

PERICLASE FROM CRESTMORE NEAR RIVERSIDE,  
CALIFORNIA,\* WITH A LIST OF MINERALS  
FROM THIS LOCALITY

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One of the most famous mineral localities in the United States is Crestmore, near Riverside, California. Here the Riverside Portland Cement Company has been quarrying metamorphic limestone and altered granodiorite which are used in the manufacture of cement at a nearby plant.

At this locality nearly 70 different minerals have been found since quarrying operations began about 15 years or so ago. A list of these minerals will be found on page 469. A few more have been reported but they are regarded as uncertain. Of the minerals listed, the starred ones which number seven (wilkeite, crestmoreite, riversideite, plazolite, jurupaite, merwinite, and foshagite) were new minerals described from this locality; of these merwinite has since been found at Larne, Ireland, and Velardena, Mexico (12). Probably only two other American mineral localities, Franklin Furnace, N. J., and Branchville, Conn., have furnished more new minerals than Crestmore.

Appended to this article will be found a bibliography of publications relating to the mineralogy of Crestmore. Article 3 by Professor A. S. Eakle of the University of California contains the best general account of the Crestmore minerals.

Periclase or isometric magnesium oxide was first found in ejected blocks of limestone on Monte Somma, Vesuvius. It was described by Scacchi in 1841 under the name periclasia. The English equivalent of this is periclase, but some American mineralogists insist upon calling the mineral periclasite. Periclase is simpler and more euphonious and should be retained. As Cole<sup>1</sup> has well said “. . . . the terminology of minerals formerly possessed, for the founders of the science, as agreeable a variety as that of other branches of natural history. There seems no need to make technical language harsh by undue repetition of sounds that have no historic warrant.”

Since its original discovery, periclase has been found at ten other localities.<sup>2</sup> While it is a comparatively rare mineral, it seems to be widely distributed.

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<sup>1</sup> *Outlines of Mineralogy*, G. A. J. Cole, p. 169, London, 1913.

<sup>2</sup> Teulada (Sardinia), León (Spain), Predazzo (Tyrol), Nordmarken, Långban, and Tenneberg (Sweden), Pulpit Rock and River Don (Tasmania), Bogoslawsk district (Urals), and Riverside (California).

## DESCRIPTION OF THE CALCITE-BRUCITE ROCK OR PREDAZZITE.

I first found periclase at Crestmore in July, 1926, in what is known as the "Wet Weather" Quarry. It occurs in a calcite-brucite rock or predazzite. The predazzite is a white medium-grained crystalline (metamorphic) limestone with disseminated spots of a light gray mineral which proves to be brucite by chemical and blow-pipe tests.

The brucite spots are equant and vary in size from 1 to 3 mm. A thin section of the predazzite is shown in Fig. 1. For comparison a photomicrograph of predazzite from Fassathal, the type locality for predazzite, is shown (Fig. 2). Here the brucite spots are smaller, but more regularly distributed. It is no wonder that predazzite was described as a mineral by Petzholdt in 1843 when it is recalled that thin sections were not used at that time.

The brucite occurs not only in the definite areas described and figured (Fig. 1), but also in minute veinlets between these areas. Some of these veinlets definitely replace calcite.

The Crestmore brucite has a complicated scaly-concentric structure which is well brought out in Fig. 3. I say scaly-concentric rather than fibro-concentric structure since the elongation of the units is parallel to the faster ray and hence we have sections of basal plates and not fibers. (The optical character of brucite is positive).

The brucite shows anomalous interference colors; a peculiar reddish-brown hue takes the place of orange and red of the first order and first-order yellow is lacking. If the section is too thin the anomalous interference colors are not present.

**CHONDRODITE.** In addition to the brucite, the predazzite contains numerous small (0.03 to 0.35 mm.) colorless crystals of chondrodite. These are much rounded crystals, somewhat tabular parallel to {010}. Fig. 4 is a photomicrograph of some of the chondrodite grains which were isolated by dissolving the predazzite in very dilute hydrochloric acid. The rounded character is not due to solution in the acid, for the mineral grains in thin section also show a rounded outline. Many of the chondrodite crystals are twinned on {001} and are usually made up of 2, 3, 4, or 5 individuals, rarely more. Fig. 5 is a camera lucida drawing of a few of these twinned crystals of chondrodite. The chondrodite is identified by the indices of refraction ( $n_\gamma = 1.635$ ,  $n_\alpha = 1.605$ , determined by the immersion method) and by the maximum extinction angle of  $26^\circ$  in twinned

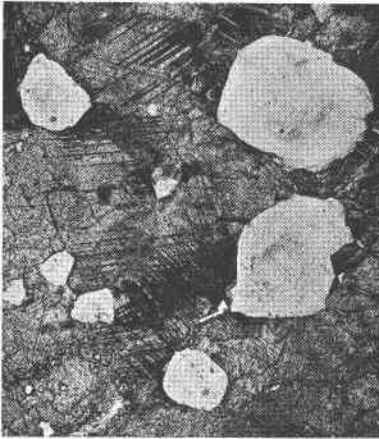


FIG. 1. (X18 diameters). Thin section of predazzite from Crestmore, California. Light areas = brucite



FIG. 2. (X30). Thin section of predazzite from Fassathal, Tyrol. Light areas = brucite.

