

SHORT COMMUNICATIONS

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Roepperite from Broken Hill (New South Wales) is ferroan tephroite

AN iron manganese zinc chrysolite, forming dark mottled masses or distinct crystals, was described from Sterling Hill, New Jersey, by W. T. Roepper, in 1870. On the basis of Roepper's analytical work and his outline of its crystallographic properties, the mineral was considered authentic and in 1872 was named roepperite by Professor G. J. Brush. It has since appeared in all editions of Dana and become generally accepted—Fleischer (1980) accords it the status of a manganoan zincian fayalite.

At Broken Hill, New South Wales, an apparently similar mineral was encountered in the Junction North and Block 14 Mines, in contact with the sulphide ore. Described by George Smith, initially in 1922 and in more detail in 1926, it was massive reddish brown to grey. Analysis by Mingaye and White of the New South Wales Department of Mines showed it to be an olivine-like mineral, but with 8.2% ZnO. The name roepperite must have been applied to the Broken Hill mineral much earlier, however, as Mason (1973) states that George Smith sent a specimen of roepperite, 'the latest discovery in Broken Hill mineralogy', to W. A. Roebling, at the Smithsonian Institution, in 1897. A specimen named roepperite from Broken Hill was purchased by the National Museum of Victoria (NMV) in 1900. No entry for roepperite, however, appears in Anderson's *Bibliography of Australian Mineralogy*, published in 1916.

In 1955 F. L. Stillwell re-examined in detail the 'type' specimen of Broken Hill roepperite, obtained by the Australian Museum in 1907 when it purchased a collection belonging to George Smith (Chalmers, pers. comm., 1982). A small sliver of a coarse crystal on this specimen, stated by Stillwell to be free of sphalerite inclusions, was analysed by G. C. Carlos and found to contain 8.12% Zn. In his unpublished report Stillwell (1956) considered that Smith's original identification of roepperite, a zinc-bearing 'knebelite', with $Mn > Fe$, was correct.

In his discussion of the petrology of the Broken Hill lode, Stillwell (1959) described both knebelite and roepperite, the latter still being regarded as a valid species. Mason (1973) first cast doubt on the validity of Broken Hill roepperite, when micro-

probe analyses of the Smithsonian Institution's Roebling specimen revealed only 0.6% ZnO. Mason attributed the high zinc content in Smith's original analysis to microscopic sphalerite inclusions.

The discrepancies between Mason's and Stillwell's observations and results could only be resolved by microprobe analyses of the first described Broken Hill roepperite specimen in the Australian Museum collection. This, together with the NMV specimen purchased in 1900, and eight more recently collected specimens labelled either roepperite, knebelite, or tephroite were examined in this study (Table I).

The Broken Hill 'type' specimen (D19342) measures $7 \times 7 \times 3$ cm and consists of a dark-brown mineral showing imperfect cleavage and a vitreous to resinous lustre. In thin section the mineral is transparent and pale brown. Inclusions of manganopyrosomalite, garnet, apatite, calcite, and fluorite are present. Stillwell (1956) also noted rhodonite and pyroxmangite. Galena and sphalerite are visible in hand specimen and in thin section where they may occur both as inclusions or along grain boundaries. A microprobe section was prepared from the coarsest part of the specimen, where Stillwell (1956) noted a 4-cm crystal and from where he presumed Smith's analysed material came.

With the exception of sample M32135, which consists of ellipsoidal grains of 'roepperite' enclosed in sphalerite, most specimens are similar to the type specimen, with generally large crystals (up to 2 or 3 cm) associated with finer-grained aggregates. A brownish alteration product, as grain boundary and cleavage fillings and veinlets, is present to varying degrees. Two specimens from the NBHC Mine are portions of drill core from close to the southern end of the lead lode on 21 level. One consists of coarse 'roepperite' (containing abundant rod-like inclusions) with calcite, sphalerite, and galena, and the other of a polyhedral aggregate of the four minerals. A specimen from the Zinc Corporation mine consists of a granular gneissic mass of tephroite, bustamite, calcite, and sulphides.

All ten samples were analysed using a JEOL microprobe, with a beam voltage of 15 kV and a

TABLE I. *Electron microprobe analyses of Broken Hill ferroan tephroites*

wt. %	1	2	3	4	5	6	7	8	9	10
SiO ₂	30.55	29.65	29.85	29.78	29.79	30.03	29.88	30.20	30.09	29.58
TiO ₂	0.06	—	0.05	—	0.06	0.03	0.03	—	0.03	—
Al ₂ O ₃	0.05	0.03	0.05	0.02	0.03	0.04	0.02	0.03	0.10	0.04
FeO	19.16	22.14	18.63	19.31	18.19	18.32	22.06	16.02	16.65	26.42
MnO	49.20	46.57	50.42	48.99	49.17	50.18	45.17	51.71	51.04	42.99
MgO	0.06	0.22	0.18	0.12	0.78	0.19	0.74	0.72	0.40	0.10
CaO	0.07	0.39	0.03	0.39	0.35	0.04	0.42	0.21	0.35	0.05
ZnO	0.20	0.19	0.20	0.22	0.20	0.13	0.19	0.12	0.04	0.22
Total	99.35	99.19	99.41	98.83	98.57	98.96	98.51	99.01	98.70	99.40
End member ratios										
Fa	27.7	31.5	26.6	27.7	26.1	26.3	31.6	22.9	24.0	37.6
Tep	72.0	67.2	72.9	71.2	71.3	73.1	65.7	74.9	74.3	62.0
Fo	0.2	0.6	0.5	0.3	2.0	0.5	1.9	1.8	1.0	0.3
Lar	0.2	0.7	—	0.7	0.7	0.1	0.8	0.4	0.7	0.1
Fe/Mn	0.38	0.47	0.36	0.39	0.37	0.36	0.48	0.30	0.32	0.61

