

Robinson, A. J. (1948) Geological report for 1947. *Bull. annu. Soc. Jersiaise*, **14**, 360.

Teilhard de Chardin, P., and Pelletier, F. (1911) Notes minéralogiques et géologiques sur l'île de Jersey. *Ibid.* **7**, 99–111.

——— (1921) Notes minéralogiques et géologiques

sur l'île de Jersey, liste supplémentaire. *Ibid.* **9**, 293–4.

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## Some observations on the mineralogy and genesis of braunite

ALTHOUGH braunite  $3\text{Mn}_2\text{O}_3 \cdot \text{MnSiO}_3$  is best known from its occurrence in regionally metamorphosed manganese deposits such as the gonrites and kodurites of India (Roy, 1981) it also occurs in hydrothermal veins (Frenzel, 1980) and in unmetamorphosed sediments (De La Hunty, 1963). A minor occurrence in the lower Cretaceous sedimentary manganese ores of Groote Eylandt is interesting as it indicates a sabkha-type origin for the mineral, and suggests a possible origin for the presence of small amounts of boron commonly found in braunite.

The presence of braunite was first noted by the writer in 1975 (Ostwald, 1980). The occurrence of irregular zones of braunite around sand grains

in manganeseiferous clays suggested that it was a reaction product, possibly produced during sedimentation of  $\text{MnO}_2$  colloids. Occurrences of skeletal crystals in dense cryptomelane were more difficult to explain. Recently further occurrences of braunite and cryptomelane showing chevron layering have been noted and examined. Typical occurrences are shown in fig. 1.

Under the optical microscope braunite is brownish grey against pale grey cryptomelane, and it commonly occurs as parallel, tabular layers alternating with cryptomelane, and with definite angular morphology. Fortification-type structures also occur, with re-entrant angles common.

The chemical compositions of the braunite and

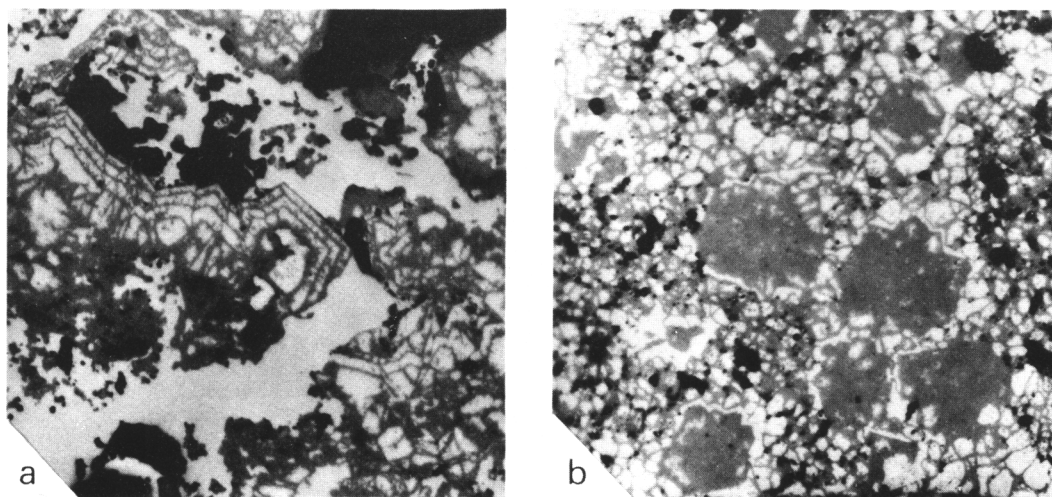


FIG. 1. Examples of (a) chevron layered structures and (b) fortification structure of braunite (dark grey) and cryptomelane (pale grey). Reflected light ( $\times 300$ ).

