Two new bismuth minerals from South Africa.

By EDGAR D. MOUNTAIN, M.A.
Professor of Geology in Rhodes University College,
Grahamstown, South Africa.

[Read March 14, 1935.]

Bismoclite from Steinkopf, Namaqualand, Cape Province.

A SMALL specimen (McGregor Museum, no. 4465) labelled 'Bismuth ore' was sent to me in 1932 by Miss M. Wilman, Curator of the McGregor Museum, Kimberley, for identification. It had been presented to the Museum by Mr. M. Caplan, a store-keeper of Steinkopf. The majority of bismuth-bearing minerals from Namaqualand come from a number of spots in the neighbourhood of the water-hole known as Jackals Water, which is situated 18 miles NNE. of the village of Steinkopf. Reference has already been made to this locality in a previous paper.[1] The exact locality of this specimen is a pegmatite outcrop in granite-gneiss about a mile and a half south of the Noumaas trigonometrical beacon which is situated some 13 miles north-west of Jackals Water to the west of the Viool's Drift road. The specimen was picked up on the surface, being obviously of eluvial origin. A few tons of bismuth-ore were subsequently removed from this locality by Mr. Caplan, but the greater part of this material was yellowish and greenish in colour and presumably consisted of bismutite.

The specimen was originally only 2 × 1 × 0·5 inches in size, weighing about 65 grams, and appeared to consist largely of the one mineral associated only with flakes, up to half an inch across, of a silvery mica, which on examination proved to be muscovite, and which was to some extent intergrown with the main mineral, though mostly occurring at the surface. The surface of the specimen was largely covered over with a dark grey discoloration, but where recently fractured the material was seen to be of a creamy white colour.

---

[1] E. D. Mountain, Pegmatites of the Cape Province. Rec. Albany Museum, Grahamstown, 1931, vol. 4, p. 128. [Min. Abstr., 4-475.]

Small pieces of the specimen were broken off and carefully examined. The new surfaces were pale greyish or creamy-white in colour, and very nearly homogeneous, being slightly yellowish in patches and penetrated by occasional very narrow veins of a somewhat darker grey material. The bulk of the material is very obviously crystalline in character, being columnar or platy-fibrous. The elongated, scaly crystal-individuals possess at least one well-defined cleavage parallel to their length which shows a pearly lustre, while the mass as a whole shows a somewhat greasy or silky lustre. It appears as if the darker veins consist of the same mineral in a more granular condition. Under the microscope, crushed fragments show no characteristic shape owing to their softness and are absolutely opaque. The hardness is 2½ and the specific gravity determined by pyknometer on 3 grams of finely powdered and purified material was 7·36 at 27° C., determinations in duplicate on different samples giving almost identical results.[1]

When gently heated in the closed tube a small quantity of moisture is given off which shows a strong acid reaction to methyl orange, while the powder becomes dark grey on the surface. On further heating it again becomes almost white and then yellow, at the same time yielding a white, cloudy sublimate. At higher temperatures the colour darkens to orange and the sublimate collects into lemon-yellow globules. Finally, the substance melts on becoming red-hot and on cooling solidifies to a lemon-yellow mass. In the open tube the behaviour is similar except that the sublimate is a dense white and does not collect into yellow globules. The mineral also gives typical reactions for bismuth and chlorine. It gives an indistinct pale-blue colour to the flame similar to that given by lead. It is completely soluble without effervescence in acids but is precipitated on considerable dilution. It dissolves in concentrated hydrochloric acid to a pale brownish-yellow solution, and in concentrated nitric acid to an almost colourless solution.

For a chemical analysis separate portions were used for determining water, bismuth, and chlorine. One portion was used to determine loss of weight on heating to 110°, 150°, 200°, and 250° C., and showed that the bulk of the combined water was released between 200° and 250° C., when a slight blackening of the powder took place. A second portion was used to determine the combined water by the direct method on ignition; great care was taken to prevent sublima-

---

[1] Compare value 7·717 for artificial $BiOCl$ (this vol., p. 51).

tion, but no attempt was made to determine the amount of acid the water contained in view of the small quantities concerned. Bismuth was determined as BiOCl and chlorine as AgCl. The following figures under column I are the results of the analysis, and the figures under column II represent the theoretical composition of bismuth oxychloride BiOCl for comparison. It is clear that the composition of the mineral approaches very closely to that of the oxychloride.

