0	0	237	0
8953(223.17m)	0	0	0	6	0	0	0	0	0	0	0	0	196	0
8955(224.84m)	0	0	0	12	0	0	0	0	0	0	0	0	190	0
8957(226.26m)	0	0	0	1	0	0	0	0	0	0	0	0	211	0
8959(227.54m)	0	2	0	30	0	0	0	0	0	0	0	0	67	1
8963(238.50m)	0	0	0	8	0	0	0	0	0	0	0	0	23	0
8965(241.70m)	0	0	0	21	0	0	0	0	0	0	0	1	57	0
8969(254.10m)	0	1	0	20	0	0	0	0	0	0	0	0	93	0
8971(267.53m)	0	1	0	4	0	0	0	0	0	0	0	3	156	0
8973(268.43m)	0	0	0	6	0	0	0	0	0	0	0	1	126	0
8975(271.98m)	0	1	0	5	0	0	0	0	0	0	0	0	230	0
8977(273.00m)	0	0	0	2	0	0	0	0	0	0	0	0	193	0
8979(277.15m)	0	7	0	2	0	0	0	0	0	0	0	0	164	0
8981(279.30m)	0	3	0	5	0	0	0	0	0	0	0	0	173	0
8983(280.59m)	0	1	0	1	0	0	0	0	0	0	0	0	164	0
8985(284.34m)	0	0	0	1	0	0	0	0	0	0	0	4	210	0
8987(286.25m)	0	1	0	1	0	0	0	0	0	0	0	6	171	0
8989(287.50m)	0	0	0	1	0	0	0	0	0	0	0	6	183	0
8991(288.74m)	0	0	0	1	0	0	0	0	0	0	0	3	178	0
8993(290.00m)	0	0	0	5	0	0	0	0	0	0	0	0	189	0
8995(293.90m)	0	0	0	3	0	0	0	0	0	0	0	5	151	1
8997(296.60m)	0	0	0	5	0	0	0	0	0	0	0	0	199	0
8999(297.93m)	0	0	0	3	0	0	0	0	0	0	0	13	258	1
9001(299.17m)	0	0	0	18	0	0	0	0	0	0	0	0	44	2
9003(302.82m)	0	0	0	24	0	0	0	0	0	0	0	3	176	1
9005(304.41m)	0	0	0	2	0	0	0	0	0	0	0	7	199	0
9007(306.64m)	0	0	0	6	0	0	0	0	0	0	0	0	25	0
9009(307.24m)	0	0	0	0	0	0	0	0	0	0	0	4	188	0
9011(310.37m)	0	0	0	0	0	0	0	0	0	0	0	11	202	0
9013(312.33m)	0	0	0	3	0	0	0	0	0	0	0	1	83	0
9015(313.97m)	0	0	0	2	0	0	0	0	0	0	0	2	184	0
9017(316.45m)	0	0	0	7	0	0	0	0	0	0	0	2	187	0
9019(318.45m)	0	1	0	3	0	0	0	0	0	0	0	3	137	0
9021(320.36m)	0	0	0	10	0	0	0	0	0	0	0	6	116	10
9023(320.86m)	0	0	0	7	0	0	0	0	1	0	0	1	170	4
9025(323.28m)	0	0	0	0	0	0	0	0	0	0	0	0	43	0

TABLE 2A (CONT'D.). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE: CORES OL-92-1 & OL-92-2

DEPTH	QUER	SALIX	SARCO	SELAG	SHEPH	TCT	TSUG-MER	TYPH/SPAR	UK-ANG	UK-SPO	UK-UND	TOTAL COUNT
8935(202.05m)	1	1	0	0	0	2	1	0	1	0	0	200
8937(203.40m)	3	4	0	0	1	19	2	0	3	0	10	200
8939(204.60m)	3	1	0	0	0	20	1	4	0	0	6	200
8941(207.89m)	0	0	0	0	3	11	3	1	0	1	2	200
8943(209.26m)	0	0	0	1	4	10	0	0	8	0	0	258
8945(212.14m)	0	0	0	0	0	0	0	0	2	0	0	213
8947(213.49m)	0	0	0	0	0	0	0	0	1	0	0	253
8949(216.52m)	0	0	0	0	0	0	0	0	0	0	0	219
8951(221.48m)	0	0	0	0	0	1	0	0	0	0	0	251
8953(223.17m)	0	0	0	0	0	8	0	0	10	0	0	236
8955(224.84m)	0	0	0	1	0	8	0	7	12	0	0	269
8957(226.26m)	0	0	0	0	0	1	0	1	5	0	0	225
8959(227.54m)	0	0	0	0	0	3	0	29	13	1	0	208
8963(238.50m)	0	1	0	0	25	22	0	20	49	1	0	237
8965(241.70m)	0	0	0	0	4	7	0	49	10	0	0	221
8969(254.10m)	0	0	0	0	6	3	0	27	21	0	0	209
8971(267.53m)	0	0	0	0	14	12	0	0	12	0	0	228
8973(268.43m)	0	0	0	0	27	3	0	4	14	0	0	218
8975(271.98m)	0	0	0	0	3	8	0	1	11	0	0	281
8977(273.00m)	0	0	0	0	14	19	0	1	11	1	0	289
8979(277.15m)	1	0	0	1	7	35	0	3	13	0	0	275
8981(279.30m)	1	2	0	0	10	11	0	3	4	0	0	253
8983(280.59m)	2	0	0	0	0	0	0	7	19	0	0	236
8985(284.34m)	2	0	0	0	1	0	0	0	1	0	0	229
8987(286.25m)	5	0	0	0	0	0	0	1	3	0	0	224
8989(287.50m)	1	0	0	0	0	2	0	2	8	0	0	225
8991(288.74m)	0	0	0	0	0	4	0	0	5	0	0	207
8993(290.00m)	0	0	0	0	0	6	0	0	7	0	0	225
8995(293.90m)	0	0	0	0	15	14	0	6	25	0	0	271
8997(296.60m)	0	0	0	0	5	2	0	9	8	0	0	256
8999(297.93m)	0	0	0	0	0	1	0	2	7	0	0	320
9001(299.17m)	0	1	0	0	1	0	0	55	4	0	0	150
9003(302.82m)	0	1	0	0	6	1	0	7	6	0	0	248
9005(304.41m)	0	2	0	0	2	0	0	1	5	0	0	227
9007(306.64m)	0	0	0	0	0	3	0	0	4	0	0	48
9009(307.24m)	0	0	0	0	1	0	0	0	0	0	0	200
9011(310.37m)	0	0	0	0	3	3	0	0	11	0	0	244
9013(312.33m)	0	0	0	0	6	6	0	0	24	0	0	210
9015(313.97m)	0	1	0	0	1	0	0	0	6	0	0	215
9017(316.45m)	4	0	0	0	0	0	0	0	7	0	0	223
9019(318.45m)	3	0	0	0	0	5	0	1	11	0	0	208
9021(320.36m)	0	1	0	0	0	1	0	29	7	0	0	198
9023(320.86m)	0	0	0	0	1	1	0	12	0	0	0	205
9025(323.28m)	0	1	0	0	2	1	0	0	0	0	0	75

TABLE 2B. FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE, CALIFORNIA: CORE OL-92 (NORMALIZED COUNTS)

DEPTH	ABIES	ALNUS	ARTEM	ARTMD	AZOLL	BETUL	CASTA	CH-AM	COMP-SS	COMP-LS	COMP-LG	CORYL	CYPER	EPH-NEV
8935(202.05m)	10	0	0	0	0	0	0	3	2	1	0	0	5	0
8937(203.40m)	1	1	3	1	0	0	0	4	1	0	0	0	1	0
8939(204.60m)	4	1	0	3	0	0	0	4	1	0	0	0	3	0
8941(207.89m)	2	0	0	0	0	0	0	3	2	0	0	0	6	0
8943(209.26m)	4	0	0	0	0	0	0	8	4	3	0	0	0	0
8945(212.14m)	0	0	0	0	0	0	0	3	0	0	0	0	0	0
8947(213.49m)	3	0	1	0	0	0	0	5	1	0	0	0	0	0
8949(216.52m)	2	0	0	0	0	0	0	2	2	0	0	0	1	0
8951(221.48m)	2	0	1	0	0	0	0	4	3	0	0	0	0	0
8953(223.17m)	2	1	0	0	0	0	0	8	1	2	0	0	0	0
8955(224.84m)	2	2	2	0	0	0	0	7	4	2	0	0	10	0
8957(226.26m)	2	0	0	0	0	0	0	3	1	0	0	0	0	0
8959(227.54m)	0	0	1	0	4	0	1	21	3	21	0	0	9	0
8963(238.50m)	1	0	17	7	0	1	0	17	8	8	0	0	16	0
8965(241.70m)	0	0	1	0	0	0	0	19	6	15	0	0	24	0
8969(254.10m)	0	0	1	3	0	0	0	19	1	2	0	0	10	0
8971(267.53m)	2	0	0	2	0	0	0	9	4	5	0	0	1	0
8973(268.43m)	1	0	0	2	0	0	0	7	14	8	0	0	2	0
8975(271.98m)	1	0	2	0	0	0	0	2	2	2	0	0	6	0
8977(273.00m)	1	0	2	0	0	0	0	14	6	8	0	0	2	0
8979(277.15m)	1	0	4	1	0	0	0	20	2	3	0	0	0	0
8981(279.30m)	2	0	7	0	0	0	0	9	2	3	0	0	9	0
8983(280.59m)	3	2	3	2	0	0	0	10	3	9	0	0	3	0
8985(284.34m)	4	0	1	0	0	0	0	3	1	0	0	0	0	0
8987(286.25m)	10	1	2	1	0	0	0	6	6	2	0	0	4	0
8989(287.50m)	6	2	3	1	0	0	0	4	1	0	0	0	2	0
8991(288.74m)	6	0	1	0	0	0	0	7	1	0	0	0	0	0
8993(290.00m)	7	0	0	0	0	0	0	2	2	3	0	0	3	0
8995(293.90m)	1	0	3	0	0	1	0	21	4	2	0	0	6	0
8997(296.60m)	3	0	4	0	0	1	0	9	0	0	0	0	5	0
8999(297.93m)	19	0	0	0	0	0	0	2	1	0	0	0	0	0
9001(299.17m)	4	0	4	0	4	0	0	4	0	1	0	0	16	0
9003(302.82m)	4	0	1	0	0	0	0	5	2	1	0	0	5	0
9005(304.41m)	2	0	0	0	0	0	0	2	0	2	0	0	2	0
9007(306.64m)	0	0	8	8	0	0	0	0	8	17	0	0	0	0
9009(307.24m)	7	0	0	0	0	0	0	0	0	0	0	0	0	0
9011(310.37m)	0	0	1	6	0	0	0	1	2	0	0	0	2	0
9013(312.33m)	2	0	8	28	0	0	0	32	7	1	0	0	4	0
9015(313.97m)	11	1	0	0	0	0	0	3	2	1	0	0	0	0
9017(316.45m)	6	0	0	0	0	0	0	5	2	1	0	0	0	0
9019(318.45m)	13	1	7	0	0	0	1	14	6	0	0	0	0	0
9021(320.36m)	10	0	2	0	0	0	0	3	1	0	2	0	0	0
9023(320.86m)	5	0	2	0	0	0	0	1	0	0	0	0	0	0
9025(323.28m)	3	0	34	3	0	3	0	21	11	0	0	0	0	0

TABLE 2B (CONT'D). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE, CALIFORNIA: CORE OL-92 (NORMALIZED COUNTS)

DEPTH	EPH-TOR	EPH-SP	ERICA	GRAMI	JUGLA	?LARIX	LYCOP	MENYA	NUPHAR	NYMPH	NYMPH-ALL	ONAG	PICEA	PINUS
8935(202.05m)	0	0	0	0	0	0	0	0	0	0	0	0	6	167
8937(203.40m)	0	0	0	1	0	0	0	1	0	1	1	0	0	143
8939(204.60m)	0	0	0	1	0	0	1	0	0	0	0	0	2	145
8941(207.89m)	0	0	0	1	0	0	0	1	0	1	1	0	2	161
8943(209.26m)	0	0	0	1	0	0	0	0	0	0	0	0	0	162
8945(212.14m)	0	0	0	0	0	0	0	0	0	0	0	0	0	195
8947(213.49m)	0	0	0	0	0	0	0	0	0	0	0	0	0	189
8949(216.52m)	0	1	0	0	0	0	0	0	0	0	0	0	0	192
8951(221.48m)	0	0	0	0	0	0	0	0	0	0	0	0	0	189
8953(223.17m)	0	0	0	5	0	0	0	0	0	0	0	0	0	166
8955(224.84m)	0	0	0	9	0	0	0	0	0	0	0	0	0	141
8957(226.26m)	0	0	0	1	0	0	0	0	0	0	0	0	0	187
8959(227.54m)	0	2	0	29	0	0	0	0	0	0	0	0	0	64
8963(238.50m)	0	0	0	7	0	0	0	0	0	0	0	0	0	19
8965(241.70m)	0	0	0	19	0	0	0	0	0	0	0	0	1	52
8969(254.10m)	0	1	0	19	0	0	0	0	0	0	0	0	0	89
8971(267.53m)	0	1	0	3	0	0	0	0	0	0	0	0	3	137
8973(268.43m)	0	0	0	5	0	0	0	0	0	0	0	0	1	115
8975(271.98m)	0	1	0	3	0	0	0	0	0	0	0	0	0	164
8977(273.00m)	0	0	0	1	0	0	0	0	0	0	0	0	0	133
8979(277.15m)	0	5	0	2	0	0	0	0	0	0	0	0	0	119
8981(279.30m)	0	2	0	4	0	0	0	0	0	0	0	0	0	137
8983(280.59m)	0	1	0	1	0	0	0	0	0	0	0	0	0	139
8985(284.34m)	0	0	0	1	0	0	0	0	0	0	0	0	3	183
8987(286.25m)	0	1	0	1	0	0	0	0	0	0	0	0	5	153
8989(287.50m)	0	0	0	1	0	0	0	0	0	0	0	0	5	163
8991(288.74m)	0	0	0	1	0	0	0	0	0	0	0	0	3	172
8993(290.00m)	0	0	0	4	0	0	0	0	0	0	0	0	0	168
8995(293.90m)	0	0	0	2	0	0	0	0	0	0	0	0	4	111
8997(296.60m)	0	0	0	4	0	0	0	0	0	0	0	0	0	155
8999(297.93m)	0	0	0	2	0	0	0	0	0	0	0	0	8	161
9001(299.17m)	0	0	0	24	0	0	0	0	0	0	0	0	0	59
9003(302.82m)	0	0	0	19	0	0	0	0	0	0	0	0	2	142
9005(304.41m)	0	0	0	2	0	0	0	0	0	0	0	0	6	175
9007(306.64m)	0	0	0	25	0	0	0	0	0	0	0	0	0	104
9009(307.24m)	0	0	0	0	0	0	0	0	0	0	0	0	4	188
9011(310.37m)	0	0	0	0	0	0	0	0	0	0	0	0	9	166
9013(312.33m)	0	0	0	3	0	0	0	0	0	0	0	0	1	79
9015(313.97m)	0	0	0	2	0	0	0	0	0	0	0	0	2	171
9017(316.45m)	0	0	0	6	0	0	0	0	0	0	0	0	2	168
9019(318.45m)	0	1	0	3	0	0	0	0	0	0	0	0	3	132
9021(320.36m)	0	0	0	10	0	0	0	0	0	0	0	0	6	117
9023(320.86m)	0	0	0	7	0	0	0	0	1	0	1	0	1	165
9025(323.28m)	0	0	0	0	0	0	0	0	0	0	0	0	0	114

TABLE 2B (CONT'D). FOSSIL PALYNOMORPH CENSUS DATA, OWENS LAKE, CALIFORNIA: CORE OL-92 (NORMALIZED COUNTS)

