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HAIWEEITE, A NEW OCCURRENCE IN BRAZIL

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ABSTRACT

Haiweeite has been found at Perus, San Paulo, Brazil, along fractures of a tourmaline-bearing granite. The needle-like crystals of monoclinic symmetry have the optical constants: $\alpha=1.533$, $\beta=1.572$, $\gamma=1.573$; $2V_x=18^\circ$; pleochroism pale yellow to colorless. Main reflections of X-ray powder diagram, in \AA : 9.16 (10), 4.59 (7), 4.43 (6), 3.20 (4), 8.07 (3).

INTRODUCTION

Haiweeite, found for the first time at Coso Mountins, California, near the Haiwee Reservoir (McBurney & Murdoch, 1959), has been also encountered at Perus, 25 km north of Sao Paulo, Brazil. Here, the haiweeite occurs along fractures of a tourmaline bearing granite and correlated intruded pegmatites, together with other species of uranium secondary minerals, such as autunite, meta-autunite, uranophane, beta-uranophane phosphuranylite, torbernite, meta-torbernite and uranium opal (Camargo, 1969).

MORPHOLOGY AND OPTICAL PROPERTIES

The haiweeite occurs as spherulites, aggregates of fibrous radiated crystals, which are coating the surface of other minerals, such as opal and albite or some other primary granite mineral.

The needle-like crystals of haiweeite, usually having the dimensions of fractions of a millimeter, show a pale yellow color, with weak pleochroism and a slight fluorescing reaction of green color under U.V. radiation.

Optically, haiweeite is biaxial (-), with $2V_n=18^\circ$, as determined by Mallard's procedure, strong dispersion $r \gg v$, and a calculated birefringence of $(\gamma-\alpha)=0.040$.

The Y (β) vibration is parallel to the crystal elongation, which coincides with the crystallographic axis *b*. The extinction is parallel to the larger dimension of the crystals, which seem to have monoclinic symmetry, and the following orientation is suggested for the optical constants (Fig. 1);

| <i>Indices of refraction</i> | <i>Pleochroism</i> |
|-------------------------------|--------------------|
| $Z=\gamma=1.573$ | colorless |
| $b=Y=\beta=1.572$ | pale yellow |
| $X=\alpha=1.533$ (calculated) | |

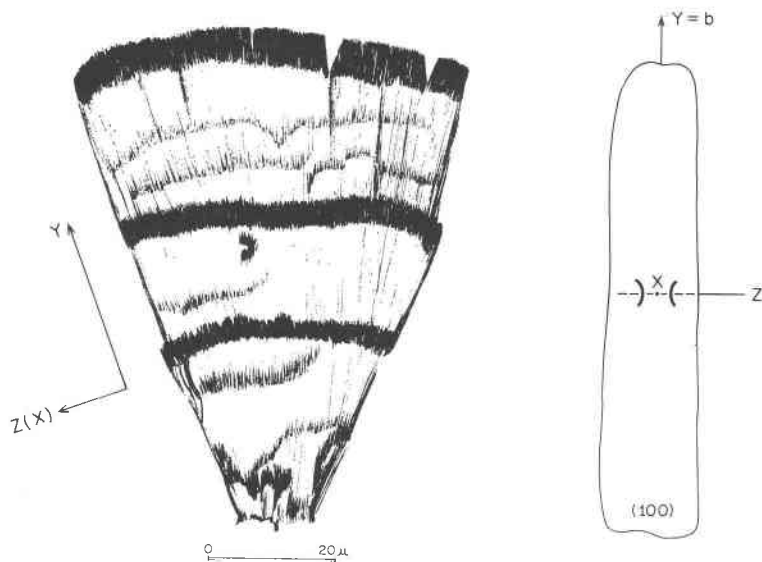


FIG. 1. Spherulitic habit and optical orientation of haiweeite.

Under progressive heating in contact with air, the mineral undergoes a complete transformation, and at 800°C , after two hours of continuous heating, haiweeite changes to a reddish material, not fluorescent under U.V. radiation, optically biaxial (-), and having refractive indices: $Z = \gamma = 1.720$ and $Y = \beta = 1.696$.

X-RAY DIFFRACTION POWDER DATA

The spherulitic material, coating the granite fractures, was treated with bromophorm and the heavy fraction, used for X-ray diffraction (Table 1). Some interplanar spacings, found by McBurney and Murdoch (1959) for the Coso Mountains specimen, do not occur in the X-ray powder diagrams of Perus material. This may be explained by a mixture of two phases in the Coso Mountains specimens, what is not the case for our material.

For two reasons the X-ray diagram of haiweeite could not be conveniently indexed. (1) The extremely minute dimensions of crystals prevented the use of monocrystal determinations and (2) The figures given by McBurney and Murdoch (1959) for the unit-cell parameters of haiweeite were unsatisfactory for indexing either for Coso Mountains or Perus material. The heated material gave the X-ray diffraction pattern of Table 2.

