TIONS (MISSISSIPPIAN-PENNSYLVANIAN), PAYNE HILLS, MARATHON REGION, TEXAS

Boulders of sedimentary rock are present in shale units in the Tesnus and Dimple formations near the western margin of the Marathon uplift in the Payne Hills, a terrane underlain by imbricate thrust plates. Although, locally, boulders have been rolled along the thrusts as "ball bearings," a sedimentary origin as submarine-slope deposits for the beds is inferred because (1) most boulders are unlike rocks involved in thrusting, (2) boulders are not brecciated, and (3) many boulders do not occur along thrust faults.

Boulders range from 1 to 24 ft long and are unevenly distributed along strike. Large boulders lie with their long dimension in the plane of bedding of the host rock. The boulder-bearing unit in the Tesnus is from 5 to 50 ft above the base of the formation; that in the Dimple is about 100 ft above its base. Common boulders are light-colored dolosparite and dolomicrite, mottled, dark-green chert, and chert sharpstone conglomerate; a few boulders are limestone, sandstone, novaculite, and porphyry (Dimple Formation only). The chert resembles, but is not identical with, beds in the Caballos Novaculite, although the other rocks are unlike indigenous Paleozoic strata in the uplift. Early Ordovician, Silurian(?), and Middle Devonian conodonts occur in the carbonate boulders.

The boulders were derived from a positive, tectonic element northwest of the basin that was active intermittently throughout Paleozoic time. The lack of fine debris in the boulder beds suggests that the boulders rolled or slid into place and outdistanced finer detritus.

MCCAMMON, RICHARD B., Dept. Geol. Sci., Univ. Illinois Chicago, Chicago, Ill.

STATISTICAL ANALYSIS OF FLYSCH SEQUENCE REGARDED AS SERIES OF POINT EVENTS

Bed-thickness distributions of alternating coarse and fine layers in flysch sequences can be regarded as the realization of a stochastic point process. The study is similar to that of earthquakes, if the log thickness of the coarse layer is treated as earthquake magnitude and the linear thickness of the fine layer is considered as the waiting time between earthquake events. A set of 489 sandstone-shale couplets measured in a flysch sequence totalling 420 ft in thickness from the Upper Cretaceous Cedar District Formation in southwest British Columbia, demonstrates that the frequency-log-thickness diagram for the sandstone beds is similar to that observed for magnitude-frequency diagrams of present-day earthquakes. Sandstone beds greater than 2 in. in thickness are essentially Poisson distributed over the interval studied, whereas beds less than 2 in. are nonrandomly distributed. The lack of correlation in thickness between successive sandstone-shale, shale-sandstone, and shale-shale beds is indicative of a renewal rather than a Markov process. The process is nonstationary, however, in that the sandstone/shale ratio decreases systematically from a value of approximately 2 to a value of approximately 1, although the number of sandstone beds per unit thickness of shale essentially triples from older to younger strata. The data are consistent with the hypothesis of a progressively deepening basin and a progressively diminishing sand supply, with sand being delivered from more widely distributed source areas.

McCOY, FLOYD W., Harvard Univ. and Woods Hole Ocean. Inst., Woods Hole, Mass.

SEDIMENTATION AND SEDIMENT-MASS BALANCE IN EASTERN MEDITERRANEAN SEA

Detailed studies of cores taken in the eastern Mediterranean Sea by the Woods Hole Oceanographic Institution and other institutions have enabled lithologic and time-stratigraphic correlations to be made between these cores, thereby contributing to an understanding of the sedimentation history of this basin during the Quaternary. The deep-sea stratigraphic section is a complex sequence of sapropels, turbidites, oozes, volcanic ashes, detrital and biogenic sands, and detrital silt beds. Integrated sedimentation rates since the Pliocene have averaged 10-20 cm/10^3 years and ranged from less than 1 to more than 100 cm/10^3 years. Rates during the Quaternary are slightly less, although variations do occur, primarily as a result of glacial/nonglacial climatic controls. Patterns of sedimentation also have been affected by these climatic changes, with only relatively minor variations reflecting tectonism and changes in provenance.

Volumetrically, the Nile River system is and has been the largest contributor of detrital material. Additional detritus is derived from Anatolia and from the Aegean Sea, the latter contributing predominantly finer material. The other borderlands do not supply large amounts; eolian material from north Africa is noticeable, however. Variations of this detrital input and in carbonate deposition have occurred primarily in response to climatic changes during the Quaternary.

McDONALD, ROBERT E., Marvin Wolf Oil Properties, Denver, Colo.

