1. Bementite, Olympic Range, Washington, Analyst, Steiger.
2. Bementite, Franklin Furnace, New Jersey, Analyst, Steiger.
3. Bementite, Franklin Furnace, New Jersey, Analyst, König.
4. Caryopilite, Pajaberg, Wermland, Sweden, Analyst, Hamberg.
5. Ectropite, Långban, Analyst, Naima Sahlborn.
6. Serpentine with cubic cleavage, Brewster, N. Y., Analyst, Friedel.

### Bementite and Serpentine Compared

The large cleavage pieces of bementite from Franklin have a striking similarity to the serpentine with cubic cleavage from Brewster, New York. The optical properties of such serpentine are given in Table 1 for comparison. The axial angle of this serpentine varies from nearly 0 to rather large and the birefringence from nearly or quite 0 to about 0.007. Large cleavage plates show rather uniform optical properties except that lamellae of rather strongly birefracting serpentine are present parallel to the cleavages. The material appears to be coarsely crystalline, but it may be made up of minute aggregates arranged so as to appear homogeneous.

As shown in Table 2 the molecular ratios for RO, $SiO_2$, and $H_2O$ for bementite and serpentine are rather near together. The similarity in physical and optical properties and in chemical composition is sufficient to suggest that bementite may be the MnO end of the serpentine series. The analyses of ectropite and caryopilite yield formulæ very similar to that of serpentine with MgO replaced by MnO.

## NOTES ON DACHIARDITE

### Harry Berman, *Harvard University*

D'Achiardi has described a supposedly new zeolite in the granite pegmatite of San Piero in Campo, Elba, associated with other zeolites, pink tourmaline, and feldspar, in a preliminary report[1] consisting chiefly of a chemical analysis and good photographic illustrations. He termed it provisionally "zeolite mimetica" from its characteristic mimetic structure. Lack of suitable material prevented a crystallographic and optical discussion of the material analyzed; however, he later published[2] an additional chemical analysis agreeing essentially with the first. The name dachiardite

[1] *Proc. Soc. Tosc.*, (Pisa) 14, **1905**.
[2] *Proc. Soc. Tosc.*, (Pisa) 22, 160, **1906**.

was proposed in honor of his father. A specimen labelled "dachiardite" presumably like the material originally described by D'Achiardi, is contained in the Harvard Mineralogical Cabinet, and was the basis of this further study.

The colorless crystals are small, 2 mm. or slightly more in diameter, and appear to be eight-sided prisms. On closer examination it is seen that each apparent crystal is a mimetic twin-group consisting of eight sectors; the tetragonal pseudo-symmetry is due to the attitude of the twin plane which is very nearly at 45° to the bounding planes of each sector (Fig. 1). Each sector is reëntrant toward the center of the eightling, giving a shallow cup-shaped
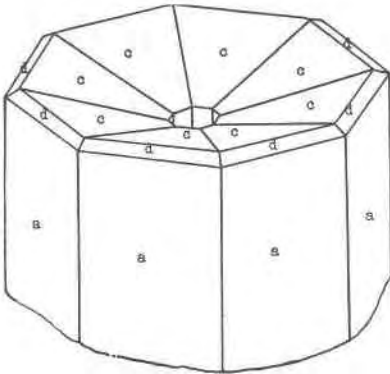


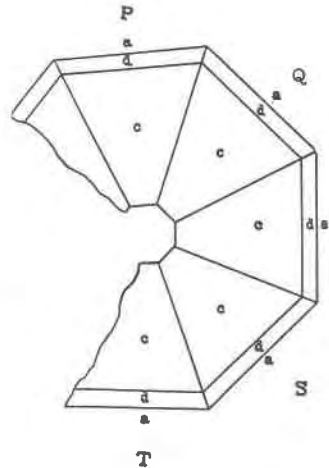Fig. 1. Twin crystals of dachiardite showing eight sectors.

Fig. 2. Orthogonal projection of dachiardite showing five sectors.

effect to the group. The center is hollow and bounded by faces parallel to those of the exterior. A third face bevels the edge between the reëntrant face and the outer prism of each sector. There was thus accessible to measurement on each sector one zone with three faces which proved to be of unlike quality and lustre. Since the mineral was known to be biaxial and has extinction parallel to each sector-edge, the only reasonable interpretation of the symmetry was that it was monoclinic with the plane of symmetry normal to the sector-edge. Accordingly the outer faces of the group were taken as orthopinacoid faces and the reëntrant faces as basal pinacoids.

