CORRESPONDENCE

An alternative to the 'Clastic Trap' interpretation of oolitic ironstone facies

SIR,—In his recent paper under the above title (*Geol. Mag.* 1971, p. 137) Brookfield sets out to explain the general separation of terrigenous sand and silt from oolitic ironstones. He suggests that the ability of iron ooliths to be rolled by gentle currents is such that they can be selectively transported relative to finer terrigenous grains. According to his hypothesis it is not necessary to invoke a 'clastic trap' mechanism to account for the general freedom of oolitic ironstone from terrigenous grains.

The general purity of the oolitic ironstones must, however, be considered in terms of their origin. The frequent association of iron ooliths with interstitial ferruginous mud indicates that the ooliths were formed in a muddy environment. The oolith assemblages, however, commonly possess a packstone or sometimes a grainstone texture; this, together with the abundance of intraclasts and the occasional development of cross-bedding, indicates that considerable reworking of the ooliths has taken place before their final accumulation (Hallimond, 1925, p. 10). Furthermore the shape and internal structure of typical chamosite ooliths suggests that they were formed on a surface of chamosite mud which was undergoing continuous gentle winnowing (Knox, 1970). Any large-scale influx of detrital sediment at this stage would destroy the environment of formation of the ooliths.

If, during the formation of the ooliths, sand or silt grains were being introduced into the overall basin of sedimentation, then some mechanism for retention of clastics must have operated to keep the ironstone area uncontaminated. However, this need not involve a basin immediately adjacent to the area of ironstone formation as illustrated by Brookfield (Fig. 1a); in fact, as discussed below, a basin-type trap may not be necessary at all.

Although oolitic ironstones commonly occur within silty and sandy sequences, the lower surface often shows a sharp demarcation from the beds beneath, in the form of an erosion surface and sometimes an unconformity. The initial phase of ironstone formation would therefore appear to take place in extremely shallow, but deepening, water. An analogous situation is present in the Eller Beck Bed (and locally in the Cornbrash) of the Middle Jurassic of Yorkshire, in which a basal marine oolitic ironstone rests directly on non-marine deltaic beds. In both types of development the ironstone appears to be associated with a transgression; in an area of very low relief this will lead to a considerable reduction in the influx of terrigenous material (Hallam, 1963, p. 449).

Chamosite mud probably formed under conditions of very slow sedimentation of the finest terrigenous material, but not necessarily on shoals as suggested by Hallam (1966). Continued transgression and deepening would further reduce the terrigenous influx; at the same time it would permit greater circulation and wave action, which could lead to the formation of ooliths. A continuing increase in water agitation would finally lead to the reworking of the ooliths; by this time the freer circulation might also permit renewed influx of terrigenous material into the ironstone environment. This would be most marked where ironstone formation was followed by a regression—the sandy Northamptonshire Ironstone and the Yorkshire Dogger ironstones are overlain by non-marine deltaic deposits, and the accumulation of the Lorraine ores was associated with regressive phases (Bubinicek, 1964). The Winter Gill ironstone (Knox, 1970) is exceptional in that both the formation and the redistribution of ooliths are associated with regressive facies.

The separation of terrigenous grains from ooliths by selective rolling was suggested by Brookfield to explain not only the absence of terrigenous grains in most ironstones but also the association in the Abbotsbury Ironstone of ooliths with smaller sand grains. This relationship is seen in some other sandy ironstones but in the Lorraine ores the diameter of ooliths and sand grains is similar (Bubinicek, 1963, p. 188). The Lorraine ores are associated closely with littoral sands, but in other sandy ironstones there is no evidence for such a close association with a shoreline; in such cases the available terrigenous grain sizes are dependent on the transporting capacity of the environment along the route of introduction. The iron ooliths, having formed by accretion within the area of sedimentation, have no such control on their size.

The Abbotsbury Ironstone is stated by Brookfield to be exceptional in its admixture of ooliths and terrigenous sand grains, but Hallimond (1925, p. 91) states that such an association is not uncommon. Quartz grains may form a high proportion of the grains in parts of the Northamptonshire Ironstone (Taylor, 1949, p. 22) and of the Lorraine ironstones (Bubinicek, 1963, Fig. 1). These examples seem to indicate that the two grain types are capable of being transported together. Where abrupt change of facies is indicated, as illustrated by Brookfield (Fig. 2), it may result from the oolite body having attained a fairly stable form before the introduction of clastic sediment.

When examined in detail the rolling mechanism itself seems unsatisfactory. The proposed levelling of surfaces by deposition of interstitial clay (Brookfield, p. 141) would lead to a greater proportion of matrix than is found in most oolitic ironstone facies, which usually consist of packstones, and sometimes of grainstones. Also a distinct lamination should result from this mode of accumulation; bioturbation could be invoked to explain the absence of lamination, but would probably contribute to surface roughness. The common presence of shells, sometimes unbroken, and of irregularly-shaped intraclasts in association with iron ooliths is another feature incompatible with selective rolling. Perhaps the most important feature in this respect is the shape of the ooliths; while some limonite oolith assemblages exhibit high sphericity, the majority of iron ooliths possess a distinctive oblate ellipsoidal shape (Hallimond, 1925, Pl. 6; Bubinicek, 1963, Pl. 2) which is of primary origin (Knox, 1970) and which would cause considerable resistance to rolling.

References

Brookfield, M. 1971. An alternative to the 'clastic trap' interpretation of oolitic ironstone facies. *Geol. Mag.* **108,** 137–43.

Bubinicek, L. 1963. Étude sédimentologique de la minéralisation ferrifére oolithique de Lorraine. *Annls Soc. geol. Belg.* **86,** 181–211.

1964. Étude sédimentologique du minerai de fer oolithique de Lorraine, *in* G. C. Amstutz (Ed.): Sedimentology and ore genesis. *Developments in Sedimentology* **2,** 113–22.

Hallam, A. 1963. Eustatic control of major cyclic changes in Jurassic sedimentation. *Geol. Mag.* **100,** 444–50.

1966 Depositional environment of the British Liassic ironstones considered in the context of their facies relationships. *Nature, Lond.* **209,** 1306–7.

Hallimond, A. F. 1925. Iron ores: Bedded ores of England and Wales. Petrography and chemistry. *Mem. geol. Surv. spec. Rep. Miner. Resour. Gt Br.* **22,** 139 p.

Knox, R. W. O'B. 1970. Chamosite ooliths from the Winter Gill ironstone (Jurassic) of Yorkshire, England. *J. sedim. Petrol.* **40,** 1216–25.

Taylor, J. H. 1949. Petrology of the Northampton Sand Ironstone Formation. *Mem. geol. Surv. Gt Br.* 111 p.

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