

Riebeckite in Trachytic Rocks from Abyssinia.

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IT is now ten years since Sauer¹ first described under the name of riebeckite a new species of blue hornblende in the granite of Socotra.

Since that time its occurrence in the British Isles has been noted in the "felsite" of Mynydd Mawr,² N. Wales; in the "microgranite" of Ailsa Craig,³ Firth of Clyde; in glacial deposits from the Isle of Man; Moel Tryfaen,⁴ N. Wales; Greystones, Co. Wicklow⁵; and Greenore, Carlingford⁶; in granophyre from Meall Dearg,⁷ Skye; and in felsite from Middle Eildon,⁸ Roxburghshire.

On the Continent it has been recorded in "granulite" from Corsica,⁹ in the trachyte of Berkum,¹⁰ Rhine, and in a minette from Wackenbach, Vosges.¹¹

In America riebeckite and blue hornblendes allied to it have been described from Colorado¹² (El Paso Co. and Silver Cliff), Texas¹³ (Paisano Pass), Michigan (Lake Superior region),¹⁴ and California (Berkeley).¹⁵

In India it has been noted in a granite from Southern Sikkim.¹⁶

¹ "Ueber Riebeckite, ein neues Glied der Hornblendegruppe." *Zeits. deutsch. geol. Ges.* XL. (1888), p. 138.

² Bonney, *Min. Mag.* VIII. (1888), pp. 103, 169; Harker, *Geol. Mag.* 1888, p. 455.

³ Teall, *Min. Mag.* IX. (1891), p. 219; Heddle, *Trans. Edin. Geol. Soc.* VII. (1897), p. 265.

⁴ Cole, *Min. Mag.* IX. (1891), p. 222.

⁵ Sollas, *Proc. Roy. Irish Acad.* III. (1895), p. 516.

⁶ Cole, *Nature*, XLVII. p. 464.

⁷ Teall, *Quart. Journ. Geol. Soc.* 1894, p. 219.

⁸ Barron, *Geol. Mag.* 1896, p. 371.

⁹ Le Verrier, *Compt. Rend.* CIX. (1889), p. 38.

¹⁰ Rosenbusch, *Mikr. Phys.* II, p. 770, 1896.

¹¹ Rosenbusch, *ibid.* p. 510, 1895.

¹² Lacroix, *Compt. Rend.* CIX. (1889), p. 39; König, *Zeits. Kryst.* 1, p. 430; Cross, *Am. Journ. Sci.* XXXIX. (1890), 359.

¹³ Osann, *Geol. Survey of Texas*, 4. *Annual Report*, 1893.

¹⁴ Lane, *Am. Journ. Sci.* XLII. (1891), 508.

¹⁵ C. Palache, *Bull. Dept. Geol. Univ. California* 1 (1894), 185.

¹⁶ Holland, *Records Geol. Survey India*, XXV. pt. 3, 1892.

The object of this note is to place on record a new occurrence of riebeckite in trachytic rocks from Abyssinia.

The specimens in the British Museum in which the riebeckite was found form part of a collection of rocks made by Mr. W. T. Blanford when acting as geologist to the Abyssinian Expedition of 1868 under Sir Robert Napier.

In his book, *Observations on the Geology and Zoology of Abyssinia* (London: Macmillan & Co. 1870), Blanford describes the geological features of the country traversed by the Expedition from Annesley Bay on the Red Sea to Magdala.

The following details as to the mode of occurrence of the trachytic rocks are drawn from that work.

The fundamental rocks of the province of Tigre "and probably of all Abyssinia" are metamorphics. On the route to Magdala almost all hills exceeding 8,000 ft. in height above the sea were found to consist of bedded traps (trachytes and basalts). Between the metamorphics and the traps occur a series of sandstones and limestones, the latter alone fossiliferous and of Jurassic age.

The volcanic rocks were first met with at Senafé, which lies in a plain with hills on both sides generally composed of basalt and trachyte, the latter predominating. The highest point, Akúb Teriki (or Arabi Teliki), 9,000 feet high, a most conspicuous object to the north of Senafé, consists near its base of basalt and trachyte, with a flat top composed of a coarse "trachyte" resembling sandstone. It was not clear whether this mass is intrusive or whether it fills a hollow in the metamorphics. About 8 miles W. by S. of Senafé is the trachytic hill of Kishyat, the north face of which is precipitous and consists of "magnificent vertical columns extending the whole height of the cliff, upwards of 300 feet, without a single break."

Similar hills of "trachyte" are dotted over the country to the south as far as Fokada, a distance of nearly 30 miles. These were regarded by Blanford as probably the remains of the same great lava flow. The columnar trachyte of a hill near Fokada closely resembles that of Kishyat; here it rests on basalt, which again overlies unconformably the Adigrat sandstone. These trachytic hills are described as rounded hummocks of very peculiar shape, suggestive rather of granitic than of trachytic masses. The geological age of the trachyte is uncertain, as no other formation rests upon it.

