or absent. Large amounts of carbonaceous matter seem to enhance the development of preferred orientation, perhaps by its ability to retain large amounts of water. Specific effects of other factors on clay fabric are less well known, but one might expect the development of preferred orientation to be enhanced by decreasing concentrations of interstitial electrolytes, decreasing valence of exchangeable cations, and decreasing acidity.

The main influences on the porosity of sand are the textural characteristics of the constituent particles: size, sorting, roundness, shape, and flexibility. Well-sorted sand has greater porosity than poorly sorted sand. Angular sand has greater initial porosity and is more compressible than rounded sand of the same size. Admixtures of platy mica particles increase the porosity, compressibility, and elasticity of sand.

The influence of most of these factors—except for particle size—is inferred from laboratory experiments on simple systems. Little is known of their relative importance in complex natural sediments.

MERRIAM, DANIEL F., State Geological Survey of Kansas, Lawrence, Kansas, and HARBAUGH, JOHN W., Stanford University, Stanford, California

Process-Response Model for Marine-Organism Communities

Computers can be used to mimic ancient marine-organism communities with surprising effectiveness.

In a series of special programs designed for the I.B.M. 7090/7094 computers, fossil communities and their environments have been symbolically simulated in a three-dimensional mathematical model. In constructing the model, each community was assigned specific properties which governed their response to environmental factors such as depth of water, distance from shore, substrate, turbulence, turbidity, temperature, and salinity. The environmental conditions in turn were varied by adjusting numerical data fed to the computer which regulated the model.

The properties assigned to the computer communities were finely adjusted by trial and error in order to make them "behave" more or less like their actual counterparts, adapting to changing conditions and even competing with each other. One of the most useful aspects of the program was the ability to advance the model through increments of geologic time where the responses of the communities and the long-term effect of environmental and evolutional factors could be observed in a way heretofore not possible.

Recent work with the model has dealt with environmental responses of leaf-like calcareous algae of late Paleozoic age. These algae were widespread in shallow Pennsylvanian and Early Permian seas, locally creating thickened banks or reefs. Today, some of these reefs serve as large oil reservoirs in southeastern Utah, northern Oklahoma, and West Texas. Exploration for such reservoirs will be greatly enhanced if the environmental response of the organisms that created them can be experimentally determined and this knowledge effectively used for exploration purposes.

MIDDLETON, GERARD V., McMaster University, Hamilton, Ontario

Turbidity-Current Experiments

Experiments were performed in the W. M. Keck Laboratory, California Institute of Technology, using a lucite channel 5 meters long, 50 cm. deep, and 15.4 cm. wide. Turbidity-current "surges" were produced by releasing suspensions of plastic beads from a lock at one end of the channel. The bottom of the flume was horizontal and before release of the suspension the water level was the same within the lock and the main channel; the experimental results may therefore be compared with the results obtained by Keulegan (1958) for saline surges. Experiments were performed at two depths (20 and 30 cm.), and two suspension concentrations (about 25% and 45% concentration by volume) were used. The sediment consisted of perfectly spherical plastic beads with a density of 1.52 and an average size of 0.18 mm. The results show that the shape of the head, the initial velocity, and the relation between the velocity of the head and its thickness and density are very similar to those reported for saline surges. The velocity of the head is given by the equation

$$V = C\sqrt{g'd_2}$$

where $g'=g^{\Delta}e/e$, d_2 is the thickness of the head, and C is a coefficient with a value of 0.75. In another series of experiments, with saline density currents, it was found that C varies little with increase in slope of the bottom, up to a slope of 0.04.

The velocity (u) of the water near the bottom, at a distance x in front of the head, was found to be given by the equation

$$\log_{10}\left(\frac{u}{V}\right) = -0.93\left(\frac{x}{d_2}\right).$$

Two types of graded bed were formed, depending on the concentration of the suspension used. The "normal" type of graded bed, formed by surges with low sediment concentration, shows continuous grading within the bed at nearly all percentiles. The "coarse-tail" type of graded bed, formed by high-concentration surges, shows little grading through most of the bed, except for the coarsest 2–5 per cent of the size distribution. The differences between the two types of grading can be related to the depositional mechanics, which are revealed by slow-motion movies. In low-concentration flows, the bed is deposited layer by layer. In high-concentration flows, most of the bed is deposited first as an expanded or "quick" bed which continues to shear and to be disturbed by waves which form at the interface between the bed and the flow above. As the bed comes to rest, the waves disappear and the upper surface becomes perfectly flat.

A 300-foot color movie of the experiments will be shown.

MOORE, RAYMOND C., University of Kansas, Lawrence, Kansas

Obscure But Important Hiatuses in Stratigraphic Columns

The thesis is advanced that virtually all stratigraphic columns exposed on land and penetrated in wells, including those of continental-shelf areas, contain hiatuses of varied nature, the aggregate geologic-time value of which may exceed that of the rock or unconsolidated sediment in the columns. Obscurity of the hiatuses—difficulty in recognizing them—is related mainly to objective features but certainly does not exclude subjective factors. Importance is judged by the amount of continuous time represented by the gaps and by their value in indicating causes for the hiatuses as well as their significance for determining basic principles that apply to time-stratigraphic classification.

Briefly analyzed examples call attention to physical and biological aspects of obscure and even problematical breaks in selected areas at or near boundaries of (1) the Permian and Triassic, (2) the Cretaceous and Paleocene, (3) the Silurian and Devonian, (4) the Devonian and Mississippian, and (5) the Pennsylvanian and Permian; and of minor stratigraphic divisions on (6) the flanks of the Nashville dome and (7) on the northern Mid-Continent stable platform. It is concluded that the obscurity of hiatuses is unrelated to their importance and that pulsatory, more or less localized, differential crustal subsidence furnishes the main control for sedimentary accumulations and the "breaks" within them.

