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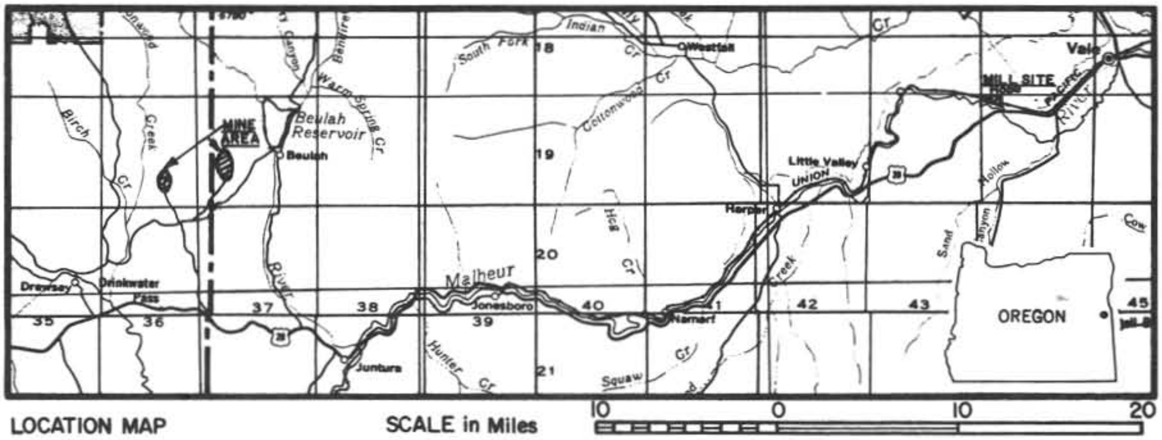

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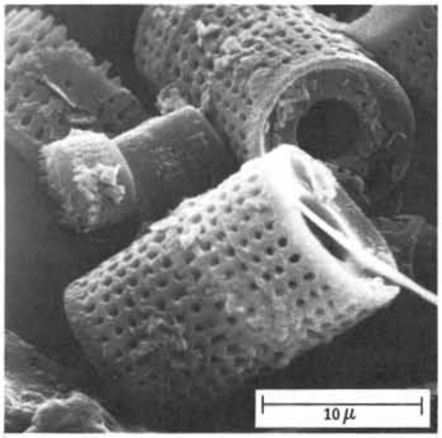

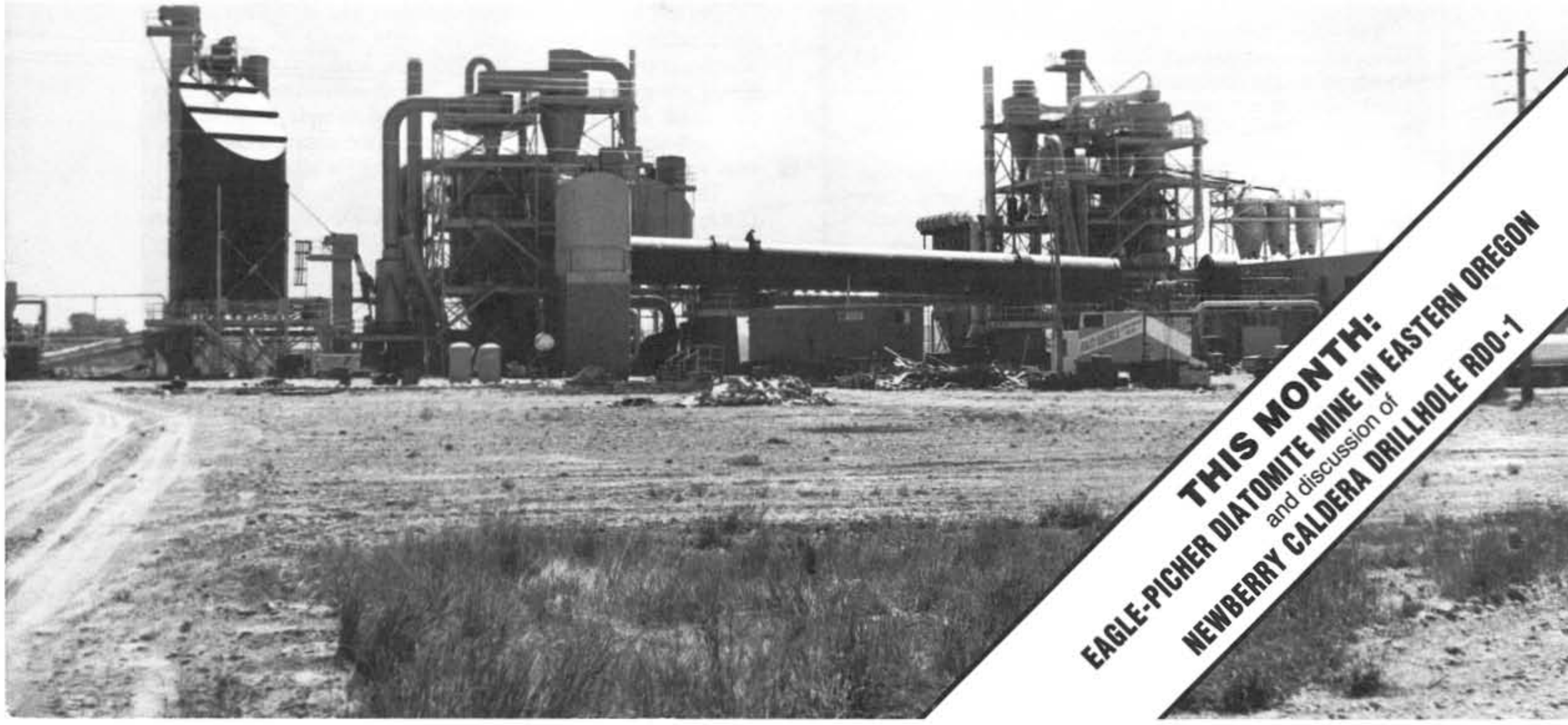

THIS MONTH:
EAGLE-PICHER DIATOMITE MINE IN EASTERN OREGON
and discussion of
NEWBERRY CALDERA DRILLHOLE RDO-1

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Information for contributors

Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

The style to be followed is generally that of U.S. Geological Survey publications (see the USGS manual *Suggestions to Authors,* 6th ed., 1978). The bibliography should be limited to "References Cited." Authors are responsible for the accuracy of the bibliographic references. Names of reviewers should be included in the "Acknowledgments."

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of DOGAMI.

COVER ILLUSTRATION

On August 18, 1986, a new diatomite mine and processing plant was dedicated near Vale, Oregon. Article describing this venture of Eagle-Picher Industries, Inc., begins on page 108. Illustration shows location map of the plant and its mining sites, view of the processing plant, and scanning electron photomicrograph of *Melosira granulata* diatoms.

OIL AND GAS NEWS

Results of Columbia County lease sale

The lease sale was held July 23 in St. Helens, Oregon. Columbia County offered 68,863 acres located throughout the county. A total of 19,070 acres were sold for a bonus of $133,405. The high bid was $70 per acre by ARCO for a 640-acre parcel, no. 321 in sec. 34, T. 6 N., R. 5 W.

The city of Clatskanie offered 572 acres of which 440 acres were sold with a high bid of $1.00 per acre by Ed Dunn.

