Phenacite and other minerals from German East Africa.

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A SMALL collection of minerals, together with other natural history specimens, has recently been acquired by the British Museum from the Rev. A. North Wood, a missionary in the Usagara (Ussagara) province of German East Africa. Mr. Wood's station is situated at Itumba, and the specimens had been brought to him by the natives from the surrounding district, mainly from places between Mamboya and Mpapwa, which lie on the caravan route from the coast opposite Zanzibar westwards into the interior to Lake Tanganyika.

The rocks of the district are biotite-gneiss and hornblende-gneiss, the latter with small garnets[1].

Phenacite from Kisitwi Mountains[2].—A single isolated crystal[3] measuring about $1\frac{1}{2}$ cm. in length by rather less than 1 cm. in diameter. It is perfectly colourless and transparent, and is bounded by numerous bright crystal-faces: it had been mounted as a pendant. It is a doubly terminated crystal, but at the end where it was attached to the matrix only a few faces are developed.

The following forms are present:—

Hexagonal prisms—

$a = \{10\bar{1}\} = \{11\bar{2}0\}$ $m = \{2\bar{1}\bar{1}\} = \{10\bar{1}0\}$

Rhombohedra of the first order—

$r = \{100\} = \{10\bar{1}1\}$ $z = \{22\bar{1}\} = \{01\bar{1}1\}$

$d = \{110\} = \{01\bar{1}2\}$ $\mu = \{11\bar{1}\} = \{02\bar{2}1\}$

Rhombohedra of the second order—

$p = \{210\} = \{11\bar{2}3\}$ $p_1 = \{201\} = \{2\bar{1}\bar{1}3\}$

Rhombohedra of the third order (hemi-scalenohedra)—

$s = \{20\bar{1}\} = \{21\bar{3}1\}$ $s_1 = \{2\bar{1}0\} = \{3\bar{1}\bar{2}1\}$

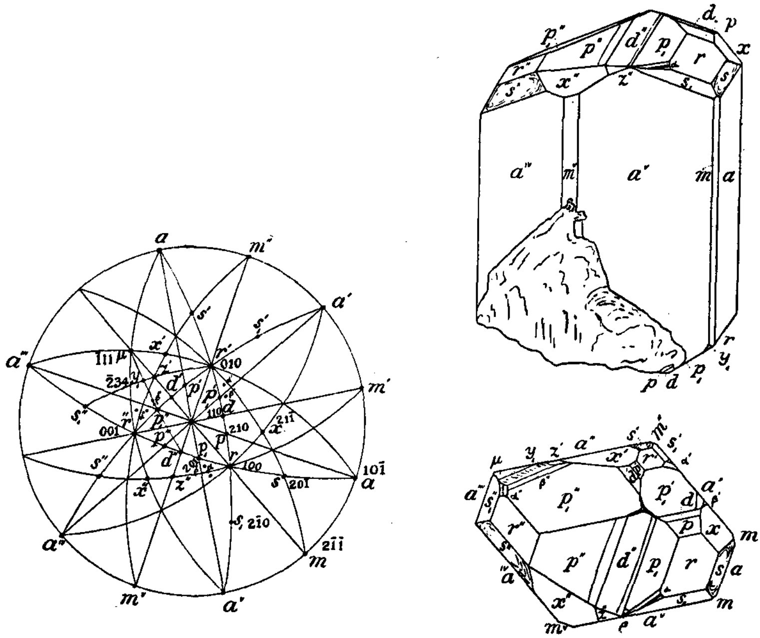
$x = \{21\bar{1}\} = \{12\bar{3}2\}$ $y_1 = \{4\bar{2}3\} = \{65\bar{1}5\}$

[1] C. Dantz, Mitth. Deutschen Schutzgebieten, 1902, vol. xv, p. 52 (Abstract in Zeits. prakt. Geol., 1902, Jahrg. x, p. 306).

[2] The Kisitwi range extends between Rubeho and Mulale (or Mlali); there is also a small village of the same name.

[3] British Museum, No. 1905,115.

The form y_1 $\{4\bar{2}3\}$, which is new for phenacite, is represented by two small and somewhat rounded faces, situated at opposite ends of the crystal and parallel to one another. The face in the position $(\bar{2}34)$ was observed to lie in the zones $[d'' p_1''] = [101, 012]$ and $[r' z'] = [010, \bar{1}22]$: it is inclined at 6° 16′ to z' and at 20° to p_1''. The form μ $\{11\bar{1}\}$ is represented by only one face, which is very rough and reflects no image. z $\{22\bar{1}\}$ has only two faces, one of which is quite small.



Phenacite from German East Africa.
(Stereographic projection, clinographic drawing, and plan[1].)

Two faces of the prism m are absent. All the other rhombohedra given in the above list are each represented on the top of the crystal by three well-developed faces. At the opposite, attached end of the crystal some of the parallel faces are present; but a face of s_1 is missing from an edge between r and a. Apart from these accidental omissions of faces, the crystal is clearly rhombohedral with parallel-faced hemihedrism, possessing only a triad axis and a centre of symmetry.