No attempt was made to separate the individual sectors for measurement; the entire aggregate was mounted, with the prism zone vertical, on the two-circle reflecting goniometer. The group measured consisted of five sectors as shown in Fig. 2. In Table I, column 1, are given the goniometric readings of the aggregate adjusted as a single crystal. Column 2 gives the readings with the prisms of the more perfect sectors adjusted to 90°.

TABLE I

| | | Column 1. | | Column 2. | |
|---|---|---|---|---|---|
| | | H | V | H | V |
| P | a | 89°37′ | 104°05′ | 90°00′ | 103°57′ |
| | d | 39°09′ | 105°39′ | 40°17′ | do. |
| | c | 340°43′ | 99°30′ | 342°09′ | do. |
| Q | a | 89°35′ | 152°05′ | 89°20′ | 152°05′ |
| | d | 40°00′ | 154°00′ | 39°33′ | do. |
| | c | 342°19′ | 145°18′ | 342°11′ | do. |
| R | a | 89°29′ | 198°35′ | 89°29′ | 198°35′ |
| | d | 39°53′ | do. | 39°53′ | do. |
| | c | 342°17′ | do. | 342°17′ | do. |
| S | a | 90°00′ | 244°30′ | 90°00′ | 244°30′ |
| | d | 39°56′ | do. | 39°56′ | do. |
| | c | 342°12′ | do. | 342°12′ | do. |
| T | a | 90°00′ | 290°22′ | 90°00′ | 290°22′ |
| | d | 40°11′ | do. | 40°11′ | do. |
| | c | 342°04′ | do. | 342°04′ | do. |

Goniometer readings of five sectors (see Fig. 2) adjusted as one crystal in Column 1, and as individual sectors in Column 2.

H=horizontal circle readings.

V = vertical circle readings.

The tabulated angles show that the sectors R, S, and T (Fig. 2) are consistently regular in the angular relations of their respectively similar faces. These were therefore taken as the basis for the calculations.

The angular value between the prism faces $a$ is $45°56'$ as shown on the orthogonal projection (Fig. 2). From this value the composition plane $m$ was computed as having an interfacial angle of $112°58'$ with $a$. Plotting these values in gnomonic projection (Fig. 3) for two adjacent sectors the monoclinic symmetry relations become evident. The angles given in Table II are the $\phi$ and $\rho$ angles as given in Goldschmidt's Winkeltabellen and are derived from the measurements given in Table I.
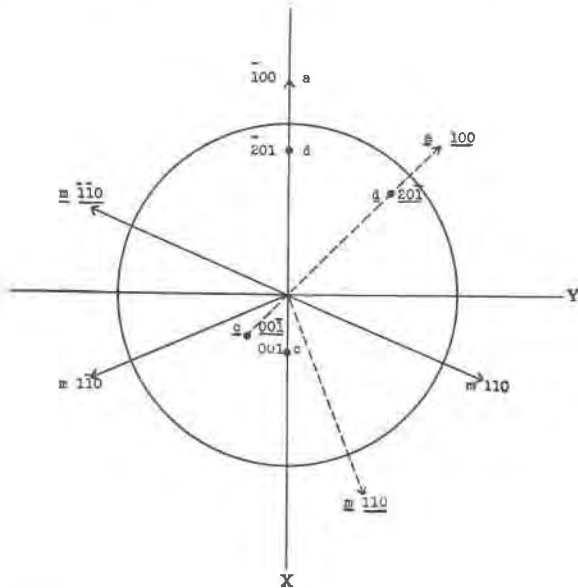


Fig. 3. Gnomonic projection of dachiardite (two sectors).