Additional information is available from the Columbia County Board of Commissioners, phone (503) 397-4322.

ARCO begins drilling at Mist Gas Field

ARCO spudded Columbia County 14-23 in the Mist Field on August 5. The well is located in SW¼ sec. 23, T. 6 N., R. 5 W., Columbia County, Oregon. This is permitted as a 2,450-ft test.

Recent permits

Permit no.	Operator, well, API number	Location	Status, proposed total depth (ft)
375	ARCO Columbia County 31-8 009-00212	NE¼ sec. 8 T. 6 N., R. 5 W. Columbia County	Application; 3,200.

□

Central Oregon geochemical survey released

The Oregon Department of Geology and Mineral Industries (DOGAMI) has released a geochemical survey of a 425-square mile area east of Madras, *Mineral Assessment of the Southwest Quarter of the Stevenson Mountain 30- by 60-Minute Quadrangle, Jefferson and Crook Counties, Oregon.* The release is DOGAMI Open-File Report O-86-4, by J.J. Gray and G.L. Baxter (DOGAMI) and R.O. Van Atta (Portland State University).

The survey identifies several areas that would justify more intensive exploration efforts for hot-spring-type gold and other metal deposits. Breccia pipes, bleached zones, jasperoids, hot springs, sinter, and anomalous metal values were found within the study area. Analyses identified such ore minerals as arsenopyrite, azurite, cerussite, cinnabar, and malachite in gold-pan concentrates.

For the study, 416 stream-sediment and rock-chip samples were collected and assayed for eight elements, gold, silver, arsenic, copper, mercury, molybdenum, lead, and zinc. The published report consists of a 69-page text with numerous illustrations and data tables, a geologic and sample-location map, element-abundance maps for each of the assayed elements, a land status map, and detailed data tables for all samples.

The report is now available at the Oregon Department of Geology and Mineral Industries, 910 State Office Building, Portland, OR 97201. The purchase price is $10. Orders under $50 require prepayment. □

Correction

The following sentence was inadvertently omitted from last month's feature article ("Oil and Gas Exploration for the Nongeologist," by Wesley G. Bruer):

"Many thanks to reviewers H. Jack Meyer, Dena Nelson, Dennis Olmstead, D. Brian Williamson, and David Williamson."

The error was ours, and we apologize for it.

— *Editor*

Lithology and hydrothermal alteration of drill hole RDO-1, Newberry caldera, Oregon

by Terry E.C. Keith[1], Marshall W. Gannett[2], John C. Eichelberger[3], and Albert F. Waibel[4]

ABSTRACT

Lithologies penetrated by Sandia National Laboratories drill hole RDO-1 are correlative with those encountered by U.S. Geological Survey (USGS) Newberry 2 drill hole located 0.5 kilometers (km) to the northwest of RDO-1. Minerals produced by hydrothermal alteration are similar in both holes, but distribution with depth shows that higher temperatures were reached at a shallower level in RDO-1 as compared to Newberry 2. An aquifer penetrated by RDO-1 between 379.5 and 397 meters (m) induced artesian flow of water with temperatures in excess of 158° Celsius (C). This hot-water aquifer in RDO-1 correlates with the 100° C temperature maximum at 415 m in the upper part of Newberry 2. Hot water may flow upward from the ring fracture southeast of RDO-1 and spread laterally into permeable layers within the caldera; however, RDO-1 appears to be more directly in the path of the hot-water aquifer than Newberry 2.

INTRODUCTION

RDO-1 was drilled to a depth of 424 m by Sandia National Laboratories, using mud rotary drilling methods. Drilling began on September 16 and ended on October 20, 1983. The hole was sited at an elevation of 1,969.0 m, approximately 0.5 km southeast of the USGS drill hole Newberry 2 (N2) (Figure 1).

Cuttings were collected from either 3- or 6.1- m intervals as drilling progressed and were logged at the drill site using a binocular microscope. A split of the cuttings was further studied in the laboratory by binocular microscope examination and petrographic and X-ray diffraction techniques. Detailed mineralogical studies were conducted on selected samples using a scanning electron microscope equipped with an X-ray energy dispersive analyzer.

Temperature data and some of the drilling history have been reported by Black and others (1984) and are summarized here. Maximum measured temperature in the well was 158° C at the 350.5-m depth two days after circulating mud; temperatures were not measured below 350.5 m at this time because the temperature probe failed. Between 379.5- and 397-m depth, the well penetrated an aquifer with a temperature in excess of 158° C and sufficient hydrostatic pressure to cause the well to dis-