BIG PINEY-LA BARGE PRODUCING COMPLEX, WYOMING

The Big Piney-La Barge complex has been the major gas producing area in Wyoming since 1957, and during the past 10 years it also has become a leading oil producing area. Recoverable natural gas is estimated at 3 Tcf and recoverable oil exceeds 100 million bbl.

The area is along the western margin of Wyoming's Green River basin, occupying a zone of transition between the overthrust belt and the basin. This position of transition typifies much of the depositional history for this part of Wyoming, whose stratigraphic record reflects both the influence of the craton on the east and the Cordilleran geosyncline on the west.

Productive reservoirs include the Triassic-Jurassic Nugget Sandstone, the Cretaceous Dakota, Frontier, and Mesaverde Formations, and sandstones of Paleocene age. Trapping mechanisms are diverse, and structural, structural-stratigraphic, and purely stratigraphic accumulations are represented.

Commencing in Late Triassic and extending into Early Jurassic time, the Nugget was deposited as a massive blanket of largely eolian sand. In Early Jurassic time, seas spread southward across the Cordilleran front and the Wyoming craton during a major marine pulse that deposited the Twin Creek Limestone on the west, and Gypsum Springs and Sundance Formations on the east. The Gypsum Springs appears to be recognizable, but the Twin Creek terminology is better applied at La Barge.

Jurassic time closed with continental deposition of the Morrison sequence. On the Wyoming shelf the transition from Jurassic to Cretaceous is commonly a straightforward transition from continental Morrison through transitional Lakota-Dakota and into marine Thermopolis Shale. La Barge appears to have been a hingeline in Early Cretaceous time and relations are not clear cut. All shelf units are recognizable and shelf terminology may be applied on the east side of the complex, but in a distance of 12 mi these units become nearly unrecognizable.

In early Paleocene time the platform underwent folding, thrusting, and erosion. The Hogsback thrust was moving eastward and the newly formed La Barge anticline was deformed further. North of the platform a major drainage system developed that flowed southward and southeastward through the Green River basin. As Paleocene progressed, the Hogsback thrust reached its present position and aggradation commenced across the Big Piney-La Barge area. Deposition was dominated by a coarse, commonly conglomeratic facies adjacent to the Hogsback thrust, which graded abruptly through an alluvial, piedmont, and small stream fluvial unit. This low-energy facies graded basinward into a high-energy fluvial and paludal facies of the large river environment. As the basin subsided further, the major drainage facies encroached onto the flanks of the La Barge platform, resulting in buildups of thick channel, bar, and point-bar sands into the lower energy muds and silts. It is at this transition between the high- and low-energy environments the Paleocene is most commonly productive.

In early Eocene time the disturbed belt gave a last shudder, reflected by the La Barge thrust and other faults that break Paleocene strata. Of particular interest are two east-dipping thrusts, and the tendency for the young thrusts to terminate as tear faults which assist in controlling accumulation. Tectonic activity since early Eocene time has been confined primarily to regional elevation and slight basinward tilting.

The Frontier sandstones are the major gas reservoirs on the platform, and demonstrate a marked thinning from west to east. The second Frontier appears to reflect paralic depositional environments and strikingly variable reservoir conditions. Following deposition of the second Frontier, transgression resulted in the deposition of a few thousand feet of marine shale, except over the western part of the La Barge area, where a major drainage from the west built a delta into the shallow Coloradan sea. This unit is locally called the first Frontier.

Regression from west to east in Montanan time deposited the fluival and paludal sediments of the Mesaverde Formation. Littoral transitional sands at the base of the Mesaverde commonly are productive both on subcrop and across structure.

Isopach maps of Cretaceous units suggest the existence of the Moxa arch, a structural feature that now plunges southward from the La Barge platform. It was a northward-plunging positive feature during Cretaceous deposition. In latest Cretaceous and early Paleocene times, the Big Piney-La Barge area was uplifted and folded into a large anticlinal feature, with erosion stripping away newly deposited Mesaverde.

MCHURON, ERIC J., KENNETH J. MCMILLEN, and JOHN E. WARME, Dept. Geology, Rice Univ., Houston, Tex.

GEOMETRY AND MORPHOLOGY OF CRUSTACEAN BURROWS IN TORREY PINES AND BODEGA ESTUARIES, CALIFORNIA

Resin casts were used to document the geometry and morphology of crustacean burrows from two California estuaries. Burrows studies include those of two ghost shrimps (*Callianassa californiensis* and *C. longimana*), a fiddler crab (*Uca crenulata*), and two grapsoid crabs (*Pachygrapsus crassipes* and *Hemigrapsus oregonensis*). Further documentation is under way with the use of direct observations and radiographs of ghost shrimp burrowing through layered sediment in aquaria.

