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ORIGIN OF OREGON PRICEITE

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Despite the fact that priceite was first described as a new mineral from Lone Ranch, Curry County, Oregon, and that the mineral was commercially mined in 1892, very little is known concerning its occurrence or origin. The tunnels, now caved, are all in serpentine, which makes this occurrence for priceite unique. A colloform white mineral found on the surface and often mistaken for priceite is calcite, which frequently contains a minute core of priceite.

The origin of the priceite is probably related to the intrusion of a prominent rhyolite dike which parallels the priceite zone. This dike is unusual in that it contains graphite disseminated throughout most of its length. Reaction of this intrusive and its boron emanations with a concealed calcareous rock probably accounted for both the graphite and the preceite.

Spectrographic studies show the presence of boron in the rhyolite, and several elements such as strontium and copper occur in unusual concentrations in both the rhyolite and priceite, confirming to some extent their genetic relationship.

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RECORD IDENTIFICATION
  RECORD NO.............  M013596
  RECORD TYPE...........  XIN
  COUNTRY/ORGANIZATION.   USGS
  FILE LINK ID..........  CINSV
  MAP CODE NO. OF REC..

REPORTER
  NAME............................  LEE, W
  DATE............................  74 01
  UPDATED.........................  81 04
  BY..............................  FERNS, MARK L. (BROOKS, HOWARD C.)

NAME AND LOCATION
  DEPOSIT NAME..................  LONE RANCH PRICEITE

  COUNTRY CODE..................  US
  COUNTRY NAME:  UNITED STATES
                                        Chetco
  STATE CODE................  OR
  STATE NAME:  OREGON

  COUNTY....................  CURRY
  DRAINAGE AREA.............  17100312 PACIFIC NORTHWEST
  PHYSIOGRAPHIC PROV........  13 KLAMATH MOUNTAINS
  LAND CLASSIFICATION.......  01  30

  QUAD SCALE          QUAD NO OR NAME
   1: 62500             CAPE FERRELO

  LATITUDE            LONGITUDE
   43-26-05N            124-20-30W

  UTM NORTHING        UTM EASTING          UTM ZONE NO
   4809750.4            391413.4             +10

  TWP......  40S
  RANGE....  14W
  SECTION..  22
  MERIDIAN.  W.M.

  POSITION FROM NEAREST PROMINENT LOCALITY:  NE1/4

  LOCATION COMMENTS: SURFACE RIGHTS HELD BY STATE OF OREGON AND IS NOW A STATE PARK.

COMMODITY INFORMATION
  COMMODITIES PRESENT..........  B
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EXPLORATION AND DEVELOPMENT
  STATUS OF EXPLOR. OR DEV.   8

DESCRIPTION OF DEPOSIT

DEPOSIT TYPES:
  UNKNOWN
FORM/SHAPE OF DEPOSIT:

SIZE/DIRECTIONAL DATA
  SIZE OF DEPOSIT......   SMALL
COMMENTS(DESCRIPTION OF DEPOSIT):
  HYDROTHERMAL DEPOSIT?

DESCRIPTION OF WORKINGS
  UNDERGROUND

COMMENTS(DESCRIP. OF WORKINGS):
  480 FOOT MAIN TUNNEL

PRODUCTION
  YES

CUMULATIVE PRODUCTION (ORE,COMMOD.,CONC.,OVERBUR.)

ITEM	ACC	AMOUNT	THOUS.UNITS	YEAR	GRADE,REMARKS
15 ORE	EST	0000.580	TONS	1890-1892	$23/TON

RESERVES AND POTENTIAL RESOURCES

ITEM	ACC	AMOUNT	THOUS.UNITS	YEAR	GRADE OR USE
1 ORE	EST	0005.000	TONS	1892	BORATE

GEOLOGY AND MINERALOGY

AGE OF HOST ROCKS.............   JUR
HOST ROCK TYPES...............   SERPENTINE

AGE OF ASSOC. IGNEOUS ROCKS..   JUR?
IGNEOUS ROCK TYPES...........   RHYOLITE DIKE

PERTINENT MINERALOGY.........   ARAGONITE

*The Occurrence of Priceite in Oregon**

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BORAX AND THE BORATE MINERALS are associated in the minds of most people with the desert, especially with Death Valley. It is therefore interesting to note that in the summer of 1872 a deposit of borate was mined in Oregon, within a stone's throw of the Pacific Ocean. This was about one year before borax was discovered in Death Valley and some seven years prior to its first extraction from this California locality.