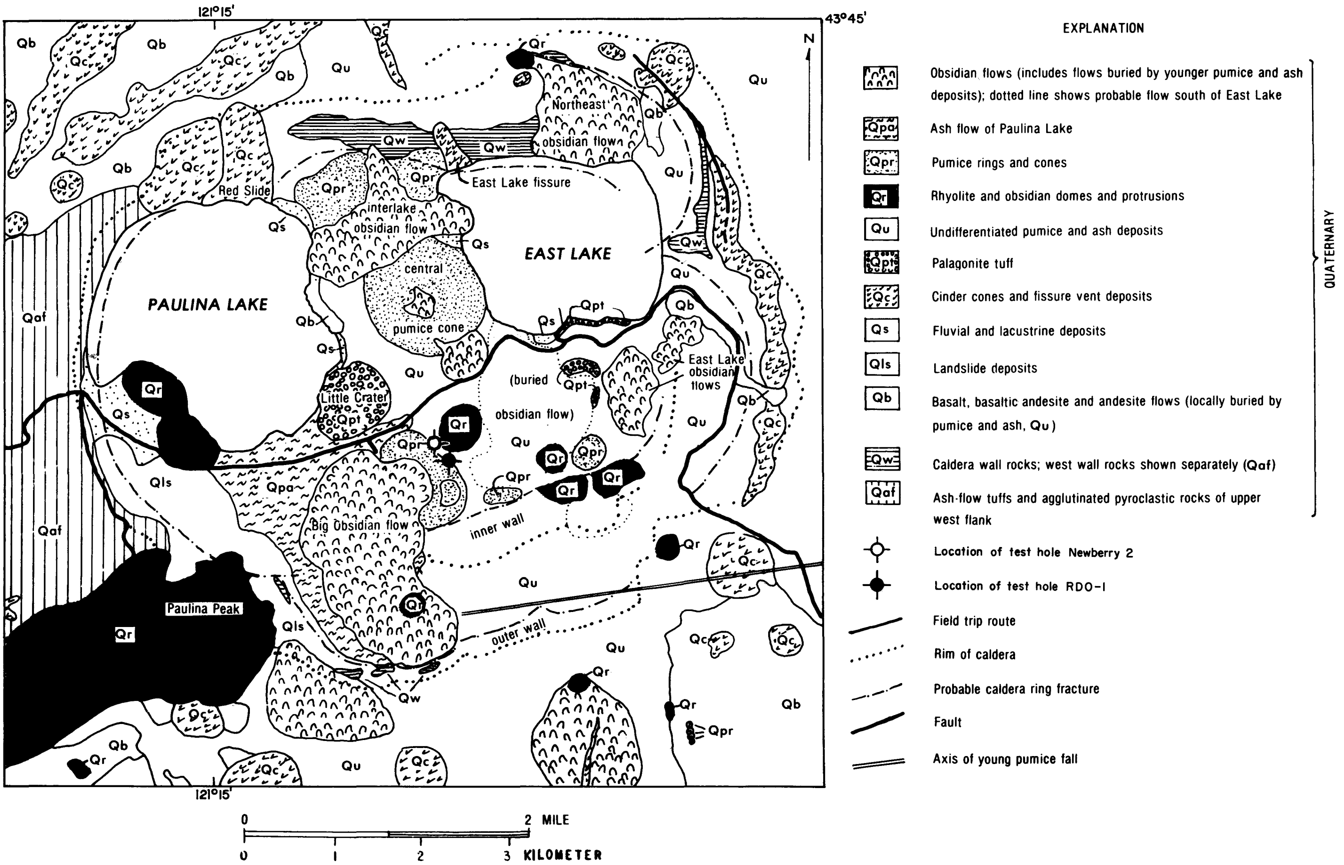

Figure 1. Geologic map (modified by Black and others, 1984, from MacLeod and Sammel, 1982), showing locations of the RDO-1 and N2 drill holes at Newberry caldera, central Oregon.

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[1] U.S. Geological Survey, Menlo Park, California.

[2] Columbia Geoscience; now with Oregon Department of Water Resources, Salem, Oregon.

[3] Sandia National Laboratories, Albuquerque, New Mexico.

[4] Columbia Geoscience, Hillsboro, Oregon

charge at the surface at a rate of approximately 340 liters per minute. Black and others (1984) suggest that the temperature of the main fluid entry of the aquifer may be in excess of 170° C.

LITHOLOGIC DESCRIPTIONS

Lithologic descriptions for RDO-1, except for the lowest unit, are given in Figure 2 and are not repeated here.

The lowest unit, a pumice and lithic tuff breccia extending from 328.6 to 424 m, appears to be the same as the pumiceous sand and gravel unit and the pumice lapilli tuff and lithic breccia unit of N2 (MacLeod and Sammel, 1982) (Figure 3). The core samples of N2 show similar textures and relative amounts of pumice fragments, pumiceous tuff matrix, and lithic fragments including mostly aphanitic to porphyritic mafic volcanic rocks. Clast sizes in N2 cores range from less than 1 millimeter (mm) to much larger than the core diameter of 6 centimeters (cm) (probably boulders). In RDO-1, six stratigraphic subdivisions have been recorded for the pumice and lithic tuff breccia unit on the basis of binocular examination of cuttings (Gannett and Waibel, 1983); these subdivisions are made on the basis of relative abundance of pumiceous and lithic material.

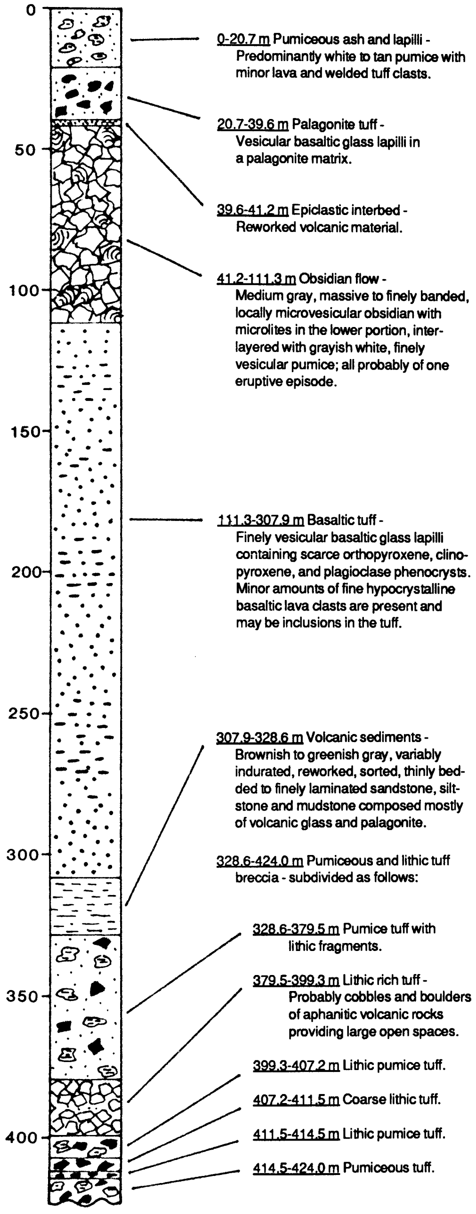


Figure 2. Lithologic log for drill hole RDO-1 (after Gannett and Waibel, 1983).

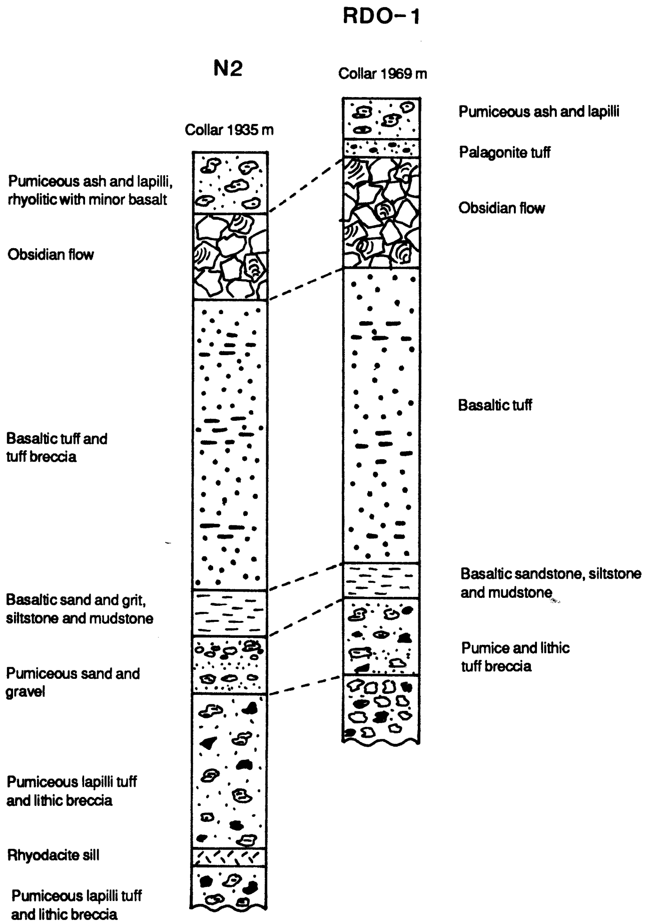


Figure 3. Lithologic correlation between drill holes RDO-1 and N2, with data for N2 from MacLeod and Sammel (1982). Collar elevations are approximately 1,935 m for N2 and 1,969 m for RDO-1.

Of particular significance is the subdivision between 379.5 and 399.3 m, which contains the 158+° C water that induced artesian flow. Hydrothermally deposited minerals in this interval are as long as 4 mm in the largest dimension, and textures of intergrown minerals show abundant open spaces. The fact that these minerals had space to grow suggests (1) that this interval contains a large proportion of cobbles and boulders and/or (2) that the interval may have large, open fractures resulting in high secondary permeability.