The specimens containing riebeckite which form the subject of this note come from Akúb Teriki, Kishyat, and Fokada.

The trachyte from the hill near Fokada is a fine-grained pale lavender-coloured rock, showing to the naked eye a few porphyritic crystals of glassy felspar. Under the microscope it exhibits trachytic structure, and is seen to consist of a felt of small lath-shaped felspars with a little quartz, uniformly distributed in which occurs in moss-like sub-ophitic patches the riebeckite, presenting much the same appearance as it does in the Mynydd Mawr rock. In this groundmass porphyritic crystals of felspar (probably anorthoclase), mostly in Carlsbad twins, occur sparingly, either singly or in groups. In this respect, as well as in the character of the groundmass, the rock bears a more striking resemblance to the well-known trachyte of the Hohenberg at Berkum, near Remagen, on the Rhine, than to the Mynydd Mawr rock.

This Berkum trachyte is referred by Rosenbusch to a special arfvedsonite (riebeckite) type of trachyte. Examination of a specimen in the Museum collection shows that the blue hornblende in moss-like patches which it contains presents precisely the same pleochroism (deep indigo-blue to pale yellowish-brown) as that in the Mynydd Mawr rock, and that the a (not the c) axis of the indicatrix is the one nearly coincident with the vertical crystallographic axis c .

In the Abyssinian rock the blue hornblende shows similar characters. Prismatic sections compensate with the quartz wedge along their length, and give low angles of extinction (in one section about 5°). Such sections show pleochroism from a dirty pale yellowish-brown to deep indigo-blue (almost black). In a section showing the prismatic cleavage (inclined at an angle of about 120°) the pleochroism was from deep blue to pale yellowish-brown. For the three axes of the indicatrix we have therefore—

- a (nearly parallel to c)=dark indigo-blue,
- b (bisecting the acute angle of the cleavage)=deep blue,
- c =pale yellowish-brown.

This is precisely similar to the pleochroism in the rocks from Mynydd Mawr, Berkum, and Ailsa Craig, but differs slightly from that of the original riebeckite from Socotra, in which, according to Rosenbusch, c =green.

The section of the trachyte from Kishyat presents somewhat similar characters to that of the rock from Fokada, but is slightly coarser-grained and contains more quartz; in the specimen examined the moss-like riebeckite was to a large extent converted into a black alteration product.

A minute crystal fragment of riebeckite detached from a cavity in this rock has at my request been measured by my colleague, Mr. L. J.

Spencer. The fragment showed the following forms:— $m(100)$, four planes; $n(310)$, a single narrow plane, new for riebeckite; $c(001)$, $z(021)$, $a(100)$, one plane of each; amn were striated vertically, and c and z parallel to their intersections. The following measurements were made:—

	Measured (L.J.S.)	Calcd. for Riebeckite (Sollas).	Hornblende (Dana).
110 : $\bar{1}\bar{1}0$	54° and 56½°	mm 56°	mm 55°49'
001 : 100	76°15'	ac 76°10'	ac 73°58½'
001 : 110	77°46'	cm 77°50'	cm 75°52½'
021 : 001	29°46'	cz 29°36'	cz (29°27'), not an [observed form]
021 : 110	65°5'	zm 65°28½'	
021 : 100	77°39'	ar 78°0'	
100 : 310	9°0'	an (10°3'), not an observed form	an 10°0½'

The rock from Akúb Teriki is of a somewhat different type to those from Fokada and Kishyat. Instead of being rough and porous as they are, it is compact, with a peculiar scaly appearance, rather like some phonolites. The microscopic characters suggest that it may be an intrusive rock. The groundmass consists of a felt of lath-shaped feldspars similar to that of the preceding rocks, but of much coarser grain. Large phenocrysts of glassy feldspar (probably anorthoclase¹) occur, in some of which are included rectangular sections of zircon, showing in convergent light a positive uniaxial figure. In this rock the riebeckite is accompanied by grass-green ægyrine, and in less amount by a brown hornblende, with which it often forms intergrowths similar to those described by Whitman Cross (*loc. cit.*) in the rock from Rosita Hills, Silver Cliff, Colorado. Irregular sections of hornblende (showing pleochroism from light brown to deep brownish-black) intergrown with ægyrine (compensating along the length of prismatic sections and showing pleochroism from grass-green to yellow), are fringed with tufts of indigo-blue riebeckite.

This last rock, as well as the preceding, if intrusive, would fall into the "Paisanite" group of Rosenbusch, in which he includes the rocks from Mynydd Mawr and Ailsa Craig as well as the riebeckite rock described by Osann (*loc. cit.*) from Paisano Pass, Texas, which gives its name to the group.

¹ Extinction on $c(001)$ 0°—2°, on $b(010)$ 9°—12°; strong sodium flame.