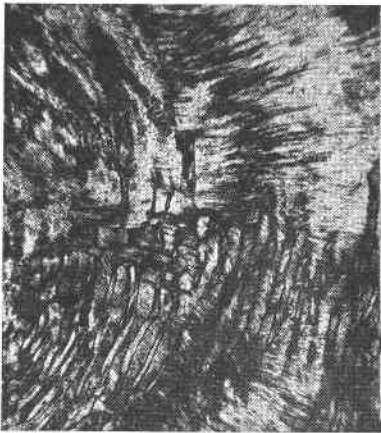


FIG. 3. (X100). Thin section of brucite showing scaly-concentric structure. (crossed nicols) Crestmore, California.

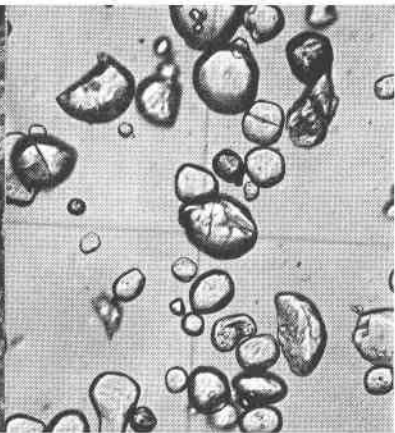


FIG. 4. (X60). Chondrodite crystals isolated from predazzite. The dark fragment in the upper right-hand corner is spinel. Crestmore, California.

crystals, where the trace of the twin-plane {001} is used as a reference line.

**WILKEITE.** Some thin sections of the predazzite contain a number of subhedral prismatic crystals of wilkeite. They vary in size from 0.3 mm. to 1.2 mm. In the hand specimen they are visible with a lens as minute, colorless, subhedral crystals. Ordinarily these crystals would be called apatite, for they show low first-order colors, elongation parallel to the faster ray, and rather high relief. The

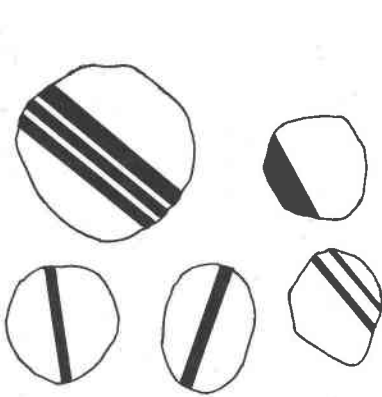


FIG. 5. (X90). Twin-crystals of chondrodite. {001} = twin-plane.

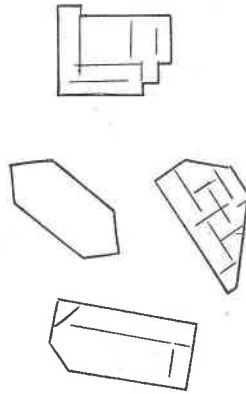


FIG. 8. (X40). Cleavage fragments of periclase.

nitric acid solution of the predazzite gives a wet test for the phosphate radical, and with 50% ethyl alcohol, microchemical gypsum is deposited from the nitric acid solution on cooling. Isolated fragments of the mineral also give the same tests. Only minerals containing calcium sulfate (which are anhydrite, bassanite, gypsum, polyhalite, thaumasite, glauberite, syngenite, haüyne, scapolite, and wilkeite) give microchemical gypsum from acid solutions. This is proof that the mineral is wilkeite and not apatite. This is confirmed by an index of refraction determination of 1.650.<sup>3</sup> The original wilkeite was found in a blue crystalline limestone with another rock type (predazzite).<sup>4</sup>

<sup>3</sup> The index of refraction for wilkeite ( $1.640 \pm 005$ ) given by Eakle and Rogers (Ref. 1, p. 264) is too low. The value should be  $n_\alpha = 1.650$ ;  $n_\gamma = 1.655$ . (Det. by the writer).

<sup>4</sup> The calcite-brucite rock described by the writer in his 1918 paper (4) contains wilkeite and not apatite as reported. To make the test, dissolve some of the rock in dilute nitric acid, add 50% ethyl alcohol, and then drop in another fragment of the rock. The solubility is diminished and gypsum is precipitated.

SPINEL. The predazzite also contains a few minute (about 0.1 mm.) olive-green isotropic grains of spinel. (See Fig. 4).