	I.	II.
Bi_2O_3	88·49	89·41
Fe_2O_3	0·12	—
PbO	trace	—
Cl	13·00	13·67
H_2O+ (above 110° C.)	0·45	—
H_2O- (below 110° C.)	0·42	—
Insoluble	0·77	—
	103·25	103·08
Less O = Cl	2·93	3·08
	100·32	100·00

The composition and properties of the mineral bear some resemblance to daubreeite as given in Dana's 'System of Mineralogy'. For this reason I took the specimen to the British Museum (Natural History) in London for comparison. Mr. F. A. Bannister kindly examined the mineral by X-ray methods and has informed me that it is identical with the artificial compound BiOCl which crystallizes in the tetragonal system and which he has recently described before this Society (this vol., p. 49). He has also made a study of specimens of daubreeite kindly loaned by Professor A. Lacroix and has found small but definite differences in cell-dimensions and atomic positions between the two minerals. The distinction on chemical grounds is even more certain. The original analysis of daubreeite shows a chlorine content of 7·5 %, whereas the figure for BiOCl should be 13·67 %. The South African material, which is almost anhydrous, contains 13 % chlorine, and gives powder photographs exactly identical with those of artificial BiOCl, cannot, therefore, be identified with daubreeite. Mr. Bannister has suggested the name bismoclite in reference to its composition, and I propose to adopt this as a very suitable name.

I have examined a number of specimens of bismuth-ore from the Jackals Water localities presented to the Albany Museum, mostly by Mr. Redmond Orpen and Major Leipoldt, but I have found nothing quite identical with this bismoclite. Several specimens with a rolled or water-worn appearance and blackened surface appear on being broken to be identical, but when tested are found to contain besides bismuth and chlorine at least some quantity of carbon dioxide and what appears to be more than 1 % of water. One specimen is dark grey throughout, though similar in texture, and on testing chemically was found to contain, in addition to bismuth and chlorine, appreciable amounts of copper, carbon dioxide, and water. This specimen also contains quartz and chrysocolla. From rough qualitative tests other bismuth minerals occurring in these ores are hydroxide, carbonate, and hydrous carbonate, but they are ill-defined and indistinguishable with certainty without chemical tests. Most of the material would appear to come into the species-category of bismutite, but some of it might repay further qualitative examination.

Most of these specimens are of a pegmatitic nature consisting chiefly of quartz, orthoclase, albite, and muscovite with occasional brown garnets, some of the specimens being brightly coloured with small quantities of green copper minerals. None of the felspar examined under the microscope showed the twinning characteristic of microcline. Other specimens consist of garnetiferous granite and biotite segregations, probably from schists, with bismuth-ochre disseminated. Incidentally, it might be mentioned that the specimen of bismoclite described contains the minutest trace of copper. The bismuth minerals appear to be of later origin than the orthoclase, in part replacing it, and are most intimately associated with the muscovite of pegmatite and greisen.

Boksputite from Boksput, Langklip, Gordonia, Cape Province.

The farm Boksput, part of a large area leased to private individuals by the Government and situated in the north-east angle at the confluence of the Bak and Orange rivers, is a highly mineralized area. Horizontal beds of the Zwartmodder Series have been eroded through in this highly dissected region exposing a wonderful variety of igneous and metamorphic rocks and minerals. I have elsewhere described a number of minerals from this area (loc. cit., p. 122), but I have since received specimens of a new mineral from the occupant of the farm, Mr. A. Marsh. The specimens come from quartz-veins and pegmatites, and similar material has been collected as far east as the Molopo river and to the west beyond the border of South-West Africa. According to Mr. Marsh it occurs in quartz-veins in association with wolframite, scheelite, and beryl. It was said to contain uranium and lead, and indeed the colour very much resembles that of some of the amorphous uranium-bearing pseudomorphs after uraninite, but on testing it was not found to be radioactive.