HYDROTHERMAL ALTERATION

In RDO-1, there is virtually no hydrothermal alteration to a depth of 285 m. Local traces of deuteric minerals above 285 m consist of clear to white amorphous silica and thin greenish coatings of incipient clay minerals in vesicles. Present temperatures vary between 14.4° and 44.7° C from the surface to a depth of 285 m (Figure 4).

Hydrothermal alteration begins at 285 m and increases rapidly with depth; corresponding temperatures increase rapidly from 31° C at 275 m to 158° C at 350.5 m. Hydrothermal mineral distribution with depth is shown in Figure 4. The greatest proportion of the hydrothermal minerals (quartz, calcite, mordenite, chlorite, smectite, pyrite, and pyrrhotite) occur in open spaces such as vesicles, fractures, and pore spaces. Replacement of pumice matrix and mafic phenocrysts by smectite, chlorite, mordenite, quartz, and pyrite is locally pervasive.

The base of the basaltic tuff unit from 285 to 307.9 m contains trace amounts of smectite and pyrite as replacement minerals that may have formed from diagenetic processes and trace amounts of hydrothermally deposited siderite in small vesicles. Minor alteration in the basaltic sandstone, siltstone, and mudstone unit from 307.9 to 328.6 m consists of incipient replacement of basalt glass by smectite and local thin veinlets filled with calcite, aragonite, and rhodochrosite.

Alteration in the pumice and lithic tuff breccia unit from 328.6 to 424 m has resulted in replacement of glass in the pumiceous tuff groundmass and pumice fragments, and hydrothermal minerals have precipitated in open spaces. Volcanic lithic fragments were not permeable to hydrothermal fluids and, therefore, have only local alteration rims. Minor amounts of analcime fill pore spaces in the upper part of the unit. Pyrite, pyrrhotite, quartz, and either smectite or chlorite are concentrated from 328.6 to 379.5 m. The most intense hydrothermal alteration is in and adjacent to the interval from 379.5 to 397 m which contains the present hot-water (158+° C) aquifer. At approximately 386 m and extending down to approximately 414 m, large (4-mm) calcite blades have been deposited with quartz, mordenite, and chlorite in open spaces (Figures 5 and 6).

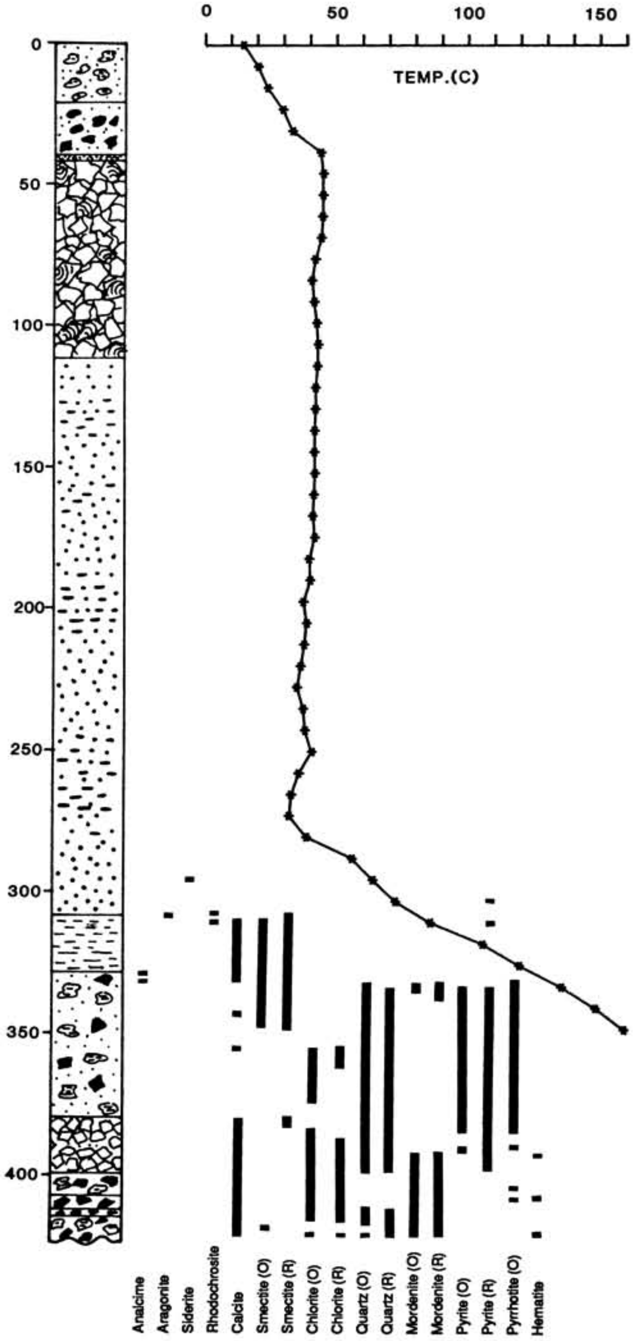


Figure 4. Lithology, hydrothermal mineral distribution, and measured temperatures plotted against depth for RDO-1. Lithologic symbols are as for Figures 2 and 3. No indications of relative abundances of minerals are shown. O = open-space deposit; R = replacement. Temperature data are from Black and others (1984).

In general, through the more highly altered part of RDO-1, the iron sulfides were deposited early, along with smectite. Pyrrhotite crystals are structurally hexagonal, as determined by X-ray diffraction techniques, and have not been altered or etched (Figure 7). The main sequence of deposition of the later minerals from first to last is pyrrhotite, mordenite, calcite, quartz, and chlorite; however, there is significant overlap of these phases, suggesting codeposition.

Most of the units of RDO-1 are quite permeable because of their primary lithologies; however, hydrothermal minerals have locally reduced permeability. The basaltic sandstone, siltstone, and mudstone unit would be expected to have lower primary permeability because of the fine-grained layers composing the unit. Reduction in permeability is caused principally by partial alteration of the glass particles to smectite, and this reaction, along with further reduction in permeability, can be expected to continue. Permeability of the pumiceous and lithic tuff breccia unit is greater where the proportion of lithic fragments to pumice fragments is greater and where the size of the fragments is larger. Pumice is more susceptible to hydrothermal alteration than are the volcanic lithic fragments. The present alteration is still in an early stage, and permeability is high through most of the unit. From 414.5 to 424 m, permeability has decreased because a high proportion of small pumice and tuff fragments have been extensively replaced, and vesicles have been filled by mordenite and chlorite. Quartz and calcite usually occur as euhedral crystals rather than massive vein or pore filling and, therefore, have less effect on overall rock permeability.

The effects of present temperatures on hydrothermal mineralogy can best be seen in the distribution of smectite and chlorite (Figure 4). Smectite occurs from 308 to 350 m at temperatures from approximately 80° to 150° C. Chlorite first appears at 355 m, where present temperatures are greater than 158° C. Isolated occurences of smectite are present at 380 and 417 m, where temperatures are probably higher than 158° C. There are no mixed-layer clays in RDO-1. Chlorite appears to be the clay mineral in equilibrium with the present waters below 355 m, and smectites either have not had time to react or have been shielded from the hydrothermal fluids by their location in small vesicles and in groundmass pore spaces.

Trace amounts of hematite that occur with chlorite below 393 m are more dependent upon local increases in oxygen fugacity than temperature.