DEPTH	POL-PER	QUER	SALIX	SARCO	SELAG	SHEPH	TCT	TSUG-MER	TYPH/SPAR	UK-ANG	UK-SPO	UK-UND	TOTAL COUNT
8935(202.05m)	0	1	1	0	0	0	2	1	0	1	0	0	200
8937(203.40m)	0	3	4	0	0	1	19	2	0	3	0	9	200
8939(204.60m)	0	3	1	0	0	0	20	1	4	0	0	6	200
8941(207.89m)	0	0	0	0	0	3	11	3	1	0	1	1	200
8943(209.26m)	0	0	0	0	1	3	8	0	0	6	0	0	200
8945(212.14m)	0	0	0	0	0	0	0	0	0	2	0	0	200
8947(213.49m)	0	0	0	0	0	0	0	0	0	1	0	0	200
8949(216.52m)	0	0	0	0	0	0	0	0	0	0	0	0	200
8951(221.48m)	0	0	0	0	0	0	1	0	0	0	0	0	200
8953(223.17m)	0	0	0	0	0	0	7	0	0	8	0	0	200
8955(224.84m)	0	0	0	0	1	0	6	0	5	9	0	0	200
8957(226.26m)	0	0	0	0	0	0	1	0	1	4	0	0	200
8959(227.54m)	1	0	0	0	0	0	3	0	28	12	1	0	200
8963(238.50m)	0	0	1	0	0	21	18	0	17	41	1	0	200
8965(241.70m)	0	0	0	0	0	4	6	0	44	9	0	0	200
8969(254.10m)	0	0	0	0	0	6	3	0	26	20	0	0	200
8971(267.53m)	0	0	0	0	0	12	11	0	0	10	0	0	200
8973(268.43m)	0	0	0	0	0	25	3	0	4	13	0	0	200
8975(271.98m)	0	0	0	0	0	2	6	0	1	8	0	0	200
8977(273.00m)	0	0	0	0	0	10	13	0	1	8	1	0	200
8979(277.15m)	0	1	0	0	1	5	25	0	2	9	0	0	200
8981(279.30m)	0	1	2	0	0	8	9	0	2	3	0	0	200
8983(280.59m)	0	2	0	0	0	0	0	0	6	16	0	0	200
8985(284.34m)	0	2	0	0	0	1	0	0	0	1	0	0	200
8987(286.25m)	0	4	0	0	0	0	0	0	1	3	0	0	200
8989(287.50m)	0	1	0	0	0	0	2	0	2	7	0	0	200
8991(288.74m)	0	0	0	0	0	0	4	0	0	5	0	0	200
8993(290.00m)	0	0	0	0	0	0	5	0	0	6	0	0	200
8995(293.90m)	1	0	0	0	0	11	10	0	4	19	0	0	200
8997(296.60m)	0	0	0	0	0	4	2	0	7	6	0	0	200
8999(297.93m)	1	0	0	0	0	0	1	0	1	4	0	0	200
9001(299.17m)	3	0	1	0	0	1	0	0	73	6	0	0	200
9003(302.82m)	1	0	1	0	0	5	1	0	6	5	0	0	200
9005(304.41m)	0	0	2	0	0	2	0	0	1	4	0	0	200
9007(306.64m)	0	0	0	0	0	0	13	0	0	17	0	0	200
9009(307.24m)	0	0	0	0	0	1	0	0	0	0	0	0	200
9011(310.37m)	0	0	0	0	0	2	2	0	0	9	0	0	200
9013(312.33m)	0	0	0	0	0	6	6	0	0	23	0	0	200
9015(313.97m)	0	0	1	0	0	1	0	0	0	5	0	0	200
9017(316.45m)	0	4	0	0	0	0	0	0	0	6	0	0	200
9019(318.45m)	0	3	0	0	0	0	5	0	1	10	0	0	200
9021(320.36m)	10	0	1	0	0	0	1	0	30	7	0	0	200
9023(320.86m)	4	0	0	0	0	1	1	0	11	0	0	0	200
9025(323.28m)	0	0	3	0	0	5	3	0	0	0	0	0	200

TABLE 3. ALGAL, FUNGAL, AND INVERTEBRATE EXOSKELETAL CENSUS DATA: CORES OL-92-1 & OL-92-2

DEPTH	BOTR	FUNGI	PEDIA	INVERT	DEPTH	BOTR	FUNGI	PEDIA	INVERT	DEPTH	BOTR	FUNGI	PEDIA	INVERT
8747(21.09m)	28	0	1396	0	8841(113.64m)	66	0	137	0	8935(202.05m)	19:200	0	1676:200	0
8749(22.57m)	54	0	22	0	8843(116.04m)	60	0	19	1	8937(203.40m)	27:200	0	2258:200	0
8751(25.26m)	1780	0	2290	0	8845(117.91m)	4	0	1	0	8939(204.60m)	458:200	0	626:200	0
8753(27.56m)	20	0	0	1	8847(118.48m)	38	0	0	1	8941(207.89m)	0:200	0	1:200	0
8755(32.31m)	1902	0	214	0	8849(119.65m)	3	0	3	0	8943(209.26m)	0	17:257	1:257	0
8757(33.68m)	54	0	0	1	8851(121.32m)	0	0	8	1	8945(212.14m)	5:213	0	178:213	0
8759(38.82m)	0	0	1	2	8853(122.95m)	12	0	9	0	8947(213.49m)	5:253	0	0	0
8761(40.96m)	0	0	0	0	8855(124.44m)	0	0	1	0	8949(216.52m)	10:219	0	0	0
8763(41.79m)	0	0	0	0	8857(126.31m)	129	0	196	0	8951(221.48m)	1:251	2:251	0	0
8765(43.75m)	174	0	712	0	8859(127.17m)	66	0	45	0	8953(223.17m)	3:237	4:237	100:21	0
8767(45.38m)	166	0	138	0	8861(129.18m)	22	0	316	0	8955(224.84m)	3:268	34:268	100:8	0
8769(46.50m)	272	0	356	0	8863(130.62m)	7	0	5	0	8957(226.26m)	0	2:225	422:225	0
8771(49.60m)	30	0	0	0	8865(131.74m)	1	0	0	0	8959(227.54m)	0	25:203	0	0
8773(53.35m)	0	0	0	0	8867(133.29m)	2	0	2	0	8961(235.61m)	0	0	0	0
8775(54.80m)	0	0	0	0	8889(134.61m)	17	0	0	0	8963(238.50m)	2:236	31:236	0	0
8777(56.50m)	0	0	0	0	8871(135.85m)	80	0	1	0	8965(241.70m)	0	9:221	0	0
8779(57.76m)	0	0	0	0	8873(137.43m)	68	0	161	0	8967(246.20m)	0	0	0	0
8781(58.95m)	12	0	0	1	8875(139.54m)	2	0	0	0	8969(254.10m)	0	12:209	0	0
8783(60.63m)	9	0	25	0	8877(141.42m)	0	0	0	0	8971(267.53m)	3:228	43:228	1:228	0
8785(61.73m)	125	0	0	0	8879(142.29m)	1	0	1	0	8973(268.43m)	0	10:218	1:218	0
8787(62.96m)	175	0	40	0	8881(143.91m)	2	0	3	0	8975(271.98m)	0	3:281	1:281	0
8789(64.94m)	293	0	157	0	8883(145.69m)	36	0	18	0	8977(273.00m)	0	81:288	1:288	0
8791(65.94m)	4	0	0	0	8885(147.24m)	0	0	0	0	8979(277.15m)	2:274	5:274	6:274	0
8793(67.49m)	102	0	0	0	8887(148.43m)	0	0	0	0	8981(279.30m)	2:253	40:253	17:253	0
8795(68.59m)	503	0	5	0	8889(149.19m)	71	0	4	0	8983(280.59m)	8:236	32:236	20:236	0
8797(71.06m)	46	0	1	0	8891(152.48m)	291	0	2	0	8985(284.34m)	1:229	5:229	1:229	0
8799(72.26m)	22	0	5	0	8893(154.06m)	46	0	2	0	8987(286.25m)	13:224	1:224	100:6	0
8801(77.16m)	0	0	0	0	8895(155.11m)	13	0	3	0	8989(287.50m)	11:225	7:225	100:33	0
8803(78.39m)	157	0	1	0	8897(156.71m)	359	0	168	1	8991(288.74m)	8:207	2:207	102:56	0
8805(79.90m)	271	0	0	0	8899(162.89m)	192	0	7	0	8993(290.00m)	42:225	5:225	110:14	0
8807(81.42m)	1	0	1	0	8901(167.49m)	39	0	0	0	8995(293.90m)	3:271	11:271	0	0
8809(83.55m)	69	0	0	0	8903(172.43m)	0	0	3	0	8997(296.60m)	0	18:256	17:256	0
8811(85.17m)	21	0	0	0	8905(174.76m)	3	0	8	0	8999(297.93m)	25:180	6:320	301:180	0
8813(86.55m)	77	0	4	0	8907(177.05m)	12	0	11	0	9001(299.17m)	0	32:147	0	0
8815(88.06m)	0	0	0	0	8909(179.00m)	42	0	9	0	9003(302.82m)	2:248	60:248	67:248	0
8817(89.65m)	115	0	0	0	8911(182.79m)	22	0	6	0	9005(304.41m)	10:227	2:227	195:227	0
8819(91.17m)	3	0	7	0	8913(184.18m)	76	0	63	0	9007(306.64m)	0	9:048	9:048	0
8821(92.60m)	0	0	1	0	8915(185.34m)	591	0	776	0	9009(307.24m)	8:200	9:200	2:200	0
8823(94.12m)	16	0	3	1	8917(186.92m)	105	0	14	0	9011(310.37m)	29:244	3:244	100:36	0
8825(96.66m)	49	0	35	0	8919(188.63m)	12	0	9	0	9013(312.33m)	0	5:210	70:210	0
8827(98.64m)	0	0	0	0	8921(190.15m)	8	0	2	0	9015(313.97m)	0	4:215	65:215	0
8829(100.14m)	0	0	0	1	8923(191.53m)	134	0	1024	0	9017(316.45m)	1:223	1:223	100:51	0
8831(101.59m)	13	0	5	0	8925(192.61m)	65	0	5	0	9019(318.45m)	1:208	7:208	47:208	0
8833(103.07m)	6	0	5	0	8927(195.08m)	171	0	118	0	9021(320.36m)	0	0	0	0
8835(109.96m)	95	0	1	0	8929(196.54m)	154	0	81	0	9023(320.86m)	0	0	0	0
8837(111.24m)	3	0	0	1	8931(199.29m)	199	0	8	0	9025(323.28m)	1:75	0	0	0
8839(112.33m)	173	0	171	0	8933(201.30m)	6:201	1:201	100:7	0					

Owens Lake, Core OL-92-1
Sample number 8747, Depth 21.090

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	116	58.00
51	Broken *Pinus*	18	4.50
26	*Picea*	1	0.50
20	*Pseudotsuga*(?)	1	0.50
34	TCT	25	12.50
30	*Salix*	3	1.50
3	*Artemisia*	15	7.50
4	Artemisioids	4	2.00
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	5	2.50
8	Cheno-Ams	9	4.50
31	*Sarcobatus*	3	1.50
14	*Ephedra, nevadensis*-type	2	1.00
15	*Ephedra, torreyana*-type	1	0.50
18	Gramineae	1	0.50
13	Cyperaceae	5	2.50
36	*Typha/Sparganium*	4	2.00
22	*Menyanthes*	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.00
45	*Botryococcus*	28	14.00
47	*Pediastrum*	1396	698.00
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-1
Sample number 8749, Depth 22.570

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.55
27	*Pinus*	128	69.95
51	Broken *Pinus*	20	5.46
35	*Tsuga mertensiana*	4	2.19
20	*Pseudotsuga*(?)	1	0.55
34	TCT	7	3.83
29	*Quercus*	1	0.55
33	*Shepherdia*	1	0.55
3	*Artemisia*	7	3.83
4	Artemisioids	1	0.55
10	Long-spine Compositae	2	1.09
8	Cheno-Ams	5	2.73
31	*Sarcobatus*	2	1.09
14	*Ephedra, nevadensis*-type	2	1.09
13	Cyperaceae	3	1.64
36	*Typha/Sparganium*	9	4.92
40	Unknown #4	17	9.29
41	Unknown #5	1	0.55
42	Unknown #8	1	0.55
37	Unknown Angiosperms	7	3.83
45	*Botryococcus*	54	29.51
47	*Pediastrum*	22	12.02
	Sum 1 -- Total Pollen	183.0	

Owens Lake, Core OL-92-1
Sample number 8751, Depth 25.260

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.00
27	*Pinus*	149	74.50
51	Broken *Pinus*	18	4.50
35	*Tsuga mertensiana*	3	1.50
34	TCT	9	4.50
29	*Quercus*	4	2.00
30	*Salix*	1	0.50
3	*Artemisia*	7	3.50
4	Artemisioids	1	0.50
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	3	1.50
31	*Sarcobatus*	2	1.00
15	*Ephedra, torreyana*-type	1	0.50
18	Gramineae	1	0.50
13	Cyperaceae	3	1.50
36	*Typha/Sparganium*	9	4.50
24	Nymphaceae	1	0.50
37	Unknown Angiosperms	2	1.00
45	*Botryococcus*	1780	890.00
47	*Pediastrum*	2290	1145.00
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-1
Sample number 8753, Depth 27.560

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	98	49.49
51	Broken *Pinus*	12	3.03
35	*Tsuga mertensiana*	1	0.51
34	TCT	47	23.74
29	*Quercus*	5	2.53
30	*Salix*	1	0.51
33	*Shepherdia*	1	0.51
3	*Artemisia*	13	6.57
4	Artemisioids	2	1.01
9	Short-spine Compositae	2	1.01
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	5	2.53
31	*Sarcobatus*	3	1.52
18	Gramineae	3	1.52
13	Cyperaceae	5	2.53
22	*Menyanthes*	1	0.51
40	Unknown #4	1	0.51
41	Unknown #5	1	0.51
37	Unknown Angiosperms	6	3.03
38	Unknown spores	1	0.51
45	*Botryococcus*	20	10.10
52	'Scolecodonts'	1	0.51
	Sum 1 -- Total Pollen	198.0	

Sample number 8755, Depth 32.310

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.50
27	*Pinus*	153	76.88
51	Broken *Pinus*	70	17.59
26	*Picea*	2	1.01
34	TCT	16	8.04
29	*Quercus*	1	0.50
6	*Betula*	1	0.50
3	*Artemisia*	9	4.52
4	Artemisioids	2	1.01
9	Short-spine Compositae	2	1.01
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	5	2.51
13	Cyperaceae	1	0.50
36	*Typha/Sparganium*	4	2.01
40	Unknown #4	1	0.50
45	*Botryococcus*	1902	955.78
47	*Pediastrum*	214	107.54
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-1
Sample number 8757, Depth 33.680

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.50
27	*Pinus*	142	71.00
51	Broken *Pinus*	46	11.50
34	TCT	18	9.00
30	*Salix*	2	1.00
33	*Shepherdia*	1	0.50
3	*Artemisia*	12	6.00
4	Artemisioids	1	0.50
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	4	2.00
8	Cheno-Ams	2	1.00
31	*Sarcobatus*	2	1.00
18	Gramineae	1	0.50
13	Cyperaceae	3	1.50
42	Unknown #8	1	0.50
37	Unknown Angiosperms	9	4.50
48	Unknown #1	1	0.50
45	*Botryococcus*	54	27.00
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8759, Depth 38.820

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	151	76.65
51	Broken *Pinus*	8	2.03
35	*Tsuga mertensiana*	2	1.02
34	TCT	14	7.11
29	*Quercus*	5	2.54
3	*Artemisia*	9	4.57
4	Artemisioids	2	1.02
9	Short-spine Compositae	3	1.52
8	Cheno-Ams	8	4.06
14	*Ephedra, nevadensis*-type	1	0.51
13	Cyperaceae	2	1.02
40	Unknown #4	3	1.52
47	*Pediastrum*	1	0.51
52	'Scolecodonts'	2	1.02
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-1
Sample number 8761, Depth 40.960