Specimens

1. D19342 (av. of 3). Junction North Mine (Aust. Mus.).
2. D40144 (av. of 2). 20 level, NBHC Mine (Aust. Mus.).
3. M2680 (av. of 2). (Nat. Mus. Vic.).
4. D42171 (av. of 2). 18 level, Zinc Corp. Mine (Aust. Mus.).
5. M32135 (av. of 2). (Nat. Mus. Vic.).
6. M23102 (av. of 2). (Nat. Mus. Vic.).
7. M36201 (av. of 3). 21 level, NBHC Mine (Nat. Mus. Vic.).
8. M36202 (av. of 2). 21 level, NBHC Mine (Nat. Mus. Vic.).
9. M33087. 13 level, Zinc Corp. Mine (Nat. Mus. Vic.).
10. M23420. 26 level, North Mine (Nat. Mus. Vic.).

Analyst: W. Birch.

specimen current of the order of 0.025 μ A (25 nA). Standards used included metallic Fe, Mn, and Zn, with appropriate oxides and silicates for the remaining elements.

Up to three points were selected for analysis on each sample. All proved to be ferroan tephroites, with a limited compositional range (Fe/Mn between 0.61 and 0.30). The ZnO contents ranged between 0.04 and 0.43%; on the 'type' specimen, the maximum zinc content was 0.34%. Clearly, roepperite is not, on the basis of these results, a valid mineral at Broken Hill and the conclusion drawn by Mason (1973) is confirmed.

Overlooking the small zinc contents, the compositions (Table I) lie very close to the fayalite-tephroite join. The minor larnite component shows more variability than forsterite and reaches a maximum value of 0.9 mol. % (corresponding to 0.52% CaO). The fayalite-tephroite ratios in these ferroan tephroites agree closely with the rather limited published data (Mason, 1973; Hodgson, 1975). The only analysis known to contain less than

60–75% of the tephroite end member is from a drill core in the Zinc Corporation Mine (Stillwell, 1959). The composition is that of a manganoan fayalite (Fa:Tep = 54:42) with ZnO and MgO contents of 1.54 and 1.46% respectively. A mineral much closer to pure tephroite with only 8 wt. % Fe was found associated with jacobsonite in NBHC ore (Segnit, 1977).

X-ray powder diffraction analysis, using a Philips system with Ni filtered Cu-K α radiation was undertaken for all ten samples. The position of the 130 reflection in the fayalite-tephroite series was measured using synthetic calcium carbonate (calcite) as an internal standard. Runs were made in duplicate or triplicate at a chart speed of $\frac{1}{4}^{\circ}$ 2 θ per minute. The measured position of the 130 reflection showed little variation, giving d values from 2.859 to 2.863 Å with an estimated error of ± 0.002 .

Mossman and Pawson (1976) constructed a determinative grid for forsterite-fayalite-tephroite minerals based on composition, d_{130} and β . Use of this grid, together with the d_{130} values and the

compositions of the Broken Hill ferroan tephroites from this study, gives a predicted β refractive index close to $\beta = 1.820$. Refractive indices determined by Dr J. McAndrew on the Broken Hill type specimen (cited in Stillwell's report) were $\alpha = 1.791$, $\beta = 1.819$, $\gamma = 1.829$, with errors of ± 0.002 . Thus, the measured β agrees with that predicted by the Mossman-Pawson grid.

The terms knebelite, tephroite, and roepperite have all been used for what appears to be essentially the same mineral at Broken Hill. Their use, however, has been arbitrary in the absence of sufficient data to establish natural compositional limits. The results of this study indicate that most (if not all) of the Broken Hill occurrences are ferroan tephroite, with a compositional range defined by Fe/Mn between 0.61 and 0.30. However, more data are needed to determine whether there are any compositional variations related to either position in the lode horizon or the nature of the tephroite-bearing assemblage.

The term knebelite, now defined as a synonym for manganoean fayalite (Fleischer, 1980) is not generally applicable to any Broken Hill mineral and roepperite, on the basis of this study, is not a valid mineral at Broken Hill (Birch *et al.*, 1982).

The nature of the original roepperite specimen from Sterling Hill is unknown. However, there may be some doubt cast on its validity, since Hurlbut (1961) demonstrated that the solid solubility of Zn in tephroite is limited and, of the four Franklin roepperite specimens available for Hurlbut's study, three proved to be black willemite and the fourth to be ferroan tephroite with exsolved willemite.

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An unusual pyrite-sulphur-jarosite assemblage from Arkaroola, South Australia

AN occurrence of co-existing pyrite, elemental sulphur, and jarosite ($\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$) has recently been discovered in South Australia. Although jarosite is a common alteration product of pyrite (e.g. Furbish, 1963; Bladh, 1982), this is apparently the first time that native sulphur has been reported in association with the two.

The occurrence was discovered by Mr Edward Madden of Echunga, South Australia, in a metamorphic formation known as the Woodnamoka Phyllite, which is in the lower part of the Proterozoic Adelaidean system in the Mount Painter Province of South Australia. A description of the regional geology is provided by Coats and Blissett