COMPARISON OF RDO-1 AND N2

RDO-1 and N2 correlate well lithologically, as would be expected from their close proximity (Figure 3). The cores from N2 served as a guide for interpreting the cuttings from RDO-1. Intervals from the lower part of RDO-1 that could have been interpreted as lava flows were correlated with cores from N2 containing large volcanic lithic fragments.

Measured temperatures are consistently hotter in RDO-1 than at equivalent depths in N2 (Figures 4 and 8). The occurrence of hexagonal pyrrhotite in RDO-1 is suggestive of higher temper-

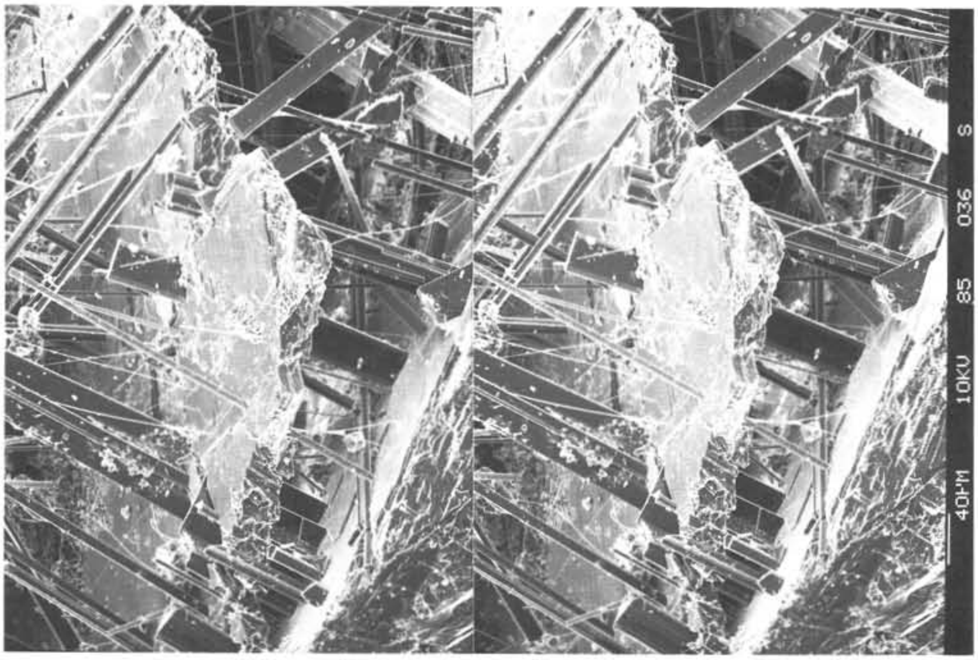


Figure 5. Scanning electron photomicrographs (stereo pair) showing bladed calcite and fibrous mordenite from a depth of 393 m.

atures than are found in the upper 500 m of N2, where pyrrhotite is monoclinic (Bargar and Keith, 1984). One bladed calcite sample from 390 m in RDO-1 was studied for oxygen and carbon isotopes for comparison with N2 carbonates. Assuming the same water occurs at this depth in both drill holes, calculated temperature of deposition of the bladed calcite is 220° C (Carothers and others, in preparation), which is higher than any measured temperature in RDO-1 but which corresponds to the temperature extrapolated by projecting the measured gradient to the aquifer depth by Black and others (1984) (Figure 4).

Rocks in both drill holes are virtually unaltered to approximately the 300-m depth; present temperatures between the surface and 300 m reach a maximum of about 40° C in N2 and 45° C in RDO-1. Incipient alteration in the basaltic sandstone, siltstone, and mudstone unit is similar in both holes where calcite and aragonite occur. Analcime in RDO-1 occurs very close to the same depth where analcime and other zeolites occur in N2 (Bargar and Keith, 1984). Only a trace of siderite is found in RDO-1, whereas it is abundant in N2; in both, it is a late mineral. The one occurence of rhodochrosite in RDO-1 appears to be codepositional with siderite; microprobe analyses of siderite crystals in N2 consistently show a large manganese component (Bargar and Keith, 1984). Calcite is the prominent carbonate in RDO-1, whereas siderite is prominent in the corresponding interval of N2.

In N2, a rhyodacite sill between 460 and 470 m interrupts the alteration mineralogy through a long interval of pumice and lithic tuff extending from 320 to 500 m (Figure 8). A higher temperature assemblage of quartz, calcite, chlorite, mordenite, pyrrhotite, and pyrite is superimposed upon a lower temperature assemblage of hydrated pumice glass and smectite assemblage between approximately 435 and 490 m. The intrusion of the rhyodacite sill could have caused the higher temperature mineral crystallization, or the fractures in the sill may have been sufficient to allow flow of thermal waters similar to that in RDO-1 at some time in the past. Later siderite, pyrite, and marcasite with locally developed native sulfur and iron hydroxide from oxidizing pyrrhotite occur in fractures in the massive rhyodacite sill, indicating that temperatures have decreased. Isotope data from N2 show that siderite was deposited at present measured temperatures, which range from 76° to 100° C (Carothers and others, in preparation). Present temperatures in the rhyodacite sill reach a maximum of 95° C, and the temperature maximum for the 320-to 500-m interval is 100° C at 415 m in the pumice and lithic tuff just above the sill. The rhyodacite sill is not penetrated in RDO-1, although stratigraphic correlation suggests that it might be present below total depth.

Alteration mineralogy in the pumice and lithic tuff breccia of RDO-1 samples below 328.6 m consists mainly of large, well-developed crystals of calcite, chlorite, quartz, and mordenite; in

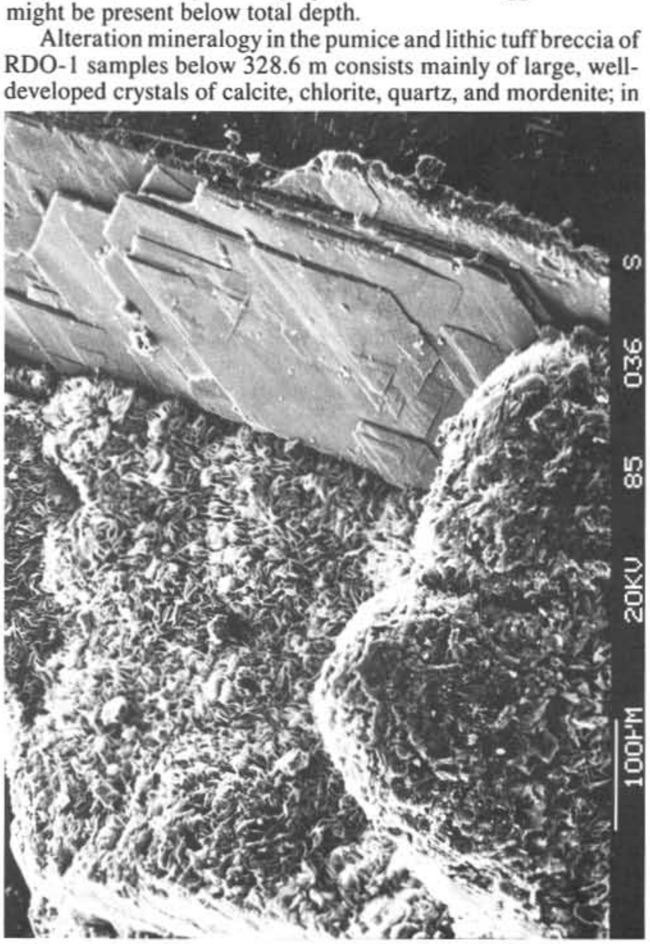


Figure 6. Scanning electron photomicrograph showing bladed calcite with chlorite from a depth of 390 m. 1 cm = 67 µm.