HYDROMAGNESITE. On and near the surface of some of the blocks of predazzite, the brucite is altered to a white, nearly opaque mineral which is identified as hydromagnesite.

The predazzite from the "Wet Weather" Quarry is similar to the one from the Chino Hill quarry described by Eakle (3) and Rogers (4), except that the brucite aggregates are smaller. No periclase was ever found in the Chino Hill specimens though Eakle (3) came to the conclusion that the brucite had been formed from periclase.

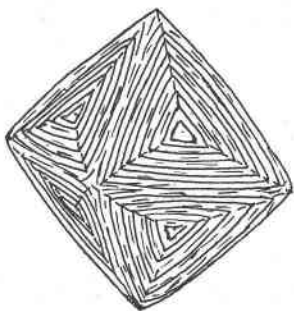


FIG. 9. (X30). Form of the original periclase crystals, now converted into brucite.

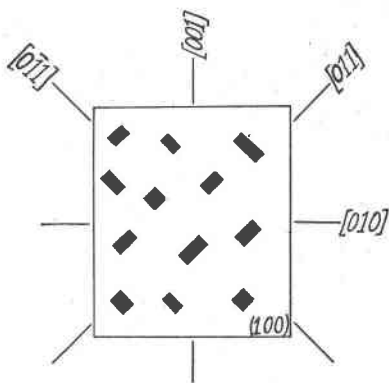


FIG. 12. (X15). Inclusions of magnetite in periclase.

#### DESCRIPTION OF THE PERICLASE.

The periclase is found as cores within some of the brucite aggregates, as shown in Fig. 6. The mineral is pale gray to almost colorless with a subadamantine luster and reaches a maximum size of about a millimeter. The mineral is similar to the Riverside periclase described by the writer (4) a decade ago. Crushed fragments of the periclase are clear and colorless, with a square or rectangular outline as shown in Fig. 8. They have a perfect cubical cleavage and a dodecahedral parting. They are dark between crossed nicols and have an index of refraction slightly greater than 1.74. The fragments are soluble in hot dilute hydrochloric acid and give a microchemical test (struvite) for magnesium with  $\text{NH}_4\text{OH}$  and  $\text{Na}_2\text{HPO}_4$ .

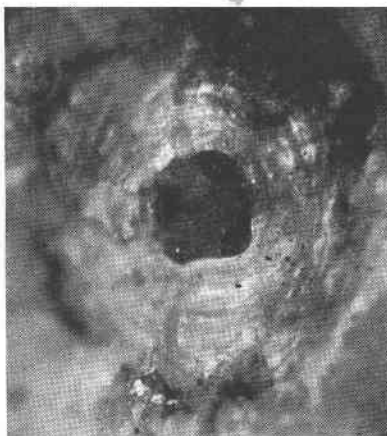


FIG. 6. (X16). Hand specimen. Periclase core surrounded by concentric layers of brucite. Crestmore, California.

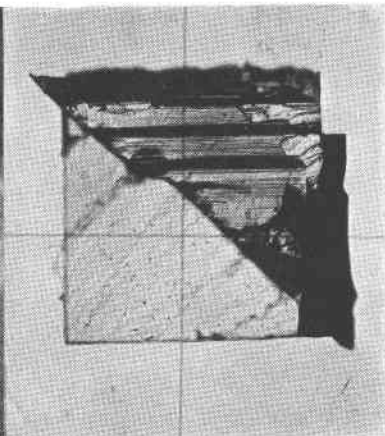


FIG. 7. (X12). Artificial periclase, showing cubic cleavage and dodecahedral parting. If the plate is taken parallel to (001), the horizontal lines represent parting parallel to (101).

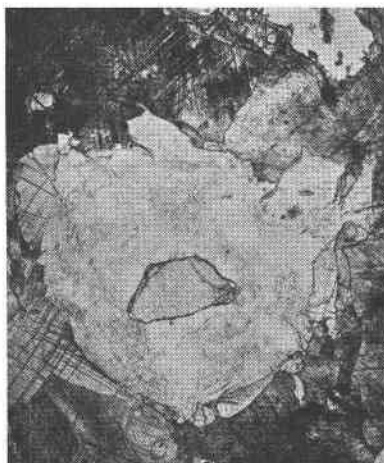


FIG. 10 (X25). Thin section of predazite showing core of periclase in brucite aggregate. Crestmore, California.

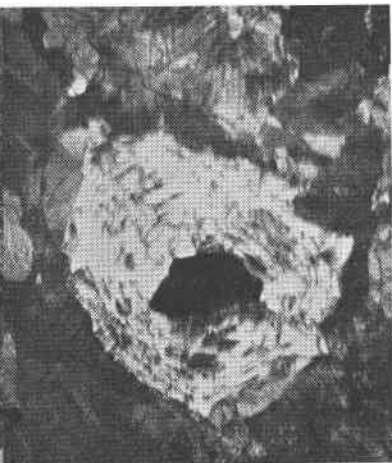


FIG. 11. (X25). The same as Fig. 10, but taken with crossed nicols.

