Note on 'Feather-ore': identity of 'Domingite' (='Warrenite') with Jamesonite.

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THE formula $2PbS.Sb_2S_3$, given for jamesonite in all the textbooks, does not belong to jamesonite at all, but to the 'Federerz' ('feather-ore') from Wolfsberg in the Harz analysed by H. Rose in 1829, and for which the mineralogical names wolfsbergite (Huot, 1841) and plumosite (Haidinger, 1845) have been proposed. Rose's formula for the cleavable jamesonite from Cornwall was $3PbS.2Sb_2S_3$. In 1860 Rammelsberg[1] united these, together with heteromorphite, under the name jamesonite and with the formula $2PbS.Sb_2S_3$: this has since been followed in the textbooks, but, as will be pointed out below, it is very probable that there are here three distinct mineral species.

The original jamesonite formula, $3PbS.2Sb_2S_3$, thus came to be forgotten, and when it again appeared in the literature it was consequently assumed to represent a new species. In this way one of the sulphantimonites of lead from Colorado analysed by Mr. L. G. Eakins[2] in 1888 was named 'domingite' by Professor Groth[3] in 1889, and 'warrenite' by Eakins[4] himself in 1890. The latter name has been generally accepted, although 'domingite' is the earlier of the two.

Eakins's formula, $3(Pb,Fe)S.2Sb_2S_3$, was deduced from a single analysis, made on material described as occurring in matted, wool-like aggregates of acicular crystals, and known locally as 'mineral-wool'. The results of his analysis (I) are compared below with the mean (II) H. Rose's

[1] For fuller historical details see Min. Mag., 1899, vol. xii, p. 58.

[2] L. G. Eakins, 'Two sulphantimonites from Colorado.' Proc. Colorado Sci. Soc., 1888, vol. iii, pp. 73–76; Amer. Journ. Sci., 1888, ser. 3, vol. xxxvi, pp. 450–453. The second of these minerals, which was described as freieslebenite, has since been shown to be boulangerite.

[3] 'Tabell. Uebersicht d. Mineralien.' Braunschweig, 1889, 3rd edit., p. 30.

[4] Amer. Journ. Sci., 1890, ser. 3, vol. xxxix, p. 74; Bull. United States Geol. Survey, 1890, no. 60, p. 117.

analyses of Cornish jamesonite and with Dr. G. T. Prior's analysis (III) of crystallized jamesonite from Bolivia [1].

	S.	Sb.	Pb.	Fe.	Cu.	Ag.	Mn.	Gangue.	Total.
I.	21·19	36·34	39·33	1·77	traces			0·52	99·15
II.	22·56	34·26	40·18	2·63	0·18	—	—	—	99·81
III.	20·52	34·53	41·18	2·76	0·26	0·01	—	—	99·26

In the absence of any determinable physical or crystallographic characters, this analysis is scarcely sufficient to define a mineral species, especially among the sulphantimonites of lead. There is no guarantee that the material analysed was all of one kind. Nevertheless, on comparing the analysis of 'domingite' with the few analyses that have been made of cleavable jamesonite, it will be seen that they agree sufficiently closely to suggest an identity.

A specimen (British Mus. no. 84697) of 'domingite', collected in 1899 by Mr. E. R. Warren at the original locality (Domingo mine, Elk Mountain mining district, Gunnison Co., Colorado), was obtained in that year, through Mr. W. F. Ferrier, for the British Museum. The matrix of this specimen, collected twelve years after the abandonment of the mine, does not, however, agree with that of the original specimens, also collected by Mr. Warren, and described by Mr. Eakins as 'a highly decomposed gangue rock of siliceous material mixed with some calcite'. In the British Museum specimen the felted aggregates of short and straight needles fill cavities in pink rhodochrosite; the latter encloses a few specks of tetrahedrite, iron-pyrites, and arsenopyrite, and in the cavities it is crystallized as curved rhombohedra.

Attempts were made to measure the very minute, striated needles on the goniometer, but without result. It was, however, determined that the needles are brittle and not flexible. For reasons stated below, this latter character indicates that the material must be referred to jamesonite.

'Domingite' is thus one of the black, metallic minerals, capillary in form, to which the name 'feather-ore' would be applied.

Previous to Rose's analysis of 1829, 'feather-ore' was referred to stibnite, later it was referred to plumosite, while at the present time it is included under jamesonite. As a matter of fact 'feather-ore' may be stibnite [2] or any of the several acicular (orthorhombic) sulphantim-

[1] An account of this will be given in the next number of this Magazine.

[2] E. Kaiser, 'Haarförmiger Antimonglanz aus Rheinland und Westfalen.' Zeits. Kryst. Min. 1896, vol. xxvii, pp. 49–51. I have also found several specimens of capillary stibnite amongst the jamesonites in the British Museum collection.

onites of lead. Of 'feather-ores' containing lead, antimony, and sulphur there are, as indicated by external characters, at least two kinds, viz.:

(*a*) Flexible 'feather-ore'.
(*b*) Brittle 'feather-ore'.