Figure 7. Scanning electron photomicrograph of twinned hexagonal pyrrhotite crystals from a depth of 335 m. 1 cm = 50 µm.

N2 adjacent to the rhyodacite sill, the same minerals occur, but they are fine grained. Large, hydrothermally deposited crystals in RDO-1 indicate open fractures or spaces between large lithic fragments, as opposed to small fractures and pore filling in N2.

The hot-water aquifer of RDO-1 is within the highly fractured or open-textured interval of the pumice and lithic tuff breccia between 379.5 and 397 m; in N2, the temperature bulge occurs in the same lithologic interval. The aquifer of RDO-1 projects parallel to stratigraphy to the temperature maximum of 100° C at 415 m in N2. Since the hydrothermal mineralogy at this level in N2 is incipient smectite replacement of pumice glass along with late siderite deposition in open spaces, temperatures at this level in N2 have not been higher than 100° C and probably have not been as hot as 100° C for a very long time (otherwise smectite alteration would be more extensive). A problem of cooling from at least 158° C in RDO-1 to 100° C in N2 over only 0.5 km horizontal distance suggests the path of the fluids may have been diverted from N2. Since the zone of the rhyodacite sill in N2 was once hotter than at present, either part of the N2 system may have been self sealed so that hot fluids no longer have access, or the total amount of hot fluids in the system has decreased so they are no longer reaching N2. The rhyodacite sill itself might now be a low-permeability layer providing a base for an aquifer in both drill holes. In any case, RDO-1 appears to be closer to a major upflow zone for thermal waters upflowing from a caldera ring fracture to the southeast (Figure 1) as suggested by Black and others (1984).

CONCLUSIONS

Lithologies can be correlated between RDO-1 and N2, and comparison of measured temperatures and hydrothermal alteration mineralogy show that RDO-1 is consistently hotter for given depths than N2. In RDO-1, the chlorite, calcite, quartz, and mordenite assemblage below approximately 355 m crystallized at temperatures at least as hot as the highest measured temperature of 158° C at 350.5 m. The minerals were probably deposited

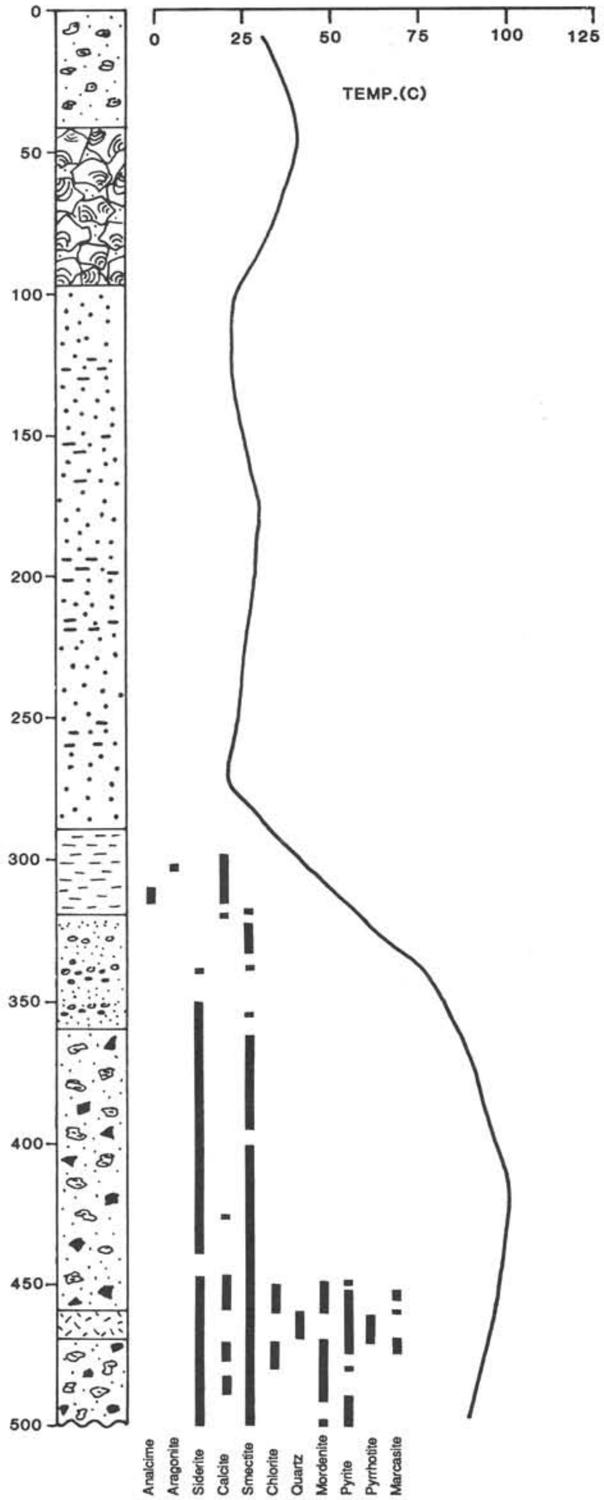


Figure 8. Lithology, hydrothermal mineral distribution, and temperatures measured during drilling plotted against depth for the upper 500 m of N2 (after Keith and others, 1984). Temperature data are from Sammel (1981). Lithologic symbols are as for Figure 3.

*(Continued on page 110, **Newberry**)*

Eagle-Picher diatomite mine and processing plant, eastern Oregon

by R.C. Brittain, Exploration Manager, Minerals Division, Eagle-Picher Industries, Inc., P.O. Box 12130, Reno, Nevada 89510

INTRODUCTION

Eagle-Picher Industries, Inc., has commenced production of diatomaceous-earth filter aids at a processing plant located 7 mi west of Vale, Oregon. Crude ore is hauled to the plant from mine sites located northwest of Juntura in Harney and Malheur Counties.

The capital investment for the project was $13.5 million, with the major part of financing provided by Industrial Development Revenue Bonds.

COMPANY HISTORY

Eagle-Picher Industries, Inc., is a diversified manufacturer of industrial products with shares listed on the New York Stock Exchange. The company was started in 1843 and until the 1940's was principally a lead and zinc mining and smelting firm. It has since diversified into manufacturing and no longer is producing lead and zinc.

A partial list of products produced by the various divisions includes construction equipment, agricultural chemicals, concrete pipe, porcelain enamel frit, flexible packaging materials, diatomaceous earth products, tire molds, precision bearings, cleaning machinery, special-purpose batteries, molded automotive components, vibration-dampening assemblies, specialty-rubber-bonded parts, and high-speed printing services.

The company's first diatomite plant began production in 1946 at Clark, Nevada, and is still producing oil and grease absorbents and a variety of other products. In 1958, the company started production of filter aids at a plant located near Lovelock, Nevada, and subsequently expanded the capacity of that plant to meet the demands of a growing market.

