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## Arsenolamprite confirmed from the Copiapó area, northern Chile

UNTIL its characterization by Johan (1959), arsenolamprite, the orthorhombic modification of native arsenic, had an unconvincing career as a mineral species. This name was first applied, by Hintze (1886), to apparently pure black arsenic from 'Copiapó, Chile', but both Jung (1926) and Paděra and Fišera (1956) found only rhombohedral arsenic in X-ray studies of specimens from this area. However, it has not been clear whether the specimens examined by these authors were similar to that described by Hintze.

In the course of an examination of hypogene mineral assemblages from the Mina Alacrán polymetallic veins in the Pampa Larga mining district (27° 36' S.; 70° 11' W.), near Copiapó, Atacama Province, Chile, the occurrence of arsenolamprite has been confirmed by X-ray and electron microprobe study. This district is the only well-known locality for native arsenic in the Copiapó area, and was very probably the source of the specimens examined by Hintze and later workers.

The Mina Alacrán veins comprise a gangue of baryte, quartz, and calcite, in association with a varied suite of hypogene ore minerals, among which stibnite, pyrite, galena, orpiment, realgar, and native arsenic predominate (Seegerstrom and Parker, 1959). In addition to these minerals, Parker, Salas, and Pérez (1963) record 'argentite', native silver, 'sulphosalts of silver', chalcopyrite, and pitchblende, while the author has identified arsenopyrite, sphalerite, greigite, high-realgar, and smithite, as well as arsenolamprite, in specimens unaffected by supergene oxidation. A more comprehensive discussion of the assemblages represented in this complex ore is in preparation. The mineralization is probably of lower Palaeocene age, by analogy with that associated with the nearby Cabeza de Vaza pluton (Sillitoe, Mortimer, and Clark, 1968).

Arsenolamprite was found to occur in appreciable amounts in two hand specimens taken from the dumps of the mine, but is generally subordinate to normal rhombohedral arsenic in the ore in sight. The striking flaky or scaly habit noted by Hintze (1886) is well shown in these samples, and the arsenolamprite does not show the

massive or colloform texture exhibited by the rhombohedral arsenic at this locality. On exposed surfaces, the arsenolamprite has altered to a dull black coating, which yields the stronger X-ray powder lines of arsenolite, but has a high lustre on freshly broken surfaces. It occupies in the vein material a textural environment similar to that of the normal native arsenic, but is characteristically located at the cores of colloform aggregates of the latter. Both forms of arsenic are associated with realgar, but only arsenolamprite has been observed in actual contact with high-realgar ( $\alpha\text{-As}_2\text{S}_2$ ).

X-ray powder patterns of the arsenolamprite are closely comparable to that found for a specimen from Cerný Důl by Johan (1959). Guinier-de-Wolff films of three carefully separated specimens (Cu- $K\alpha$  radiation) were identical, with lines at 5.46 (relative intensity, estimated visually, 10); 3.48 (6); 2.74<sub>5</sub> (8); 2.72<sub>0</sub> (10); 2.230 (5); 1.875 (7); 1.836 (0.5); 1.817 (5); 1.730 (7); and 1.695 (2) Å. As pointed out by Johan (1959), this pattern is basically similar to that of orthorhombic black phosphorus.

Qualitative electron-microprobe analysis of the native metal showed it to consist of essentially pure arsenic; no minor elements (in amounts  $\leq 0.1\text{--}0.5$  wt. %) were detected in spectrometer scans. The rhombohedral arsenic is similarly unalloyed.

The interrelationships of the polymorphs of arsenic are poorly understood, and the conditions favouring the natural formation of arsenolamprite are undefined. Orthorhombic, black arsenic was synthesized by Krebs *et al.* (1957) at 200 °C, a temperature not far removed from that at which it may have crystallized in association with high-realgar in the Mina Alacrán deposit. The assemblage, high-realgar-arsenic is stable only between 281 $\pm$ 5 °C and 265 $\pm$ 5 °C (Hall and Yund, 1964).

In summary, Hintze's (1886) original identification of arsenolamprite from the Copiapó area was probably correct, while Jung (1926) and Paděra and Fišera (1956) may have examined material from the same locality, but rich in rhombohedral arsenic.

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