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SEDIMENTARY BRECCIA IN BAYPORT LIMESTONE AT BELLEVUE, MICHIGAN

The Late Mississippian Bayport Limestone contains a breccia, 1–5 ft thick, between undisturbed, nearly horizontal beds of marine limestone. Fractures and spaces between limestone fragments are filled with crystalline pyrite and calcite. The breccia appears to be the result of breaking by shearing and dislocating movement, but apparently was formed without disturbing strata above or below.

Hypotheses such as tectonic movement or hydrothermal or volcanic intrusion have been rejected because of field evidence. The main sedimentary hypotheses considered are: (1) Reef talus or backreef breccia produced by storm wave action. The stratigraphy, clast-type, and orientation rule against this hypothesis. (2) Weathering breccia where joints, opened by solution, later were buried deeply and underwent collapse. This hypothesis, proposed by Taylor, is rejected by Parker because of lack of evidence of an erosion surface and lack of a distinct preferred orientation in the vein pattern. (3) Gypsum-anhydrite hydration and dehydration, plus solution hypothesis. Long-term episodes of hydration, dehydration, and solution of thin lenses of evaporites have brecciated the limestone layer. Parker believes that the gypsum-anhydrite lenses originally were interbedded with the limestone as products of normal evaporite sedimentation during a low sea level in the Late Mississippian. Frosted quartz grains in the brecciated limestone, as well as in the underlying nonbrecciated limestone suggest the presence of nearby land, perhaps arid. Actual evidence of any evaporite lenses are lacking at Bellevue and constitute Taylor's main objection to this theory.

A last stage of groundwater solution and precipitation of pyrite and calcite cemented the breccia.

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INFLUENCE OF DEEP SEA DRILLING PROJECT ON CONCEPTS OF GLOBAL TECTONICS

The concept of sea-floor spreading has been examined in the Atlantic and Pacific oceans by paleontologic dating of the sediments that lie in contact with acoustic basement. Despite errors that could be introduced by burial of sediments by sills, paleontologic dating limitations, and deep-sea currents creating a hiatus at the basement-sediment contact, there is an extraordinarily good relation between age of the basal sediments and distance from the ridge crest. Based on these data, an average Cenozoic spreading rate in the north Atlantic is 1.2 cm/yr, in the south Atlantic 2.0 cm/yr, and in the equatorial Pacific 12 cm/yr. By extrapolating spreading rates Heirtzler *et al.* proposed an age scale for the identifiable magnetic anomalies that typify a spreading sea floor. The ages of the basal sediments recovered by drilling agree very well with the time scale to about 45 m.y. ago. From 45 to 70 m.y. ago the agreement is also good, but the age of the basal sediment appears consistently lower than the proposed time scale. The sediments indicate there may be significant mineralization associated with the basal sediments. Samples should make possible reconstruction of oceanic circulations of the past and the dependence of these circulations on arrangement and emergence above sea level of land masses. Migration of the crust relative to effects related to the rotational poles of the earth, such as the equatorial zone, can be deduced.

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OIL-IMPREGNATED LACUSTRINE AND FLUVIAL SANDSTONE IN GREEN RIVER FORMATION (EOCENE), SOUTHEASTERN UINTA BASIN, UTAH

Oil-impregnated sandstone, in units up to 75 ft thick, are present in the lower Green River Formation in the P.R. Spring area, southeastern Uinta basin. Reserve estimates indicate that there may be about 3.7 billion bbl in place.

A total of 308 paleocurrent measurements were made at 13 localities in the upper Wasatch Formation (Paleocene-Eocene) and the lower Green River Formation. Of these measurements, 123 were from fluvial sandstone and 185 were from lacustrine sandstone.

Streams flowed northward into Lake Uinta in the P.R. Spring area. The considerable scatter in the fluvial paleocurrents suggests that the streams had low gradients and were meandering. Many of the fluvial sandstone bodies are oriented approximately north-south.

Lacustrine paleocurrents are generally southeasterly, representing dominantly onshore lake currents. Thus, the shorelines trended northeast through much of the area, although in local embayments shorelines were oriented northwest.

The paleocurrent patterns of fluvial and lacustrine sandstone are both unimodal with equal distribution of directions. The 2 environments can be differentiated, however, on the basis of paleocurrent orientations. Fluvial currents flowed northward; lacustrine currents were southerly.

Both fluvial and lacustrine sandstones are mostly arkose. Potassium feldspar is more abundant than plagioclase. Quartz-feldspar ratios are greater for lacustrine sandstone than for fluvial sandstone. Lacustrine sandstone contains more quartz and authigenic carbonate and less feldspar, "coarse" mica, and matrix than fluvial sandstone. Some lacustrine sandstone is also characterized by intraclasts, oolite, fossil fragments, and analcime in contrast to fluvial sandstone.

Most of the oil-impregnation is in lacustrine sandstone. Detailed sedimentological study has led to the discovery of new intervals. Such studies will also be useful when these and similar reservoirs are developed.

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SEDIMENTARY STRUCTURES AND BEDDING ALONG EPHEMERAL STREAMS

Sedimentary structures are useful for interpreting conditions of deposition of sediments. Experimental studies utilizing flumes indicate the possibility of quantitative interpretations that are based on sedimentary structures. In order to bridge the gap between experimental studies and sedimentary rocks, ephemeral streams in northeastern Utah have been observed. Ephemeral streams serve as natural experiments, exhib-