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DEPOSITIONAL ENVIRONMENT OF THE DEVONIAN TULLY LIMESTONE OF CENTRAL NEW YORK

Recent investigation of the Tully Limestone has resulted in the recognition of several general facies. Certain key beds appear to be relatively synchronous units that permit environmental reconstruction of several phases of deposition.

In general, Tully deposition occurred in a carbonate mud-depositing sea with an eastern clastic source that exerted decreasing influence through time.

The lower part of the Tully Limestone consists of arenaceous deltaic beds of limited areal extent. On the east, abundant *Chonetes aurora* and occasional *Leptostrophia* represent the restricted fauna of the brackish nearshore environment. Westward, the addition of other brachiopods, notably *Hypothyridina*, *Atrypa*, and *Schizophoria*, characterizes the more marine facies.

Above the lower part of the formation, sandy limestone overlies the beveled eastern end of the delta and grades eastward into an iron-rich oölite which contains pebbles of dark siltstone. Deposition was extended also to the west, where purer carbonate mudstone is developed.

The upper part of the Tully Limestone consists of carbonate mudstone characterized by the presence of metriophyllid and auloporid corals, styliolines, trilobites, and pelmatozoans. Toward the middle of this part, and representing normal marine conditions, is a diverse fauna developed to the east in dark calcareous shale and to the west in limestone.

Erosion surfaces with burrows, channels, local carbonate-pebble conglomerates and filled mud cracks are evidence for the intermittent nature of carbonate mud deposition and are observed especially in the central and western regions.

In the upper part of the formation near the town of Borodino, two elongate mounds of pure carbonate mudstone, about 15 feet high, contain structures similar to stromatactis and grade laterally into much thinner pelmatozoan calcarenites. These mounds are overlain by similar calcarenites which locally contain pebbles of carbonate mudstone. Whereas the lower mound contains a network of auloporid corals that could have been responsible for its development, the upper mound lacks auloporids. The position of the upper mound on the western flank, and quite possibly in the lee, of the lower mound suggests a current-controlled origin.

Tully deposition was ended by the reducing environment of the Geneseo Black Shale, which encroached progressively from the west. Local lingering of the carbonate environment is shown by dark argillaceous limestone at the top of the section which contain only scattered remnants of the Tully fauna.

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PROJECT MOHOLE, A PROGRESS REPORT

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HETEROGENEITY OF THE UPPER MANTLE

In their investigations of the interior of the earth, geophysicists have generally regarded the mantle as composed of homogeneous shells and have considered the crust of the earth as varying laterally in composition and thickness. Evidence from measurements of the gravitational field and of the heat flow to the surface have suggested that differences exist in the composition of the upper mantle. Very recent information on seismic velocities and attenuations clearly indicates that substantial lateral variations in the physical properties of the mantle exist beneath both continents and oceans. The geological complexities evident at the earth's surface now appear to be reflected in the upper mantle.

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LATE PALEOZOIC TECTONICS AND MOUNTAIN RANGES, WESTERN TEXAS TO SOUTHERN COLORADO

Underlying the Permian rocks of the West Texas basin are the roots of a Paleozoic mountain range. In direction of strike and structure, the folds of these mountains bear a general resemblance to the mountains of central Colorado. However, the Permian and younger rocks of the West Texas basin were not refolded during the early Tertiary as were the ranges of central Colorado. In this paper, the author attempts to show the reason for this difference in tectonic history which has resulted in the absence of a folded front range province from northern New Mexico as far south as the Sierra Madre Oriental in the Republic of Mexico. In the course of the investigation, paleogeologic maps were constructed of the area from Big Bend of Texas to central Colorado for the beginning of Pennsylvanian and the beginning of Permian time. From them a tectonic map showing elements existing at the beginning of Permian time was built and compared with a similar map showing present elements. Cross sections were made comparing homologous tectonic units of the West Texas basin with the Cordillera of central Colorado.

In this manner the author has come to the conclusion that the pre-Permian folds of the West Texas basin are not tectonically related to the younger folds of central Colorado although they do have certain characters in common. The Paleozoic rocks of the two areas were laid down in different basins separated by the Precambrian massifs of the continental backbone throughout most of Paleozoic time. These massifs, together with the tightly folded Paleozoic rocks of the Marathon-Ouachita belt, absorbed and distributed Laramide stresses and preserved the West Texas Permian basin from early Tertiary mountain building in spite of the presence of structural and sedimentational features favorable to mountain building.

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CROSS-LAMINATIONS IN GRADED-BED SEQUENCES

Thin units of cross-laminated sandy and silty sediments are common in graded-bed sequences. One characteristic common to all is that the thickness of the cross-laminated bed does not exceed 3 inches and rarely exceeds one inch. These sediments have been commonly interpreted as turbidity current deposits because of their association with graded beds. The writer offers evidence to demonstrate that such cross-laminated sediments in several instances were transported by turbidity currents to deep-sea bottom and deposited originally as graded beds, but subsequently were reworked and redeposited by the rippling action of deep-marine bottom currents. Evidence includes these facts: (1) deep-marine bottom currents exist and are occasionally strong enough to ripple deep-sea bottom as indicated by photographs; (2) cross-laminated deep-sea sands are, in places, considerably better sorted than graded-bedded deep-sea sands which were supposedly deposited by turbidity currents; (3) cross-laminated sands, in places, contain a rich deep-sea benthonic fauna, suggesting a rate of deposition slow enough for the establishment of this fauna; (4) presence of parallel ripples and interference ripples on top of some such cross-laminated sediments; (5) the direction of transport shown by cross-lamination is, in places, quite different from that shown by bottom markings which were supposedly scoured by turbidity currents.

