TOOL MARKINGS IN THE TRIASSIC KEUPER MARL OF LEICESTERSHIRE, WITH SOME PALAEOGEOGRAPHICAL CONSIDERATIONS

by

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Summary

Some tool markings are described from the Keuper Marl of Newhurst Quarry, Leicestershire, and their environmental significance is discussed, with particular reference to palaeogeographic concepts.

Introduction

Taylor (in Sylvester-Bradley & Ford, 1968) recently noted that, although the existence of some sedimentary structures in the Keuper Marl of the East Midlands had been known for a long time, only Elliott (1961) and Klein (1962) had described them in detail. The purpose of this present communication is to record and illustrate some other sedimentary structures and to comment on some possible environmental and palaeogeographical implications.

Description

Newhurst Quarry (Grid Ref. SK 487180), at the north east corner of Charnwood Forest, affords an impressive section through the Triassic-Basement unconformity. It shows how Triassic valleys (wadis), cut into the Precambrian Charnian rocks, were almost infilled with (probable) Upper Keuper breccias and conglomerates before the residual relief was overlapped and buried by the fine-grained sediments of the basal Keuper Marl. The latter consist of red and green, thin bedded and laminated, fine sandstones, siltstones and mudstones; they contain abundant sedimentary structures of Klein's "Type II combination" (1962). A few feet above the base, a bedding surface in red mudstone was found exhibiting a suite of small, clearly defined and well preserved tool markings. These include prod marks (Pl. 9 fig. 1), brush marks (Pl. 9 fig. 2 & 3), groove marks (one with flanking chevron marks, Pl.10 fig. 1), and skip marks (Pl.10 fig. 2) and some indeterminate forms. There were in addition some unusual dendritic pseudomorphs (Pl. fig. 2), assumed to be after halite (Llewellyn, Sedimentology, in press). These structures are preserved as indentations in the bedding surface and as small raised casts on the sole of the overlying bed of red siltstone.

Discussion and Interpretation

The tool marks can be compared with structures described and illustrated by Dzulynski & Walton (1965) and a similar mode of origin is envisaged. They clearly record the passage of a

current carrying a number of variously shaped objects, probably clay flakes, over a soft sediment layer. These objects struck the surface at different angles, scraping and bouncing off again and even rolling or skipping along. The plastic condition of the substrate at the time is evident from the uncracked convolutions pushed up ahead of the scrape marks and deeply chiselled gouges (Pl. 9 figs. 1, 2 & 3; Pl.10 fig. 2). Some variation in current direction is suggested, possibly resulting from turbulence.

There seems to be no necessity, however, to invoke a subaqueous turbidity current mechanism to explain the formation of these structures, as the action of a flash flood sweeping across a partially dried-up lake bed could suffice. Klein (1962) listed even bedding, rhythmic lamination, oscillation and interference ripple marks, rib-and-furrow, "hopper-shaped mineral casts (probably salt)", mud cracks and raindrop imprints, under his "Type II combination" of sedimentary structures. He noted that this combination was limited to the basal Keuper Marl where it rested unconformably on pre-Triassic rocks, and interpreted it as indicating a lacustrine environment with deposition above wave base. He suggested that deposition occurred on a periodically-exposed plain of coalescing deltas or a stable shelf, and furthermore, that the confinement of this combination of structures to the basal Keuper Marl pointed to sedimentation during lacustrine encroachment over a previously-exposed terrain. Klein also suggested that "during lake level fluctuations, local fluvial systems were extended across the stable nearshore, lake shelf and imparted groove casts and current lineation to the sediment". Taylor (op.cit.), in a recent discussion of the Triassic palaeogeography of the region, has advanced a different environmental explanation, suggesting that during Lower Keuper times the sea margin migrated southwards..."the transgression continued, and by the time the Keuper Marls were formed the northern part of the Mercian Highlands, including the whole of Charnwood Forest, was submerged".

