and intrastratal solution will require revision of some previous interpretations of their provenance and of some prior reconstructions of the paleoclimate and paleotectonics.

HIRSCH, ALFRED M., Rutgers Univ., Camden, N.J., and DAVID GOVONI, State Univ. New York, Stony Brook, N.Y.

FOOD SUPPLY—LIMITING FACTOR OF FORAMINIFERAL POPULATIONS

The standing crop of benthonic Foraminifera declines during the fall and increases during the early spring in Great Bay, New Jersey. Population sizes correlate with seasonal variations in phytoplankton and particulate organic carbon abundances, but do not correlate with changes in temperature or salinity or with differences in substrate textures.

Foraminiferal populations at 7 stations were repeatedly examined from the head to the mouth of the bay. The substrate ranged from a silty clay to a shelly, gravelly sand. Maximum salinity-temperature range within the bay on any sampling day never exceeded 8 °/oo or 2°C, although salinities and temperatures varied from a maximum of 31 °/oo and 26°C in late summer to a minimum of 10 °/oo and 0°C in mid-winter, respectively.

The foraminiferal fauna is a typical midlatitude estuarine assemblage. The dominant species differ among stations and appear to be controlled by substrate texture and salinity; however, the standing crop at all stations exhibits a consistent seasonal variation. The live percentage of the total foraminiferal population decreases by more than 30% in the fall and winter and increases more than 10% in late winter-early spring. The decrease coincides with a decrease in chlorophyll *a*, but not with any marked change in temperature or salinity. In early March the increase coincides with an increase in chlorophyll *a* or particulate organic carbon, although temperatures in the bay are 5-6°C and salinities are depressed by runoff. The dominant zooplankton, copepods and nauplius larvae, as determined by others, exhibit a similar seasonal pattern.

HITCHON, BRIAN, Research Council Alberta, Edmonton, Alta., and M. K. HORN, Cities Service Oil Co., Tulsa, Okla.

PETROLEUM INDICATORS IN FORMATION WATERS FROM ALBERTA, CANADA

A statistical study, including discriminant analysis, was carried out on a suite of 438 formation waters from Alberta, Canada, which had been analysed for Cl, Br, I, HCO_3, SO_4, Ca, Mg, and Na. The analyses were divided into 2 populations, depending on whether the initial status of the well was producing oil and/or gas (322 samples) or nonproducing, *i.e.*, abandoned (116 samples). The populations were further subdivided into Paleozoic and Mesozoic groups, and these 2 groups, together with the entire suite of analyses, were subjected to statistical study. With 95% assurance, the Alberta formation waters associated with producible hydrocarbons are chemically different, in a multivariate sense, from the formation waters from abandoned wells. Further, iodine and magnesium are the most important discriminators in the Paleozoic group, whereas sodium and chlorine are the most important in the Mesozoic group. These discriminators reflect the different organic geochemical, geologic, and hydrodynamic history of the Paleozoic and Mesozoic strata. Reclassification of the analyses using the discriminant functions resulted in only a 0.65 success ratio, thereby indicating that the chemical analysis of formation water is not a completely reliable predictor of the occurrence of hydrocarbons, at least at the Paleozoic-Mesozoic level. The 0.65 probability of successful classification may be increased with the acquisition of a larger data base and consequent statistical analysis at the formation level.

HOERING, THOMAS C., and P. E. HARE, Geophys. Lab., Carnegie Inst. Washington, Washington, D.C.

COMPARISON OF NATURAL HUMIC ACIDS WITH AMINO ACID—GLUCOSE REACTION PRODUCTS

Amino acids and carbohydrates disappear rapidly in recent marine sediments. Most of the organic matter exists as a high-molecular weight, insoluble polymer which has properties similar to humic acids. Glucose and amino acids react rapidly at neutral pH in the laboratory by the Maillard reaction, to produce a polymer that has many properties common to natural humic acids.

Both form gels that bind large quantities of water. They have comparable elemental compositions. The synthetic reaction produces a polymer with a wide molecular weight range extending to very high values similar to humic acids. They react rapidly with added amino acids. Both give a similar electron spin resonance spectrum. Degradation of the natural and synthetic humic acids by methylation, chlorination, and mild oxidation yields a similar suite of low-molecular-weight, chlorinated organic acids.

Carbohydrate-amino acid-reaction products are likely precursors of part of the polymeric organic matter in recent sediments.

HOWARD, JAMES D., Skidaway Inst. Oceanography, Savannah, Ga.; ROBERT W. FREY, Univ. Georgia, Athens, Ga.; and FRANK A. KINGERY, San Diego State Univ., San Diego, Calif.

PHYSICAL AND BIOGENIC CHARACTERISTICS OF SEDIMENTS FROM OUTER GEORGIA CONTINENTAL SHELF

Eighty-eight box cores were taken on the outer Georgia continental shelf, in water depths from 15 to 200 m. Textural analysis indicates that the midshelf area is covered by medium to coarse sand, evenly distributed, with no north-south linear trends. Areas of fine sand are present on the inner and outer shelf edges, and in 2 distinct lobes extending seaward from the Georgia coast. Parts of the lobes suggest that the finer material forming them was supplied by the Savannah and Altamaha Rivers. Local patches of semiconsolidated mud indicate the location of remnant marsh or estuary deposits.

Offshore shell assemblages indicate a mixing of faunas in terms of both environment and age. Pleistocene regressions and transgressions across the shelf resulted in alternate oceanward and landward migrations of nearshore and estuarine faunas, reworked subsequently with open-ocean faunas. Live animals offshore are adding their shells to the already mixed assemblages.

Biogenic sedimentary structures significantly exceed those of primary physical structures. All box cores show some degree of biogenic reworking, and most were more than 60% bioturbated. Physical sedimentary structures include crossbedding, ripple lamination, interbedded sand and mud, wavy bedding, and graded bedding.

Physical and biogenic reworking of the outer Georgia continental shelf sediments has removed or greatly modified most of their original depositional characteristics. Thus, reference to these sediments as "relict" is misleading.

HUANG, T. C., and N. D. WATKINS, Graduate School Oceanography, Univ. Rhode Island, Kingston, R.I., and R. H. FILLON, Woods Hole Oceanog. Inst., Woods Hole, Mass.

DIAGNOSIS OF PROCESSES MODIFYING DISTRIBUTION OF ATMOSPHERICALLY TRANSPORTED VOLCANIC GLASS IN DEEP-SEA SEDIMENTARY CORES

Analysis has been made of tephra in deep-sea sedimentary cores downwind from Pleistocene and late Pliocene eruptions on the Balleny Islands in the southwest Pacific. The volcanic glass is finely dispersed and megascopically indistinguishable in the cores examined. Despite modification of the vertical distri-