TABLE II.  Angle Table, Dachiardite

| $a=2.4786$ | | $\log a=$ .39421 | | $\log p_0=9.74134$ | | $p_0=$ .55124 |
|---|---|---|---|---|---|---|
| $c=1.3663$ | | $\log c=$ .13555 | | $\log q_0=$ .11318 | | $q_0=1.3007$ |
| $\mu=72°11'$ | | $\dfrac{\log h}{\log \sin \mu}=9.97866$ | | $h=$ .95204 | | $e=$ .30668 |
| No. | Letter | Goldschmidt Symbol | Miller Symbol | $\phi$ | | $\rho$ |
| 1 | $c$ | 0 | 001 | 90°00′ | | 17°49′ |
| 2 | $a$ | $-\infty$ 0 | $\bar{1}$00 | $-$90°00′ | | 90°00′ |
| 3 | $d$ | $-20$ | $\bar{2}$01 | $-$90°00′ | | 39°55′ |
| 4 | $m$* | $\infty$ | 110 | 22°58′ | | 90°00′ |

$m$* by computation.

Since there is no form on the crystal from which the axial ratio can be directly computed it is necessary to calculate the ratio by using the composition plane of the twins, which gives the ratio of $p_0$ and $q_0$ and the negative orthodome (Fig. 3) which gives directly the value of $p_0$. The composition plane is considered as unit prism, (110) and the orthodome as ($\bar{2}$01), in order to obtain the best ratio. Since this method is somewhat indirect it may be desirable to illustrate the procedure. The formulae used are all to be found in the *American Mineralogist*, Vol. **5**, p. 72, 1921.

For the prism (110): $\tan \phi = \dfrac{pp_0}{qq_0}$

where $\phi$ is the angle $110 \wedge 010$ and $p$ and $q$ are unity.
    Substituting values the equation becomes

(1)    $\text{Tan } 22°58' = \dfrac{1p_0}{1q_0}$

where $p_0$ and $q_0$ are the units of the gnomonic net.
For the negative orthodome ($\bar{2}$01)

$\text{Tan } \rho = \dfrac{pp_0 - e}{h.\sin \phi}$

where $h$, $e$, $\sin \phi$, and $\tan \rho$ are derived by the Goldschmidt method from the gnomonic projection. (See Table II.)

Substituting the values,

$$\tan \rho = \tan 39°55'$$
$$p = -2 \qquad \text{(Table II)}$$
$$e = e' \sin \mu = \tan 17°49' \sin 72°11' \qquad \text{(Table II)}$$
$$h = \sin \mu = \sin 72°11' \qquad \text{(Table II)}$$
$$\sin \phi = \sin 90° = 1 \qquad \text{(Table II)}$$

the equation becomes

$$(2) \quad \tan 39°55' = \frac{-2p_0 - \tan 17°49' \cdot \sin 72°11'}{\sin 72°11'}$$

solving for $p_0$ gives

$$p_0 = .55124$$

and substituting this value in equation (1.) gives

$$q_0 = 1.3007$$

By using the conversion formulas for changing from polar to linear values:  $a = \dfrac{c}{p_0}$ and $c = \dfrac{q_0}{\sin \mu}$

we get      $a : b : c = 2.4786 : 1 : 1.3663$
$$\beta = 72°11'.$$

## Physical Properties

The mineral is transparent, colorless, and has a hardness of 4 to 4.5. The specific gravity is given as 2.165. There are two perfect cleavages, one parallel to the orthopinacoid (100), the other parallel to the base $c$ (001).

## Chemical Properties

All of the chemical data have been taken from D'Achiardi's reports, as sufficient material for chemical analysis was not available.

Chemical Analyses

| | I | II* | Theory for Proposed Formula |
|---|---|---|---|
| $SiO_2$ | 61.41 | 62.01 | 62.53 |
| $Al_2O_3$ | 11.15 | 11.35 | 11.75 |
| CaO | 5.52 } | 6.80 | 5.80 |
| SrO | 1.14 } | | |
| $K_2O$ | 3.31 | 3.31 | 3.25 |
| $Na_2O$ | 2.06 | 2.06 | 2.14 |
| $H_2O$ | 13.51 | 14.52 | 14.53 |
| Total | 98.10 | 100.05 | 100.00 |

* $Li_2O$ and $Cs_2O$ proven present in small amounts.

D'Achiardi proposed the formula: $R_3^{II}R_4^{III}$ $(Si_2O_5)_9.14H_2O$
or $3(Ca, Na_2, K_2)O \cdot 2Al_2O_3 \cdot 18SiO_2 14H_2O$
where $R^{II} = (Na_2, K_2, Ca)$
and $R^{III} = Al$.

The mineral is decomposed by hydrochloric acid and, before the blowpipe it decrepitates, exfoliates, and fuses to white enamel.

