$\delta^{13}C$ values (PDB)—of dolomites in the Monterey Formation, California, and in recent sediments in the Gulf of California, controlled by the CH_4/CO_2 ratio; and (3) the often observed similar oxygen isotope values of coexisting calcites and dolomites in limestones which were dolomitized by seawater mixed with large volumes of fresh water.

Thus, in low or sulfate-free environments, dolomitization of $CaCO_3$ and the formation of primary dolomite are limited by supply of alkalinity, calcite or aragonite, or dissolved Ca^{2+} or Mg^{2+}. Even in the absence of sulfate, dolomitization may be retarded or inhibited by the transformation of opal-A to opal-CT, a reaction which can compete with dolomite for available Mg^{2+}.

BALCH, A. H., M. W. LEE, and J. J. MILLER, et al, U.S. Geol. Survey, Denver, CO

Use of Vertical and Surface Seismic Profiles to Investigate Distribution of Aquifers in Madison Group and Red River Formation, Powder River Basin, Wyoming-Montana

Intensive energy development activity in the Powder River basin area of eastern Wyoming has placed heavy demands on the limited water resources of the state. Water cannot be obtained from streams, rivers, or shallow wells to support coal-slurry pipelines, coal gasification, shale retorting, or even in many places enlarged municipal water systems. The U.S. Geological Survey is, therefore, promoting the water resource potential of the Madison Group and Red River Formation. Such water is to be produced from depths of 2,500 to 7,500 ft (762 to 2,286 m) to supply some of the needs cited.

Because deep water wells are expensive, and Madison-Red River productivity varies drastically throughout the area, it is highly desirable to select drilling sites with a high probability of good water production. The exploration seismograph is a promising tool to aid in site selection. The object of the investigation was to determine under what conditions the exploration seismograph can be used to detect porosity development at depth in the horizons of interest, an application which also has obvious significance to the petroleum industry.

In-situ measurements of the acoustic properties of the Madison-Red River interval have been made using vertical seismic profiles in several wells. Surface seismic profiles were then run over the wells in which vertical seismic profiles had been made. The combination of these results, together with well log data and regional geologic subsurface studies, give one considerable insight into the problem of exploring for commercial quantities of water at depth.

BALL, MAHLON M., U.S. Geol. Survey, Woods Hole, MA, RAY G. MARTIN, U.S. Geol. Survey, Corpus Christi, TX, and WAYNE D. BOCK, Univ. Miami, Miami, FL, et al

Multichannel Measurements Over a Possible Gas-Bearing Structure Near Cay Sal, Bahamas

Multichannel reflection measurements in water depths of 500 m reveal an asymmetric anticline 70 km southeast of Cay Sal Bank. This fold has an apparent width of 10 km. The northern flank has a maximum relief of 1 km, and the southern flank's maximum relief is 400 m. North of this structure, in Santaren Channel, coherent reflections occur throughout our 5-sec record. Depth at 5 sec is approximately 10 km. South of the anticline, reflections are discontinuous below 1 sec, and no coherent reflections can be seen below 2 sec. A strong reflection at 2.3 sec in Santaren Channel (approximately 3 km depth) probably marks a middle Cretaceous unconformity. Seismic units inferred to be youngest Cretaceous and Paleogene show maximum thinning over this fold. The Upper Cretaceous sequence shows maximum structural relief here. Amplitude anomalies occur on the crest. Reflections from the uppermost Cretaceous to Paleogene section are dim above reflections from inferred Upper Cretaceous units that contain several bright spots. Some flat reflections on the structure may stem from gas-liquid contacts.

Ten kilometers south of the asymmetric anticline, a tilted block that may be composed of platform carbonate rocks rises to within 0.3 sec of the sea floor. This block has an east-west dimension of more than 20 km and a maximum relief of 1.3 km. A Lower Cretaceous carbonate platform edge underlies 800 m of water and 1.5 km of sediment at the junction of Nicholas Channel and Florida Straits. In Florida Straits, a strong reflection correlates with the middle Cretaceous unconformity.