The Oregon occurrence contained the mineral priceite and this is noteworthy because priceite not only was first discovered and described from this locality, but was also the first new mineral ever found in and described from Oregon. With such an unusual background, the deposit, one might assume, would be well known and thoroughly studied; but, as a matter of fact, very little has been written about it and much of this is incorrect. For an example, it has been recently stated (*1*) that priceite "was first reported from the Gobi Desert in China."

LOCATION

THE PRICEITE DEPOSIT is located in Curry County, Oregon, in Section 22, T. 40 S., R. 14 W., where Lone Ranch Creek (formerly called Cresswell Creek) empties into the Pacific Ocean. To reach the Lone Ranch deposit, one leaves the Pacific Highway (U.S. 101) exactly 8 miles north of the north boundary of Brookings and then follows a dirt road for about 4 miles toward the ocean.

* Presented at the annual meeting of the Oregon Academy of Science, Willamette University, Salem, Oregon, January 17, 1948.

This road has steep grades, and one must go through four gates and ford Lone Ranch Creek to reach the deposit. In wet weather, the road is impassable, and at no time is it an easy trip, contrary to the impression gained from a recent account (*2*) which stated, "The locality is very near the highway (U.S. No. 101) at the town of Brookings."

The writer had an opportunity to study this deposit during the summer of 1947, in connection with appraisal work on mineral lands formerly owned by the Chetco Indian Tribe. At the time of this visit, Everett Isenhart and his family were living at the mine, having leased the property for ranching purposes from the owners, the Pacific Coast Borax Company. The writer wishes to express his thanks to Mr. Isenhart for permission to visit the old workings.

History

IN ADDITION to the information obtained from the early accounts of the priceite locality (see "Literature Cited"), two other sources supplied the writer with historical data. One of these was the records at the Curry County courthouse at Gold Beach. The other source of information was Delmer Colegrove, who was able to offer valuable information since he worked in the mines during their operation about fifty-eight years ago.

About 1862, John and Emma L. Cresswell settled on a ranch north of what is now Brookings, and because their ranch was 5 miles from the nearest neighbor, they called it "Lone Ranch." John Cresswell noticed an outcrop of a kind of "chalk" on the banks of Lone Ranch Creek, about 500 yards from the ocean and 20 feet above the creek level. Chalk was in demand in this region, and the material was soon in use by carpenters and by coopers at fisheries on the Rogue River.

George S. Harris—who, the records indicate, bought some land in 1878 from the Cresswells—thought that he and Cresswell could mine the white mineral, which by this time had been shown to be a borate. They attempted to sink a 75-foot shaft but had difficulty with water and finally gave up. In 1885, the Cresswells sold 897 acres of their land, containing the borate deposit, to Dennis Tryon for $6,000. Subsequently, the property was obtained by Mary and Frank Smith, who in turn sold it in 1890 to the Pacific Coast Borax Company, the present owners. This company operated the mine both directly and on a lease basis.

While the activity described above was taking place in Curry County, mineralogists were showing considerable interest in the borate mineral. The first technical account of the occurrence at Lone Ranch was in April, 1873, by Lt. A. W. Chase, whose attention was attracted to the mineral because it provided an excellent polish for silver. In the previous year, some of the mineral had been sent to San Francisco, where H. G. Hanks, a chemist, studied it, noted its rhombic character and lack of diatoms, and claimed it identical with cryptomorphite. Chase (3) reported an analysis by Thomas Price and concluded that "it might be called a new variety." He deserves credit for being the first to report that this was a new mineral. However, it was Benjamin Silliman, famous Yale mineralogist, who, having received a specimen of the material in March, 1872, from Thomas Price, a metallurgist of San Francisco, studied the mineral and stated definitely that it was not cryptomorphite, because it lacked soda. Silliman claimed that it was a new mineral and proposed the name "priceite" for it in honor of Mr. Price (*11*). This paper was published only four months after the account by Lt. Chase.

