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# An occurrence of brucite at Merehead Quarry, Cranmore, Somerset

THIS note offers the first record of an occurrence of brucite in the Mendip Hills. The locality is in Merehead Quarry (grid ref. O.S. 1″ map ST 698443), which is situated on the south flank of the Beacon Hill Pericline. The rocks quarried are well-bedded limestones that are referred to the Lower Carboniferous Clifton Down Limestone. A notable feature of this locality is the occurrence of a varied assemblage of rare lead and copper minerals. These have recently been described by Alabaster (1975: see references there to the no. 2 vein, at which brucite has now been discovered). The rare minerals are found within the pods of manganese oxide that occur, together with iron oxides, as replacement deposits set in faults and Trias-filled fissures developed in the Carboniferous Limestone. Doulting Stone (mid Jurassic: Upper Inferior Oolite) rests unconformably on the Carboniferous Limestone at Merehead and can be seen to truncate the mineralized fissures. The fissures occasionally contain inserted sedimentary materials ranging in age from Rhaetic to Upper Inferior Oolite.

The pods of manganese oxide contain numerous small cavities, the ore from no. 2 vein being especially cavernous. The secondary minerals occur either as simple cavity fillings or else are contained in calcite nodules, which have themselves grown in, and may in some instances have enlarged, the original cavities. The brucite has been found occupying a small central cavity in two of these calcite nodules.

Brucite occurs in each of these two cases as a compact mass of transparent, prismatic-acicular crystals, arranged in radiating groups that are intergrown with one another. The crystals are elongate ‖ [0001] and grow out from the cavity walls. In both specimens there is some degree of alteration to white hydromagnesite and pseudomorphs after brucite are seen. A thin (up to 0·5 mm) discontinuous light-brown rim occurs at the brucite/calcite interface. This light-brown material is translucent, has a vitreous-resinous lustre, and is appreciably harder than the brucite, which it invariably pseudomorphs. XRD analysis shows it to consist of a mixture of brucite and crystalline hydromagnesite. Both the brucite and the white hydromagnesite are seen to grade into this material.

In one specimen (now in two parts deposited in the Geology Museum, University of Bristol, numbered B3624 and B3625: see the former in fig. 1) brucite is associated with massive orange blixite, which shows partial alteration to hydrocerussite. Contacts between brucite and blixite are sharp. The gently undulating contact is uninfluenced by both cleavages and crystallographic orientation of the brucite crystal groups. There is no evidence to suggest that brucite is intergrown with the blixite/hydrocerussite. It seems to be the case that brucite formed before blixite in this nodule.

The two brucites are of different colours, brownish green in the nodule that has blixite and pale green in the other. Refractive indices (determined using white light) too are different in

the two specimens (brownish green: $\epsilon$ 1·559, $\omega$ 1·564; pale green: $\epsilon$ 1·557, $\omega$ 1·561). A partial chemical analysis of the pale-green brucite (specimen no. B 3626) shows a very low content of iron and manganese (MnO 0·025 %; $Fe_2O_3$ 0·09 %). The maximum amount of calcium found is a little over 1 % (this may be to some extent due to contamination by calcite). No zinc was detected, although it is known that the zinc content of manganese oxide in this neighbourhood can reach a level of 0·15 % ZnO. Although insufficient pure brownish green brucite was available for chemical analysis, the colour and the higher refractive indices would suggest that there is a higher content of iron and manganese in this material.
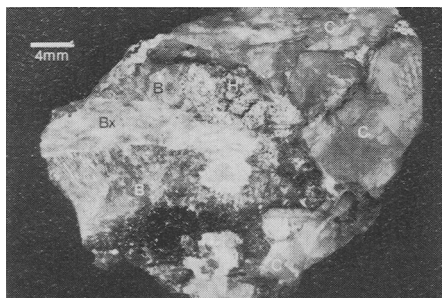


FIG. 1. Brucite (B) with blixite (BX), calcite (C), and hydromagnesite (H). Specimen B3624.