TABLE I. *Microanalyses of braunite and cryptomelane (wt. %)*

	Braunite	Braunite	Cryptomelane
MnO <sub>2</sub> *	77.5	77.3	91.5
Al <sub>2</sub> O <sub>3</sub>	1.4	1.7	1.6
Fe <sub>2</sub> O <sub>3</sub>	6.2	5.7	0.7
SiO <sub>2</sub>	9.8	9.9	0.4
CaO	2.2	1.8	0.1
BaO	1.4	1.9	0.5
Na <sub>2</sub> O	0.2	0.5	1.2
K <sub>2</sub> O	0.1	0.1	2.7
B	0.12	0.14	n.d.
Total	98.92	99.04	98.7

\* Reported as MnO<sub>2</sub>. Distribution of valency states not obtained. n.d. = not detected.

cryptomelane, as determined by electron probe microanalysis, are listed in Table I. The Table also contains data on boron content of the minerals, determined by ion microprobe analysis. It will be seen that the braunite belongs to the normal braunite class, with about 10% SiO<sub>2</sub> and is not low-silica braunite II (De Villiers and Herbstein, 1967). It also contains low levels of Ca, Al, and Fe, and trace of boron. The cryptomelane is normal Groote Eylandt cryptomelane with K<sub>2</sub>O > BaO and with minor amounts of Na<sub>2</sub>O. No B was detected in this mineral.

The suggestion that these layered structures were the product of a sabkha environment is based on the following:

(1) The layered fortification–chevron structures are morphologically similar to that of salt deposits on recent and ancient sabkhas (Shearman, 1966, 1970) (Wardlaw and Schwerdtner, 1966).

(2) The braunite contains Ca and traces of B, two elements which are characteristic of the minerals of closed basin evaporites (Clark, 1924).

(3) The Groote Eylandt deposits show evidence of biogeochemical precipitation of manganese oxides in the form of manganese oxide algal mats, which are characteristic of sabkhas (Ostwald, 1981).

(4) The Groote Eylandt deposits are considered to have developed in estuaries, lagoons, and off-shore regions (Slee, 1980).

(5) A sabkha origin for braunite in Precambrian biogenetic sedimentary deposits has been proposed by Serdyuchenko (1980).

These arguments suggest that the braunite and cryptomelane developed by the replacement of evaporite minerals of salt flats. The evaporite minerals were no doubt diagenetic (Kinsman, 1966). At some subsequent period the salt crusts were replaced by manganese oxides. It is likely that the Ca and B of braunite may be relicts of the earlier minerals.

Although the origin of the small amounts of boron in the braunite is unknown it is possible that it was initially concentrated by algal activity (Guliaeva, 1942) and bonded into algal sapropel in the sediments.

## REFERENCES

- Clark, F. W. (1924) *The Data of Geochemistry*. U.S. Geol. Survey Bull. 770.
- De La Hunty, L. E. (1963) *Geol. Survey West. Austral. Bull.* 116.
- De Villiers, P. R., and Herbstein, F. H. (1967) *Am. Mineral.* **52**, 20–30.
- Frenzel, G. (1980) In *Geology and Geochemistry of Manganese*, Vol. 1 (ed. I. M. Varentsov and G. Grasselly), Stuttgart, 25–157.
- Guliaeva, L. A. (1942) *Dokl. Akad. Nauk. SSSR* **37**, 28.
- Kinsman, D. V. (1966) *2nd Symposium on Salt*, Vol. 1 (ed. J. L. Rau), North Ohio Geol. Soc., Cleveland, Ohio, 302–26.
- Ostwald, J. (1980) In *Geology and Geochemistry of Manganese*, Vol. 2 (ed. I. M. Varentsov and G. Grasselly), Stuttgart, 149–81.
- (1981) *Econ. Geol.* **76**, 556–67.
- Roy, S. (1981) *Manganese Deposits*, Academic Press, NY, 458 pp.
- Serdyuchenko, D. P. (1980) In *Geology and Geochemistry of Manganese*, Vol. 2 (ed. I. M. Varentsov and G. Grasselly), Stuttgart, 61–85.
- Shearman, D. J. (1966) *Trans. Inst. Min. Metall.* **B, 75**, 208–15.
- (1970) *Ibid.* **79**, 155–62.
- Slee, K. J. (1980) In *Geology and Geochemistry of Manganese*, Vol. 2 (ed. I. M. Varentsov and G. Grasselly), Stuttgart, 125–48.
- Wardlaw, N. C., and Schwerdtner, W. M. (1966) *Geol. Soc. Am. Bull.* **77**, 331–42.

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