In the specimens the mineral occurs intimately associated with quartz which is mostly very coarse-grained vein-quartz, highly jointed, and in parts honeycombed with cavities partly filled with limonite. The quartz also contains rare small flakes of muscovite. The substance which forms the greater part of the specimens is in general of a pale-yellow colour with a more or less earthy lustre. In places this colour passes into a greyish-brown, at the same time associated with a somewhat greasy lustre, and in patches the substance becomes iron-grey in colour with a sub-metallic lustre. Occasionally within these latter patches, and only there, are to be found small inclusions, scarcely visible without a lens, of native bismuth. The specimens also are locally stained green in minute patches by traces of copper.

Much of the yellow material is distinctly crystalline, being fine-grained with a slightly pearly lustre, apparently due to a cleavage or a scaly habit. About 10 grams were isolated, powdered, and examined. On gently heating in a closed tube the powder decrepitates slightly and gives off a small amount of moisture. On further heating it first becomes orange, then brown, and begins to melt below red-heat to a blackish melt which solidifies on cooling to a yellowish-brown mass. Where the mass creeps up the side of the tube the colour of the thin film is lemon-yellow. In the open tube the behaviour is identical. Strongly heated alone on charcoal it easily melts, giving a yellow sublimate near the assay and passing into white farther away. At the same time metallic beads are formed which are soft and malleable and mark paper. When heated with potassium iodide and sulphur an orange sublimate is formed near the assay, passing into a brilliant red farther away, indicating the presence of bismuth and possibly of lead. The flame tests give a very distinct lead reaction, quite different from that of typical bismuth minerals. It is soluble with effervescence in both hydrochloric and nitric acids, giving off carbon dioxide. The solution in concentrated hydrochloric acid is greenish-yellow in colour, that in nitric acid almost colourless. When 50 % dilute sulphuric acid and alcohol are added to a slightly dilute nitric acid solution a white precipitate forms and settles after a few minutes, indicating the presence of lead and clearly distinguishing the mineral from bismutite.

The hardness is 3½ and the specific gravity determined on 3 grams at 28° C. is 7·29. Under the microscope it is opaque in crushed fragments. A chemical analysis gave the results under column I. The determinations of lead and carbon dioxide were made in duplicate on portions of the same powder and gave substantial agreement.

	I.		II.
PbO	67·22	...	69·13
Bi_2O_3	22·92	...	24·05
CO_2	6·96	...	6·82
Cl	0·99	...	—
H_2O+	0·73	...	—
H_2O-	0·19	...	—
Insoluble	0·34	...	—
	99·35	...	100·00
Less O = Cl	0·22		
	99·13		

Under II is given the composition corresponding to the formula $6PbO.Bi_2O_3.3CO_2$. The analysis agrees fairly well with these figures and suggests this fairly simple ratio between the chief constituents. Had there been no such simple relation I should have hesitated to describe the material as a mineral species. The mineral in general bears some resemblance on the one hand to massicot and on the other to the bismuth carbonates, bismutosphaerite and bismutite, but the $CO_2 : Bi_2O_3$ ratio is much too high in the mineral to regard it as a possible mixture of these minerals. The variations in colour and lustre are similar to those exhibited by the bismuth carbonates and would appear to be the result of different conditions of crystallization. Indeed, the mineral might possibly be regarded as a variety of bismutite in which the bismuth is very largely replaced by lead, especially when we bear in mind the very vague and variable composition of the material which is given that name.

Mr. F. A. Bannister has kindly examined some of the material by X-ray methods. Two fragments from different parts of the same specimen yielded identical powder photographs. These, however, are rich in lines and have not been identified with the powder photograph of any known mineral.

It is proposed to call the new mineral boksputite after the locality. The name Boksput is a typical South African farm name meaning a well for goats, or possibly for wild buck.