Description of Priceite

As has been mentioned, it was first thought that priceite was a variety of cryptomorphite. Silliman proved that this could not be true, as sodium was lacking, and later work showed the formula to be $5CaO\ 6B_2O_3\ 9H_2O$. A mineral of similar composition from Panderma, Turkey, called "pandermite," was shown by Larsen (9) to be identical with priceite; and, as the name "priceite" had priority over "pandermite," the name "priceite" was the one retained.

For many years fine-grained specimens of borate minerals from Death Valley and other California localities were labeled "priceite." Many of these were howlite, a silico-borate of calcium, and it was not until 1924 that Foshag proved that some nodules from a shale in Furnace Creek wash, Inyo County, California, were actually priceite. The near-surface material resembles the Oregon priceite, but most of the material seen in collections is dense and compact like the Panderma material.

The priceite available now at Lone Ranch is of the soft, chalky variety, so fine that it is almost powdery. At many places on the surface, there occur harder colloform masses which might easily be confused with priceite, but which are calcite. Some of this material was noted in 1873 by Silliman, who stated: "Miners frequently mistook mammillary aragonite for the priceite." Optical methods prove the carbonate to be calcite. The origin of these peculiar forms which resemble priceite aroused the writer's curiosity, and, as suspected, there was found a center core of priceite which remained after dissolving off the calcite in hydrochloric acid. As it was not possible to study the underground occurrence of the priceite, it cannot be determined whether these colloform specimens represent accretion of calcite on priceite or alteration of priceite to calcite, starting from the outside. Either explanation could account for the form.

With the microscope, a simple and effective qualitative microchemical test can be made for priceite and similar calcium borates. If a fragment of the mineral is immersed in a few drops of warm dilute sulfuric acid on a microscope slide and is observed after about five minutes, it will be seen that crystals of microchemical gypsum have formed as a hairy coat on the mineral fragment. In addition, boric-acid crystals will be precipitated and appear throughout the liquid as hexagonal plates and doubly refracting branching forms. These tests have been described in detail by the writer (*12*).

OCCURRENCE AND PRODUCTION

THE OLD ACCOUNTS do not give a very clear picture of the occurrence of priceite. Chase described it as occurring both as layers of hard white borate, filling seams and cavities of slate, and as boulders or rounded masses completely imbedded in steatite. Above these, are "soft green clay" or "talc" and "black slate." As for the "boulders" of priceite, Chase reported that they were touching each other and were of uniform size in the main "flow," weighing up to 450 pounds each. Branching off from the main deposit were side "flows" where the boulders ran from 20 pounds down to pellets the size of a pea or smaller.

At the time of the writer's visit to this area, very little could be seen of the old mine workings because of caving. The fact that the tunnels were in serpentine hastened their collapse. One tunnel on the south side of the creek is still open, but there is water in it, and a bad cave-in at about 60 feet from the portal makes exploration unsafe. As a result, all that one can infer of the underground geology is that the priceite is associated with serpentine. White areas on the surface indicate old dumps, now thoroughly decomposed, where vegetation has been unable to obtain a foothold. The country rock containing the serpentine and priceite is sandstone and conglomerate. In spite of the fact that it was impossible to go underground, it seems evident from the surface geology that Chase confused serpentine with several other types of metamorphic rocks.

As the workings are badly caved and yield no information, the writer was fortunate in obtaining firsthand information concerning the deposit from Delmer Colegrove, owner of the Colegrove ranch. Mr. Colegrove recalled that the longest tunnel driven on the property was about 480 feet long. This reached the priceite at about 150 feet, where it was very bouldery, and, after passing through some 15 feet of it, the tunnel was barren for about 75 feet. Then a second concentration of priceite was encountered, and Mr. Colegrove thought this might represent the other limb of a mineralized syncline.

During mining operations, the priceite was broken up and sacked in 100-pound sacks, taken to the wharf constructed at the beach, and shipped to San Francisco. At present, there are only a few remnants left to indicate the former location of the wharf and mine houses. See Figure 1.