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	159	79.90
51	Broken *Pinus*	12	3.02
35	*Tsuga mertensiana*	3	1.51
20	*Pseudotsuga*(?)	1	0.50
34	TCT	11	5.53
29	*Quercus*	1	0.50
3	*Artemisia*	8	4.02
4	Artemisioids	1	0.50
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	4	2.01
8	Cheno-Ams	4	2.01
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.50
40	Unknown #4	1	0.50
	Sum 1 -- Total Pollen	199.0	

Sample number 8763, Depth 41.790

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.62
27	*Pinus*	135	70.68
51	Broken *Pinus*	32	8.38
35	*Tsuga mertensiana*	4	2.09
34	TCT	17	8.90
29	*Quercus*	3	1.57
33	*Shepherdia*	1	0.52
3	*Artemisia*	3	1.57
4	Artemisioids	3	1.57
9	Short-spine Compositae	2	1.05
10	Long-spine Compositae	4	2.09
8	Cheno-Ams	5	2.62
14	*Ephedra, nevadensis*-type	4	2.09
13	Cyperaceae	1	0.52
36	*Typha/Sparganium*	4	2.09
40	Unknown #4	9	4.71
	Sum 1 -- Total Pollen	191.0	

Owens Lake, Core OL-92-1
Sample number 8765, Depth 43.750

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.59
27	*Pinus*	133	70.37
51	Broken *Pinus*	20	5.29
35	*Tsuga mertensiana*	1	0.53
34	TCT	7	3.70
29	*Quercus*	5	2.65
6	*Betula*	1	0.53
17	Ericaceae	1	0.53
3	*Artemisia*	13	6.88
4	Artemisioids	6	3.17
9	Short-spine Compositae	3	1.59
8	Cheno-Ams	5	2.65
31	*Sarcobatus*	2	1.06
14	*Ephedra, nevadensis*-type	1	0.53
13	Cyperaceae	4	2.12
36	*Typha/Sparganium*	1	0.53
24	Nymphaceae	1	0.53
40	Unknown #4	11	5.82
41	Unknown #5	1	0.53
37	Unknown Angiosperms	1	0.53
45	*Botryococcus*	174	92.06
47	*Pediastrum*	712	376.72
	Sum 1 -- Total Pollen	189.0	

Owens Lake, Core OL-92-1
Sample number 8767, Depth 45.380

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	129	65.15
51	Broken *Pinus*	36	9.09
35	*Tsuga mertensiana*	1	0.51
34	TCT	14	7.07
29	*Quercus*	5	2.53
30	*Salix*	2	1.01
33	*Shepherdia*	3	1.52
3	*Artemisia*	20	10.10
4	Artemisioids	3	1.52
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
11	Liguliflorae	1	0.51
8	Cheno-Ams	5	2.53
31	*Sarcobatus*	1	0.51
18	Gramineae	1	0.51
13	Cyperaceae	3	1.52
24	Nymphaceae	1	0.51
39	Unknown #3	2	1.01
40	Unknown #4	1	0.51
41	Unknown #5	2	1.01
37	Unknown Angiosperms	1	0.51
48	Unknown #1	1	0.51
38	Unknown spores	1	0.51
45	*Botryococcus*	166	83.84
47	*Pediastrum*	138	69.70
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-1
Sample number 8769, Depth 46.500

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.51
27	*Pinus*	122	61.62
51	Broken *Pinus*	28	7.07
35	*Tsuga mertensiana*	1	0.51
34	TCT	18	9.09
29	*Quercus*	6	3.03
30	*Salix*	6	3.03
3	*Artemisia*	6	3.03
4	Artemisioids	3	1.52
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	10	5.05
31	*Sarcobatus*	8	4.04
13	Cyperaceae	5	2.53
36	*Typha/Sparganium*	4	2.02
24	Nymphaceae	1	0.51
40	Unknown #4	2	1.01
42	Unknown #8	1	0.51
37	Unknown Angiosperms	4	2.02
45	*Botryococcus*	272	137.37
47	*Pediastrum*	356	179.80
	Sum 1 -- Total Pollen	198.0	

Sample number 8771, Depth 49.600

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.00
27	*Pinus*	186	93.00
51	Broken *Pinus*	32	8.00
35	*Tsuga mertensiana*	1	0.50
34	TCT	2	1.00
11	Liguliflorae	1	0.50
8	Cheno-Ams	6	3.00
13	Cyperaceae	2	1.00
45	*Botryococcus*	30	15.00
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-1
Sample number 8773, Depth 53.350

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.01
27	*Pinus*	154	77.39
51	Broken *Pinus*	20	5.03
26	*Picea*	1	0.50
35	*Tsuga mertensiana*	2	1.01
34	TCT	8	4.02
29	*Quercus*	2	1.01
30	*Salix*	5	2.51
3	*Artemisia*	1	0.50
4	Artemisioids	1	0.50
9	Short-spine Compositae	3	1.51
8	Cheno-Ams	13	6.53
14	*Ephedra, nevadensis*-type	1	0.50
13	Cyperaceae	2	1.01
40	Unknown #4	1	0.50
37	Unknown Angiosperms	2	1.01
	Sum 1 -- Total Pollen	199.0	

Sample number 8775, Depth 54.800

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.51
27	*Pinus*	179	90.40
51	Broken *Pinus*	22	5.56
34	TCT	4	2.02
3	*Artemisia*	1	0.51
9	Short-spine Compositae	1	0.51
8	Cheno-Ams	7	3.54
31	*Sarcobatus*	2	1.01
39	Unknown #3	2	1.01
40	Unknown #4	1	0.51
37	Unknown Angiosperms	1	0.51
38	Unknown spores	1	0.51
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-1
Sample number 8777, Depth 56.500

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	178	89.00
51	Broken *Pinus*	20	5.00
26	*Picea*	2	1.00
34	TCT	8	4.00
29	*Quercus*	1	0.50
4	Artemisioids	2	1.00
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	3	1.50
14	*Ephedra, nevadensis*-type	1	0.50
24	Nymphaeceae	1	0.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8779, Depth 57.760

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.00
27	*Pinus*	174	87.00
51	Broken *Pinus*	26	6.50
35	*Tsuga mertensiana*	2	1.00
34	TCT	5	2.50
6	*Betula*	1	0.50
30	*Salix*	1	0.50
3	*Artemisia*	2	1.00
4	Artemisioids	2	1.00
9	Short-spine Compositae	1	0.50
8	Cheno-Ams	5	2.50
14	*Ephedra, nevadensis*-type	1	0.50
18	Gramineae	1	0.50
25	Onagraceae	1	0.50
39	Unknown #3	2	1.00
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-1
Sample number 8781, Depth 58.950

Variable Number	Type	Number of Grains	Percent
1	*Abies*	7	3.50
27	*Pinus*	179	89.50
51	Broken *Pinus*	56	14.00
35	*Tsuga mertensiana*	2	1.00
34	TCT	4	2.00
29	*Quercus*	1	0.50
6	*Betula*	1	0.50
9	Short-spine Compositae	1	0.50
8	Cheno-Ams	4	2.00
25	Onagraceae	1	0.50
45	*Botryococcus*	12	6.00
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8783, Depth 60.630

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.51
27	*Pinus*	97	49.24
51	Broken *Pinus*	8	2.03
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	25	12.69
29	*Quercus*	4	2.03
2	*Alnus*	1	0.51
30	*Salix*	1	0.51
3	*Artemisia*	15	7.61
4	Artemisioids	2	1.02
9	Short-spine Compositae	11	5.58
10	Long-spine Compositae	1	0.51
11	Liguliflorae	1	0.51
8	Cheno-Ams	18	9.14
31	*Sarcobatus*	3	1.52
14	*Ephedra, nevadensis*-type	3	1.52
18	Gramineae	5	2.54
13	Cyperaceae	4	2.03
39	Unknown #3	2	1.02
40	Unknown #4	3	1.52
42	Unknown #8	1	0.51
45	*Botryococcus*	9	4.57
47	*Pediastrum*	25	12.69
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-2
Sample number 8785, Depth 61.730

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.50
27	*Pinus*	178	89.45
51	Broken *Pinus*	42	10.55
35	*Tsuga mertensiana*	2	1.01
34	TCT	3	1.51
29	*Quercus*	2	1.01
3	*Artemisia*	1	0.50
4	Artemisioids	1	0.50
9	Short-spine Compositae	3	1.51
8	Cheno-Ams	1	0.50
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.50
25	Onagraceae	1	0.50
40	Unknown #4	1	0.50
37	Unknown Angiosperms	3	1.51
45	*Botryococcus*	125	62.81
	Sum 1 -- Total Pollen	199.0	

Sample number 8787, Depth 62.960

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.51
27	*Pinus*	141	70.85
51	Broken *Pinus*	18	4.52
35	*Tsuga mertensiana*	2	1.01
34	TCT	2	1.01
29	*Quercus*	1	0.50
30	*Salix*	1	0.50
3	*Artemisia*	3	1.51
4	Artemisioids	2	1.01
8	Cheno-Ams	38	19.10
31	*Sarcobatus*	1	0.50
13	Cyperaceae	1	0.50
39	Unknown #3	1	0.50
40	Unknown #4	1	0.50
37	Unknown Angiosperms	1	0.50
45	*Botryococcus*	175	87.94
47	*Pediastrum*	40	20.10
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8789, Depth 64.940

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.53
27	*Pinus*	154	78.57
51	Broken *Pinus*	62	15.82
34	TCT	11	5.61
29	*Quercus*	1	0.51
30	*Salix*	1	0.51
33	*Shepherdia*	1	0.51
3	*Artemisia*	11	5.61
4	Artemisioids	3	1.53
9	Short-spine Compositae	1	0.51
8	Cheno-Ams	2	1.02
31	*Sarcobatus*	1	0.51
39	Unknown #3	4	2.04
40	Unknown #4	4	2.04
42	Unknown #8	2	1.02
37	Unknown Angiosperms	1	0.51
45	*Botryococcus*	293	149.49
47	*Pediastrum*	157	80.10
	Sum 1 -- Total Pollen	196.0	

Sample number 8791, Depth 65.940

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.54
27	*Pinus*	160	81.22
51	Broken *Pinus*	20	5.08
35	*Tsuga mertensiana*	2	1.02
34	TCT	7	3.55
29	*Quercus*	1	0.51
3	*Artemisia*	2	1.02
4	Artemisioids	3	1.52
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	8	4.06
14	*Ephedra, nevadensis*-type	2	1.02
18	Gramineae	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	2	1.02
41	Unknown #5	2	1.02
37	Unknown Angiosperms	1	0.51
21	*Lycopodium*	1	0.51
45	*Botryococcus*	4	2.03
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-2
Sample number 8793, Depth 67.490

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.02
27	*Pinus*	133	67.17
51	Broken *Pinus*	10	2.53
34	TCT	17	8.59
29	*Quercus*	1	0.51
33	*Shepherdia*	1	0.51
3	*Artemisia*	7	3.54
4	Artemisioids	7	3.54
9	Short-spine Compositae	2	1.01
10	Long-spine Compositae	2	1.01
11	Liguliflorae	1	0.51
8	Cheno-Ams	11	5.56
14	*Ephedra, nevadensis*-type	1	0.51
13	Cyperaceae	2	1.01
39	Unknown #3	2	1.01
40	Unknown #4	1	0.51
41	Unknown #5	3	1.52
37	Unknown Angiosperms	4	2.02
38	Unknown spores	1	0.51
45	*Botryococcus*	102	51.52
	Sum 1 -- Total Pollen	198.0	

Sample number 8795, Depth 68.590

Variable Number	Type	Number of Grains	Percent
1	*Abies*	10	5.03
27	*Pinus*	144	72.36
51	Broken *Pinus*	44	11.06
26	*Picea*	2	1.01
35	*Tsuga mertensiana*	2	1.01
34	TCT	12	6.03
29	*Quercus*	2	1.01
3	*Artemisia*	3	1.51
4	Artemisioids	6	3.02
9	Short-spine Compositae	6	3.02
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	4	2.01
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	2	1.01
15	*Ephedra, torreyana*-type	1	0.50
39	Unknown #3	1	0.50
37	Unknown Angiosperms	2	1.01
38	Unknown spores	1	0.50
45	*Botryococcus*	503	252.76
47	*Pediastrum*	5	2.51
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8797, Depth 71.060

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.53
27	*Pinus*	137	69.19
51	Broken *Pinus*	24	6.06
35	*Tsuga mertensiana*	3	1.52
34	TCT	5	2.53
29	*Quercus*	2	1.01
30	*Salix*	16	8.08
3	*Artemisia*	1	0.51
4	Artemisioids	1	0.51
9	Short-spine Compositae	4	2.02
11	Liguliflorae	1	0.51
8	Cheno-Ams	7	3.54
14	*Ephedra, nevadensis*-type	3	1.52
13	Cyperaceae	3	1.52
25	Onagraceae	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	1	0.51
37	Unknown Angiosperms	8	4.04
38	Unknown spores	1	0.51
45	*Botryococcus*	46	23.23
47	*Pediastrum*	1	0.51
	Sum 1 -- Total Pollen	198.0	

Sample number 8799, Depth 72.260

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.54
27	*Pinus*	107	54.31
51	Broken *Pinus*	26	6.60
35	*Tsuga mertensiana*	2	1.02
34	TCT	5	2.54
29	*Quercus*	10	5.08
30	*Salix*	2	1.02
3	*Artemisia*	8	4.06
4	Artemisioids	2	1.02
9	Short-spine Compositae	3	1.52
11	Liguliflorae	1	0.51
8	Cheno-Ams	26	13.20
14	*Ephedra, nevadensis*-type	2	1.02
18	Gramineae	1	0.51
13	Cyperaceae	18	9.14
40	Unknown #4	3	1.52
41	Unknown #5	1	0.51
37	Unknown Angiosperms	4	2.03
45	*Botryococcus*	22	11.17
47	*Pediastrum*	5	2.54
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-2
Sample number 8801, Depth 77.160

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.55
27	*Pinus*	109	56.19
51	Broken *Pinus*	6	1.55
35	*Tsuga mertensiana*	4	2.06
34	TCT	45	23.20
29	*Quercus*	2	1.03
30	*Salix*	2	1.03
33	*Shepherdia*	7	3.61
3	*Artemisia*	3	1.55
9	Short-spine Compositae	1	0.52
10	Long-spine Compositae	3	1.55
8	Cheno-Ams	3	1.55
31	*Sarcobatus*	3	1.55
15	*Ephedra, torreyana*-type	1	0.52
13	Cyperaceae	7	3.61
40	Unknown #4	4	2.06
37	Unknown Angiosperms	1	0.52
48	Unknown #1	1	0.52
38	Unknown spores	2	1.03
	Sum 1 -- Total Pollen	194.0	

Sample number 8803, Depth 78.390

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.00
27	*Pinus*	98	49.00
51	Broken *Pinus*	14	3.50
35	*Tsuga mertensiana*	4	2.00
34	TCT	67	33.50
29	*Quercus*	3	1.50
2	*Alnus*	1	0.50
33	*Shepherdia*	4	2.00
3	*Artemisia*	2	1.00
9	Short-spine Compositae	2	1.00
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	6	3.00
13	Cyperaceae	6	3.00
37	Unknown Angiosperms	4	2.00
45	*Botryococcus*	157	78.50
47	*Pediastrum*	1	0.50
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-2
Sample number 8805, Depth 79.900

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.52
27	*Pinus*	95	49.48
51	Broken *Pinus*	6	1.56
35	*Tsuga mertensiana*	2	1.04
34	TCT	65	33.85
29	*Quercus*	8	4.17
30	*Salix*	2	1.04
33	*Shepherdia*	2	1.04
4	Artemisioids	3	1.56
9	Short-spine Compositae	2	1.04
8	Cheno-Ams	1	0.52
18	Gramineae	5	2.60
13	Cyperaceae	3	1.56
39	Unknown #3	1	0.52
40	Unknown #4	8	4.17
37	Unknown Angiosperms	2	1.04
45	*Botryococcus*	271	141.15
	Sum 1 -- Total Pollen	192.0	