MOORHOUSE, M. D., Socony Mobil Oil of Canada, Ltd., Calgary, Alberta

Eagle Plain Basin of Yukon Territory

The Eagle Plain basin is an intermontane structural depression, 120 by 60 miles, which straddles the Arctic Circle in the Yukon Territory, Canada. Geologic history was influenced by a mildly positive central core which was flanked by local depositional basins through most of post-Cambrian time. Paleozoic basins include the Richardson basin, the area of the present southern Richardson Mountains, a Late Devonian basin west of the Richardson Mountains in the northeast, and a prominent Permo-Pennsylvanian area of depression in the southeast. Depositional topographic profiles identified in Permo-Pennsylvanian seismic record sections suggest shoreline conditions north of the present erosional limit of the Pennsylvanian, indicating increasingly positive behavior of the central core during the late Paleozoic.

Regional uplift during the Triassic hiatus culminated in the development and erosion of the Eagle arch, which plunged gently northeast through the stable core. Late Jurassic and Early Cretaceous sands onlapped the area from the north. Not until Albian time, when a depositional trough along the present Dave Lord ridge linked the northern Richardson Mountains to the Kandik basin of the Alaska border region, did Mesozoic seas inundate the Eagle arch and the southern Eagle Plain. Laramide deformation of the mountain belts and the concurrent development of simple folds in the enclosed Eagle Plain basin were the final acts in a Mesozoic diastrophic cycle, during which pressure from the Yukon stable block in the northwest at first fostered and later crushed the Kandik-Richardson trough against the stable Eagle Plain.

Exploratory drilling has been directed mainly toward the testing of the folded subcrop of Permo-Pennsylvanian sandstone, and the lower Paleozoic carbonate reservoirs on major anticlines. Fourteen wells have been drilled, with the resultant discovery of one oil and two gas accumulations, all in Permo-Pennsylvanian rocks.

MOUND, MICHAEL C., Chevron Research Company, La Habra, California

Late Devonian Conodonts from Alberta Subsurface

Cores from four wells in mid-southern Alberta have yielded diverse and abundant conodont faunas. Large numbers of specimens were recovered from Upper Devonian strata assigned to the Wabamun Group (Famennian) and the stratigraphically lower Winterburn Group, Woodbend Group, and Beaverhill Lake Formation (Frasnian). Included in the Wabamun Group are the Big Valley Limestone and the lower evaporitic and dolomitic Stettler Formation. Named units of the Winterburn Group include, in descending order, the Graminia, Calmar, and Nisku. The upper two units of the Winterburn Group did not yield conodonts; the Nisku contained a sparse fauna. In descending order, the Woodbend Group includes shale of the Ireton, limestone of the Duvernay, and limestone and dolomite of the Cooking Lake units. These last units are in juxtaposition with the reefs of the Leduc Formation. All Woodbend strata contain well-preserved and diagnostic conodont faunas which are markedly different from the forms of the Famennian Wabamun rocks above. Below the Woodbend Group lies the Beaverhill Lake Formation, which is predominantly limestone and contains a moderately abundant conodont fauna.

Comparison of faunas recognized in the Alberta subsurface with other described faunas reveals correspondence with forms known in North America and western Europe. Alberta subsurface strata contain significant forms representing widely distributed species of *Apatognathus*, *Ancyrodella*, *Ancyrognathus*, *Enantiognathus*, *Falcodus*, *Hibbardella*, *Icriodus*, *Nothognathella*, *Palmatodella*, *Palmatolepis*, *Pelekysgnathus* and *Polygnathus*. These species, among other characteristically Devonian conodonts, are present in sufficient quantities to demonstrate a typically Late Devonian faunal sequence.

MOUNTJOY, ERIC W., McGill University, Montreal, Quebec

Unconformities in Phanerozoic Succession of Northern Jasper National Park, Alberta

Several unconformities occur in the Paleozoic and Mesozoic shelf sequences of the Alberta Rocky Mountains. The stratigraphic succession is repeated several times because of thrust faulting. This repetition, combined with excellent exposures, permits a study of the lateral variations in the stratigraphic units and of the contacts of these units. Most of the stratigraphic breaks are disconformities in local outcrops, but regionally some are important angular unconformities.

The stratigraphic, sedimentologic, and paleontologic evidence is reviewed for the following unconformities: (1) Precambrian-Cambrian and Lipalian interval, (2) Cambrian-Ordovician, (3) sub-Devonian, (4) Late Devonian Frasnian-Famennian, (5) Devonian-Mississippian, (6) Carboniferous-Triassic, and (7) Triassic-Jurassic boundary and gaps in the Jurassic sequence.

The important criteria for recognition of these breaks in the stratigraphic succession are, in order of importance: (1) regional stratigraphy, (2) paleontology, and (3) sedimentary phenomena. Of the sedimentary phenomena, eroded surfaces or truncations and residual concentrations of quartz and chert are very useful. Fossils also are useful for locating stratigraphic breaks. Other features, including phosphates and abrupt changes of lithology, also are associated with some unconformities. In several cases it is impossible without paleontologic evidence to determine the position of a particular stratigraphic break even with complete exposure and closely spaced stratigraphic sections.

MURRAY, RAYMOND C., Shell Development Company, Houston, Texas