It seems reasonable, considering the characteristics of the lower part of the Keuper Marl in the north Charnwood area, to follow Klein's hypothesis, with some qualification. This is to suggest that the relief on the Keuper landmass was gradually buried by the accumulation of playa-type deposits - a terrestrial, predominantly subaerial environment. As in modern playa environments, where lakes are typically ephemeral, the sediment surface was more commonly exposed than covered by water. Periodic, possibly rather violent flooding occurred, and depending on the magnitude of the floods so the water depths varied, but probably seldom exceeded a few inches to a foot. Sedimentation resulted from this flooding, with bed thickness and sediment grade probably reflecting the magnitude of the flood. Ripple mark patterns could develop during standing water periods, following flooding and prior to dessication. During exposure periods the surface dried out, sometimes with the formation of halite crystals which were later dissolved by, and pseudomorphed in sediments of, the next flood. Mud cracks reflect extremes of dessication. Sole markings point to inundation by a fresh flood while the sediment surface was still moist and plastic; it would have to be in a similar condition too for raindrops to imprint.

While this environment satisfies Klein's proposed conditions, it may be useful to realise that "deposition above wave base", i.e. in agitated water, could include deposition in a playa environment, which is commonly exposed and may be only occasionally covered with water. This environmental concept is important when considering the palaeogeography of the basal Keuper Marl, and possibly some other parts of the sequence as well. It may be particularly significant if it can be extended to other areas and when considering the depositional environment(s) of Keuper evaporites.

Conclusions

The tool markings described, and some other primary sedimentary structures mentioned, resulted from the intermittent flooding of a playa surface. Some structures were formed

beneath a current (flood) of sediment-charged water; others formed during a succeeding period of sedimentation from a standing, wind-agitated, body of water (lake); and others during a third period of evaporation to dryness and of dessication of the lake floor. This environmental interpretation differs from those advanced previously, and may be significant in regional palaeogeographic interpretations if it can be applied outside this area.

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References

DZULYNSKI, S. & WALTON, E.K.
1965. Sedimentary features of flysch and greywackes. Amsterdam; Elsevier, 274 pp., 167 figs.

ELLIOTT, R.E.
1961. The Stratigraphy of the Keuper Series in Southern Nottinghamshire. Proc. Yorks. Geol. Soc., vol. 33, pp. 197-234.

KLEIN, G. de V.
1962. Sedimentary Structures of the Keuper Marl (Upper Triassic). Geol. Mag., vol. 99, pp. 137-144.

SYLVESTER-BRADLEY, P.C. & FORD, T.D. (Editors)
1968. The Geology of the East Midlands. Leicester; University Press. 400 pp., 7 Pls., 57 figs.

Manuscript received 2nd April, 1969.

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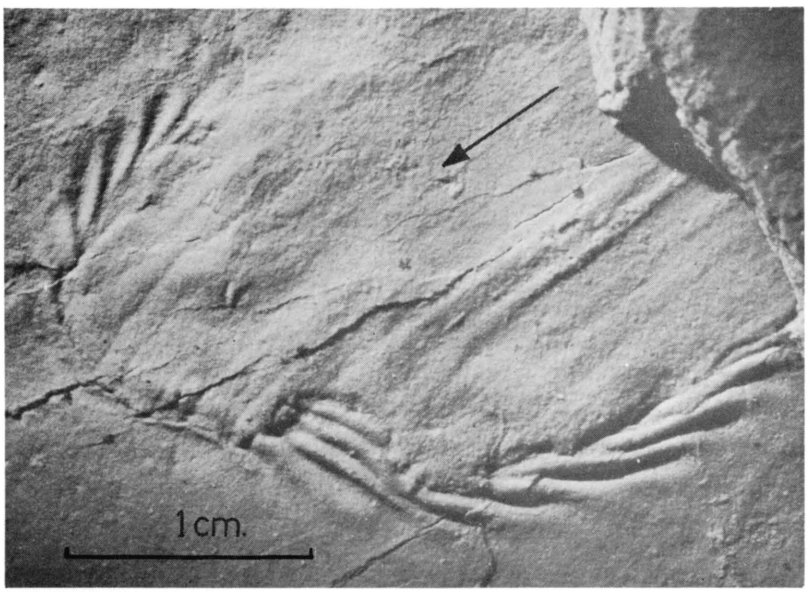
Fig. 1 Prod marks, cut into bedding surface of red mudstone, with small ridges pushed up at the front end of each gouge.