The fine capillary crystals of the former may be bent double without breaking, and when released they spring back to their original position. This would scarcely be possible if they possessed a good cleavage perpendicular to their length, as does jamesonite. Because of this cleavage, brittle 'feather-ore' is no doubt in all cases identical with jamesonite.

On the other hand, flexible 'feather-ore' may be either zinckenite, plumosite, boulangerite, or meneghinite, but it seems impossible to distinguish between these when only capillary crystals are available. In the absence of any characteristic feature it would be impossible to collect material all of one kind for chemical analysis. There is nothing to show that these finely acicular aggregates are not mixtures of various sulphantimonites of lead, or of these with stibnite. Further, when the hairs are closely examined with a lens or under the microscope there may often be seen minute crystals of galena threaded on them like beads on a string. Analyses of such undeterminable material are useless, and can only lead to error. I have for several years been looking out for material suitable for detailed examination, but so far without success.

Zinckenite, boulangerite, and meneghinite appear to be well established as distinct mineral species, but the existence of plumosite ($2PbS . Sb_2S_3$) is based only on the chemical analyses of felted masses of capillary crystals. The published analyses of 'feather-ore' which agree approximately with this formula are quoted below:[1]—

	I.	II.	III.	IV.	V.	Calculated $2PbS . Sb_2S_3$.
S ...	19·72	18·40	19·25	20·49	19·84	19·68
Sb ...	31·04	30·19	29·24	27·72	28·53	29·55
Pb ...	46·87	47·68	49·31	48·38	49·74	50·77
Fe ...	1·30	0·26	—	3·47	0·53	—
Cu ...	—	1·11	2·00	—	—	—
Zn ...	0·08	1·09	0·21	—	—	—
	99·01	98·73	100·01	100·06	98·64	100·00

[1] Three analyses of 'Federerz' agreeing very closely with the above formula are also given by C. Guillemain, Inaug.-Diss., Breslau, 1898, pp. 21, 24.

I. H. Rose, Ann. Phys. Chem. (Poggendorff), 1829, vol. xv, p. 471. 'Federerz' from Wolfsberg, Harz.

II. E. Bechi, quoted by Meneghini, Amer. Journ. Sci., 1852, ser. 2, vol. xiv, p. 60. Capillary; from Bottino, Tuscany.

III. Ditto. Acicular; same locality.

IV. E. Bořický[1], quoted by V. von Zepharovich, Sitz.-Ber. Akad. Wiss. Wien, 1867, vol. lvi, Abth. I, p. 37. Fine elastic needles described as 'boulangerite'; from Przibram, Bohemia.

V. G. Baumert, quoted by O. Luedecke, 'Die Minerale des Harzes,' Berlin, 1896, p. 127. Felty mass of very fine fibres; from Schwenda, Harz.

Flexible 'feather-ore' containing lead, antimony, and sulphur must therefore be removed from jamesonite, and in collections can only be placed in a natural history group to which the name plumosite may be conveniently applied, although specimens so placed are not necessarily the same as Rose's plumosite.

In a previous paper[2] I have pointed out that heteromorphite must also be removed from jamesonite. The former is monoclinic with pyramidal cleavages, whilst the latter is orthorhombic with a basal cleavage.

In conclusion, the several sulphantimonites of lead are tabulated below, but the formulae assigned to them can only be regarded as provisional. They fall into two dimorphous groups. Those of the orthorhombic group occur as acicular and capillary crystals or as fibrous masses, whilst those of the monoclinic group occur as short pyramidal and tabular crystals or as granular masses. The former usually contain a small percentage of iron, whilst the latter contain none.

Orthorhombic.[3]		Monoclinic.	
Zinckenite,	$PbS . Sb_2S_3$	Plagionite,	$5PbS . 4Sb_2S_3$
Jamesonite,[4]	$7(Pb, Fe)S . 4Sb_2S_3$	Heteromorphite,	$7PbS . 4Sb_2S_3$
Plumosite,	$2PbS . Sb_2S_3$	Semseyite,	$9PbS . 4Sb_2S_3$
Boulangerite,	$5PbS . 2Sb_2S_3$		
Meneghinite,	$4PbS . Sb_2S_3$		

[1] Bořický also analysed a massive, fibrous 'jamesonite' from Przibram, which gave results agreeing with this formula (loc. cit., p. 32).

[2] 'Plagionite, heteromorphite and semseyite as members of a natural group of minerals.' Min. Mag., 1899, vol. xii, pp. 55–68.

[3] 'Schulzite' ($5PbS . Sb_2S_3$) and 'plumbostibite' ($10PbS . 3Sb_2S_3$) may possibly also belong to this group, but not geocronite (=kilbrickenite) since this appears to be a double salt, $5PbS . Sb_2S_3 + 5PbS . As_2S_3$ (Min. Mag., 1902, vol. xii, p. 188).

[4] This formula is deduced from the analysis, quoted above, of crystallized jamesonite from Bolivia.