sure and by as much as 1,900 psi below the outcrop-controlled systems. This system is interpreted to be a sandstone lens completely enclosed in shale; its pressures were developed by geo-osmosis, as indicated by facies relations, shale analyses, and salinity maps.

The osmotic cell in this system consists of the low-salinity Viking sandstone and the deeper, high-salinity, Mannville sandstone and shale; the semipermeable membrane of the system is the intervening Joli Fou shale. Because the Viking sandstone system is isolated from the outcrop by shale and shaly rocks of very low permeability, the osmotic process produced a marked pressure anomaly.

HAUN, JOHN D., Colorado School of Mines, Golden, Colo., and JAMES A. BARLOW, JR., Barlow and Haun, Casper, Wyo.

LOWER TERTIARY DELTAS AND PETROLEUM, ROCKY MOUNTAIN REGION

Paleocene and Eocene lacustrine deltas are present in several Rocky Mountain intermontane basins. Deltaic deposits of the Eocene Green River Formation in the Red Wash-Raven Ridge area, northeastern Utah, have been studied intensively. Recognition of the Red Wash delta is based on distribution of (1) fluviatile red and green shale facies (Wasatch Formation), distributary and nearshore sandstone facies, and lacustrine oolitic, ostracodal limestone facies (Green River Formation); (2) geographic orientation and spatial dimensions of thick sandstone bodies projecting into the lake beds, indicating positions of entry into Lake Uinta of south-flowing streams; and (3) sedimentary structures that are in accord with a deltaic environmental interpretation (although they are present also in other environments).

An estimated 100 million bbl of oil reserves (ultimate production) is trapped in a series of discrete sandstone bodies within the Red Wash delta. Variations in petroleum chemistry from pool to pool indicate local source beds and short-distance migration. Several billion bbl of oil in Wasatch-Green River outcrops (not including oil shale) attest to the almost incredible petroleum-generating power of Eocene lake deposits.

In the Piceance Creek basin, northwestern Colorado, Douglas Creek sandstones (basal member of the Green River Formation) were deposited at the mouth of a southwestward-flowing river, and facies associations similar to those of the Red Wash area are present. The lobate shape of sandstone deposition is not as distinctively developed as in Red Wash. An estimated 250 billion cu ft of gas is trapped at the up-dip edge of porous intervals on Piceance Creek anticline. Oil saturation is common in outcrops and is present in the subsurface although high wax content and low reservoir temperature prevent commercial production.

A similar facies association in the Wasatch-Green River section is present in the Washakie basin, southern Wyoming. A river flowing northwestward deposited thick sandstone beds that interfinger with lake beds in the vicinity of the basin axis and along the west flank of the basin. Oil and gas shows have been reported in these beds, but no commercial production has been developed.

Paleocene lakes in several basins have shoreline deposits, in part deltaic, that contain oil and gas fields and are targets for future exploration. Examples are the Fort Union Formation in the Big Piney–La Barge area, Waltman Shale lake beds in the Wind River basin, and Fort Union lake deposits in the Big Horn basin. The lobate configuration of Fort Union coarse clastics on the west flank of the Big Horn basin is very suggestive of deltaic deposits.

HAYES, MILES O., JON C. BOOTHROYD, and ALBERT C. HINE, III, Coastal Research Group, Dept. Geology, Univ. Massachusetts, Amherst, Mass.

DIAGNOSTIC PRIMARY STRUCTURES OF ESTUARINE SAND BODIES

Estuarine sand bodies assume complex morphologic characteristics in response to multidirectional tidal currents and wave action. Studies in 8 New England estuaries show, however, that the major forms are repetitive from estuary to estuary and that they display diagnostic suites of primary structures.

Sand accumulation around the seaward margin of the major inlets takes the form of ridge-and-runnel systems and recurved spits attached to the barrier beaches, large swash bars offshore, and submerged ebb-dominated sand sheets. Wave-generated flow over the intertidal bars creates an abundance of large-scale (up to 20 ft thick) planar cross-beds oriented landward.

Tidal deltas inside the inlets consist mainly of sand flats covered with flood-oriented sand waves—$>$20-ft wave lengths (λ). Margins of the deltas (ebb shields and ebb spits) contain predominantly ebb-oriented megaripples (λ = 2–20 ft) which produce festoon cross-bedding. In places, the deltas are cut by spillover lobes formed by ebb currents. Thus, zones of flood dominance are differentiated from zones of ebb dominance by distinct differences in scale and type of cross-bedding formed.

Major tidal channels are floored with large sand waves that may be ebb or flood oriented or bidirectional, depending on relation of bottom topography to current flow.

With respect to primary structures, a preserved regressive sequence of estuarine sand bodies would begin with large-scale, bimodal cross-bedding at the base that would grade upward into broad zones of flood-oriented, planar cross-beds interfingering with linear zones of small-scale, ebb-oriented festoon cross-beds. The sequence would be capped by burrowed sand (clam flats), mud (mud flats), and peat (salt marsh).

HECKEL, PHILIP H., Kansas Geol. Survey, Lawrence, Kan.

ORGANIC CARBONATE BUILDUPS IN EPEIRIC SEAS: SOME THEORETICAL ASPECTS

Organic carbonate buildups form where conditions are favorable for calcareous organisms to flourish and to secrete enough calcium carbonate to build up the substrate locally. Advantages from buildup include inducing better water-circulation patterns and providing firm substrate for organisms not suited to live elsewhere. Perhaps most importantly, buildup involves simply production of enough sediment for the substrate to remain continually in the optimum zone for proliferation of the organisms.

R. J. Dunham's distinction between "ecologic reefs" in which organisms provide rigid framework and bind sediment, and "geologic reefs" in which the restricted area of thickened carbonate is due to localized organic proliferation without necessity of framework or sediment binding, resolves much of the nomenclatural controversy concerning organic carbonate buildups. Perhaps distinction also can be made between geologic