## OPTICAL PROPERTIES

The optical constants were measured by the immersion method, and are: $\alpha = 1.492$, $\beta = 1.496$, $\gamma = 1.500$; $X = b$, $Z : c = 35°$, Biaxial $(+)$, $2V = 65°$.

The axial angle was measured as 65° on a figure that was somewhat uncentered.

The inclined extinction and the uncentered interference figure, on cleavage, are, together with the crystallographic data given above, sufficient reasons for assigning this mineral to the monoclinic system.

The author wishes to thank Professor Charles Palache and Professor E. S. Larsen for their kind assistance and suggestions in the preparation of this paper.

## SUMMARY

The mineral examined seems to have distinct chemical, crystallographic, and optical properties quite different from any other known zeolite and it is suggested that the name "dachiardite" be adopted, as proposed by Giovianni D'Achiardi, in honor of his father.

Dachiardite—near 438 (Dana).   A zeolite occurring in the granite pegmatites at San Piero in Campo, on the Island of Elba, in small eight-sided prismatic crystals showing a mimetic structure on a section perpendicular to the prisms.   The aggregates consist of 8 monoclinic sectors with the $c$ axis in the direction of the prisms.

Composition: $R_3^{II}R_4^{III}$ $(Si_2O_5)_9 \cdot 14H_2O$
$$R^{II} = (Na_2, K_2, Ca)$$
$$R^{III} = Al.$$

Physical and chemical properties: $H = 4$ to $4.5$;  $G = 2.165$. Cleavage (100), (001) perfect.  Before the blowpipe decrepitates, exfoliates, and fuses to a white enamel.  Decomposed by HCl.

Crystallographic relations: Monoclinic $a : b : c = 2.4786 : 1 : 1.3663$; $\beta = 72°11'$. Forms: $(001)c$, $(\bar{1}00)a$, $(\bar{2}01)d$. Twinning and composition plane $= (110)m$.

Optical properties: Biaxial $(+)$ $2V = 65°$. $\alpha = 1.492$, $\beta = 1.496$, $\gamma = 1.500$; $X = b$, $Z \wedge c = 35°$.

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# THE IDENTITY OF "LEHNERITE" AND LUDLAMITE

## HARRY BERMAN, *Harvard University*

A recent paper[1] on the phosphate-bearing pegmatites of Hagendorf, Bavaria, contained descriptions of several new minerals, among which was "lehnerite" a basic hydrous phosphate of iron, manganese, and magnesium. The optical properties and specific gravity of a specimen labelled "lehnerite" recently acquired in this laboratory, were determined, since such data were not given in the original description. As shown in the following table the optical properties of "lehnerite" are so near those of ludlamite as to indicate that the former is simply a manganese-magnesium bearing ludlamite.

| | $\alpha$ | $\beta$ | $\gamma$ | Opt. Char. | Orientation | Dispersion | Axial angle | Cleavage | Specific Gravity | Hardness |
|---|---|---|---|---|---|---|---|---|---|---|
| "Lehnerite," | 1.650 | 1.669 | 1.689 | + | Z ∧ C = large | $\gamma > \nu$ perc. | large | (001) perfect | 3.19 | 3.5 |
| Ludlamite[2] | 1.653 | 1.675 | 1.697 | + | Z ∧ C = 67° | $\gamma > \nu$ perc. | 82° | (001) perfect | 3.12 | 3-4 |

A comparison of the chemical analyses of the two minerals shows likewise a close similarity in their composition. Allowing for the possible inaccuracy of the analyses, especially that of ludlamite, which is an old analysis, the two minerals appear to be chemically the same.

| | "Lehnerite" | Ludlamite |
|---|---|---|
| $P_2O_5$ | 33.87 | 30.11 |
| FeO | 45.91 | 52.76 |
| MnO | .3.10 | —— |
| MgO | 2.21 | —— |
| $H_2O$ | 14.91 | 16.98 |
| Total | 100.00 | 99.85 |

[1] Mullbauer, F.; Die Phosphatpegmatite von Hagendorf i. Bayern; *Zeit. Kryst. Min.*, **61**, 331, 1925.

[2] Larsen, E. S., Microscopic Determination Non-Opaque Minerals., *U. S. Geol. Surv.*, *Bull.* 679, 223, 1921.