Sample number 8807, Depth 81.420

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	78	40.00
51	Broken *Pinus*	14	3.59
35	*Tsuga mertensiana*	4	2.05
34	TCT	75	38.46
29	*Quercus*	4	2.05
7	*Chrysolepis*	1	0.51
33	*Shepherdia*	5	2.56
3	*Artemisia*	1	0.51
4	Artemisioids	1	0.51
9	Short-spine Compositae	6	3.08
8	Cheno-Ams	8	4.10
18	Gramineae	2	1.03
13	Cyperaceae	4	2.05
39	Unknown #3	1	0.51
40	Unknown #4	5	2.56
42	Unknown #8	1	0.51
37	Unknown Angiosperms	4	2.05
49	Unknown #6	2	1.03
45	*Botryococcus*	1	0.51
47	*Pediastrum*	1	0.51
	Sum 1 -- Total Pollen	195.0	

Owens Lake, Core OL-92-2
Sample number 8809, Depth 83.550

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.05
27	*Pinus*	66	34.74
51	Broken *Pinus*	12	3.16
35	*Tsuga mertensiana*	6	3.16
34	TCT	66	34.74
29	*Quercus*	3	1.58
2	*Alnus*	1	0.53
30	*Salix*	3	1.58
7	*Chrysolepis*	1	0.53
33	*Shepherdia*	9	4.74
3	*Artemisia*	2	1.05
4	Artemisioids	1	0.53
9	Short-spine Compositae	3	1.58
10	Long-spine Compositae	5	2.63
8	Cheno-Ams	5	2.63
31	*Sarcobatus*	3	1.58
14	*Ephedra, nevadensis*-type	1	0.53
18	Gramineae	2	1.05
13	Cyperaceae	2	1.05
39	Unknown #3	4	2.11
40	Unknown #4	9	4.74
37	Unknown Angiosperms	5	2.63
49	Unknown #6	5	2.63
38	Unknown spores	1	0.53
45	*Botryococcus*	69	36.32
	Sum 1 -- Total Pollen	190.0	

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Owens Lake, Core OL-92-2
Sample number 8811, Depth 85.170

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.09
27	*Pinus*	98	51.31
51	Broken *Pinus*	10	2.62
20	*Larix*(?)	1	0.52
34	TCT	47	24.61
29	*Quercus*	3	1.57
12	*Corylus*	1	0.52
33	*Shepherdia*	1	0.52
3	*Artemisia*	4	2.09
4	Artemisioids	1	0.52
9	Short-spine Compositae	4	2.09
10	Long-spine Compositae	3	1.57
8	Cheno-Ams	5	2.62
31	*Sarcobatus*	6	3.14
18	Gramineae	2	1.05
13	Cyperaceae	1	0.52
25	Onagraceae	1	0.52
39	Unknown #3	1	0.52
40	Unknown #4	9	4.71
37	Unknown Angiosperms	8	4.19
45	*Botryococcus*	21	10.99
	Sum 1 -- Total Pollen	191.0	

Owens Lake, Core OL-92-2
Sample number 8813, Depth 86.550

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.54
27	*Pinus*	85	43.59
51	Broken *Pinus*	20	5.13
35	*Tsuga mertensiana*	2	1.03
20	*Larix*(?)	2	1.03
34	TCT	63	32.31
29	*Quercus*	3	1.54
30	*Salix*	1	0.51
33	*Shepherdia*	1	0.51
3	*Artemisia*	2	1.03
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	6	3.08
31	*Sarcobatus*	3	1.54
18	Gramineae	2	1.03
13	Cyperaceae	12	6.15
36	*Typha/Sparganium*	1	0.51
39	Unknown #3	4	2.05
40	Unknown #4	5	2.56
41	Unknown #5	2	1.03
37	Unknown Angiosperms	2	1.03
45	*Botryococcus*	77	39.49
47	*Pediastrum*	4	2.05
	Sum 1 -- Total Pollen	195.0	

Owens Lake, Core OL-92-2
Sample number **8815**, Depth **88.060**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.04
27	*Pinus*	90	46.63
51	Broken *Pinus*	6	1.55
35	*Tsuga mertensiana*	3	1.55
34	TCT	54	27.98
29	*Quercus*	4	2.07
30	*Salix*	2	1.04
33	*Shepherdia*	1	0.52
3	*Artemisia*	7	3.63
4	Artemisioids	2	1.04
9	Short-spine Compositae	4	2.07
10	Long-spine Compositae	3	1.55
8	Cheno-Ams	8	4.15
31	*Sarcobatus*	5	2.59
18	Gramineae	1	0.52
13	Cyperaceae	5	2.59
40	Unknown #4	6	3.11
41	Unknown #5	1	0.52
37	Unknown Angiosperms	1	0.52
38	Unknown spores	1	0.52
	Sum 1 -- Total Pollen	193.0	

Owens Lake, Core OL-92-2
Sample number **8817**, Depth **89.650**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.06
27	*Pinus*	48	25.40
51	Broken *Pinus*	8	2.12
34	TCT	87	46.03
29	*Quercus*	4	2.12
30	*Salix*	3	1.59
33	*Shepherdia*	6	3.17
3	*Artemisia*	1	0.53
9	Short-spine Compositae	7	3.70
10	Long-spine Compositae	2	1.06
11	Liguliflorae	4	2.12
8	Cheno-Ams	1	0.53
31	*Sarcobatus*	5	2.65
14	*Ephedra, nevadensis*-type	1	0.53
15	*Ephedra, torreyana*-type	1	0.53
18	Gramineae	1	0.53
13	Cyperaceae	4	2.12
36	*Typha/Sparganium*	2	1.06
28	*Polygonum persicaria*	1	0.53
39	Unknown #3	2	1.06
40	Unknown #4	11	5.82
41	Unknown #5	1	0.53
37	Unknown Angiosperms	6	3.17
48	Unknown #1	1	0.53
49	Unknown #6	8	4.23
45	*Botryococcus*	115	60.85
	Sum 1 -- Total Pollen	189.0	

Owens Lake, Core OL-92-2
Sample number 8819, Depth 91.170

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.03
27	*Pinus*	114	57.87
51	Broken *Pinus*	16	4.06
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	4	2.03
34	TCT	37	18.78
29	*Quercus*	3	1.52
30	*Salix*	2	1.02
33	*Shepherdia*	4	2.03
3	*Artemisia*	1	0.51
4	Artemisioids	2	1.02
9	Short-spine Compositae	2	1.02
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	6	3.05
31	*Sarcobatus*	1	0.51
14	*Ephedra, nevadensis*-type	2	1.02
15	*Ephedra, torreyana*-type	1	0.51
18	Gramineae	1	0.51
13	Cyperaceae	2	1.02
39	Unknown #3	3	1.52
40	Unknown #4	2	1.02
42	Unknown #8	1	0.51
37	Unknown Angiosperms	3	1.52
49	Unknown #6	9	4.57
38	Unknown spores	1	0.51
45	*Botryococcus*	3	1.52
47	*Pediastrum*	7	3.55
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-2
Sample number 8821, Depth 92.600

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.55
27	*Pinus*	136	69.39
51	Broken *Pinus*	30	7.65
35	*Tsuga mertensiana*	2	1.02
34	TCT	32	16.33
3	*Artemisia*	2	1.02
4	Artemisioids	3	1.53
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	2	1.02
8	Cheno-Ams	3	1.53
31	*Sarcobatus*	2	1.02
23	*Nuphar*	2	1.02
39	Unknown #3	1	0.51
40	Unknown #4	3	1.53
41	Unknown #5	2	1.02
37	Unknown Angiosperms	3	1.53
38	Unknown spores	1	0.51
47	*Pediastrum*	1	0.51
	Sum 1 -- Total Pollen	196.0	

Sample number 8823, Depth 94.120

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.04
27	*Pinus*	142	73.58
51	Broken *Pinus*	76	19.69
35	*Tsuga mertensiana*	2	1.04
34	TCT	2	1.04
29	*Quercus*	2	1.04
30	*Salix*	2	1.04
3	*Artemisia*	14	7.25
4	Artemisioids	5	2.59
8	Cheno-Ams	9	4.66
31	*Sarcobatus*	1	0.52
13	Cyperaceae	5	2.59
28	*Polygonum persicaria*	1	0.52
39	Unknown #3	3	1.55
40	Unknown #4	7	3.63
41	Unknown #5	2	1.04
37	Unknown Angiosperms	1	0.52
45	*Botryococcus*	16	8.29
47	*Pediastrum*	3	1.55
52	'Scolecodonts'	1	0.52
	Sum 1 -- Total Pollen	193.0	

Owens Lake, Core OL-92-2
Sample number 8825, Depth 96.660

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	154	77.00
51	Broken *Pinus*	54	13.50
35	*Tsuga mertensiana*	1	0.50
20	*Pseudotsuga*(?)	1	0.50
34	TCT	17	8.50
29	*Quercus*	1	0.50
30	*Salix*	2	1.00
3	*Artemisia*	4	2.00
9	Short-spine Compositae	1	0.50
8	Cheno-Ams	8	4.00
31	*Sarcobatus*	2	1.00
25	Onagraceae	1	0.50
39	Unknown #3	1	0.50
42	Unknown #8	1	0.50
37	Unknown Angiosperms	3	1.50
50	Unknown #7	22	11.00
45	*Botryococcus*	49	24.50
47	*Pediastrum*	35	17.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8827, Depth 98.640

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.02
27	*Pinus*	149	75.25
51	Broken *Pinus*	20	5.05
35	*Tsuga mertensiana*	1	0.51
34	TCT	15	7.58
30	*Salix*	1	0.51
3	*Artemisia*	4	2.02
4	Artemisioids	2	1.01
9	Short-spine Compositae	1	0.51
8	Cheno-Ams	5	2.53
31	*Sarcobatus*	2	1.01
14	*Ephedra, nevadensis*-type	6	3.03
39	Unknown #3	2	1.01
40	Unknown #4	1	0.51
42	Unknown #8	1	0.51
37	Unknown Angiosperms	5	2.53
38	Unknown spores	1	0.51
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8829, Depth 100.140

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.01
27	*Pinus*	156	78.39
51	Broken *Pinus*	16	4.02
35	*Tsuga mertensiana*	1	0.50
34	TCT	18	9.05
29	*Quercus*	1	0.50
3	*Artemisia*	2	1.01
4	Artemisioids	2	1.01
11	Liguliflorae	1	0.50
8	Cheno-Ams	4	2.01
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.50
39	Unknown #3	3	1.51
40	Unknown #4	1	0.50
42	Unknown #8	1	0.50
37	Unknown Angiosperms	2	1.01
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	199.0	

Sample number 8831, Depth 101.590

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	169	84.92
51	Broken *Pinus*	34	8.54
35	*Tsuga mertensiana*	5	2.51
34	TCT	5	2.51
9	Short-spine Compositae	3	1.51
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	5	2.51
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.50
39	Unknown #3	2	1.01
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.01
45	*Botryococcus*	13	6.53
47	*Pediastrum*	5	2.51
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8833, Depth 103.070

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.03
27	*Pinus*	169	85.79
51	Broken *Pinus*	60	15.23
35	*Tsuga mertensiana*	1	0.51
34	TCT	5	2.54
29	*Quercus*	1	0.51
4	Artemisioids	5	2.54
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	2	1.02
31	*Sarcobatus*	2	1.02
14	*Ephedra, nevadensis*-type	1	0.51
13	Cyperaceae	2	1.02
39	Unknown #3	2	1.02
40	Unknown #4	3	1.52
37	Unknown Angiosperms	1	0.51
45	*Botryococcus*	6	3.05
47	*Pediastrum*	5	2.54
	Sum 1 -- Total Pollen	197.0	

Sample number 8835, Depth 109.960

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	3.02
27	*Pinus*	162	81.41
51	Broken *Pinus*	68	17.09
35	*Tsuga mertensiana*	4	2.01
34	TCT	6	3.02
29	*Quercus*	1	0.50
3	*Artemisia*	3	1.51
9	Short-spine Compositae	2	1.01
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	8	4.02
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.50
39	Unknown #3	2	1.01
40	Unknown #4	1	0.50
37	Unknown Angiosperms	1	0.50
49	Unknown #6	1	0.50
45	*Botryococcus*	95	47.74
47	*Pediastrum*	1	0.50
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8837, Depth 111.240

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	3.00
27	*Pinus*	157	78.50
51	Broken *Pinus*	20	5.00
35	*Tsuga mertensiana*	6	3.00
34	TCT	5	2.50
33	*Shepherdia*	1	0.50
3	*Artemisia*	7	3.50
4	Artemisioids	1	0.50
8	Cheno-Ams	7	3.50
14	*Ephedra, nevadensis*-type	2	1.00
13	Cyperaceae	1	0.50
25	Onagraceae	1	0.50
39	Unknown #3	3	1.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.00
45	*Botryococcus*	3	1.50
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	200.0	

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Owens Lake, Core OL-92-2
Sample number 8839, Depth 112.330

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.02
27	*Pinus*	142	71.72
51	Broken *Pinus*	70	17.68
35	*Tsuga mertensiana*	2	1.01
34	TCT	5	2.53
29	*Quercus*	1	0.51
6	*Betula*	1	0.51
12	*Corylus*	1	0.51
19	Juglandaceae	1	0.51
3	*Artemisia*	6	3.03
4	Artemisioids	5	2.53
9	Short-spine Compositae	6	3.03
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	8	4.04
31	*Sarcobatus*	1	0.51
14	*Ephedra, nevadensis*-type	1	0.51
13	Cyperaceae	5	2.53
36	*Typha/Sparganium*	1	0.51
39	Unknown #3	2	1.01
40	Unknown #4	2	1.01
41	Unknown #5	1	0.51
42	Unknown #8	1	0.51
37	Unknown Angiosperms	1	0.51
48	Unknown #1	1	0.51
49	Unknown #6	10	5.05
45	*Botryococcus*	173	87.37
47	*Pediastrum*	171	86.36
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8841, Depth 113.640

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.52
27	*Pinus*	104	52.53
51	Broken *Pinus*	58	14.65
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	6	3.03
20	*Pseudotsuga*(?)	1	0.51
34	TCT	13	6.57
29	*Quercus*	2	1.01
6	*Betula*	1	0.51
12	*Corylus*	1	0.51
30	*Salix*	1	0.51
3	*Artemisia*	11	5.56
4	Artemisioids	6	3.03
9	Short-spine Compositae	3	1.52
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	14	7.07
31	*Sarcobatus*	5	2.53
18	Gramineae	2	1.01
13	Cyperaceae	5	2.53
39	Unknown #3	4	2.02
40	Unknown #4	2	1.01
42	Unknown #8	1	0.51
37	Unknown Angiosperms	12	6.06
48	Unknown #1	1	0.51
45	*Botryococcus*	66	33.33
47	*Pediastrum*	137	69.19
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8843, Depth 116.040

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	145	72.86
51	Broken *Pinus*	14	3.52
35	*Tsuga mertensiana*	2	1.01
34	TCT	14	7.04
29	*Quercus*	6	3.02
3	*Artemisia*	2	1.01
4	Artemisioids	2	1.01
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	4	2.01
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	6	3.02
18	Gramineae	1	0.50
13	Cyperaceae	2	1.01
39	Unknown #3	1	0.50
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
42	Unknown #8	1	0.50
37	Unknown Angiosperms	6	3.02
45	*Botryococcus*	60	30.15
47	*Pediastrum*	19	9.55
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8845, Depth 117.910

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.50
27	*Pinus*	122	61.31
51	Broken *Pinus*	8	2.01
35	*Tsuga mertensiana*	1	0.50
34	TCT	13	6.53
29	*Quercus*	1	0.50
30	*Salix*	1	0.50
33	*Shepherdia*	1	0.50
3	*Artemisia*	3	1.51
9	Short-spine Compositae	8	4.02
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	15	7.54
31	*Sarcobatus*	4	2.01
14	*Ephedra, nevadensis*-type	5	2.51
15	*Ephedra, torreyana*-type	3	1.51
13	Cyperaceae	2	1.01
24	Nymphaceae	1	0.50
39	Unknown #3	10	5.03
40	Unknown #4	1	0.50
37	Unknown Angiosperms	7	3.52
45	*Botryococcus*	4	2.01
47	*Pediastrum*	1	0.50
	Sum 1 -- Total Pollen	199.0	