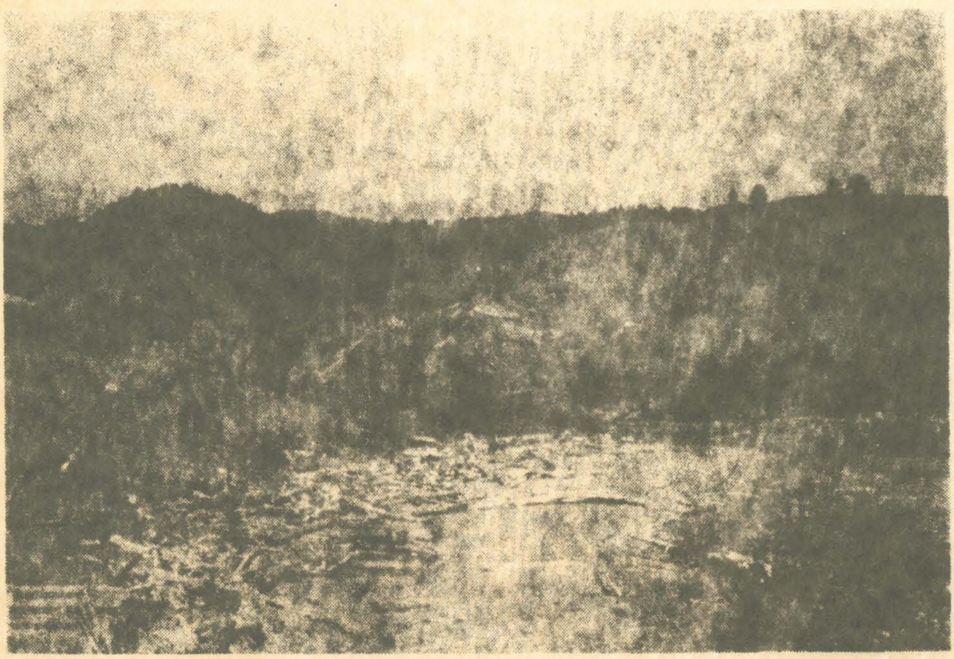

Fig. 1.—Photograph of Lone Ranch Creek entering the ocean, taken from site of old wharf. White areas on hills show old workings. Mine camp was located near ranch house on low terrace at right side of picture.

Most of the records of the mine were lost in the 1906 earthquake and fire at the San Francisco offices of the Pacific Coast Borax Company. It is known that at the peak of operations some forty miners were leasing, and Chris Christensen was one of the most fortunate and able of these. He opened considerable reserves, and then the operation was stopped by litigation over the leases.

This closure was in 1892. Gale reports that about 580 tons of priceite were mined in 1891 and 1892 and the company paid $23 per ton for it (*8*). At the time of closure, there was supposed to be some 3,600 to 5,400 tons of borate blocked out.

Origin of the Priceite

As HAS BEEN NOTED, the origin of the priceite has never been satisfactorily explained. We can safely assume that the origin of the boron was related to volcanic activity. Evidence of this mode of origin is plentiful; for example, boric acid (sassolite) is found at Vesuvius and in large quantities in the crater of Vulcano in the Lipari Islands. In addition, numerous hot springs are known to have a high boron content, and at Steamboat Springs, Nevada, the B_2O_3 content has been reported as high as 9 per cent of the dissolved solids.

The processes by which the original volcanic boron is finally concentrated as commercial deposits of borate minerals are numerous; and many papers have been written to attempt an explanation of the various deposits. In general, these explanations call for deposition from lakes or lagoons during periods of evaporation. Thus the large deposit of priceite (pandermite) in Turkey, which consists of compact material like the better-known Death Valley priceite, was thought by G. Linck to have been formed as an amorphous precipitate from boraciferous waters of lagoons and then crystallized (*10*). Foshag, who described the Death Valley priceite, believed it was deposited in a similar way, as it has a metacolloidal character (*6*).

As the Oregon priceite is found in serpentine, the origin suggested for the occurrences at Death Valley and Turkey is not acceptable here. Chase (*3*) described the Oregon priceite as being formed from "a spring of boric acid in the crater of a mud volcano." No reason was given for arriving at this conclusion. Gale (*8*), in discussing this priceite, concluded that it was deposited from ground water which carried boric acid and reacted with "an available base." He also suggested what seems an unlikely possibility, namely, that the spray of sea water carrying calcium chloride may have had some precipitating effect. However, it is possible that the ground water was saline and aided in the precipitation of priceite from the calcium-borate solutions, a chemical reaction proved by Van't Hoff to be demonstrable in the laboratory.