2



3

Fig. 2 & 3 Casts (from the base of the overlying bed) of brush marks on the same surface as Fig. 1 above.

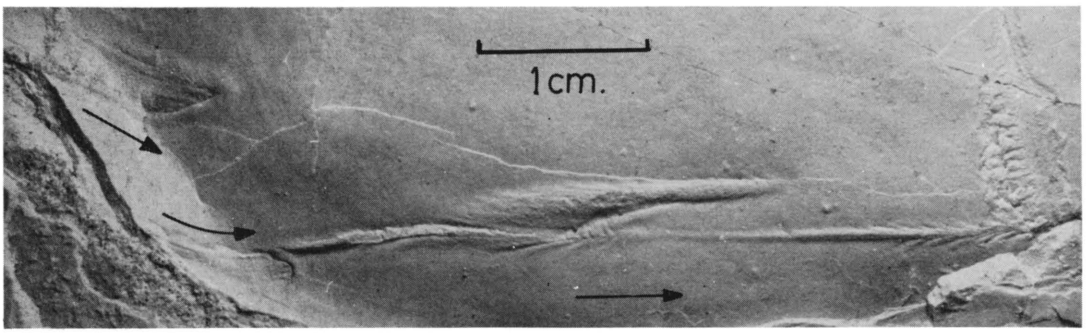


Fig. 1 Brush (mark) cast and groove (mark) casts, one with flanking chevron marks.

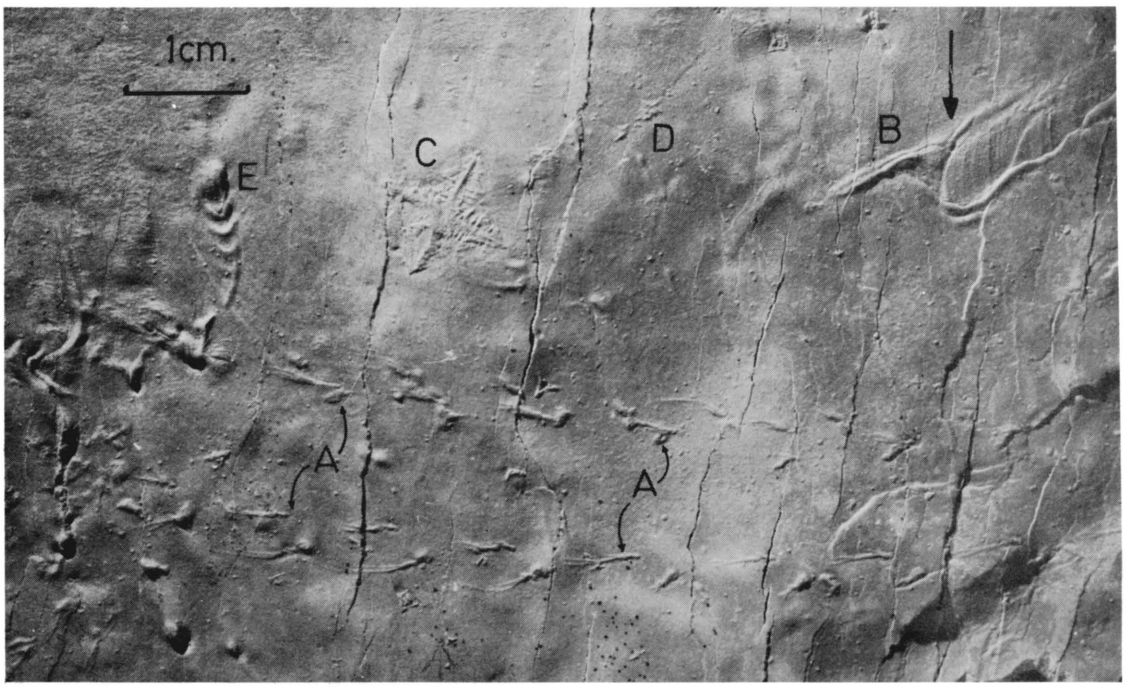


Fig. 2 Skip (mark) casts (A), brush (mark) cast (B), dendritic halite pseudomorphs - both large (C) and small (D) forms, and a drag (mark) cast (E).