Sample number 8847, Depth 118.480

Variable Number	Type	Number of Grains	Percent
1	*Abies*	7	3.52
27	*Pinus*	177	88.94
51	Broken *Pinus*	18	4.52
35	*Tsuga mertensiana*	1	0.50
34	TCT	7	3.52
29	*Quercus*	1	0.50
33	*Shepherdia*	1	0.50
13	Cyperaceae	2	1.01
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.01
38	Unknown spores	1	0.50
45	*Botryococcus*	38	19.10
52	'Scolecodonts'	1	0.50
	Sum 1 -- Total Pollen	199.0	

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Owens Lake, Core OL-92-2
Sample number **8849**, Depth **119.650**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.50
27	*Pinus*	144	72.36
51	Broken *Pinus*	86	21.61
26	*Picea*	3	1.51
35	*Tsuga mertensiana*	4	2.01
34	TCT	11	5.53
29	*Quercus*	1	0.50
3	*Artemisia*	2	1.01
9	Short-spine Compositae	4	2.01
8	Cheno-Ams	6	3.02
31	*Sarcobatus*	1	0.50
15	*Ephedra, torreyana*-type	1	0.50
39	Unknown #3	5	2.51
40	Unknown #4	1	0.50
41	Unknown #5	6	3.02
42	Unknown #8	1	0.50
37	Unknown Angiosperms	9	4.52
45	*Botryococcus*	3	1.51
47	*Pediastrum*	3	1.51
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number **8851**, Depth **121.320**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.59
27	*Pinus*	96	49.74
51	Broken *Pinus*	48	12.44
35	*Tsuga mertensiana*	5	2.59
34	TCT	54	27.98
29	*Quercus*	1	0.52
30	*Salix*	1	0.52
33	*Shepherdia*	1	0.52
3	*Artemisia*	7	3.63
4	Artemisioids	1	0.52
9	Short-spine Compositae	1	0.52
10	Long-spine Compositae	1	0.52
8	Cheno-Ams	5	2.59
14	*Ephedra, nevadensis*-type	1	0.52
13	Cyperaceae	4	2.07
23	*Nuphar*	1	0.52
39	Unknown #3	3	1.55
40	Unknown #4	5	2.59
41	Unknown #5	1	0.52
42	Unknown #8	2	1.04
37	Unknown Angiosperms	3	1.55
48	Unknown #1	1	0.52
38	Unknown spores	2	1.04
47	*Pediastrum*	8	4.15
52	'Scolecodonts'	1	0.52
	Sum 1 -- Total Pollen	193.0	

Sample number 8853, Depth **122.950**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.03
27	*Pinus*	120	61.86
51	Broken *Pinus*	42	10.82
35	*Tsuga mertensiana*	1	0.52
34	TCT	47	24.23
30	*Salix*	1	0.52
33	*Shepherdia*	2	1.03
3	*Artemisia*	5	2.58
10	Long-spine Compositae	1	0.52
8	Cheno-Ams	1	0.52
13	Cyperaceae	1	0.52
39	Unknown #3	1	0.52
40	Unknown #4	6	3.09
37	Unknown Angiosperms	12	6.19
45	*Botryococcus*	12	6.19
47	*Pediastrum*	9	4.64
	Sum 1 -- Total Pollen	194.0	

Owens Lake, Core OL-92-2
Sample number 8855, Depth 124.440

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.02
27	*Pinus*	163	82.74
51	Broken *Pinus*	60	15.23
35	*Tsuga mertensiana*	3	1.52
20	*Pseudotsuga*(?)	1	0.51
34	TCT	8	4.06
3	*Artemisia*	5	2.54
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	5	2.54
13	Cyperaceae	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	3	1.52
41	Unknown #5	1	0.51
37	Unknown Angiosperms	3	1.52
48	Unknown #1	1	0.51
47	*Pediastrum*	1	0.51
	Sum 1 -- Total Pollen	197.0	

Sample number 8857, Depth 126.310

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.54
27	*Pinus*	117	59.39
51	Broken *Pinus*	100	25.38
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	19	9.64
29	*Quercus*	1	0.51
2	*Alnus*	1	0.51
33	*Shepherdia*	4	2.03
3	*Artemisia*	21	10.66
4	Artemisioids	5	2.54
9	Short-spine Compositae	3	1.52
8	Cheno-Ams	5	2.54
31	*Sarcobatus*	6	3.05
14	*Ephedra, nevadensis*-type	1	0.51
23	*Nuphar*	1	0.51
39	Unknown #3	2	1.02
40	Unknown #4	3	1.52
41	Unknown #5	2	1.02
37	Unknown Angiosperms	2	1.02
45	*Botryococcus*	129	65.48
47	*Pediastrum*	196	99.49
	Sum 1 -- Total Pollen	197.0	

Owens Lake, Core OL-92-2
Sample number 8859, Depth 127.170

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	3.00
27	*Pinus*	137	68.50
51	Broken *Pinus*	36	9.00
35	*Tsuga mertensiana*	1	0.50
34	TCT	4	2.00
29	*Quercus*	1	0.50
3	*Artemisia*	3	1.50
4	Artemisioids	7	3.50
9	Short-spine Compositae	18	9.00
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	6	3.00
31	*Sarcobatus*	1	0.50
13	Cyperaceae	1	0.50
39	Unknown #3	3	1.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	10	5.00
45	*Botryococcus*	66	33.00
47	*Pediastrum*	45	22.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8861, Depth 129.180

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	3.02
27	*Pinus*	121	60.80
51	Broken *Pinus*	36	9.05
35	*Tsuga mertensiana*	6	3.02
34	TCT	13	6.53
29	*Quercus*	2	1.01
33	*Shepherdia*	1	0.50
3	*Artemisia*	2	1.01
4	Artemisioids	8	4.02
9	Short-spine Compositae	23	11.56
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	2	1.01
31	*Sarcobatus*	4	2.01
14	*Ephedra, nevadensis*-type	1	0.50
40	Unknown #4	1	0.50
41	Unknown #5	3	1.51
37	Unknown Angiosperms	6	3.02
45	*Botryococcus*	22	11.06
47	*Pediastrum*	316	158.79
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8863, Depth 130.620

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.00
27	*Pinus*	177	88.50
51	Broken *Pinus*	38	9.50
35	*Tsuga mertensiana*	2	1.00
34	TCT	3	1.50
3	*Artemisia*	2	1.00
10	Long-spine Compositae	3	1.50
8	Cheno-Ams	2	1.00
31	*Sarcobatus*	1	0.50
13	Cyperaceae	1	0.50
39	Unknown #3	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	3	1.50
45	*Botryococcus*	7	3.50
47	*Pediastrum*	5	2.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8865, Depth 131.740

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.05
27	*Pinus*	159	81.54
51	Broken *Pinus*	30	7.69
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	11	5.64
29	*Quercus*	2	1.03
3	*Artemisia*	1	0.51
4	Artemisioids	1	0.51
9	Short-spine Compositae	2	1.03
10	Long-spine Compositae	2	1.03
8	Cheno-Ams	4	2.05
31	*Sarcobatus*	2	1.03
14	*Ephedra, nevadensis*-type	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	5	2.56
37	Unknown Angiosperms	3	1.54
49	Unknown #6	2	1.03
45	*Botryococcus*	1	0.51
	Sum 1 -- Total Pollen	195.0	

Owens Lake, Core OL-92-2
Sample number 8867, Depth 133.290

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	134	67.68
51	Broken *Pinus*	30	7.58
35	*Tsuga mertensiana*	2	1.01
34	TCT	23	11.62
29	*Quercus*	1	0.51
33	*Shepherdia*	2	1.01
3	*Artemisia*	1	0.51
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	3	1.52
31	*Sarcobatus*	4	2.02
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	6	3.03
39	Unknown #3	4	2.02
40	Unknown #4	2	1.01
41	Unknown #5	6	3.03
37	Unknown Angiosperms	6	3.03
49	Unknown #6	1	0.51
45	*Botryococcus*	2	1.01
47	*Pediastrum*	2	1.01
	Sum 1 -- Total Pollen	198.0	

Sample number 8869, Depth 134.610

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.02
27	*Pinus*	116	59.18
51	Broken *Pinus*	42	10.71
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	29	14.80
29	*Quercus*	4	2.04
30	*Salix*	5	2.55
3	*Artemisia*	5	2.55
4	Artemisioids	3	1.53
9	Short-spine Compositae	9	4.59
11	Liguliflorae	1	0.51
8	Cheno-Ams	10	5.10
31	*Sarcobatus*	3	1.53
14	*Ephedra, nevadensis*-type	3	1.53
13	Cyperaceae	3	1.53
40	Unknown #4	4	2.04
37	Unknown Angiosperms	1	0.51
48	Unknown #1	1	0.51
45	*Botryococcus*	17	8.67
	Sum 1 -- Total Pollen	196.0	

Owens Lake, Core OL-92-2
Sample number 8871, Depth 135.850

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.02
27	*Pinus*	174	87.88
51	Broken *Pinus*	40	10.10
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	2	1.01
29	*Quercus*	1	0.51
3	*Artemisia*	4	2.02
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	4	2.02
13	Cyperaceae	1	0.51
39	Unknown #3	1	0.51
41	Unknown #5	1	0.51
37	Unknown Angiosperms	3	1.52
38	Unknown spores	2	1.01
45	*Botryococcus*	80	40.40
47	*Pediastrum*	1	0.51
	Sum 1 -- Total Pollen	198.0	

Sample number 8873, Depth 137.430

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.51
27	*Pinus*	156	78.39
51	Broken *Pinus*	28	7.04
35	*Tsuga mertensiana*	1	0.50
34	TCT	6	3.02
29	*Quercus*	2	1.01
30	*Salix*	1	0.50
3	*Artemisia*	12	6.03
9	Short-spine Compositae	3	1.51
8	Cheno-Ams	3	1.51
13	Cyperaceae	7	3.52
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.01
49	Unknown #6	1	0.50
50	Unknown #7	36	18.09
45	*Botryococcus*	68	34.17
47	*Pediastrum*	161	80.90
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8875, Depth 139.540

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.54
27	*Pinus*	171	86.80
51	Broken *Pinus*	66	16.75
35	*Tsuga mertensiana*	1	0.51
34	TCT	9	4.57
3	*Artemisia*	1	0.51
8	Cheno-Ams	4	2.03
14	*Ephedra, nevadensis*-type	2	1.02
39	Unknown #3	1	0.51
40	Unknown #4	3	1.52
41	Unknown #5	1	0.51
37	Unknown Angiosperms	2	1.02
49	Unknown #6	3	1.52
45	*Botryococcus*	2	1.02
	Sum 1 -- Total Pollen	197.0	

Sample number 8877, Depth 141.420

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	192	96.00
51	Broken *Pinus*	12	3.00
35	*Tsuga mertensiana*	2	1.00
37	Unknown Angiosperms	3	1.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8879, Depth 142.290

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	178	89.00
51	Broken *Pinus*	16	4.00
35	*Tsuga mertensiana*	1	0.50
34	TCT	7	3.50
29	*Quercus*	1	0.50
3	*Artemisia*	2	1.00
4	Artemisioids	1	0.50
9	Short-spine Compositae	1	0.50
8	Cheno-Ams	4	2.00
13	Cyperaceae	1	0.50
41	Unknown #5	1	0.50
49	Unknown #6	2	1.00
45	*Botryococcus*	1	0.50
47	*Pediastrum*	1	0.50
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-2
Sample number 8881, Depth 143.910

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	170	85.43
51	Broken *Pinus*	30	7.54
35	*Tsuga mertensiana*	1	0.50
34	TCT	7	3.52
29	*Quercus*	2	1.01
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	6	3.02
31	*Sarcobatus*	2	1.01
13	Cyperaceae	1	0.50
39	Unknown #3	2	1.01
40	Unknown #4	1	0.50
37	Unknown Angiosperms	3	1.51
49	Unknown #6	1	0.50
45	*Botryococcus*	2	1.01
47	*Pediastrum*	3	1.51
	Sum 1 -- Total Pollen	199.0	

Sample number 8883, Depth 145.690

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	149	74.87
51	Broken *Pinus*	48	12.06
26	*Picea*	1	0.50
35	*Tsuga mertensiana*	2	1.01
34	TCT	24	12.06
3	*Artemisia*	5	2.51
4	Artemisioids	2	1.01
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	6	3.02
31	*Sarcobatus*	1	0.50
13	Cyperaceae	1	0.50
22	*Menyanthes*	1	0.50
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.01
49	Unknown #6	27	13.57
45	*Botryococcus*	36	18.09
47	*Pediastrum*	18	9.05
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8885, Depth 147.240

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.00
27	*Pinus*	154	77.00
51	Broken *Pinus*	30	7.50
35	*Tsuga mertensiana*	4	2.00
34	TCT	11	5.50
29	*Quercus*	2	1.00
3	*Artemisia*	4	2.00
4	Artemisioids	3	1.50
9	Short-spine Compositae	2	1.00
8	Cheno-Ams	8	4.00
31	*Sarcobatus*	3	1.50
14	*Ephedra, nevadensis*-type	4	2.00
18	Gramineae	1	0.50
13	Cyperaceae	1	0.50
41	Unknown #5	1	0.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8887, Depth 148.430

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	177	88.50
51	Broken *Pinus*	15	3.75
35	*Tsuga mertensiana*	1	0.50
34	TCT	10	5.00
12	*Corylus*	1	0.50
30	*Salix*	1	0.50
4	Artemisioids	1	0.50
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	3	1.50
31	*Sarcobatus*	1	0.50
18	Gramineae	1	0.50
13	Cyperaceae	2	1.00
42	Unknown #8	1	0.50
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-2
Sample number 8889, Depth **149.190**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	166	83.00
51	Broken *Pinus*	46	11.50
26	*Picea*	1	0.50
35	*Tsuga mertensiana*	1	0.50
34	TCT	25	12.50
9	Short-spine Compositae	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	2	1.00
45	*Botryococcus*	71	35.50
47	*Pediastrum*	4	2.00
	Sum 1 -- Total Pollen	200.0	

Sample number 8891, Depth **152.480**

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	79	41.80
51	Broken *Pinus*	10	2.65
26	*Picea*	1	0.53
35	*Tsuga mertensiana*	1	0.53
34	TCT	79	41.80
29	*Quercus*	1	0.53
33	*Shepherdia*	4	2.12
3	*Artemisia*	4	2.12
4	Artemisioids	2	1.06
9	Short-spine Compositae	5	2.65
8	Cheno-Ams	6	3.17
15	*Ephedra, torreyana*-type	2	1.06
18	Gramineae	1	0.53
13	Cyperaceae	1	0.53
40	Unknown #4	10	5.29
42	Unknown #8	1	0.53
37	Unknown Angiosperms	2	1.06
38	Unknown spores	1	0.53
45	*Botryococcus*	291	153.97
47	*Pediastrum*	2	1.06
	Sum 1 -- Total Pollen	189.0	

Owens Lake, Core OL-92-2
Sample number **8893**, Depth **154.060**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.01
27	*Pinus*	169	84.92
51	Broken *Pinus*	10	2.51
26	*Picea*	2	1.01
35	*Tsuga mertensiana*	3	1.51
34	TCT	11	5.53
29	*Quercus*	1	0.50
3	*Artemisia*	1	0.50
4	Artemisioids	1	0.50
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	1	0.50
31	*Sarcobatus*	2	1.01
24	Nymphaceae	1	0.50
39	Unknown #3	2	1.01
40	Unknown #4	1	0.50
45	*Botryococcus*	46	23.12
47	*Pediastrum*	2	1.01
	Sum 1 -- Total Pollen	199.0	