The question whether turbidity currents could deposit cross-laminated sediments remains unsolved. The writer points out, however, that an indiscriminate assumption of turbidity current deposition of all deep-marine sandy sediments has led to confusion, inconsistencies, and controversies. The postulate of bottom-current redeposition helps to resolve this paradox.

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EVIDENCE FOR A COUNTERCURRENT BENEATH THE FLORIDA CURRENT

About 60 per cent of the area shown in photographs taken at the axis of Florida Straits exhibit well defined current ripple marks. These ripples indicate a flow of water of at least .23 to .59 kts. from the north. This current is in the opposite direction from the surface currents of 2 to 4 or more knots.

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PALEOECOLOGIC, SEDIMENTARY, AND STRUCTURAL HISTORY OF THE LATE TERTIARY CAPISTRANO EMBAYMENT, CALIFORNIA

The Capistrano Embayment comprises a distinct geologic unit of the southern California area. Paleobathymetry, sediments, and microfaunas within the embayment indicate that it has had a different structural history, different from the Los Angeles Basin on the north. Marine invasion of the trough began in the Paleocene and ceased in the Pleistocene. This report develops a detailed history of the embayment from middle Miocene to late Pliocene time using data from two well exposed sections within the boundaries of the embayment.

Analogy between ecologic niches of living benthonic Foraminifera and fossil forms encountered indicates that middle bathyal depths were attained by the middle Miocene. By late Pliocene the trough was filled to shelf depths. Repetitive changes in morphology of benthonic species provides additional evidence of varying paleobathymetry.

Variation in abundance of cool and warm-water planktonic Foraminifera indicates three periods of distinctly cool surface temperature between late Miocene and late Pliocene time. Increase in radiolarian diameter provides evidence for surface temperatures in sediments barren of Foraminifera.

Peak radiolarian abundance suggests that the deepest point in basinal evolution existed in the early Pliocene at which time water depth neared 1,750 meters.

Correlation of the two sections is based on: (a) a Mohnian horizon of *Globigerina pachyderma* which coil sinistrally, (b) the uppermost point of abundant radiolarian tests, (c) the uppermost point of the radiolarian *Prunopyle titan*, and (d) the horizon of peak radiolarian number. These mutually corroborative planktonic criteria demonstrate the time transgressive relationship of existing stages based on benthonic Foraminifera. Repettian faunas, for example, appear much earlier in the rapidly filling southern end of the embayment than in the northern deeper area.

A restricted, oxygen-deficient, closed-basin system, characterized by laminated diatomaceous sediments, originated during a period of early Miocene diastrophism. Closed-basin conditions allowed only a marginal benthonic foraminiferal fauna to exist, analogous to the existing fauna of the oxygen deficient Santa Barbara basin. Restricted basin plain conditions prevailed until the end of the Miocene.

Instantaneously deposited coarse sediments (turbidites) emphasize pulses of structural activity in the middle Miocene, late Miocene, and middle Pliocene. Sediments provide evidence of a landmass to the west of the embayment. Turbidites are recognized on the basis of displaced Foraminifera, plant material, and sedimentary structures.

Paleoecologic and sedimentary analyses delineate a characteristic basin-filling sequence in the Capistrano Embayment, similar to events taking place today in the Gulf of California and off southern California.

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LOWER DEVONIAN ALGAE AND ENCRUSTING FORAMINIFERA FROM NEW SOUTH WALES

An algal florule of 13 species, belonging to 11 genera, is described from New South Wales, Australia. Of these, one genus and 7 species are new. The majority are green algae mixed with a few attributed to the blue-green. Five of these genera have been previously known only from the Kasbas region of the U.S.S.R.

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SEDIMENTARY FACIES AND PALAEOCURRENTS IN THE BOSS POINT FORMATION, SOUTHEASTERN NEW BRUNSWICK

The Pennsylvanian Boss Point Formation was examined in gently folded coast sections on the Bay of Fundy and Petitcodiac estuary, including the type section north of Joggins, Nova Scotia, more than 3,130 feet thick.

Two main intergrading facies are present. At Hopewall, Dorchester, and Aulac, cross-bedded sandstones and quartz-pebble conglomerates are greatly dominant; to the south and southwest, mainly cross-bedded sandstones alternate with siltstone and thin sandstone sequences. The coarser beds are interpreted as river channel and levee deposits, and the interbedded siltstone sequences, with root beds, represent flood-plain deposits. Mud-pellet conglomerates and marl-nodule conglomerates are common in the sandstones, the latter usually filling channels near the base of each sequence; probably these are the result of redistribution of the more tenacious flood-plain deposits during major changes of river course. Bituminous shales with non-marine pelecypods (*Carbonicola* and others) and nodular argillaceous limestones occur sparingly. Plant fragments, including transported *Calamites* and *Lepidodendron* logs, are abundant, especially in lenses of irregularly bedded sandstone thought to represent crevasse fillings in levees. Quicksand slump structures were identified in conglomeratic sandstones. No marine beds were found.

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