The *Callianassa* burrows are in muddy to clean sand found in the lower parts of tidal creeks and on sand flats. Their burrows have a main shaft up to 1 m long with constant diameter (up to 2 cm) except for narrowing produced by excurrent activity either at the surface or between burrow systems, and except for enlarged turn-around nodes commonly present at branches or direction changes. Up to 5 openings were observed per system; they are connected by twos and threes in horizontal to inclined Y's with the junction of the Y up to 15 cm below the surface. The geometry of the main shaft is dependent on species, intertidal position, sediment size, and layering. The burrows have a smooth internal and external morphology.

The grapsoid burrows are on and above the banks of tidal creeks in slightly silty clay to slightly muddy sand. They vary from complex shapes, with several layers and entrances in a box-type framework, to a simple U-shape depending on topography, tidal level, and the number of organisms and species per system. Commonly two *H. oregonensis*, one *P. crassipes*, and one or more *U. crenulata* are found using parts of the same burrow system. The numerous entrances allow only lateral passage but internal enlargements permit turning around and passage of individuals. In cross section the burrows are lenticular, and the morphology of the walls *is very knobby*. Burrow entrances of *Uca crenulata* are at, or near, higher high water and extend either into a grapsoid system or a simple J-shape (up to 20 cm), both of which may have a Y-shaped entrance. The entrance and extremity chamber are about twice the diameter of the knobby, cylindrical shaft which normally has a diameter less than 1 cm.

MCKELVEY, V. E.

USGS VIEWPOINT

No abstract available.

MECHALAS, BYRON J., Dept. Geol. Sci., Univ. Southern California, Los Angeles, Calif.

INTERACTIONS BETWEEN MICROBIAL POPULATIONS AND ORGANIC-MATTER DISCHARGES

Organic matter in the form of waste discharges entering an aquatic environment stimulates the growth of the resident microorganisms. The size of the resultant microbial population depends on the quantity of organic matter and the ease with which the organisms can metabolize this to obtain energy and nutrients. The oxygen supply that is essential for energy conversion is the dissolved oxygen of the water. As long as oxygen is available bacteria can oxidize the organics to simpler compounds such as CO_2, H_2O, NO_3^-, PO_4^- and mitigate adverse environmental effects.

In the natural environment microbial populations are made up of heterogeneous groups of species. Each group has a different set of nutritional requirements, and the ability to utilize specific compounds shows a great deal of variation. Complex mixtures of wastes require a heterogeneous mixture of microbial types to bring about complete degradation.

Crude petroleum is an example of a complex organic mixture. No single microbial species can bring about its complete degradation. However, a mixed population provided with the proper environmental conditions can bring about dramatic changes in oil composition. These changes follow a predictable sequence proceeding from the light-molecular-weight compounds to the heavier end of the molecular-weight spectrum and are related to natural weathering processes that occur in the marine environment.

MERRILL, GLEN K., 138 Westwood Dr., Cumberland, Md.

UPPERMOST CARBONIFEROUS STRATIGRAPHY AND DEPOSITIONAL HISTORY NEAR HUNTINGTON, WEST VIRGINIA

Excellent exposures of Conemaugh strata are present in road cuts along both sides of the Ohio and Big Sandy rivers near their confluence. Dense locality spacing permits a detailed 3-dimensional reconstruction of these repetitive, vertically and laterally diverse rocks. Most of the succession was deposited by an actively prograding delta and consists of upper-delta-plain channel, natural levee, lacustrine, and oxidized flood-plain deposits. Lesser amounts of lower delta-plain sediments include laminated, interdistributary bay and backswamp deposits, and a few thin coal seams and seat rocks.

Intercalated into the lower delta-plain sediments is one prominent, laterally extensive marine unit correlated with the Ames Member of southeastern Ohio. In this area, the Ames is tripartite and as much as 40 ft thick. The lowest part is a bluish-green, calcareous, highly fossiliferous shale, with a megafauna dominated by *Neochonetes*. It becomes coarser grained and less fossiliferous upward and is succeeded by a brackish-marine, fissile, maroon shale with pectens and ostracods. The maroon shale similarly grades upward into a massive, calcareous, crinoidal sandstone, formed as a regressive barrier, that ranges in thickness from 0 to 22 ft within a few miles. The entire marine succession was formed under extremely near-