Sample number **8895**, Depth **155.110**

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.01
27	*Pinus*	128	64.32
51	Broken *Pinus*	4	1.01
53	Total pine	130	65.33
35	*Tsuga mertensiana*	4	2.01
34	TCT	30	15.08
29	*Quercus*	4	2.01
2	*Alnus*	1	0.50
33	*Shepherdia*	4	2.01
3	*Artemisia*	7	3.52
4	Artemisioids	2	1.01
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	2	1.01
8	Cheno-Ams	2	1.01
13	Cyperaceae	1	0.50
39	Unknown #3	3	1.51
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	5	2.51
49	Unknown #6	1262	634.17
45	*Botryococcus*	13	6.53
47	*Pediastrum*	3	1.51
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8897, Depth 156.710

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.03
27	*Pinus*	114	57.87
51	Broken *Pinus*	72	18.27
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	6	3.05
34	TCT	16	8.12
29	*Quercus*	2	1.02
2	*Alnus*	1	0.51
12	*Corylus*	2	1.02
33	*Shepherdia*	2	1.02
3	*Artemisia*	17	8.63
4	Artemisioids	1	0.51
9	Short-spine Compositae	2	1.02
10	Long-spine Compositae	1	0.51
11	Liguliflorae	2	1.02
8	Cheno-Ams	11	5.58
31	*Sarcobatus*	3	1.52
13	Cyperaceae	1	0.51
36	*Typha/Sparganium*	1	0.51
39	Unknown #3	5	2.54
40	Unknown #4	3	1.52
41	Unknown #5	1	0.51
37	Unknown Angiosperms	4	2.03
45	*Botryococcus*	359	182.23
47	*Pediastrum*	168	85.28
52	'Scolecodonts'	1	0.51
	Sum 1 -- Total Pollen	197.0	

Sample number 8899, Depth 162.890

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	173	86.93
51	Broken *Pinus*	34	8.54
34	TCT	6	3.02
2	*Alnus*	1	0.50
3	*Artemisia*	2	1.01
8	Cheno-Ams	3	1.51
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	1	0.50
13	Cyperaceae	3	1.51
39	Unknown #3	1	0.50
40	Unknown #4	1	0.50
41	Unknown #5	2	1.01
37	Unknown Angiosperms	4	2.01
45	*Botryococcus*	192	96.48
47	*Pediastrum*	7	3.52
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8901, Depth 167.490

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.04
27	*Pinus*	145	73.98
51	Broken *Pinus*	30	7.65
35	*Tsuga mertensiana*	2	1.02
34	TCT	16	8.16
29	*Quercus*	2	1.02
2	*Alnus*	2	1.02
3	*Artemisia*	7	3.57
4	Artemisioids	3	1.53
9	Short-spine Compositae	4	2.04
8	Cheno-Ams	5	2.55
14	*Ephedra, nevadensis*-type	3	1.53
39	Unknown #3	1	0.51
40	Unknown #4	3	1.53
37	Unknown Angiosperms	2	1.02
38	Unknown spores	1	0.51
45	*Botryococcus*	39	19.90
	Sum 1 -- Total Pollen	196.0	

Sample number 8903, Depth 172.430

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.04
27	*Pinus*	122	62.24
51	Broken *Pinus*	74	18.88
35	*Tsuga mertensiana*	2	1.02
34	TCT	44	22.45
29	*Quercus*	1	0.51
33	*Shepherdia*	2	1.02
3	*Artemisia*	5	2.55
9	Short-spine Compositae	2	1.02
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	5	2.55
13	Cyperaceae	3	1.53
39	Unknown #3	2	1.02
40	Unknown #4	3	1.53
37	Unknown Angiosperms	3	1.53
48	Unknown #1	1	0.51
38	Unknown spores	1	0.51
47	*Pediastrum*	3	1.53
	Sum 1 -- Total Pollen	196.0	

Owens Lake, Core OL-92-2
Sample number 8905, Depth 174.760

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.51
27	*Pinus*	105	53.03
51	Broken *Pinus*	54	13.64
34	TCT	50	25.25
29	*Quercus*	3	1.52
2	*Alnus*	1	0.51
3	*Artemisia*	6	3.03
4	Artemisioids	3	1.52
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
11	Liguliflorae	1	0.51
8	Cheno-Ams	4	2.02
31	*Sarcobatus*	3	1.52
14	*Ephedra, nevadensis*-type	1	0.51
13	Cyperaceae	1	0.51
24	Nymphaceae	1	0.51
39	Unknown #3	3	1.52
40	Unknown #4	2	1.01
41	Unknown #5	5	2.53
37	Unknown Angiosperms	8	4.04
45	*Botryococcus*	3	1.52
47	*Pediastrum*	8	4.04
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8907, Depth 177.050

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.06
27	*Pinus*	116	59.79
51	Broken *Pinus*	26	6.70
35	*Tsuga mertensiana*	1	0.52
34	TCT	49	25.26
29	*Quercus*	1	0.52
33	*Shepherdia*	3	1.55
3	*Artemisia*	4	2.06
4	Artemisioids	1	0.52
9	Short-spine Compositae	3	1.55
10	Long-spine Compositae	2	1.03
8	Cheno-Ams	1	0.52
31	*Sarcobatus*	2	1.03
13	Cyperaceae	1	0.52
39	Unknown #3	1	0.52
40	Unknown #4	5	2.58
41	Unknown #5	2	1.03
37	Unknown Angiosperms	3	1.55
38	Unknown spores	1	0.52
45	*Botryococcus*	12	6.19
47	*Pediastrum*	11	5.67
	Sum 1 -- Total Pollen	194.0	

Sample number 8909, Depth 179.000

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.53
27	*Pinus*	146	73.74
51	Broken *Pinus*	38	9.60
34	TCT	28	14.14
29	*Quercus*	1	0.51
3	*Artemisia*	3	1.52
4	Artemisioids	1	0.51
9	Short-spine Compositae	1	0.51
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	3	1.52
31	*Sarcobatus*	4	2.02
25	Onagraceae	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	1	0.51
37	Unknown Angiosperms	3	1.52
38	Unknown spores	1	0.51
45	*Botryococcus*	42	21.21
47	*Pediastrum*	9	4.55
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8911, Depth 182.790

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	181	90.50
51	Broken *Pinus*	28	7.00
26	*Picea*	1	0.50
35	*Tsuga mertensiana*	2	1.00
34	TCT	9	4.50
29	*Quercus*	2	1.00
33	*Shepherdia*	1	0.50
25	Onagraceae	1	0.50
48	Unknown #1	2	1.00
45	*Botryococcus*	22	11.00
47	*Pediastrum*	6	3.00
	Sum 1 -- Total Pollen	200.0	

Sample number 8913, Depth 184.180

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.50
27	*Pinus*	166	83.00
51	Broken *Pinus*	38	9.50
20	*Pseudotsuga*(?)	1	0.50
34	TCT	7	3.50
29	*Quercus*	5	2.50
2	*Alnus*	1	0.50
33	*Shepherdia*	1	0.50
3	*Artemisia*	4	2.00
4	Artemisioids	2	1.00
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	1	0.50
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	5	2.50
48	Unknown #1	1	0.50
45	*Botryococcus*	76	38.00
47	*Pediastrum*	63	31.50
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-2
Sample number 8915, Depth 185.340

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.52
27	*Pinus*	154	77.78
51	Broken *Pinus*	106	26.77
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	3	1.52
34	TCT	5	2.53
29	*Quercus*	3	1.52
3	*Artemisia*	9	4.55
4	Artemisioids	5	2.53
9	Short-spine Compositae	3	1.52
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	8	4.04
31	*Sarcobatus*	2	1.01
14	*Ephedra, nevadensis*-type	1	0.51
40	Unknown #4	2	1.01
45	*Botryococcus*	591	298.48
47	*Pediastrum*	776	391.92
	Sum 1 -- Total Pollen	198.0	

Sample number 8917, Depth 186.920

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	156	78.79
51	Broken *Pinus*	64	16.16
35	*Tsuga mertensiana*	2	1.01
34	TCT	10	5.05
29	*Quercus*	1	0.51
2	*Alnus*	1	0.51
3	*Artemisia*	3	1.52
4	Artemisioids	3	1.52
9	Short-spine Compositae	3	1.52
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	3	1.52
31	*Sarcobatus*	2	1.01
14	*Ephedra, nevadensis*-type	2	1.01
13	Cyperaceae	1	0.51
25	Onagraceae	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	2	1.01
37	Unknown Angiosperms	4	2.02
45	*Botryococcus*	105	53.03
47	*Pediastrum*	14	7.07
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8919, Depth 188.630

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	141	70.50
51	Broken *Pinus*	16	4.00
35	*Tsuga mertensiana*	1	0.50
34	TCT	25	12.50
33	*Shepherdia*	1	0.50
3	*Artemisia*	9	4.50
4	Artemisioids	4	2.00
9	Short-spine Compositae	1	0.50
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	7	3.50
14	*Ephedra, nevadensis*-type	3	1.50
13	Cyperaceae	1	0.50
39	Unknown #3	1	0.50
41	Unknown #5	2	1.00
37	Unknown Angiosperms	3	1.50
45	*Botryococcus*	12	6.00
47	*Pediastrum*	9	4.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8921, Depth 190.150

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.02
27	*Pinus*	142	71.72
51	Broken *Pinus*	32	8.08
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	29	14.65
2	*Alnus*	1	0.51
3	*Artemisia*	1	0.51
10	Long-spine Compositae	1	0.51
8	Cheno-Ams	7	3.54
13	Cyperaceae	2	1.01
23	*Nuphar*	1	0.51
39	Unknown #3	1	0.51
40	Unknown #4	2	1.01
37	Unknown Angiosperms	7	3.54
45	*Botryococcus*	8	4.04
47	*Pediastrum*	2	1.01
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8923, Depth 191.530

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	159	80.30
51	Broken *Pinus*	112	28.28
26	*Picea*	1	0.51
35	*Tsuga mertensiana*	1	0.51
34	TCT	25	12.63
2	*Alnus*	1	0.51
9	Short-spine Compositae	1	0.51
13	Cyperaceae	2	1.01
39	Unknown #3	2	1.01
40	Unknown #4	2	1.01
37	Unknown Angiosperms	4	2.02
48	Unknown #1	2	1.01
45	*Botryococcus*	134	67.68
47	*Pediastrum*	1024	517.17
	Sum 1 -- Total Pollen	198.0	

Sample number 8925, Depth 192.610

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.01
27	*Pinus*	168	84.42
51	Broken *Pinus*	58	14.57
34	TCT	10	5.03
9	Short-spine Compositae	2	1.01
8	Cheno-Ams	4	2.01
31	*Sarcobatus*	1	0.50
14	*Ephedra, nevadensis*-type	1	0.50
13	Cyperaceae	3	1.51
37	Unknown Angiosperms	6	3.02
38	Unknown spores	1	0.50
45	*Botryococcus*	65	32.66
47	*Pediastrum*	5	2.51
	Sum 1 -- Total Pollen	199.0	

Owens Lake, Core OL-92-2
Sample number 8927, Depth 195.080

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	162	81.41
51	Broken *Pinus*	86	21.61
26	*Picea*	3	1.51
35	*Tsuga mertensiana*	2	1.01
34	TCT	11	5.53
29	*Quercus*	2	1.01
2	*Alnus*	1	0.50
3	*Artemisia*	6	3.02
9	Short-spine Compositae	3	1.51
8	Cheno-Ams	3	1.51
24	Nymphaceae	1	0.50
39	Unknown #3	1	0.50
40	Unknown #4	1	0.50
41	Unknown #5	1	0.50
37	Unknown Angiosperms	1	0.50
48	Unknown #1	1	0.50
45	*Botryococcus*	171	85.93
47	*Pediastrum*	118	59.30
	Sum 1 -- Total Pollen	199.0	

Sample number 8929, Depth 196.540

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	119	60.10
51	Broken *Pinus*	48	12.12
35	*Tsuga mertensiana*	3	1.52
34	TCT	31	15.66
29	*Quercus*	2	1.01
2	*Alnus*	1	0.51
30	*Salix*	1	0.51
3	*Artemisia*	3	1.52
4	Artemisioids	3	1.52
9	Short-spine Compositae	4	2.02
10	Long-spine Compositae	3	1.52
8	Cheno-Ams	3	1.52
31	*Sarcobatus*	1	0.51
14	*Ephedra, nevadensis*-type	1	0.51
18	Gramineae	1	0.51
13	Cyperaceae	2	1.01
39	Unknown #3	4	2.02
40	Unknown #4	2	1.01
41	Unknown #5	3	1.52
37	Unknown Angiosperms	11	5.56
45	*Botryococcus*	154	77.78
47	*Pediastrum*	81	40.91
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8931, Depth 199.290

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	167	83.92
51	Broken *Pinus*	54	13.57
26	*Picea*	2	1.01
34	TCT	10	5.03
29	*Quercus*	1	0.50
2	*Alnus*	1	0.50
3	*Artemisia*	1	0.50
9	Short-spine Compositae	1	0.50
8	Cheno-Ams	3	1.51
31	*Sarcobatus*	1	0.50
18	Gramineae	1	0.50
13	Cyperaceae	3	1.51
22	*Menyanthes*	1	0.50
41	Unknown #5	2	1.01
37	Unknown Angiosperms	5	2.51
48	Unknown #1	1	0.50
38	Unknown spores	1	0.50
45	*Botryococcus*	199	100.00
47	*Pediastrum*	8	4.02
	Sum 1 -- Total Pollen	199.0	

Sample number 8933, Depth 201.300

Variable Number	Type	Number of Grains	Percent
1	*Abies*	9	4.48
27	*Pinus*	174	86.57
26	*Picea*	7	3.48
4	Artemisioids	2	1.00
9	Short-spine Compositae	2	1.00
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	4	1.99
13	Cyperaceae	1	0.50
37	Unknown Angiosperms	1	0.50
5	*Azolla*	1	0.50
	Sum 1 -- Total Pollen	201.0	

Owens Lake, Core OL-92-2
Sample number 8935, Depth 202.050

Variable Number	Type	Number of Grains	Percent
1	*Abies*	10	5.00
27	*Pinus*	167	83.50
51	Broken *Pinus*	17	4.25
26	*Picea*	6	3.00
35	*Tsuga mertensiana*	1	0.50
34	TCT	2	1.00
29	*Quercus*	1	0.50
30	*Salix*	1	0.50
9	Short-spine Compositae	2	1.00
10	Long-spine Compositae	1	0.50
8	Cheno-Ams	3	1.50
13	Cyperaceae	5	2.50
37	Unknown Angiosperms	1	0.50
	Sum 1 -- Total Pollen	200.0	

Sample number 8937, Depth 203.400

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.52
27	*Pinus*	143	74.48
51	Broken *Pinus*	27	7.03
35	*Tsuga mertensiana*	2	1.04
34	TCT	19	9.90
29	*Quercus*	3	1.56
2	*Alnus*	1	0.52
30	*Salix*	4	2.08
33	*Shepherdia*	1	0.52
3	*Artemisia*	3	1.56
4	Artemisioids	1	0.52
9	Short-spine Compositae	1	0.52
8	Cheno-Ams	4	2.08
18	Gramineae	1	0.52
13	Cyperaceae	1	0.52
24	Nymphaceae	1	0.52
22	*Menyanthes*	1	0.52
39	Unknown #3	2	1.04
40	Unknown #4	8	4.17
37	Unknown Angiosperms	3	1.56
	Sum 1 -- Total Pollen	192.0	

Owens Lake, Core OL-92-2
Sample number 8939, Depth 204.600

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	2.04
27	*Pinus*	145	73.98
51	Broken *Pinus*	29	7.40
26	*Picea*	2	1.02
35	*Tsuga mertensiana*	1	0.51
34	TCT	20	10.20
29	*Quercus*	3	1.53
2	*Alnus*	1	0.51
30	*Salix*	1	0.51
4	Artemisioids	3	1.53
9	Short-spine Compositae	1	0.51
8	Cheno-Ams	4	2.04
18	Gramineae	1	0.51
13	Cyperaceae	3	1.53
36	*Typha/Sparganium*	4	2.04
39	Unknown #3	3	1.53
40	Unknown #4	3	1.53
21	*Lycopodium*	1	0.51
	Sum 1 -- Total Pollen	196.0	

