controlled in part by underlying, commonly inconspicuous, erosional surfaces. Reconstruction of the paleotopography of the unconformity thus may commonly delineate prospective trends. The distribution of trap barriers may be controlled by environment. For example, discrete shoreline sandstone bodies replaced updip by lagoonal shales are better prospects than those replaced updip by sandy ("leaky") deltaic deposits. Such sandstones are more likely to be related to interdeltaic rather than deltaic areas.

Most progress will come from further development and refinement of depositional models. A greater understanding of shallow-marine sandstone bodies is especially needed. Moreover, as exploration emphasis shifts offshore, there will be a growing premium on one's ability to recognize depositional models in the absence of cores and outcrops.

MACKENZIE, FRED T., Dept. Geol., Northwestern Univ., Evanston, IL 60201, and ROBERT M. GARRELS, Scripps Inst. Oceanog., La Jolla, CA 92037

CHEMICAL HISTORY OF OCEANS

The reaction "igneous rocks plus acid volatiles to give sedimentary rocks plus seawater" has long been the basis for geochemical balance calculations, and also the basis for chemical arguments for the constancy of seawater composition. In most balance calculations based on continental igneous rocks as the sediment source, there is an unaccounted excess of iron and calcium in the sediments. This excess may well have come from submarine alteration of mafic volcanic rocks, a process shown to be important today by recent dredging and coring, and probably of greater relative importance in early earth history. Both subaerial and submarine weathering contribute to the mass of cycling sedimentary rocks and hence to oceanic composition.

The submarine alteration branch of the sedimentary geochemical balance may be written: mafic volcanics + volatiles = greenstones + cherty iron formations + carbonate rocks. No major differences in oceanic composition have been deduced as stemming from early greater relative submarine alteration, but the sedimentary mass is predicted to have been richer than now in carbonate rocks, chert, and iron minerals. Most of the early carbonate rocks, because of selective cycling, now exist as Phanerozoic deposits.

MALEK-ASLANI, M., Tenneco Oil Co., Houston, TX 77001

DEPOSITIONAL ENVIRONMENT OF MISSION CANYON (MISSISSIPPIAN) OIL FIELDS IN NORTH-CENTRAL NORTH DAKOTA

Three fourths of the oil fields in the Mission Canyon carbonates of north-central North Dakota are stratigraphic traps. The hydrocarbons in the Mission Canyon carbonates occur in 6 marker-defined beds, each representing a generally regressive off-lap carbonate cycle which is capped with the supratidal evaporite facies. Two types of depositional cycles are recognized: those formed when the shelf was stable and those which developed when the shelf was structurally deformed. The vertical patterns of the facies changes have been analyzed in the context of these 2 types.

The deepest part of the Williston basin during Mission Canyon deposition was in the northwestern corner of North Dakota. A broad open shelf extended eastward, where marine water circulation was sufficient to support bottom-dwelling and skeletal-producing organic communities. A trend of oolitic bars separated the open shelf from a restricted lagoon farther east. The lagoon was an area of nonskeletal carbonate sedimentation which changed facies eastward to tidal flats and supratidal "sabkhas" where evaporite deposition occurred.

The stratigraphic traps are related to the tidal flat facies. The reservoir rocks are covered by evaporites and are best developed where lobes of shelf carbonates extend eastward into the predominantly evaporite areas. Locally, traps also were formed within the structurally controlled mud islands. The preferential dolomitization of tidal-flat and mud-island facies resulted in good reservoirs.

Prolific growth of blue-green algae on the tidal flats probably provided the organic source material for petroleum within the stratigraphic traps.

MARTIN, WAYNE D., Dept. Geol., Miami Univ., Oxford, OH 45056

PETROGRAPHY OF COMPOSITE VERTICAL SECTION OF CINCINNATIAN SERIES LIMESTONES, SOUTHWESTERN OHIO AND ADJACENT AREAS

An offshore, shallow-water environment was in existence during the accumulation of the major part of the Cincinnatian Series, Eden to Saluda. The upper part of the section, Saluda and Whitewater, was formed under nearshore, subtidal, and lagoonal conditions.

The average limestone, Eden to Saluda, is a biocalcirudite, an autochthonous coquinoid rock. It is coarse-grained, poorly sorted and contains approximately 38% fossil allochems which were originally deposited with ooze. The carbonate mud of the limestones has been recrystallized almost completely and many fossil allochems have undergone recrystallization as well. Coarse pseudospar forming 40% of the rock is about equal in abundance to allochems with microspar (5–30 μ) forming the remaining 20%. Chemically precipitated sparry calcite is uncommon and apparently exists only in fossil cavities and under umbrellas.

Bryozoa are slightly more abundant than brachiopods through all of the units and each of these phyla exceeds echinoderms by 3 to 2 and trilobites by 3 to 1. Pelecypods, gastropods, and ostracods are minor constituents. The relative order of abundance of phyla holds through all of the formations.

Allochems average about 28% of the upper part of the series; microspar forms about 55% of the average rock and pseudospar forms about 15%. Micrite is minor but more abundant than in the lower, thicker part of the series. The major fossil phyla have the same relative order of abundance, but bryozoans exceed brachiopods by 10%. Ostracods, algal products, and coral become very conspicuous and are the only allochems in some beds. Dolomite is abundant in many beds of the upper Cincinnatian.

MASTERS, C. D., West Georgia College, Carrollton, GA 30117

"MUDDY" MISSISSIPPI

The application of geologic science to oil exploration requires achievement of sufficient understanding to make predictions. One of the most important predictions geologists are called upon to make is the distribution of rock stratigraphic units. Prediction may be enhanced by interpreting the vertical profile of associ-