"reefs," which are elongate and differentiate facies on either side, and "mounds" which are merely bumps on the sea floor. Ecologic reefs can be either geologic reefs (barrier and fringing) or mounds (patch reefs); a bank is a geologic reef with no organic framework.

All calcareous organisms are capable of providing sediment to buildups. The more important modern contributors are algae, foraminifers, corals, and mollusks; in the Paleozoic they include pelmatozoans, bryozoans, and brachiopods. Organisms providing framework in large-scale ecologic reefs today are mainly hexacorals, but formerly have included rudistids, stromatoporoids, and perhaps tetracorals. Sediment binding on the same scale is provided mainly by red algae today and has involved blue-green algae, stromatoporoids, and Problematica in the past. Builders of small-scale "mounds" that also are ecologic reefs, include red algae, foraminifers, sponges, corals, bryozoans, brachiopods, polychaete worms, oysters, and sessile gastropods. In many of these mounds, the same organism served as frame and binder; in others, blue-green algae, red algae, Problematica, or bryozoans were binders. Some modern carbonate mounds are not organic in origin, but are merely hydrodynamic accumulations of sediment; perhaps some ancient carbonate mud mounds have a similar inorganic origin.

Formation of organic carbonate buildups results from any combination of environmental factors that causes localized organic proliferation. Favorable oxygenation, water circulation, and nutrient replenishment are necessary for all organic buildups; other factors may have different optima for different organisms, and exclusively invertebrate buildups can form at any depth. Buildups containing algae, however, are restricted to the photic zone, thus are more predictable as to initiation and maintenance. Algal buildups tend to start on better-lit topographic highs, and with bottom subsidence, grow upward where the algae remain in optimum photic conditions. Invertebrate buildups, however, form where other factors are optimal, which may or may not be on highs.

Initiation of a geologic reef involving algae requires simply a bottom slope upon which algae proliferate only above a certain depth. The interval on the slope within which subsidence is equally compensated by algal sedimentation eventually becomes steeper and forms a "reef front" as algal and associated sedimentation keeps the entire shallower side near the surface, whereas the deeper side on which algae are inhibited receives progressively less autochthonous sediment and eventually depends primarily on allochthonous material from any source.

HITCHON, BRIAN, Research Council of Alberta, Edmonton, Alta., GALE K. BILLINGS, Louisiana State Univ., Baton Rouge, La., and J. E. KLOVAN, Univ. Calgary, Calgary, Alta.

FACTORS CONTROLLING CHEMICAL COMPOSITION OF FORMATION WATERS, ALBERTA

Twenty major and minor components were determined in 79 formation waters from oil fields and gas fields in Alberta. An R-mode statistical factor analysis revealed that the major influence on composition has been from the original seawater, with additional effects due to the uptake of Br and I from organic matter and the decomposition of sulfides or H_2S. Other possible processes which may have been operative include differential solution of evaporites, exchange of alkali metals on clay surfaces, and the removal of hydroxides of Fe, Mn, Ni, and Co from the surrounding sedimentary rocks.

HOPKINS, JOHN P., and ERIC W. MOUNTJOY, Dept. Geological Sciences, McGill Univ., Montreal, Que.

REEF-MARGIN AND BASIN SEDIMENTATION, MIETTE REEF COMPLEX, JASPER NATIONAL PARK, ALBERTA

The southeastern margin of the Devonian Miette reef complex exposed in the Miette thrust sheet near Marmot Cirque has been reexamined and the geometric arrangement of strata from the reef margin to the basin established by tracing units laterally and by detailed examination of several closely spaced stratigraphic sections.

These observations, together with those from other reef-margin exposures in the Miette and Ancient Wall reef complexes, provide a model for reef-margin sedimentation.

The reef margin at Marmot Cirque (which comprises a series of dolomitized units built up as successive layers) remained "passive" throughout its history; *i.e.*, sediments seaward of the reef complex for the most part do not grade into the reef complex, but rather lap onto it. Reef-derived sediment in the offreef position came from lateral "active" reef margins where sediment from the reef was carried into the basin.

Sedimentation at the margin of the reef complex is a function of 4 important processes: (1) sea-level fluctuations and stillstands, (2) production rates and nature of materials building the reef complex, (3) local currents and wave action, and (4) rate of influx of fine terrigenous sediment. The last process has not been stressed in the past and is thought to be particularly important.

Availability and volume of fine terrigenous sediment in the surrounding basin at any particular time influenced the nature and form of reef development. Part of the Miette reef complex and the subsurface Leduc reefs may be explained on this basis.

HORVITZ, LEO, Horvitz Research Lab., Houston, Tex.

GEOCHEMICAL PROSPECTING FOR PETROLEUM

Geochemical methods have been applied in exploration that hydrocarbon gases migrate, essentially in a being employed, perhaps to an extent greater than ever.

All geochemical techniques are based on the assumption that hydrocarbon gases migrate, essentially in a vertical direction, from oil and gas accumulations to the surface of the earth. This assumption is supported by the observation that the saturated hydrocarbons that are present in near-surface soil air, or adsorbed on the soil itself, can be related to buried deposits.

Data have been published which appear to discredit hydrocarbon geochemical techniques by attempting to show that saturated hydrocarbons heavier than methane occur in the soil from sources other than petroleum. In 1963, Smith and Ellis reported the presence of unsaturated hydrocarbons and saturated hydrocarbons, ranging from propane through the pentanes, in grasses and roots, and suggested that vegetation was the source of soil hydrocarbon anomalies.

Studies have been made on grasses and roots which show that, aside from methane, only unsaturated hydrocarbons in relatively large amounts are present in or produced by vegetation. However, soils in the vicin-