[1] The method of giving a plan of the crystal together with the clinographic drawing was employed by N. I. Koksharov, in 1853, in his 'Materialien zur Mineralogie Russlands' (compare this volume, p. 44).

The faces of the complementary forms p and p_1 show little or no difference in surface characters, but, as may be seen from the figure, those of the latter are somewhat the larger in each of the three pairs. The faces of s and s_1 are equal in size and brightness; but whilst those of s_1 are even, those of s are rounded with platy layers of growth. There are no indications of the presence of the form complementary to x, though near by this position there are some irregular planes and rounded surfaces. The two complementary rhombohedra of phenacite have been distinguished by some authors according to whether they lie on the right-hand or on the left-hand side of r. Thus in the accompanying figures and projection x lies on the right of r; but it must be remembered that at the other end of the crystal x lies on the *left* of r.

Several good readings of the angles between the faces were obtained. Thus the angles over the six edges rp at the top of the crystals were determined as 20° 4′, 20° 6′, 20° 5′, 20° 5′, 20° 4½′, 20° 4′; and the three angles pp_1'' over the apex as 47° 38½′, 47° 38′, 47° 37½′. From the mean value $pp_1'' = 47° 38'$ is calculated $rp = 20° 5'$, agreeing with the mean of the measured angles. The corresponding angles given by Koksharov in 1857 for phenacite from the Urals, and adopted for the species in the textbooks, are 47° 34′ and 20° 4′. (Miller, in 1852, gave 47° 30′ and 20° 3′.)

The images reflected from the faces are often very good, though not always single. Portions of the two faces lettered d'' and p'' in the figures are replaced by smooth and well-defined vicinal faces, which give sharp images and lie accurately in the zone [rr'']. The vicinal face on d'' makes a salient angle of 56′ with this face; and that on p'' gives two images at 44½′ and 1° 0′ from the true position of p''.

Associated with the three faces of the form p_1 there are also three bright vicinal faces β, β', β'', which lie in the zones [$s_1\ d''\ p_1''\ y_1$], &c., and are inclined to p_1 at about 3°: they are slightly rounded in these zones, the face in the position β'' being more rounded than the other two and giving a band of reflected light between 3° and 6° from p_1''.

Another set of small bright faces a, a', a'', somewhat similar to the last in character, replace the three corners ($r\,p_1\,s_1$), &c. From each face of the form p_1 these faces form a banded zone; the angles measured for the more definite images in each being:

$$p_1\,a = 6°\,43',\ 10°\,21',\ \text{and}\ 12°\,56'.$$
$$p_1'\,a' = 7°\,24'.\quad (r'a' = 14°\,49'.)$$
$$p_1''a'' = 6°\ \text{and}\ 13°.$$

The middle one of the three narrow faces at a, which gives the reading $p_1 a = 10° 21'$, lies in the zone $[r z'']$ and makes with r an angle of $13° 9'$: it therefore has the indices $(7\bar{1}2) = (8\bar{3}58)$. The indices of the zone $[p_1 a]$ will then be $[13\bar{2}]$. The only other face on the crystal which should lie in this zone is μ $(\bar{1}11)$, but as this happens to be the only face which gives no reflected image this zonal relation could not be tested: some of the scattered and banded images reflected from the rounded surfaces on y_1 were, however, observed to lie in this zone.

Many of the edges between the faces of the crystal are perfectly sharp; but others, especially those between the prism and rhombohedron faces and those at the apex of the crystal, are rounded as if by corrosion. These rounded surfaces are quite bright, and reflect numerous scattered images. Some of the vicinal faces noted above are therefore probably of the nature of prerosion faces. They conform in their arrangement with the symmetry of the crystal.

The faces of the crystal are not marked with any definite etched figures. They are usually quite smooth and bright, but when examined closely many of them show duller and brighter areas with a patchy distribution.

The refractive indices for sodium light were determined as

$$\omega = 1{\cdot}653 \qquad \epsilon = 1{\cdot}672$$

but the images seen through the natural prism-faces being rather scattered, these results are only approximate. The specific gravity of the crystal is 2·8, this low value being readily accounted for by the numerous cavities. The crystal readily becomes electrified when rubbed.

The large number of cavities, some of them of considerable size, present in the crystal are of various shapes: (*a*) small and rounded; (*b*) lamellar, with surfaces parallel to the faces s and s_1, and bounded at the edges by small bright planes; (*c*) long and tubular, parallel to the triad axis of the crystal. Many of the cavities contain small black spots and globules of carbonaceous (?) material, and others contain brown films of iron oxide. A few contain a liquid with a bubble of gas, which disappear when the crystal is held in the warm hand; the liquid is therefore carbon dioxide.

Corundum from Mulale (eight miles west of Kisitwi).—Isolated crystals, 2–3 cm. in length, of a rose-red or flesh-red colour, and opaque or only slightly translucent. The predominating form is a steep hexagonal bipyramid ν $\{1{\cdot}13{\cdot}\bar{1}\bar{1}\} = \{44\bar{8}1\}$, with faces inclined to the basal plane at about 84°. Other forms present are the basal pinacoid $c = \{111\} = \{0001\}$, the rhombohedron $r = \{100\} = \{10\bar{1}1\}$, and the hexagonal bipyramid $n = \{13\bar{1}\} = \{22\bar{4}3\}$. Parting planes parallel to the rhombohedron r are sometimes present.