Products from the Nevada plants and the new plant at Vale are all marketed worldwide under the trade name of Celatom, and this name was selected as a name for the rail siding at the Vale site.

DIATOMITE: WHAT IT IS AND HOW IT IS USED

Diatomite, or diatomaceous earth, is a sedimentary material that is formed by the accumulation of microscopic siliceous skeletons (frustules) of diatoms, which are single-celled aquatic plants related to algae that live in large numbers in bodies of water where suitable conditions exist.

The diatom skeletons are intricate structures with many submicron-sized pores and occur in a variety of sizes and shapes, with over 16,000 species having been identified.

Diatomite is normally white in color when exposed to oxidation and resembles chalk in color and texture. Because of a high ratio of voids to solids, it is light weight. When dry, a chunk of diatomite will float on water.

The chemical composition is amorphous silica, with impurities present in various amounts. Chemical impurities are primarily iron, calcium, aluminum, magnesium, and trace amounts of other elements. Physical impurities consisting of volcanic ash, clay minerals, and detrital material are common.

As an industrial mineral, diatomite has been used in a variety of ways, including filter aid, filler, absorbent, abrasive, anti-caking agent, insecticide carrier, catalyst support, and insulating material.

The most important use at the present time is for the production of filter aids that are used in the filtering of such liquids as corn syrup, beer, wine, raw sugar syrup, pharmaceuticals, edible oils, alginates, fruit and vegetable juices, dry-cleaning solvents, jet fuel, swimming pools, and municipal water.

Kadey (1983) has written an excellent article for the reader wishing more information on diatomite.

GEOLOGY

The diatomite deposits in the Juntura and Otis Basins are fossil diatomites that formed in fresh-water lakes during late Miocene and early Pliocene time. Because this was a period of intense volcanic activity, the lake waters had a high silica content, which was one of the required favorable conditions for the prolific diatom growth that developed and ultimately formed the deposits.

The bed rock underlying the sediments is an igneous complex of basalt flows and welded tuffs on which an irregular erosion surface developed prior to the deposition of the sediments. The deposits of economic interest are mostly under shallow overburden of gravel and soil. Erosion that followed extensive post-deposition faulting and uplift has removed any younger geologic units, such as the Drinkwater basalt and tuff members of the Drewsey Formation, that may have covered the diatomite at one time.

Beds of diatomite ranging in thickness from a few inches to 20 ft are separated by waste beds of volcanic ash, clay, or sandstone that are from a fraction of an inch to 10 ft thick. The dip of the beds is usually less than 15° but is locally steeper where disturbed by faulting or folding.

The thickness of the diatomite section is variable because of irregularity of the bed rock, varying conditions for diatom growth within the lakes, and post-deposition erosion. Thicknesses of 300 ft have been observed in drill holes in some localities.

The deposits of commercial-grade diatomite occur in several different locations on claims and leases covering 3,500 acres. Reserves are adequate for over 40 years of operation.

The diatomite is within the Juntura and Drewsey Formations as mapped and described by Gray (1956) and Shotwell and others (1963). These authors describe the geology and paleoecology of the Juntura Basin in detail.

MINING AND HAULING

The mining is by open-pit methods using rubber-tired scrapers and crawler bulldozers for the removal of overburden and stockpiling of ore.

The ore is mined and stockpiled at the mine site during the summer months and then hauled to the plant by trucks as required. The haulage distance is 70 mi from mine to plant.

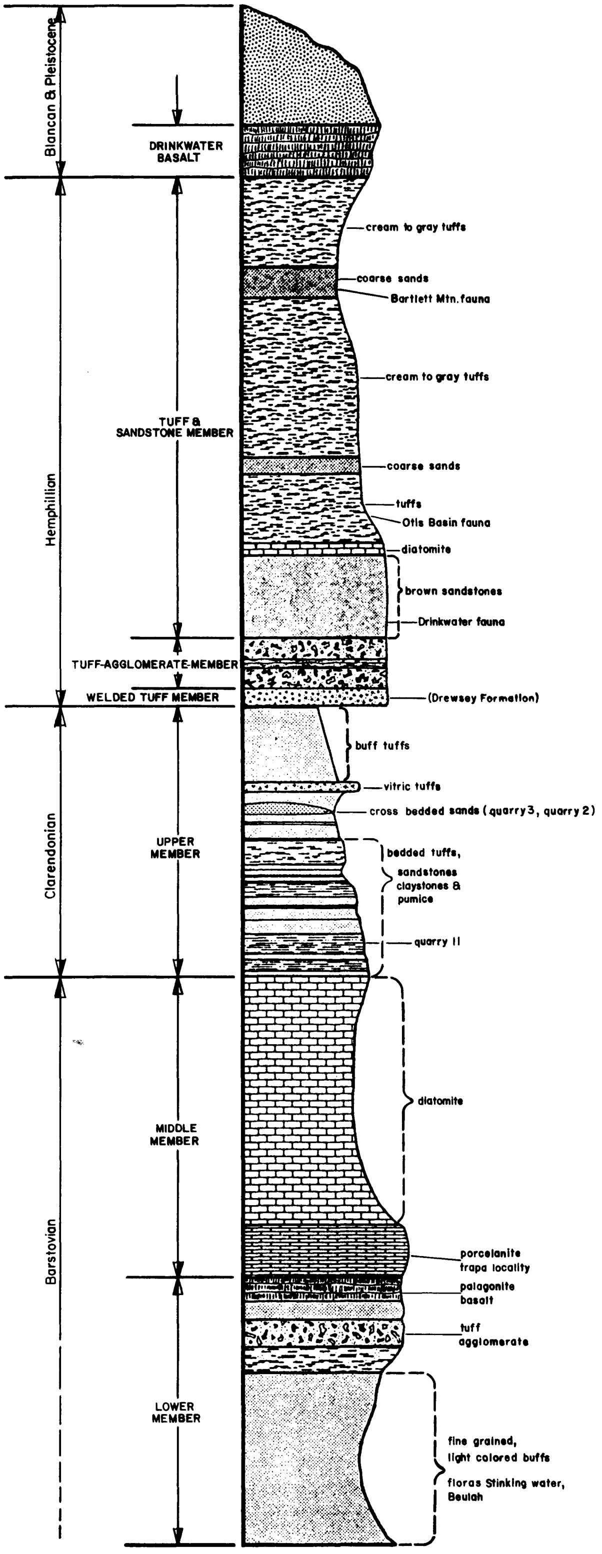
The crude ore has a moisture content of 40 to 50 percent that may be reduced some during the mining process by planning the mining to take advantage of solar evaporation.

An emergency stockpile of ore will be maintained at Vines Hill, which is about 7 mi west of the plant, so that the plant will have a ready supply of ore available in case adverse weather makes the mine roads temporarily impassable to the haulage trucks.

Some unusable beds of clay, volcanic ash, and impure diatomite must be selectively removed and placed in landfill areas or stockpiles for later use in reclamation. Careful control of ore grade through frequent sampling and close supervision is required.

PROCESSING PLANT

At the plant, the crude ore is crushed in a hammer mill and stored in fine-ore storage bins. As it is fed into the milling process from the bins, it is milled to a very fine consistency and simultaneously dried in an air system that also removes impurities and unmilled diatomite with specially designed classification equipment.