The presence of a second deposit of priceite and the occurrence of an unusual rhyolite dike, both in the Lone Ranch area, may provide new clues to the origin of this deposit. Delmar Colegrove reports that priceite was definitely known on Whalehead Creek (about 4 miles north of Lone Ranch), but slides covered this small exposure some twenty years ago. It is interesting to note that a line connecting the reported location of this priceite and the Lone Ranch occurrence is almost parallel to a prominent rhyolite dike. The writer first had his attention called to this dike by Willard Colegrove, then a student at the University of Oregon. He prepared a paper on the dike and showed that it contained graphite over most of its 10-mile length, from Brookings to a place north of the Colegrove ranch. Willard Colegrove thought that the graphite in such an unusual occurrence might be explained as being due to a magmatic origin. The presence of a sandstone country rock and the lack of any considerable amount of limestone in the region seemed to indicate that the graphite could not be explained as being due to a reaction of the rhyolite magma with limestone. This latter explanation for graphite has been discussed by Clark, who maintained that because limestone frequently provides CaO for silicates, such as scapolite and diopside, the remaining CO_2 might furnish material for graphite (*4*).

The possible presence of calcareous rocks in the area could readily explain both the priceite and the graphite. The former would be due to the reaction of boric acid with calcium carbonate, producing a hydrous calcium borate, and the latter would be formed as suggested by Clark. Although it is known that boric acid is an extremely weak acid, and, when cold, will not react with calcite, yet, under the conditions of hot-spring action, it is volatile and carried by steam. Under these conditions and given ample time, it might be expected to react more readily. Foshag (5) states: "These reactions are possible for although boric acid is a much weaker acid than carbonic, the greater volatility of the latter may allow replacement to take place in concentrated and hot solutions of boric acid." There is also evidence of the reversibility of the reaction, the alteration of colemanite to calcite being common; and possibly the change of priceite to calcite observed at Lone Ranch is also evidence of this reaction. The geology of this area has not yet been mapped in detail, and although no calcareous rocks are definitely known, there is a good likelihood that they are present, although concealed. Whether this also has a bearing on the origin of the nepheline syenite at Mt. Emily (10 miles to the east) is not known.

An attempt has been made to study the presence of trace elements in the rhyolite and priceite by means of a large Littrow spectrograph to determine if there are any similarities that might indicate some genetic relation. Professor

Fred Paul of the University of Oregon Physics Department cooperated in this work, and the writer wishes to acknowledge his contribution to this study. The spectrograph reveals that the Oregon priceite has substantial amounts of iron and magnesium in it, possibly derived from the enclosing serpentine. This is in contrast to Death Valley priceite, which is very low in these, and is higher in silicon. The Oregon priceite also contains copper and strontium, and it is interesting to note that both of these are found in substantial quantities in the rhyolite. The rhyolite was also found to contain boron. Although these facts do not necessarily prove that there is any genetic relation between the borate deposit and the rhyolite—as the above-mentioned elements are somewhat ubiquitous—it does corroborate it to some extent and would lead one to conclude that the emanations responsible for the borate deposit affected both the serpentine area and the rhyolite zone and may have been closely associated with the intrusion of the rhyolite.

Conclusions

PRICEITE, WHICH IS KNOWN from only two localities in the United States, was first discovered in Curry County, Oregon. The occurrence at this locality is unique in that the mineral is found in serpentine. An unreported occurrence of the mineral to the north of the priceite mine permits determination of the direction of a possible zone of mineralization. The strike of this zone is found to be parallel to a prominent rhyolite dike, which, in itself, is very unusual in containing graphite disseminated throughout its entire 10-mile length. A genetic relation between the priceite and the rhyolite is postulated, and although no single piece of evidence in itself can be advanced at present to prove conclusively this relation, a combination of evidence strongly indicates the validity of the genetic hypothesis suggested here.

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