The faces of the crystals are curiously marked by a network of ridges, giving rise to a number of shallow pits with flat bottoms. These are probably the impressions of a granular aggregate of crystals in which the corundum crystals were originally embedded. In fact, there are attached to the surface of the crystals, or enclosed in them, several small grains or rounded crystals of a black, lustrous mineral, which proved on examination to be *rutile*.

Tourmaline from Kisitwi Mountains.—Isolated crystals measuring about 2 cm. across. They are jet-black and opaque, and have bright faces. One doubly terminated crystal is a short prism with the forms $a = \{10\bar{1}\} = \{11\bar{2}0\}$, $m = \{2\bar{1}\bar{1}\} = \{10\bar{1}0\}$, $r = \{100\} = \{10\bar{1}1\}$, and $c = \{111\} = \{0001\}$, the last being developed at one end only of the crystal. Another crystal shows at one end large smooth faces of $u = \{03\bar{2}\} = \{3\bar{2}\bar{5}1\}$ and $r = \{100\} = \{10\bar{1}1\}$; striated prism-faces are also present.

Tourmaline is also found in the Kiboriani Mountains.

Amethyst from Midindo (between Mamboya and Kitangi).—Small (1–2 cm. across), isolated bipyramidal crystals with prism-faces. They are transparent and of fairly good colour; the colour varies, however, in intensity, and in places the crystals are colourless. Numerous needles (of göthite ?) are enclosed in the crystals.

Albite from the Itumba district.—An isolated crystal measuring $3 \times 2 \times 1\frac{1}{2}$ cm. It is white and only slightly translucent, and is bounded on all sides by crystal-faces belonging to the forms c $\{001\}$, b $\{010\}$, m $\{110\}$, M $\{1\bar{1}0\}$, e $\{021\}$, n $\{0\bar{2}1\}$, p $\{\bar{1}11\}$, o $\{\bar{1}\bar{1}1\}$, x $\{\bar{1}01\}$, y $\{\bar{2}01\}$. All the faces, except b, are striated by repeated twinning on the albite-law. The cleavage-angle bc was measured as $86° 15'$, and the angle between two c cleavages across a plane of twinning as $7\frac{1}{4}°$. The angles of optical extinction on c and b are $4°$ and $16°$ respectively with reference to the edge b/c. These determinations agree well with the constants recorded for albite, but the specific gravity of 2·55 is rather low, being less than that of orthoclase.

Orthoclase from the Itumba district.—A cleavage fragment measuring $3\frac{1}{2}$ cm. across and 1 cm. in thickness. It is milky-white and translucent, and has a pearly lustre on the basal (c) cleavage, thus somewhat resembling moon-stone in appearance. Under the microscope it shows a microperthitic structure, owing to the enclosure of spindle-shaped bodies parallel to the hemi-orthodome $(80\bar{1})$: the angle between the basal plane and ($80\bar{1}$) was measured under the microscope as 73°. The extinction angle on the plane of symmetry is +12° measured to the edge *c/b*; the plane of the optic axes is perpendicular to the plane of symmetry. The cleavage-angle *bc* was determined on the goniometer to be 90°. Specific gravity, 2·65.

Kaolin from Ikwamba (between Uponera and Kisitwi).—An incoherent mass of pure white material. Throughout the whole mass there is a minute lattice-like or cellular structure marked out by three sets of planes respectively parallel to the planes (010), (001), and ($80\bar{1}$) of orthoclase. The angle between (001) and ($80\bar{1}$) was determined to be about 73°, and the angles between these planes and (010) are 90°. The mass is thus the remains of a large crystal of orthoclase, in which the alteration to kaolin had taken place along the cleavage and parting planes.

Diopside from between Kisitwi and Mulale.—An aggregate of small indistinct crystals of a pale green colour.

Muscovite from Uluguru Mountains.—In addition to the species mentioned above, the collection also contains a sheet of mica from the Uluguru Mountains, in the Ukami province, and about 100 kilometres to the south-east of Itumba. Mr. Wood, however, states that mica is also found in the Itumba district.

The specimen is a trimmed sheet measuring 19 by 12 cm. It is transparent, with a slight smoky shade of colour, without flaws, and readily cleavable into very thin, elastic leaves. The optic axial angle (2E) is about 60°.

A detailed description of the occurrence of large sheets of mica in the pegmatite-veins traversing the gneiss of the Uluguru Mountains has been given by W. Bornhardt.[1] Sheets of commercial value have been exported from this locality.

[1] W. Bornhardt, 'Zur Oberflächengestaltung und Geologie Deutsch-Ostafrikas,' Berlin, 1900, p. 328 (abstract in Zeits. Kryst. Min., 1902, vol. xxxvi, p. 422; see also Zeits. prakt. Geol., 1903, Jahrg. xi, p. 199).