Geological sections of the Juntura and Drewsey Formations. Modified from Shotwell and others (1963). Vertical scale: 1 inch = 300 feet.

Soda ash is added to the cleaned diatomite as a fluxing agent, and the mixture is heated to incipient fusion in a rotary kiln at temperatures of 1,600° to 1,900° F.

After being discharged from the kiln, the diatomite is in soft lumps and must be milled again. It is then classified in an air system to control particle size and filtration properties in the various grades of filter aids that are produced.

The finished products are packaged in bags for shipment or may be loaded directly into rail cars or trucks in bulk form.

Waste materials removed from the diatomite are hauled back to the mine site for disposal in planned landfill sites or use in reclamation.

The plant is equipped with baghouses to remove dust particles from air that is discharged to the atmosphere and is designed to meet or exceed Oregon Department of Environmental Quality standards for air and water pollution.

RECLAMATION

The mining operation will comply with reclamation standards imposed by the Bureau of Land Management and the State of Oregon.

As planned, when mining begins in an area, all topsoil is carefully removed and saved in a stockpile area for later use in recovering mined-out areas and waste dump areas. Mined-out areas and waste dumps will be graded prior to covering with the topsoil. The areas then will be seeded with seed mixtures that have been determined to be beneficial in preventing erosion and that will provide forage for livestock and game animals. The best seed mixtures will be determined by planting test plots.

During mining, water samples will be taken from drainages in the area to monitor whether or not there is an increase in sediment or pollutants that might have an adverse effect on fisheries or downstream users of the water.

IMPACT ON AREA

The project will have a favorable effect in the area by helping diversify the local economy and by creating 30 to 35 new jobs. Four people have been transferred from other operations to manage the plant and mine. The balance of the work force has been hired locally.

The crew for the mining and crude-ore hauling is supplied by local contractors who have contracted to do this work. These activities will provide about six full-time jobs and seven seasonal jobs.

As a result of the plant construction, Cascade Natural Gas has built a natural-gas pipeline to serve both the plant and the Vale community.

Vale will receive the proceeds of a $675,000 Urban Development Action Grant loan to use for community improvements or to attract other industries.

The plant and mine are designed to be nonpolluting and will not have a significant adverse impact on the environment.

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Rapidly surging Alaska glacier seals off fiord and creates new lake

A "world class" natural event has begun in Alaska — the rapid surging of Hubbard Glacier that has sealed off Russell Fiord and could eventually fill Disenchantment Bay and Yakutat Bay with ice, according to a U.S. Geological Survey (USGS) scientist. "This event is probably the largest natural alteration in ocean, glaciers, lakes, and rivers to occur in North America within our lifetimes," Larry Mayo, a USGS glaciologist in Fairbanks, Alaska, said recently.

Mayo said measurements show that Valerie Glacier, a main tributary to Hubbard Glacier, is moving at rates of up to 130 ft per day at a point about 6 mi upstream from the end of Hubbard, although no measurements of movement have been made at the terminus. Ice calving at the terminus of Hubbard removes about 50 ft per day off the end of the glacier. The USGS scientist emphasized that, based on the geologic and hydrologic history of Hubbard Glacier, the process now going on "is not a temporary situation but is part of perhaps a thousand-year cycle that encompasses major changes in the hydrology of a large and compex system." The glacier has been in an advancing stage since 1900 but began surging forward rapidly during the winter of 1985-86.

The rising water level in Russell Fiord behind the dam formed by the glacier eventually could cause the water to overflow the dam, resulting in a sudden "outburst flood" that could wash away part of the dam and quickly lower the water level in the fiord, which is now being called Russell Lake. The entrance to the fiord was off Disenchantment Bay, which forms a narrow inner arm off the larger Yakutat Bay.

Hubbard and Valerie Glaciers are in the Wrangell St. Elias National Park, but Hubbard Glacier is surging into the Russell Fiord Wilderness Area in the Tongass National Forest. Mayo said the community of Yakutat on the Pacific Ocean coast at the mouth of Yakutat Bay would not be endangered, but saltwater fish and wildlife trapped in Russell Lake probably are doomed as the oxygen in the lake water becomes depleted.

Mayo said Hubbard is only one of about 20 glaciers that are presently surging in the area where the southeastern Alaska Panhandle connects with the main part of the state, but it is having the most dramatic effects. He said scientists don't fully understand why these glaciers are suddenly moving forward rapidly, while others in the area are not surging.

The exact reasons why glaciers surge or retreat are little understood, Mayo said, but scientists are working to solve the mystery. He said one thing being looked at is the possibility that surges are triggered by unusually deep snowpacks on the tops of glaciers.

Mayo said studies of the geologic and hydrologic history of Hubbard indicate that, during cycles of about a thousand years or longer, the glacier alternately retreats and advances. About 800 years ago, the glacier extended all the way to the sea at the mouth of Yakutat Bay and filled both Disenchantment Bay and Yakutat Bay, and there is no reason to believe that the glacier, during its current cycle, won't do the same thing within several hundred years.

Mayo said Hubbard Glacier's advance and its closing of Russell Fiord offer unprecedented opportunities for scientists to study its relationship to climate, oceans, rivers, lakes, fish and sea mammals, timber, engineering works, and people, as well as hydrology and geology. The enlarging glacier will gradually alter climate locally in the region. There are also indications that residual salt in Russell Lake may enter the local ground-water system and affect the water quality of small streams in the area.

— USGS press release

GSA announces leaders for centennial meeting in 1988

The Geological Society of America (GSA) will celebrate its 100th annual meeting, October 31 to November 3, 1988, in Denver with a special array of programs. The society recently announced the names of persons who will be chairing or coordinating the various parts of the celebration meeting.

William W. Hay, A.R. "Pete" Palmer, and Samuel S. Adams will coordinate the vast technical program for the meeting of over 6,000 earth scientists. Field trips, which will focus on classic geology or geologic problems about which our understanding has changed over the past 100 years, will be organized by Harry A. Tourtelot and Omer B. Raup. The science theater program will be led by U.S. Geological Survey geologist Kathleen M. Johnson and the transportation program by Charles F. Kluth. Technical Services Chairman William W. Atkinson, Jr., will coordinate audio-visual needs and student involvement for the meeting; Ester R. Magathan will coordinate special events and Jackie Meisner and Barbara Curtis the guest program.

—GSA news release

(Newberry, continued from page 107)

in the present hydrothermal regime. A similar mineral assemblage between 448 and 485 m in N2 is associated with a rhyodacite sill, showing that higher temperatures once existed in this part of N2.

The hot-water aquifer between 379.5 and 397 m in RDO-1 correlates with the 100° C temperature maximum at 415 m in N2. The temperature change from 158+° C to 100° C in the aquifer between the two drill holes over a distance of half a kilometer indicates that the water may not flow directly between them. Either the water has cooled in a very short distance, or it has been diverted from N2.

This study supports the conclusions of Sammel (1981, 1983) and Black and others (1984) that, relative to N2, RDO-1 is closer to a caldera ring fracture system shown by MacLeod and others (1982), where upflowing thermal waters are apparently moving upward along the ring fracture system and then spreading laterally through permeable layers within the caldera.

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