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

SIR,—Dr Knox has made some welcome additional observations on oolitic ironstones, and raised a number of pertinent objections to my hypothesis. However, like many authors, I am loath to abandon a hypothesis of mine despite evidence to the contrary and so must now try to explain away the awkward criticism.

The major objections of Dr Knox seem to me to be:

1. The packstone (grain-supported rock with mud) and grainstone (grain-supported rock without mud) textures found in oolitic ironstones cannot be reconciled with the proposed levelling of oolitic surfaces by deposition of clay. However, the hypothesis does not exclude the periodic movement of ooliths in suspension, perhaps by storm waves, which could winnow out the clay supporting them.

The most noticeable grainstones are those in which the matrix is of calcite or siderite spar. These are the fabric types which usually show the most intense reworking, containing reworked intraclasts and shell fragments (cf. Hallam, 1963). These features can be attributed to relatively short-lived highly turbulent conditions.

Other grainstones consist of flattened chamosite ooliths, which are commonest in beds where a supporting matrix is reduced to a minimum (Carozzi, 1960, p. 362; Schellmann, 1969). Though this is probably due to post-depositional compaction, it is possible considering the ease of deformation of chamosite ooliths (Wilson, 1966), that they self-compacted on the sea floor providing a relatively flat surface for rolling.

For packstones, the ooliths could be rolled over a mud carpet, and the mud later partially removed, stranding the ooliths on earlier deposited ooliths. In view of the extreme condensation of most oolitic ironstones, this improbable mechanism may have operated under some sort of tidal control, which would provide the necessary alternation of high and low energy conditions.

The absence of lamination in ironstones, expected on the rolling hypothesis, can be attributed to bioturbation. Bioturbation would not necessarily increase bed roughness, as the dominant fauna of oolitic ironstones are normally epifaunal and infaunal suspension feeders. These need not cause much disturbance of the surface layers or resistance to rolling, and in any case the currents responsible for oolith movement would soon destroy any surface irregularities due to fecal casts of the burrowers. Bioturbation could also form packstones (cf. Schäfer, 1962), where sand grains are concentrated at certain levels by the action of dense colonies of burrowers.

2. The common presence of shells and irregularly-shaped intraclasts is incompatible with selective rolling.

Shells belong to the indigenous fauna and I do not see how this would affect rolling considering their general rarity. Shell beds and intraclast rich beds can be explained as high energy or storm deposits (see above).

3. The shapes of the ooliths are dominantly oblate ellipsoids which would cause considerable resistance to rolling.

I am not completely satisfied that the oblate ellipsoidal shape is primary, despite evidence in Knox (1970), and think it more likely that the shape is due to partial compaction, especially in view of the ease of deformation of chamosite ooliths. Limonite ooliths are generally considered to be oxidized chamosite ooliths, and these frequently show high sphericity which would indicate high sphericity of their chamosite precursors. A number of limonite ooliths with oblate ellipsoidal shapes in the Abbotsbury Ironstone show radial cracking which suggests compaction. The circularity of the equator in the oblate ellipsoidal ooliths figured by Knox (1970) is also suspicious, especially where the ooliths have grown around angular nuclei. The overall equatorial symmetry shown by the ooliths, despite asymmetric increments of the laminae, seem to me to be due to a rounding off of the ooliths by rolling after accretion during periods when they were at rest. Knox (1970) showed that equatorial accretion is commonly followed by polar accretion; and an alternative to his explanation of this is that the polar accretion represents a build-up to sphericity of a chamosite oolith undergoing gravity compaction to an oblate ellipsoid on the sea floor (or alternatively an oolith partially compacted within

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a mud bed and then re-exhumed). The fact that polar accretion is formed after equatorial accretion suggests to me that, at a certain size, the chamosite clay can no longer support a spherical structure and the oolith compacts to an oblate ellipsoid.

However, the only real way of testing the rolling hypothesis is by experiment, and the necessary evidence is still lacking (though cf. Winkelmolen, 1971). The main purpose of my paper was to point out the possible influence of density, shape and method of transport on the formation of oolitic ironstones.

I would like to add a number of other comments here.

1. In one section of his reply Dr Knox states that the general purity of ironstones must be considered, but later that sandy ironstones are not uncommon. In my experience, chamosite–siderite cemented sandstones are common (and these are often loosely called sandy ironstone), but these contain only rare iron ooliths. Sandstones with high proportions of iron ooliths, and oolitic ironstones with more than a few percent of quartz sand or silt, are very rare.

2. Only very thin oolitic ironstones are associated with transgressions (e.g. Elsworth Rock; Oxfordian, Cambridge). Knox is self-contradictory on the Eller Beck (= Winter Gill) ironstone. In one section it is transgressive, in the next it is associated with regressive facies. It seems to me that oolitic ironstones tend to occur during relatively minor regressive phases of generally transgressing seas. Phanerozoic ironstones are concentrated in the Ordovician and Jurassic, both times of widely spreading shelf seas; and similar occurrences are found in other systems.

3. The Northampton Sands Ironstone is sandy only in its marginal part, where ooliths are rare. All workers have commented on the rarity of sand in the oolitic parts of ironstones.

4. Lack of association of oolitic ironstones with shorelines. Although beach deposits are rarely if ever found with ironstones, a number of oolitic ironstones have facies attributable to subtidal beach or barrier bar environments; e.g. Abbotsbury (Brookfield, in press); Furnaceville (Silurian, New York) (personal observation, see Hunter 1970, for general review), Wabana (Ordovician, Newfoundland) (Gross, 1967)

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