Sample number 8941, Depth 207.890

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	1.01
27	*Pinus*	161	81.31
51	Broken *Pinus*	24	6.06
26	*Picea*	2	1.01
35	*Tsuga mertensiana*	3	1.52
34	TCT	11	5.56
33	*Shepherdia*	3	1.52
9	Short-spine Compositae	2	1.01
8	Cheno-Ams	3	1.52
18	Gramineae	1	0.51
13	Cyperaceae	6	3.03
36	*Typha/Sparganium*	1	0.51
24	Nymphaceae	1	0.51
22	*Menyanthes*	1	0.51
40	Unknown #4	1	0.51
42	Unknown #8	1	0.51
38	Unknown spores	1	0.51
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 8943, Depth 209.260

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	2.33
27	*Pinus*	209	81.32
34	TCT	10	3.89
33	*Shepherdia*	4	1.56
9	Short-spine Compositae	5	1.95
10	Long-spine Compositae	4	1.56
8	Cheno-Ams	10	3.89
18	Gramineae	1	0.39
37	Unknown Angiosperms	8	3.11
32	*Selaginella*	1	0.39
	Sum 1 -- Total Pollen	257.0	

Sample number 8945, Depth 212.140

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	208	97.65
8	Cheno-Ams	3	1.41
37	Unknown Angiosperms	2	0.94
	Sum 1 -- Total Pollen	213.0	

Sample number 8947, Depth 213.490

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	1.58
27	*Pinus*	240	94.86
3	*Artemisia*	1	0.40
9	Short-spine Compositae	1	0.40
8	Cheno-Ams	6	2.37
37	Unknown Angiosperms	1	0.40
	Sum 1 -- Total Pollen	253.0	

Owens Lake, Core OL-92-2
Sample number 8949, Depth 216.520

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.91
27	*Pinus*	210	95.89
9	Short-spine Compositae	2	0.91
8	Cheno-Ams	3	1.37
16	*Ephedra* undiff.	1	0.46
13	Cyperaceae	1	0.46
	Sum 1 -- Total Pollen	219.0	

Sample number 8951, Depth 221.480

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.20
27	*Pinus*	237	94.42
34	TCT	1	0.40
3	*Artemisia*	1	0.40
9	Short-spine Compositae	4	1.59
8	Cheno-Ams	5	1.99
	Sum 1 -- Total Pollen	251.0	

Sample number 8953, Depth 223.170

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.85
27	*Pinus*	196	83.05
34	TCT	8	3.39
2	*Alnus*	2	0.85
9	Short-spine Compositae	1	0.42
10	Long-spine Compositae	2	0.85
8	Cheno-Ams	9	3.81
18	Gramineae	6	2.54
37	Unknown Angiosperms	10	4.24
	Sum 1 -- Total Pollen	236.0	

Owens Lake, Core OL-92-2
Sample number 8955, Depth 224.840

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.75
27	*Pinus*	190	70.90
34	TCT	8	2.99
2	*Alnus*	3	1.12
3	*Artemisia*	3	1.12
9	Short-spine Compositae	5	1.87
10	Long-spine Compositae	3	1.12
8	Cheno-Ams	9	3.36
18	Gramineae	12	4.48
13	Cyperaceae	14	5.22
36	*Typha/Sparganium*	7	2.61
37	Unknown Angiosperms	12	4.48
32	*Selaginella*	1	0.37
	Sum 1 -- Total Pollen	268.0	

Sample number 8957, Depth 226.260

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.89
27	*Pinus*	211	93.78
34	TCT	1	0.44
9	Short-spine Compositae	1	0.44
8	Cheno-Ams	3	1.33
18	Gramineae	1	0.44
36	*Typha/Sparganium*	1	0.44
37	Unknown Angiosperms	5	2.22
	Sum 1 -- Total Pollen	225.0	

Owens Lake, Core OL-92-2
Sample number 8959, Depth 227.540

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	67	33.00
34	TCT	3	1.48
7	*Chrysolepis*	1	0.49
3	*Artemisia*	1	0.49
9	Short-spine Compositae	3	1.48
10	Long-spine Compositae	22	10.84
8	Cheno-Ams	22	10.84
16	*Ephedra* undiff.	2	0.99
18	Gramineae	30	14.78
13	Cyperaceae	9	4.43
36	*Typha/Sparganium*	29	14.29
28	*Polygonum persicaria*	1	0.49
37	Unknown Angiosperms	13	6.40
5	*Azolla*	4	1.97
38	Unknown spores	1	0.49
	Sum 1 -- Total Pollen	203.0	

Sample number 8961, Depth 235.610

Variable Number	Type	Number of Grains	Percent
	Sum 1 -- Total Pollen	0.0	

Sample number 8963, Depth 238.500

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.42
27	*Pinus*	23	9.75
34	TCT	22	9.32
6	*Betula*	1	0.42
30	*Salix*	1	0.42
33	*Shepherdia*	25	10.59
3	*Artemisia*	20	8.47
4	Artemisioids	8	3.39
9	Short-spine Compositae	10	4.24
10	Long-spine Compositae	9	3.81
8	Cheno-Ams	20	8.47
18	Gramineae	8	3.39
13	Cyperaceae	19	8.05
36	*Typha/Sparganium*	20	8.47
37	Unknown Angiosperms	49	20.76
38	Unknown spores	1	0.42
	Sum 1 -- Total Pollen	236.0	

Owens Lake, Core OL-92-2
Sample number 8965, Depth 241.700

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	57	25.79
26	*Picea*	1	0.45
34	TCT	7	3.17
33	*Shepherdia*	4	1.81
3	*Artemisia*	1	0.45
9	Short-spine Compositae	7	3.17
10	Long-spine Compositae	16	7.24
8	Cheno-Ams	21	9.50
18	Gramineae	21	9.50
13	Cyperaceae	27	12.22
36	*Typha/Sparganium*	49	22.17
37	Unknown Angiosperms	10	4.52
	Sum 1 -- Total Pollen	221.0	

Sample number 8967, Depth 246.200

Variable Number	Type	Number of Grains	Percent
	Sum 1 -- Total Pollen	0.0	

Sample number 8969, Depth 254.100

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	93	44.50
34	TCT	3	1.44
33	*Shepherdia*	6	2.87
3	*Artemisia*	1	0.48
4	Artemisioids	3	1.44
9	Short-spine Compositae	1	0.48
10	Long-spine Composiine	2	0.96
8	Cheno-Ams	20	9.57
16	*Ephedra* undiff.	1	0.48
18	Gramineae	20	9.57
13	Cyperaceae	11	5.26
36	*Typha/Sparganium*	27	12.92
37	Unknown Angiosperms	21	10.05
	Sum 1 -- Total Pollen	209.0	

Owens Lake, Core OL-92-2
Sample number 8971, Depth 267.530

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.88
27	*Pinus*	156	68.42
26	*Picea*	3	1.32
34	TCT	12	5.26
33	*Shepherdia*	14	6.14
4	Artemisioids	2	0.88
9	Short-spine Compositae	5	2.19
10	Long-spine Compositae	6	2.63
8	Cheno-Ams	10	4.39
16	*Ephedra* undiff.	1	0.44
18	Gramineae	4	1.75
13	Cyperaceae	1	0.44
37	Unknown Angiosperms	12	5.26
	Sum 1 -- Total Pollen	228.0	

Sample number 8973, Depth 268.430

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.46
27	*Pinus*	126	57.80
26	*Picea*	1	0.46
34	TCT	3	1.38
33	*Shepherdia*	27	12.39
4	Artemisioids	2	0.92
9	Short-spine Compositae	15	6.88
10	Long-spine Compositae	9	4.13
8	Cheno-Ams	8	3.67
18	Gramineae	6	2.75
13	Cyperaceae	2	0.92
36	*Typha/Sparganium*	4	1.83
37	Unknown Angiosperms	14	6.42
	Sum 1 -- Total Pollen	218.0	

Owens Lake, Core OL-92-2
Sample number 8975, Depth 271.980

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.36
27	*Pinus*	230	81.85
34	TCT	8	2.85
33	*Shepherdia*	3	1.07
3	*Artemisia*	3	1.07
9	Short-spine Compositae	3	1.07
10	Long-spine Compositae	3	1.07
8	Cheno-Ams	3	1.07
16	*Ephedra* undiff.	1	0.36
18	Gramineae	5	1.78
13	Cyperaceae	9	3.20
36	*Typha/Sparganium*	1	0.36
37	Unknown Angiosperms	11	3.91
	Sum 1 -- Total Pollen	281.0	

Sample number 8977, Depth 273.000

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.35
27	*Pinus*	193	67.01
34	TCT	19	6.60
33	*Shepherdia*	14	4.86
3	*Artemisia*	3	1.04
9	Short-spine Compositae	9	3.13
10	Long-spine Compositae	11	3.82
8	Cheno-Ams	21	7.29
18	Gramineae	2	0.69
13	Cyperaceae	3	1.04
36	*Typha/Sparganium*	1	0.35
37	Unknown Angiosperms	11	3.82
38	Unknown spores	1	0.35
	Sum 1 -- Total Pollen	288.0	

Owens Lake, Core OL-92-2
Sample number 8979, Depth 277.150

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.36
27	*Pinus*	164	59.85
34	TCT	35	12.77
29	*Quercus*	1	0.36
33	*Shepherdia*	7	2.55
3	*Artemisia*	5	1.82
4	Artemisioids	2	0.73
9	Short-spine Compositae	3	1.09
10	Long-spine Compositae	4	1.46
8	Cheno-Ams	27	9.85
16	*Ephedra* undiff.	7	2.55
18	Gramineae	2	0.73
36	*Typha/Sparganium*	3	1.09
37	Unknown Angiosperms	13	4.74
32	*Selaginella*	1	0.36
	Sum 1 -- Total Pollen	274.0	

Sample number 8981, Depth 279.300

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.19
27	*Pinus*	173	68.38
34	TCT	11	4.35
29	*Quercus*	1	0.40
30	*Salix*	2	0.79
33	*Shepherdia*	10	3.95
3	*Artemisia*	9	3.56
9	Short-spine Compositae	3	1.19
10	Long-spine Compositae	4	1.58
8	Cheno-Ams	11	4.35
16	*Ephedra* undiff.	3	1.19
18	Gramineae	5	1.98
13	Cyperaceae	11	4.35
36	*Typha/Sparganium*	3	1.19
37	Unknown Angiosperms	4	1.58
	Sum 1 -- Total Pollen	253.0	

Owens Lake, Core OL-92-2
Sample number 8983, Depth 280.590

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	1.69
27	*Pinus*	164	69.49
29	*Quercus*	2	0.85
2	*Alnus*	3	1.27
3	*Artemisia*	4	1.69
4	Artemisioids	2	0.85
9	Short-spine Compositae	3	1.27
10	Long-spine Compositae	11	4.66
8	Cheno-Ams	12	5.08
16	*Ephedra* undiff.	1	0.42
18	Gramineae	1	0.42
13	Cyperaceae	3	1.27
36	*Typha/Sparganium*	7	2.97
37	Unknown Angiosperms	19	8.05
	Sum 1 -- Total Pollen	236.0	

Sample number 8985, Depth 284.340

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.18
27	*Pinus*	210	91.70
26	*Picea*	4	1.75
29	*Quercus*	2	0.87
33	*Shepherdia*	1	0.44
3	*Artemisia*	1	0.44
9	Short-spine Compositae	1	0.44
8	Cheno-Ams	3	1.31
18	Gramineae	1	0.44
37	Unknown Angiosperms	1	0.44
	Sum 1 -- Total Pollen	229.0	

Owens Lake, Core OL-92-2
Sample number 8987, Depth 286.250

Variable Number	Type	Number of Grains	Percent
1	*Abies*	11	4.91
27	*Pinus*	171	76.34
26	*Picea*	6	2.68
29	*Quercus*	5	2.23
2	*Alnus*	1	0.45
3	*Artemisia*	2	0.89
4	Artemisioids	1	0.45
9	Short-spine Compositae	7	3.13
10	Long-spine Compositae	2	0.89
8	Cheno-Ams	7	3.13
16	*Ephedra* undiff.	1	0.45
18	Gramineae	1	0.45
13	Cyperaceae	5	2.23
36	*Typha/Sparganium*	1	0.45
37	Unknown Angiosperms	3	1.34
	Sum 1 -- Total Pollen	224.0	

Sample number 8989, Depth 287.500

Variable Number	Type	Number of Grains	Percent
1	*Abies*	7	3.11
27	*Pinus*	183	81.33
26	*Picea*	6	2.67
34	TCT	2	0.89
29	*Quercus*	1	0.44
2	*Alnus*	2	0.89
3	*Artemisia*	4	1.78
4	Artemisioids	1	0.44
9	Short-spine Compositae	1	0.44
8	Cheno-Ams	5	2.22
18	Gramineae	1	0.44
13	Cyperaceae	2	0.89
36	*Typha/Sparganium*	2	0.89
37	Unknown Angiosperms	8	3.56
	Sum 1 -- Total Pollen	225.0	

Owens Lake, Core OL-92-2
Sample number 8991, Depth 288.740

Variable Number	Type	Number of Grains	Percent
1	*Abies*	6	2.90
27	*Pinus*	178	85.99
26	*Picea*	3	1.45
34	TCT	4	1.93
3	*Artemisia*	1	0.48
9	Short-spine Compositae	1	0.48
8	Cheno-Ams	8	3.86
18	Gramineae	1	0.48
37	Unknown Angiosperms	5	2.42
	Sum 1 -- Total Pollen	207.0	

Sample number 8993, Depth 290.000

Variable Number	Type	Number of Grains	Percent
1	*Abies*	8	3.56
27	*Pinus*	189	84.00
34	TCT	6	2.67
9	Short-spine Compositae	2	0.89
10	Long-spine Compositae	3	1.33
8	Cheno-Ams	2	0.89
18	Gramineae	5	2.22
13	Cyperaceae	3	1.33
37	Unknown Angiosperms	7	3.11
	Sum 1 -- Total Pollen	225.0	

Sample number 8995, Depth 293.900

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	0.37
27	*Pinus*	151	55.72
26	*Picea*	5	1.85
34	TCT	14	5.17
6	*Betula*	1	0.37
33	*Shepherdia*	15	5.54
3	*Artemisia*	4	1.48
9	Short-spine Compositae	6	2.21
10	Long-spine Compositae	3	1.11
8	Cheno-Ams	28	10.33
18	Gramineae	3	1.11
13	Cyperaceae	8	2.95
36	*Typha/Sparganium*	6	2.21
28	*Polygonum persicaria*	1	0.37
37	Unknown Angiosperms	25	9.23
	Sum 1 -- Total Pollen	271.0	

Owens Lake, Core OL-92-2
Sample number 8997, Depth 296.600

Variable Number	Type	Number of Grains	Percent
1	*Abies*	4	1.56
27	*Pinus*	199	77.73
34	TCT	2	0.78
6	*Betula*	1	0.39
33	*Shepherdia*	5	1.95
3	*Artemisia*	5	1.95
8	Cheno-Ams	11	4.30
18	Gramineae	5	1.95
13	Cyperaceae	7	2.73
36	*Typha/Sparganium*	9	3.52
37	Unknown Angiosperms	8	3.13
	Sum 1 -- Total Pollen	256.0	

Sample number 8999, Depth 297.930

Variable Number	Type	Number of Grains	Percent
1	*Abies*	30	9.38
27	*Pinus*	258	80.63
26	*Picea*	13	4.06
34	TCT	1	0.31
9	Short-spine Compositae	2	0.63
8	Cheno-Ams	3	0.94
18	Gramineae	3	0.94
36	*Typha/Sparganium*	2	0.63
28	*Polygonum persicaria*	1	0.31
37	Unknown Angiosperms	7	2.19
	Sum 1 -- Total Pollen	320.0	