Some of the periclase contain minute (0.007 to .02 mm.) black opaque inclusions of magnetite. With high magnification they are square or rectangular in outline, with the orientation shown in Fig. 12. These crystals are either octahedrons or dodecahedrons depending upon whether faces are developed in the diagonal zones  $[011]$  and  $[0\bar{1}1]$  or in the axial zones  $[010]$  and  $[001]$ . A careful examination, with reflected light thrown on the microscope stage from above, proves that faces are present in the diagonal zones and so the magnetite crystals are octahedrons.

As can be seen from Figs. 10 and 11, the brucite is clearly an alteration product of periclase and the periclase is a relict mineral from an earlier stage. Only a few periclase cores can be found within the brucite aggregates of the specimens collected. Out of about 100 brucite spots in ten thin sections only two contained any visible periclase. According to a rough statistical estimate made graphically, 100 brucite spots with periclase centers of the relative size of Fig. 10 should contain about 16 cores. This is practically proof that the alteration was in most cases virtually complete. This is one reason why periclase is such a rare mineral. The alteration of periclase to brucite is doubtless brought about by hydrothermal solutions at a stage a little later than the main period of metamorphism, which was essentially dedolomitization.

The original form of the periclase is well preserved in the brucite pseudomorphs. The crystals were similar to Fig. 9, that is to say, oscillatory combinations of the octahedron and dodecahedron with a slight development of the trisoctahedron. They very much resemble some diamond crystals.

#### NOTE ON ARTIFICIAL PERICLASE

Artificial periclase is better known than the natural mineral. It has been prepared by many investigators.<sup>4</sup> Fig. 7 is a photomicrograph of a cleavage fragment from a large (5 cm.) clear colorless cleavage block of artificial periclase, which was kindly lent to me by Mr. C. E. Hesthal, my colleague of the physics department. It shows dodecahedral parting as well as cubic cleavage.

Artificial periclase is now made on a commercial scale by the Vitrefrax Corporation of Huntington Park, near Los Angeles, California. It is produced from carefully selected magnesite in electri-

<sup>4</sup> For references see Hintze's *Handbuch der Mineralogie*, Vol. 1, 2d abth., p. 1888, 1915.

cal furnaces and is sold under the trade name "Sierra Periclase." It is said to be the most perfect electrical insulator known, but is too expensive to be used for many purposes. I am indebted to Dr. T. S. Curtis, research director of the Vitrefrax Corporation, for specimens of artificial periclase produced at their plant.

## LIST OF MINERALS FOUND AT CRESTMORE, NEAR RIVERSIDE, CALIFORNIA

(The numbers refer to the papers listed in the bibliography).

Graphite, 3	Malachite, 3	Prehnite, 3
Galena, 3	Azurite, 3	Chondrodite, 4
Sphalerite, 3	Hydromagnesite, 3, 4	Tourmaline, 3
Xanthochroite, 3	Anglesite, 3	Okenite, 3
Pyrrhotite, 4	Apatite, 3	Apophyllite, 3
Pyrite, 3	*Wilkeite, 1, this paper	Centrallassite, 9
Arsenopyrite, 3	Orthoclase, 3	Laumontite, 3
Chalcopyrite, 3	Microcline, 3	Biotite, 3
Bornite, 3	Oligoclase, 3	Phlogopite, 3
Tetrahedrite, 3	Labradorite, 3	Xanthophyllite, 2
Quartz, 3	Diopside, 3	Clinocllore, 3
Chalcedony, 7	Augite, 3	Deweylite, 4
Periclase, this paper	Wollastonite, 3	Thaumasite, 5
Opal, 3	Grossularite, 3	Titanite, 3
Hematite, 3	Monticellite, 2	*Crestmoreite, 3
Limonite, 3	Scapolite, 3	*Riversideite, 3
Brucite, 3, 4	Gehlenite, 8	*Merwinite, 8
Magnetite, 4	Vesuvianite, 3	*Jurupaite, 7
Spinel, 4	Zircon, 3	Custerite, 12
Calcite, 1	Datolite, 3	Spurrite, 5
Aragonite, 3	Epidote, 3	*Plazolite, 6
Cerussite, 3	Axinite, 3	*Foshagite, 10

\* The starred minerals were new minerals when described.

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|   | (8) Larsen, E. S. and Foshag, W. F., <i>ibid.</i> , vol. 6, pp. 143-148, 1921. | (12) Tilley, C. E., <i>Geol. Mag.</i> , vol. 65, pp. 371-372, 1928. |