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Merlinoite in manganese nodules from the Indian Ocean

A GROUP of silicate minerals including quartz, feldspar, montomorillonite, illite, phillipsite, mordenite, etc. has been found associated with manganese nodules from the Pacific Ocean, either as a nucleus or as disseminations within sub-layers (Cronan and Tooms, 1968; Burns and Burns, 1977). These are either detrital or derivatives of pumice, basalt, glass, tuff, etc. Detailed studies of individual minerals are reported by Piper and Williamson (1981) and Bischoff *et al.* (1981). While carrying out mineralogical characterisation of core materials of manganese nodules collected from different localities in the Central Indian basin, Indian Ocean, the authors recorded the occurrence of the mineral merlinoite, details of which are presented here. To our knowledge, this mineral has not been reported previously in manganese nodules.

The nodule samples were collected during September 1982 between latitude 6° and 8° S and longitude 81° to 87° E by the first author (in cruise nos. 111 and 112) in the research vessel 'Gaveshani' by the free-fall grab technique.

Merlinoite was identified by X-ray powder diffraction (XRD) technique using a Philips diffractometer, with Mo-$K\alpha$ radiation and zirconium filter, operating at 40 kV and 20 mA. The XRD pattern is almost identical to that of phillipsite, with the exception of the 10.02 and 4.48 Å lines (Table 1) which are characteristic of merlinoite (Passaglia *et al.*, 1977). Subordinate amounts of plagioclase feldspar (P), stilbite or chabazite (S) and quartz (Q) have been recorded in several samples. In thin section, merlinoite invariably appears as aggregates showing interpenetrant complex twins. Under a JEOL scanning electron microscope it appears as thin overlapping euhedral lamellae of fibrous crystals (Fig. 1). An EDAX spectrum shows that the grains contain Si, Al, K, Ca in decreasing order

Table 1 : X-ray diffraction pattern of merlinoite, Indian Ocean Manganese Nodule, Specimen No. 2, Mo/Z radiation.

dÅ	I/I_o	hkl
9.88	22	110,S
8.19	20	011, 101
7.05	57	020, 200
5.34	22	121. 211
4.95	31	002
4.46	26	310
4.25	22	031, Q
4.07	44	P, 202, S
3.32	40	Q, 330
3.23	49	103, P
3.17	100	P, 240
2.94	26	P, 213, S
2.73	29	051, 341
2.67	35	P, 242, 422
2.55	20	P, 251
1.78	10	033, 080

Q - Quartz P - Plagioclase S - Stilbite

of peak height with Si/Al = 2.8. However, the merlinoite was found to be Ba-free.

The association of the Ba zeolite harmotone with manganese minerals is recorded in Siberia (Afanesiev *et al.*, 1940). Smith (1945) has reported a similar association with banalsite, a barium feldspar, occurring as thin bands traversing manganese ores in North Wales. The invariable microscopic evidence of tuffaceous textures such as glassy (palagonitic) materials in the form of acicular crystallites/shards, devitrified spherulites and pyroclasts in the core material of several of the Indian Ocean nodule samples are indicative of pronounced volcanic activity on the Indian Ocean floor.

The authors support the conclusion of Hallam and Sellwood (1970) that the mechanism of formation of merlinoite and other zeolite minerals is the result of diagenetic alteration of volcanic ash falls in an aquatic environment, as well as Andruschenko and Skornyakova (1960) who invoke the processes of decomposition of glassy volcanic rocks on the ocean bottom.

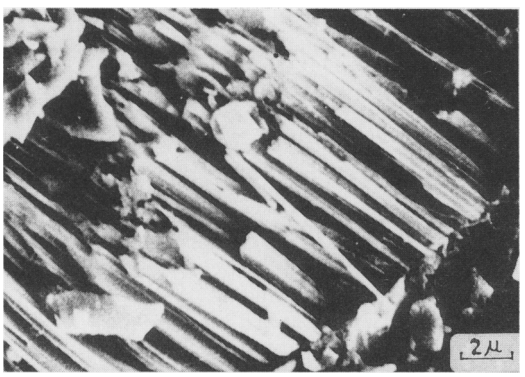

FIG. 1. Scanning electron micrograph showing fibrous crystals of merlinoite in a manganese nodule cavity.

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