Owens Lake, Core OL-92-2
Sample number 9001, Depth 299.170

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	2.04
27	*Pinus*	44	29.93
30	*Salix*	1	0.68
33	*Shepherdia*	1	0.68
3	*Artemisia*	3	2.04
10	Long-spine Compositae	1	0.68
8	Cheno-Ams	3	2.04
18	Gramineae	18	12.24
13	Cyperaceae	12	8.16
36	*Typha/Sparganium*	55	37.41
28	*Polygonum persicaria*	2	1.36
37	Unknown Angiosperms	4	2.72
5	*Azolla*	3	2.04
	Sum 1 -- Total Pollen	147.0	

Sample number 9003, Depth 302.820

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.02
27	*Pinus*	176	70.97
26	*Picea*	3	1.21
34	TCT	1	0.40
30	*Salix*	1	0.40
33	*Shepherdia*	6	2.42
3	*Artemisia*	1	0.40
9	Short-spine Compositae	3	1.21
10	Long-spine Compositae	1	0.40
8	Cheno-Ams	6	2.42
18	Gramineae	24	9.68
13	Cyperaceae	7	2.82
36	*Typha/Sparganium*	7	2.82
28	*Polygonum persicaria*	1	0.40
37	Unknown Angiosperms	6	2.42
	Sum 1 -- Total Pollen	248.0	

Owens Lake, Core OL-92-2
Sample number 9005, Depth 304.410

Variable Number	Type	Number of Grains	Percent
1	*Abies*	3	1.32
27	*Pinus*	199	87.67
26	*Picea*	7	3.08
30	*Salix*	2	0.88
33	*Shepherdia*	2	0.88
10	Long-spine Compositae	2	0.88
8	Cheno-Ams	2	0.88
18	Gramineae	2	0.88
13	Cyperaceae	2	0.88
36	*Typha/Sparganium*	1	0.44
37	Unknown Angiosperms	5	2.20
	Sum 1 -- Total Pollen	227.0	

Sample number 9007, Depth 306.640

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	25	52.08
34	TCT	3	6.25
3	*Artemisia*	2	4.17
4	Artemisioids	2	4.17
9	Short-spine Compositae	2	4.17
10	Long-spine Compositae	4	8.33
18	Gramineae	6	12.50
37	Unknown Angiosperms	4	8.33
	Sum 1 -- Total Pollen	48.0	

Sample number 9009, Depth 307.240

Variable Number	Type	Number of Grains	Percent
1	*Abies*	7	3.50
27	*Pinus*	188	94.00
26	*Picea*	4	2.00
33	*Shepherdia*	1	0.50
	Sum 1 -- Total Pollen	200.0	

Owens Lake, Core OL-92-2
Sample number 9011, Depth 310.370

Variable Number	Type	Number of Grains	Percent
27	*Pinus*	202	82.79
26	*Picea*	11	4.51
34	TCT	3	1.23
33	*Shepherdia*	3	1.23
3	*Artemisia*	1	0.41
4	Artemisioids	8	3.28
9	Short-spine Compositae	2	0.82
8	Cheno-Ams	1	0.41
13	Cyperaceae	2	0.82
37	Unknown Angiosperms	11	4.51
	Sum 1 -- Total Pollen	244.0	

Sample number 9013, Depth 312.330

Variable Number	Type	Number of Grains	Percent
1	*Abies*	2	0.95
27	*Pinus*	83	39.52
26	*Picea*	1	0.48
34	TCT	6	2.86
33	*Shepherdia*	6	2.86
3	*Artemisia*	9	4.29
4	Artemisioids	30	14.29
9	Short-spine Compositae	7	3.33
10	Long-spine Compositae	1	0.48
8	Cheno-Ams	34	16.19
18	Gramineae	3	1.43
13	Cyperaceae	4	1.90
37	Unknown Angiosperms	24	11.43
	Sum 1 -- Total Pollen	210.0	

Owens Lake, Core OL-92-2
Sample number 9015, Depth 313.970

Variable Number	Type	Number of Grains	Percent
1	*Abies*	12	5.58
27	*Pinus*	184	85.58
26	*Picea*	2	0.93
2	*Alnus*	1	0.47
30	*Salix*	1	0.47
33	*Shepherdia*	1	0.47
9	Short-spine Compositae	2	0.93
10	Long-spine Compositae	1	0.47
8	Cheno-Ams	3	1.40
18	Gramineae	2	0.93
37	Unknown Angiosperms	6	2.79
	Sum 1 -- Total Pollen	215.0	

Sample number 9017, Depth 316.450

Variable Number	Type	Number of Grains	Percent
1	*Abies*	7	3.14
27	*Pinus*	187	83.86
26	*Picea*	2	0.90
29	*Quercus*	4	1.79
9	Short-spine Compositae	2	0.90
10	Long-spine Compositae	1	0.45
8	Cheno-Ams	6	2.69
18	Gramineae	7	3.14
37	Unknown Angiosperms	7	3.14
	Sum 1 -- Total Pollen	223.0	

Owens Lake, Core OL-92-2
Sample number 9019, Depth 318.450

Variable Number	Type	Number of Grains	Percent
1	*Abies*	14	6.73
27	*Pinus*	137	65.87
26	*Picea*	3	1.44
34	TCT	5	2.40
29	*Quercus*	3	1.44
2	*Alnus*	1	0.48
7	*Chrysolepis*	1	0.48
3	*Artemisia*	7	3.37
9	Short-spine Compositae	6	2.88
8	Cheno-Ams	15	7.21
16	*Ephedra* undiff.	1	0.48
18	Gramineae	3	1.44
36	*Typha/Sparganium*	1	0.48
37	Unknown Angiosperms	11	5.29
	Sum 1 -- Total Pollen	208.0	

Sample number 9021, Depth 320.360

Variable Number	Type	Number of Grains	Percent
1	*Abies*	10	5.05
27	*Pinus*	116	58.59
26	*Picea*	6	3.03
34	TCT	1	0.51
30	*Salix*	1	0.51
3	*Artemisia*	2	1.01
9	Short-spine Compositae	1	0.51
11	Liguliflorae	2	1.01
8	Cheno-Ams	3	1.52
18	Gramineae	10	5.05
36	*Typha/Sparganium*	29	14.65
28	*Polygonum persicaria*	10	5.05
37	Unknown Angiosperms	7	3.54
	Sum 1 -- Total Pollen	198.0	

Owens Lake, Core OL-92-2
Sample number 9023, Depth 320.860

Variable Number	Type	Number of Grains	Percent
1	*Abies*	5	2.44
27	*Pinus*	170	82.93
26	*Picea*	1	0.49
34	TCT	1	0.49
33	*Shepherdia*	1	0.49
3	*Artemisia*	2	0.98
8	Cheno-Ams	1	0.49
18	Gramineae	7	3.41
36	*Typha/Sparganium*	12	5.85
28	*Polygonum persicaria*	4	1.95
23	*Nuphar*	1	0.49
	Sum 1 -- Total Pollen	205.0	

Sample number 9025, Depth 323.280

Variable Number	Type	Number of Grains	Percent
1	*Abies*	1	1.33
27	*Pinus*	43	57.33
34	TCT	1	1.33
6	*Betula*	1	1.33
30	*Salix*	1	1.33
33	*Shepherdia*	2	2.67
3	*Artemisia*	13	17.33
4	Artemisioids	1	1.33
9	Short-spine Compositae	4	5.33
8	Cheno-Ams	8	10.67
	Sum 1 -- Total Pollen	75.0	

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8.0 SUPPLEMENTAL DATA

8.1 Depths to tops of "Drives" and "Slugs" in cores OL-92-1, -2, and -3

["Drive" number represents how many times empty core barrel has re-entered the the core hole; "Slugs" are successive 1.5-m (or less) segments of each core, with "A" at top]

OL-92-1

Drive no.	Depth to top of Slug (meters) Slug A	Slug B	Slug C	Slug D
1	0.00	See OL-92-3		
2	0.61	(do)		
3	0.91	(do)		
4	1.30	(do)		
5	1.91	(do)		
6	5.49			
7	7.01			
8	8.53	9.45		
9	10.97	11.33	12.83	
10	14.02	14.30	15.90	
11	17.15	17.56		
12	20.19			
13	21.72	22.07	23.57	
14	24.77	26.26		
15	27.81			
16	30.86			
17	31.47	32.97		
18	33.91	34.46	35.97	
19	36.96	38.37		
20	40.01	41.54		
21	43.05	44.58		
22	46.10	47.62		
23	49.15			
24	52.20			
25	52.50	54.00		
26	55.25	56.76	58.21	
27	58.29	59.79	61.31	

Base of OL-92-1 = 61.34 meters

OL-92-2

Drive no.	Depth to top of Slug (meters) Slug A	Slug B	Slug C	Slug D
1	61.26	62.76		
2	64.14	65.64		
3	66.99	68.49	69.99	
4	70.46	71.46		
5	73.51			
6	74.42	75.96		
7	76.56	78.09	79.44	79.55
8	79.60	81.12		
9	82.65	84.17		
10	85.75	87.26	88.66	
11	88.75	90.27		
12	91.80	93.32	44.80	
13	94.84			
14	96.06			
15	97.84	99.34		
16	100.89	102.31		
17	103.94 (no core)			
18	106.98 (no core)			
19	107.06			
20	108.59 (no core)			
21	108.89 (no core)			
22	109.46	110.94		
23	111.33	112.84	114.36	
24	114.68 (no core)			
25	115.24			
26	116.21	117.73		
27	119.25	120.77		
28	122.30	123.84	125.36	
29	126.57	127.98	129.40	
30	129.67			
31	131.14	132.59	134.11	
32	135.10	136.63	138.06	
33	139.04	140.52	142.02	
34	142.09	143.61	144.98	
35	145.24	146.74		
36	147.68			
37	148.84	150.18		
38	150.93 (no core)			
39	151.88	153.41		
40	154.51	156.01		
41	157.35			
42	159.18 (no core)			
43	162.26 (no core)			
44	162.69			
45	163.30			
46	164.82 (no core)			
47	166.74	168.24		
48	168.63 (no core)			

Drive no.	Depth to top of Slug (meters) Slug A	Slug B	Slug C	Slug D
49	171.09 (no core)			
50	171.42			
51	171.73	173.19		
52	174.16			
53	176.30	177.83		
54	178.74	180.24		
55	181.79	183.18	184.68	
57	187.88	189.40		
58	190.63	192.16	193.63	
59	193.98	195.49	197.01	
60	197.64	199.15	200.65	
61	201.60	203.10		
62	206.17			
63	207.09			
64	208.61	210.12		
65	211.66 (no core)			
66	211.91	213.34	214.77	215.78
67	216.54			
68	217.75			
69	219.73	221.25		
70	221.72	223.24		
71	224.46	225.99		
72	226.95			
73	227.51			
74	229.82			
75	230.43 (no core)			
76	231.95 (no core)			
77	232.50 (no core)			
78	232.80 (no core)			
79	233.03			
80	233.45			
81	234.21	235.63		
82	236.45	237.98		
83	239.80	241.31		
84	242.82 (no core)			
85	244.45	245.89		
86	247.32			
87	250.37			
88	252.50	254.00		
89	255.04			
90	258.90 (no core)			
91	261.95			
92	262.79 (no core)			
93	265.98			
94	266.78	268.28		
95	269.88	271.40		
96	273.23 (no core)			
97	275.55	277.02	277.66	
98	277.80			
99	278.89			
100	282.74	284.25	285.75	

Drive no.	Depth to top of Slug (meters) Slug A	Slug B	Slug C	Slug D
101	286.94	288.45	289.97	
102	291.52	292.10		
103	294.70	296.23	297.74	
104	297.92	299.42	300.92	
105	302.01	303.53	305.04	
106	305.74	307.33	308.87	
107	310.18	311.67		
108	314.45	315.96	317.49	
109	318.11	319.61		
110	321.03			

Base of OL-92-2 = 322.86 m

OL-92-3

Drive no.	Depth to top of Slug (meters) Slug A	Slug B	Slug C	Slug D
1	3.52	4.12	5.64	

Base of OL-92-3 = 7.16 m

8.2 Depths to tops, bases, and mid-points of channel samples used for selected analytical determinations

Core numbers	Slug numbers	Top (m)	Base (m)	Midpoint (m)
OL92-3	A+B+C	3.52	7.16	5.34
OL92-1	6A+7A	5.49	8.51	7.00
	8A	8.53	9.45	8.99
	9B+C	11.33	14.02	12.68
	11A+B	17.15	19.06	18.11
	13A+B+C	21.72	24.77	23.25
	14A+B	24.77	27.78	26.28
	17A+B	31.47	33.91	32.69
	18A+B+C	33.91	36.96	35.44
	19A+B	36.96	39.93	38.45
	20A+B	40.01	42.97	41.49
	21A+B	43.05	46.10	44.58
	22A+B	46.10	48.02	47.06
	23A	49.15	50.69	49.92
	25A+B	52.50	55.25	53.88
	26A+B	55.25	58.21	56.73
	27A+B	58.29	61.31	59.80
OL92-2	1A+B	61.26	64.09	62.68
	2A+B	64.14	66.99	65.57
	3A+B	66.99	69.99	68.49
	4A+B	70.46	73.25	71.86
	6A+B	74.42	76.51	75.47
	7A+B	76.56	79.44	78.00
	8A+B	79.60	82.65	81.13
	9A+B	82.65	85.64	84.15
	10A+B	85.75	88.66	87.21
	11A+B	88.75	91.76	90.26
	12A+B	91.80	94.80	93.30
	13A+14A	94.84	96.84	95.84
	15A+B	97.84	100.84	99.34
	16A+B	100.89	103.79	102.34
	22A+B	109.46	111.33	110.40
	23A+B	111.33	114.36	112.84
	25A	115.24	116.21	115.72
	26A+B	116.21	119.25	117.73
	27A+B	119.25	122.30	120.78
	28A+B	122.30	124.54	123.42
	28B+C	124.54	126.57	125.56
	29A+B	126.57	129.40	127.98
	30A+31A	129.67	132.59	131.13
	31B+C	132.59	135.10	133.84
	32A+B	135.10	138.06	136.58
	33A+B	139.04	142.02	140.53
	34A+B	142.09	144.98	143.54
	35A+B	145.24	147.68	146.46
	36A+37A	147.68	150.18	148.93

Core numbers	Slug numbers	Top (m)	Base (m)	Midpoint (m)
	39A+B	151.88	154.51	153.20
	40A+B	154.51	157.29	155.90
	44A+45A	162.69	164.82	163.76
	47A+B	166.74	168.63	167.68
	51A+B	171.73	173.82	172.78
	52A+53A	174.16	177.83	176.00
	55A+B	181.79	184.68	183.24
	56A+B	184.84	187.70	186.27
	57A+B	187.88	190.63	189.26
	58A+B	190.63	193.63	192.13
	59A+B	193.98	196.24	195.11
	59B+C	196.24	197.64	196.94
	60B+C	199.15	201.60	200.38
	61A+B	201.60	204.27	202.93
	63A+64A	207.09	210.12	208.60
	65+66A+B	211.91	214.77	213.34
	65+66C+D	214.77	216.54	215.66
	69A+B	219.73	221.72	220.72
	70A+B	221.72	224.46	223.09
	71A+B	224.46	226.95	225.70
	81A+B	234.21	235.95	235.08
	82A+B	236.45	238.88	237.66
	83A+B	239.80	241.42	240.61
	85A+B	244.45	246.26	245.36
	88A+B	252.50	255.04	253.77
	89A	255.04	255.58	255.31
	93A+94A	265.98	268.28	267.13
	95A+B	269.88	272.61	271.24
	97A+B	275.55	277.66	276.60
	98A+99A	277.80	280.27	279.04
	100A+B	282.74	283.49	283.12
	100B+C	283.49	286.94	285.22
	101A+B	286.94	289.97	288.46
	102A+B	291.52	293.59	292.56
	103A+B	294.70	297.74	296.22
	104A+B	297.92	300.06	298.99
	104B+C	300.06	302.02	301.04
	105A+B	302.01	304.04	303.02
	105B+C	304.04	305.79	304.92
	106A+B	305.79	307.83	306.81
	106B+C	307.83	309.49	308.66
	107A+B	310.18	313.19	311.68
	108A+B	314.45	317.49	315.97
	109A+B	318.11	320.74	319.42
	110A	321.03	322.43	321.73