CORRESPONDENCE

THE LIMESTONE-SHALE RHYTHM IN THE BRITISH LOWER LIAS

SIR,—Mr. Hallam's letter in the March–April number of the *Geological Magazine* discusses an interesting viewpoint on the origin of the Liassic "Hydraulic Limestones", but the evidence of primary origin which he adduces is not supported by investigations in the Midlands, and the whole range of data has to be taken into account in considering the origin of such a persistent formation.

The first impression in the East Midlands, as elsewhere, is that the limestones are much more fossiliferous than the shales, since they contain the obvious and well-preserved fauna. The shales, however, are far from barren. A. E. Trueman (1915), listed foraminiferal and ostracod faunas obtained by washing, and was able to distinguish a basal lagoonal phase in the Pre-*planorbis* beds from normal marine beds in the ammonite-bearing parts. Detailed work at Barnstone showed a similar range of vertebrates and bottom-living mollusca in both shales and limestones (Kent, 1937). The only condensed bed in the local sequence (an echinoid spine bed) is within the shales, and the only horizon to yield corals also happens to be within the shales. Thus in the East Midlands there is no justification for regarding the shales as deposited in an anaerobic environment, or as any less marine than the limestones.

It is agreed that individual limestone beds are often strikingly persistent over many miles. This may be due either to control by primary variation of the sediments (as suggested by Mr. Hallam for nodule beds) which made some levels more favourable than others for calcium carbonate segregation, or alternatively to precipitation at some precise distance beneath the sea floor where sediments had reached a very limited degree of compaction—possibly during a pause in deposition. Either process would reflect rhythmic control of original sedimentation. The present writer prefers the latter alternative, and is prepared to believe (from the evidence of fossil preservation) that limestone formation may have been taking place within a few feet of the contemporary m d surface.

Positive evidence of dilation of the original sediment associated with limestone deposition is provided by the occurrence of *Plagiostoma gigantea* specimens which have become "crazy" (i.e. like the superficial appearance of a septarian nodule) through separation of the pieces of the fractured shell by normal limestone while retaining their original relative orientation; this has been observed in the highest part of the *planorbis* zone in Nottinghamshire, and is known elsewhere.

Dr. Scott Simpson's account of the occurrence of borings of the worm *Chondrites* (1957) is much stronger evidence of a primary origin of the limestones, but it is interesting that in commenting on his "bed junction" types in the Lias he states that the junction of the beds "is never very sharp". An imperceptible gradation between the limestone bands and the shale is much more evident in material from deep borings, so that at Portsdown (for example) it was difficult to decide where the junction should be taken in measuring cores of the "Blue Lias", and in general it was not possible to separate limestone from shale with a hammer blow. This is not a feature normally characteristic of primary limestones with shale alternations, for alternation of conditions controlling lithology is nearly always accompanied by minor breaks and hence by development of clear bedding planes.

The postulated process of interstitial deposition of calcium carbonate to form the limestone bands can have preserved most of the original sedimentary structures, and it is possible that differences between filling and matrix of worm burrows has led to their survival in association with the bedded limestones, as it undoubtedly has in limestone nodules at higher horizons. It is quite possible that limestones followed *Chondrites* horizons for reasons other than primary origin, and sediment colour differences might well be preserved during lithification.

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In all these problems it has to be remembered that we can never see the original sediment, but examination of the material in its completely unweathered form is a stage nearer this ideal. The problem might be further considered in the light of samples from deep borings.

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THE LUSTLEIGH FAULT IN NORTH-EAST DARTMOOR

SIR,—In his recent paper on the north-westerly trending Lustleigh fault-zone in Devonshire, Dr. Blyth (1957) adds little to what was already known, although he has drawn attention to an important line of dislocation which is not even shown as such on the New Series one-inch maps of the Geological Survey.

The author, in a brief discussion of the age of the faults, says " it is possible that the faulting is entirely of Tertiary age " although the fractures " may have been initiated much earlier, in the closing stages of the Armorican orogeny but following the intrusion of the Dartmoor granite " (p. 296). In this connection, any evidence of mineralization in the fault-zone, of which Dr. Blyth makes no mention, and particularly the formation of the economic minerals, would be of the utmost importance.

The paper is largely concerned with the passage of the fault-zone through the granite, where, for example, slickensided surfaces might be expected to be common, and it is perhaps surprising that the author is unable to be more specific about the actual directions of movement.

On the western side of Dartmoor, between that granite mass and the very much smaller Gunnislake granite, the post-granite faults, frequently mineralized, appear to occur in essentially two sets, an older east-west set and a younger set trending between north-south and north-west–south-east, corresponding in trend respectively to the earlier tin and copper lodes and the later lead-bearing cross-courses. However, not all the lodes are faults and not all the east-west faults are lodes. Data on this fault-system has been largely obtained from a study of the plans of the abandoned metal mines, permission to examine which being kindly given by the Ministry of Fuel and Power.

The younger set of faults is especially interesting. Of these, those with a more north-westerly trend appear to be essentially normal faults. In the country-rocks east of Tavistock eastwards to the margin of the Dartmoor granite they have a dominant westerly hade at angles up to 40°, whilst in Tavistock itself and probably westwards to the Gunnislake granite they have a dominant easterly hade, again at angles up to 40°. This pattern would suggest trough-faulting between the two exposed granites. Those faults with a more northerly trend are present in the ground east and north-east of Tavistock where the available evidence suggests that they are sinistral tear

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