

## SHORT COMMUNICATIONS

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### Armenite from Broken Hill, Australia, with comments on calciocelsian and barium anorthite

ARMENITE,  $\text{BaCa}_2\text{Al}_6\text{Si}_9\text{O}_{30} \cdot 2\text{H}_2\text{O}$ , has remained an obscure one-locality mineral since its description by Neumann (1941) from a single specimen in the Mineralogical Museum, Oslo, collected in the Armen Mine, Kongsberg, Norway, in 1877. It was therefore something of a surprise to find it as a minor rock-forming mineral in material from Broken Hill.

Mawson and Segnit (1946) described Ba-rich aplitic gneisses from the Piggery at Broken Hill, from which Segnit (1946) described a new mineral, calciocelsian, in association with celsian and bytownite. I collected material from the same outcrops in 1954 and 1964, but on a return visit in 1973 found the Piggery had been demolished and a sealed highway built over most of the original outcrops.

Microprobe analyses of thin sections of these Ba-rich gneisses confirmed the presence of bytownite and celsian as major components, but did not reveal any mineral with the composition of calciocelsian (Table 1, anal. 3). Instead there was a minor component (Table 1, anal. 2), which was eventually identified as armenite. The difficulty was to concentrate it sufficiently to obtain the characteristic X-ray diffraction pattern: armenite and bytownite have nearly identical densities, and only after tedious and time-consuming separations in methylene iodide-acetone mixtures was an identifiable armenite concentrate obtained.

Although no other Ba-Ca aluminosilicate was found in any of the material I collected, the non-existence of calciocelsian required the re-examination of Segnit's original specimen. During a visit to Adelaide University I was able to obtain a piece of this specimen (5081 in the Geology Dept. collection). Probe analyses confirmed the observations on my own collections, that the only mineral intermediate in composition between celsian and bytownite was armenite. Segnit's analysis material was evidently a mixture of armenite and celsian.

Nockolds and Zies (1933) described barium anorthite (Table 1, anal. 4) as a new barium plagi-

oclase feldspar, from a barium-rich gneiss (B222 of the New South Wales Geological and Mining Museum), collected near the De Bavay shear zone at Broken Hill. This specimen cannot now be found in the museum, and inquiries at Cambridge University failed to locate any material remaining from the work of Nockolds and Zies. However, it seems very probable that their analysed barium anorthite consisted largely of a mixture of bytownite and armenite.

The refractive indices given by Segnit for calciocelsian and by Nockolds and Zies for barium anorthite appear to be those of bytownite.

Recently I learned that Mr G. W. Drake, a graduate student in the Geology Dept. at the Australian

Table 1. Analyses of armenite and related materials

	1	2	3	4
SiO <sub>2</sub>	46.18	46.7	42.0	44.6
Al <sub>2</sub> O <sub>3</sub>	27.52	28.1	25.8	33.0
BaO	12.37	13.3	25.8	5.7
SrO	0.04	0.02	nd	nd
CaO	9.99	9.76	4.0	14.0
Na <sub>2</sub> O	0.16	0.08	0.3	2.0
K <sub>2</sub> O	0.13	0.03	1.4	0.7
H <sub>2</sub> O+	3.41	nd	nd	nd
H <sub>2</sub> O-	0.11	nd	nd	nd
Sum	99.91	98.0	99.3	100.0
$\alpha$	1.551		1.572	1.571
$\beta$	1.559		nd	1.580
$\gamma$	1.562		1.584	1.585

1. Armenite; Armen Mine, Kongsberg, Norway (Neumann, 1941).
2. Armenite; The Piggery, Broken Hill, Australia (this work).
3. Calciocelsian; The Piggery, Broken Hill, Australia (Segnit, 1946).
4. Barium anorthite; Broken Hill, Australia (Nockolds and Zies, 1933).

(nd = not determined)

National University, had identified armenite by whole-rock X-ray powder diffractometry in Ba-rich calc-silicate rocks at Purnamoota, an abandoned mining area 30 km north of Broken Hill. A specimen of this rock (33304, Geology Dept., ANU), consists almost entirely of armenite, with a little celsian and accessory minerals. This raises the question as to why the bytownite and celsian in the Piggery rocks have not reacted more completely to armenite; the controlling factor is presumably the H<sub>2</sub>O activity, probably quite low during the metamorphism of the Broken Hill gneisses (amphibolite to granulite facies).

During this research accessory minerals in the Ba-rich gneisses were analysed for barium, in order to see how this element was distributed. The only minerals with considerable amounts were biotite (BaO variable, up to 13%) and muscovite (BaO 5–7%). BaO contents of other minerals were as follows: bytownite, 0.15%; titanite, 0.2%; apatite, trace (< 0.05%); hornblende, 0.16%; zoisite, 0.13%. Clearly under the conditions of crystallization of these gneisses barium formed celsian and armenite and concentrated in potassium minerals, and was essentially rejected by calcium minerals, as would be expected on crystallochemical grounds.

KEYWORDS: armenite, celsian, anorthite, barium, Broken Hill, Australia.

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The IMA Commission on New Minerals and Mineral Names has approved the proposal to discredit calciocelsian.

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## Schachnerite, paraschachnerite and silver amalgam from the Sala mine, Sweden

SCHACHNERITE ( $\beta$ -Ag<sub>1.1</sub>Hg<sub>0.9</sub>) and paraschachnerite (Ag<sub>1.2</sub>Hg<sub>0.8</sub>) were discovered in ores from Landsberg (Germany) by Seeliger and Mücke (1972), who suggested that these minerals should also be found in other localities where silver amalgam phases occur. Until recently, however, only one other occurrence of paraschachnerite was noted (in Kremikovci, Bulgaria, by Atanasov, 1979). The Sala material thus represents the third occurrence of paraschachnerite and the second one of schachnerite.

The Sala Pb–Ag–Zn deposit is the oldest known occurrence of natural silver amalgam. In the period between 1506 and 1962 this mine produced about 515 metric tons of silver and 37 000 metric tons of lead; at one time also about 0.6 metric ton

of mercury was gained (Tegengren, 1924). Macroscopic quantities of amalgam, native mercury and cinnabar were only noted in the higher parts of the mine, especially from the Juthyll shaft. According to Sjögren (1900) 'amalgam' occurred in two different forms: A. as silvery white cubic crystals in small druses filled sometimes with native mercury; B. as yellowish irregular masses in cavities. Chemical analyses of the cubic crystals yielded the composition of moschellandsbergite ( $\gamma$ -phase Ag<sub>4</sub>Hg<sub>5</sub>) with a small excess of mercury; the irregular masses, after subtraction of mechanical impurities, have exactly the composition of the  $\gamma$ -phase. Macroscopically identical irregular material, analysed by Nordström (1881), had a significantly lower Hg content, corresponding well with results of the present