TABLE 1. X-RAY POWDER PATTERN OF HAIWEEITE.

| Haiweeite of Perus, Sao Paulo, Brazil (Cu K α) | | Haiweeite and meta- haiweeite, Coso Mts., Calif. | | Haiweeite of Perus, Sao Paulo, Brazil (Cu K α) | | Haiweeite and meta- haiweeite, Coso Mts., Calif. | |
|--|----------------------------------|--|----------------------------------|--|----------------------------------|--|----------------------------------|
| <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ |
| 9.16 | 10 | 9.14 | 10 | 2.51 | 0.5 | 2.51 | 10.5 |
| 8.07 | 3 | 8.05 | 2 | 2.39 | 1 | 2.39 | 2 |
| — | — | 7.05 | 4 | 2.29 | 1 | 2.28 | 2 |
| — | — | 5.53 | 2 | 2.22 | 1 | 2.21 | 1 |
| 5.00 | 1 | 5.06 | 1 | 2.10 | 0.5 | 2.11 | 1 |
| — | — | 4.90 | 0.5 | — | — | 1.98 | 1 |
| 4.59 | 7 | 4.56 | 6 | 1.93 | 0.5 | 1.92 | 1 |
| 4.43 | 6 | 4.42 | 6 | 1.89 | 0.5 | 1.89 | 1 |
| — | — | 3.82 | 2 | 1.86 | 0.5 | 1.85 | 0.5 |
| 3.66 | 3 | 3.64 | 0.5 | 1.83 | 1 | 1.83 | 1 |
| 3.55 | 3 | 3.54 | 4 | 1.78 | 1 | 1.78 | 1 |
| 3.41 | 2 | — | — | 1.74 | 0.5 | 1.73 | 1 |
| 3.31 | 2 | 3.30 | 3 | — | — | 1.68 | 1 |
| 3.20 | 4 | 3.19 | 5 | 1.65 | 0.5 | 1.65 | 0.5 |
| — | — | 3.10 | 5 | 1.63 | 0.5 | 1.63 | 0.5 |
| 3.03 | 2 | — | — | 1.59 | 0.5 | 1.59 | 1 |
| — | — | 2.91 | 3 | 1.56 | 0.5 | 1.56 | 1 |
| 2.82 | 1 | 2.81 | 1 | 1.53 | 0.5 | 1.53 | 0.5 |
| 2.63 | 1 | 2.62 | 2 | 1.50 | 0.5 | 1.49 | 0.5 |

TABLE 2. X-RAY POWDER PATTERN OF HEATED HAIWEEITE, (800 °C, 2 HOURS),
CuK α , PERUS, SAO PAULO, BRAZIL

| <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ |
|--------------|----------------------------------|--------------|----------------------------------|--------------|----------------------------------|--------------|----------------------------------|
| 8.89 | 9 | 3.16 | 1 | 2.34 | 4 | 1.77 | 6 |
| 5.92 | 10 | 3.06 | 6 | 2.21 | 5 | 1.69 | 0.5 |
| 4.89 | 9 | 2.94 | 7 | 2.08 | 6 | 1.66 | 0.5 |
| 4.23 | 7 | 2.78 | 6 | 1.97 | 4 | 1.63 | 0.5 |
| 3.56 | 1 | 2.63 | 0.5 | 1.90 | 1 | 1.57 | 1 |
| 3.39 | 5 | 2.45 | 4 | 1.86 | 1 | | |

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TRIPHYLITE-SARCOPSIDE-GRAFTONITE INTER-
GROWTHS FROM CUSTER, SOUTH DAKOTA¹

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ABSTRACT

Sarcopside occurs as crosscutting sets of laths, oriented approximately parallel to {112} of triphylite at the Bull Moose Quarry, Custer, South Dakota. The textural relations indicate an origin through exsolution and in this respect the material is similar to grafftonite-sarcopside and grafftonite-triphylite intergrowths. Grafftonite-sarcopside intergrowths are also found at the Bull Moose Quarry, as well as specimens showing the expected coexistence of all three phases.

Grafftonite, $(Ca, Mn, Fe)_3(PO_4)_2$, occurs as a primary mineral in pegmatites, generally in oriented lamellar intergrowths with an iron-rich member of the triphylite-lithiophilite series ($LiFePO_4$ - $LiMnPO_4$). Intergrowths of sarcopside, $(Fe, Ca, Mn)_3(PO_4)_2$, with grafftonite have recently been described as the ubiquitous mode of occurrence of sarcopside. Hurlbut (1965), Peacor and Garske (1964) and Čech, *et al.* (1962) have described such occurrences from pegmatites, and Olsen and Fredriksson (1966) have noted similar textures as occurring in meteorites. Intergrowths of both sets of minerals have been ascribed to exsolution from a single high-temperature phase, Hurlbut noting that grafftonite is the indicated "host" phase, on the basis of textural relations, in the case of grafftonite-sarcopside intergrowths.

The Bull Moose pegmatite quarry, Custer, South Dakota, is well known among mineral collectors as a source of specimens of unusual secondary phosphates such as hureaulite, strengite, tavorite, rockbridgeite and barbosalite. The abundant primary phosphate from which these were derived is generally referred to as "triphylite." The writer recently observed some unusual textural features in the primary phosphates, some resembling those involving sarcopside and grafftonite. All specimens were collected from the dump, where individual specimens are up to three or four feet in diameter. As described by the quarry owner, these materials were quarried out as several large single crystals from the

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