The mode of formation in the present case may have been: The replacement deposits developed by introduction of groundwaters, rich in iron and manganese, into faults, joints, and rubble-filled fissures; oxides of iron and manganese were deposited as gel precipitates; the transition metals were adsorbed by manganese oxide gel, and when this was later compacted and recrystallized, the metallic ions were remobilized. These processes were in progress during a time when the Mendip area was slowly subsiding and was overtaken by marine incursions. It has been proposed (Alabaster, 1975) that the oxychlorides formed as a result of reaction between Jurassic sea water and the remobilized metallic ions already established. Brucite, like the related mineral pyrochroite, tends to form under strongly alkaline conditions (Mart and Sass, 1972). The pH of sea water would not normally be high enough to induce precipitation of brucite, but at places where sea water was in contact with pods of $MnO_2$, the steady release of heavy metals from the crystallizing oxide gels might have caused the water within cavities in the ore to become strongly alkaline. Alkaline conditions appear to favour the formation of many lead oxychlorides (Mellor, 1929) as well as of cerussite and aragonite (Wray and Daniels, 1957). It may therefore be suggested that because of local build-up of heavy metals in solution, conditions within a few of the developing calcite nodules became sufficiently alkaline to allow brucite to form. In the case of one nodule, a later slight alteration of these conditions brought about partial dissolution of the brucite. Deposition of blixite followed.

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# Chromium in dravite

THE general formula of dravite is $(Na, Ca)Mg_3Al_6B_3Si_6(O,OH)_{30}(OH,F)$; it grades evenly, without miscibility gaps, to uvite $(Ca, Na)Mg_3(Al_5Mg)B_3Si_6(O,OH)_{30}(OH,F)$.

Chromium can enter the tourmaline structure in limited amounts in substitution for aluminium, and less commonly, magnesium. The substitution of trivalent elements in the normally divalent site of tourmalines has been well established, as in elbaite and in buergerite (Mason *et al.*, 1964).

A *chromturmalin* was reported in 1883 by Cossa and Arzruni from Syssertox Dach, Ural Mountains, Russia. Their analysis of this material is given in Table I. The given analysis suggests that the 10·86 % $Cr_2O_3$ is substituting for magnesium and not aluminium, and since this reported analysis has Cr > Mg > Fe, it would likely qualify as a new legitimate end-member of the tourmaline group in accordance with contemporary rules of mineral nomenclature. A re-examination of the material of Cossa and Arzruni, a sample of which was deposited in the British Museum by Arzruni (BM56285), was thus in order, and a review of chromium substitution in tourmaline was undertaken.

*Previous work.* Relatively few tourmalines with significant (> 1·00 $Cr_2O_3$) chromium content have been reported. Subsequent to the description of the original material by Arzruni (1883), a chromian dravite from Etchison, Maryland, U.S.A., was reported by Gill (1889). Recent investigations include the description of a chromian dravite from the Krivoy Rog area, U.S.S.R. by Shenderova (1955). Peltola *et al.* (1968) described samples from Outukumpu and Kaavi, Finland, and Mukherjee (1966) described a chromian dravite from Nausahi, Keonjhar District, Orissa, India. A compilation of these analyses is presented in Table I.

*Chemistry.* The analysis of additional specimens from the previously mentioned localities was performed with an ARL–SEMQ electron microprobe using an operating voltage of 15 kV and a sample current of 0·15 $\mu$A. Standards used were wet-chemically analysed elbaite, uvite, and buergerite for Si, Al, Fe, Mg, Ca, Mn, and Na and chromite for Cr. The resultant analyses are presented in Table I.

The chromian tourmaline of Cossa *et al.* was re-examined. The new analysis of this material (BM 56285) does not agree with the original analysis. The material has Mg > Cr > Fe and is a chromian dravite. The major disparity between the old and new analyses is in the chromium, iron, and magnesium content. Since there is no proof that the sample is the very one analysed by Cossa *et al.*, this difference may reflect a compositional variation in the Urals