BARKER, COLIN, Univ. Tulsa, Tulsa, OK

Organic Geochemistry as a Geologic Tool

Recent advances in techniques for analyzing organic matter, together with improved understanding of compositional changes with changing physical conditions, have led to the development of methods with considerable potential for providing insight into geologic processes. The physical character and chemical composition of organic matter change with temperature and can be used like a thermometer that is still reading its maximum value. As organic matter is extremely sensitive to past thermal effects, it responds at temperatures much lower than those needed to produce the mineral changes characteristic of the lowest grade of metamorphism. If values for geothermal gradient are known the actual depths of burial can be estimated from values for vitrinite reflectance and elemental composition. Faults or unconformities commonly show clearly in vitrinite reflectance plots and it is possible to use this information to calculate the displacement of the fault or the amount of overburden removed. Vitrinite reflectance and electron spin resonance have the potential for showing past geothermal gradients. The amount and type of organic matter in a rock are strongly influenced by the depositional environment. An obvious example is the presence of wood indicating input from terrestrial sources. A variety of characteristic organic compounds (biological markers) have potential as environmental indicators. The role of organic matter in controlling conditions, especially Eh, is well known but often poorly documented, while the significance of organic matter in complexing and transporting trace elements in the subsurface is just starting to be investigated. Organic matter may also have an important role in recrystallization and diagenesis because of its adsorption on crystal surfaces. The wide range of compounds present in organic matter is controlled by depositional environment but subsequently modified by changes in temperature, pressure, Eh, and pH, and thus provide enormous potential for studying geologic processes.

BARNARD, LEO A., Texas A&M Univ., College Station, TX, KEITH A. KVENVOLDEN, U.S. Geol. Survey, Menlo Park, CA, and DENIS A. WIESENBURG, Texas A&M Univ., College Station, TX, et al

Geochemistry of a Marine Gas Hydrate Associated with a Bottom Simulating Reflector

Multiple deployments of a pressurized core barrel (PCB) during drilling of DSDP-IPOD Site 533A on the Blake-Bahama Outer Ridge has provided conclusive evidence for the presence of gas hydrate in sediments exhibiting a well-defined bottom simulating reflector. Pressure decline curves monitored during degassing and sampling of two pressurized sediments clearly indicate a pressure plateau at about 1,500 kPa resulting from gas hydrate decomposition. The pressure decline curve also includes a region attributable to hydrostatic pressure and a sediment degassing region. The molecular compositions of volatile hydrocarbons in PCB gas samples were characterized by (a) less than 2% variation in the C_1/C_2 ratio during pressure release, (b) a fourfold increase in C_3-C_6 hydrocarbons over the duration of the experiment, and (c) a tenfold increase in CO_2 content of the expelled gases. Gas hydrate solids were recovered from Core 13-1 (~ 238 m depth) in sufficient quantity to permit several pressure/volume measurements. Gas expansion of the solids was measured at 13:1. Mole ratio of water to gas was found to be 50:1 after correcting for pore fluid content. Sediments remaining after gas hydrate decomposition were 93% H_2O by weight. Most of the water contained in the sediments appeared to be associated with the gas hydrate. The hydrates recovered were extremely fine grained and decomposed rapidly upon removal from in-situ pressures and temperatures.

BARNES, P. W., and ERK REIMNITZ, U.S. Geol. Survey, Menlo Park, CA

Seabed Changes Resulting from Combined Sea Ice and Hydraulic Processes on Shelves of Arctic Basin: Example from Harrison Bay, Alaska

Repetitive studies of Harrison Bay, a gently sloping large shelf embayment of the Beaufort Sea, reveal an interaction of ice- and water-driven processes. Sea ice covers this environment for 9 months of the year, and varying areas of open water are present during the remaining 3 months. Fathograms and sonographs recorded yearly since 1975 indicate that an area totaling 2% of the seabed is reworked each year to depths of a meter or more by ice keels in the fast-ice zone. During fall storms in 1977, when minimal ice cover allowed development of abnormal waves and currents, the jagged ice-gouged seabed in water depths of 13 m and less was transformed into sand waves 1 to 2 m high with wavelengths of 100 m. Seaward to 15-m depth, ponding of sediment both shoreward of ice-gouge ridges and within ice gouges to depths of 60 cm suggests an offshore transport direction. Since 1977, ice has continued to gouge the wave- and current-modified seabed. On the basis of our repetitive surveys, such storms should recur at greater than 5-year intervals.

The interaction is a continuum of ice gouging, broken by major open water storms that vigorously shape the upper 1+ m of the thin (3 to 5 m) Holocene sediment. Because of the interplay of these two processes, bed forms and structures vary drastically over short distances, and rates of sediment reworking greatly exceed the regional rate of sediment accretion. On this inner shelf, sea-ice and hydraulic processes are of equal importance in forming the geologic environment. Offshore and at higher latitudes (Arctic Ocean), ice processes predominate; inshore and at lower latitudes (Chukchi and Bering Seas), hydraulic processes predominate.

BARRON, E. J., National Center for Atmospheric Research, Boulder, CO, C. G. A. HARRISON, and J. L. SLOAN II, Univ. Miami, Miami, FL, et al

Paleogeographic Evolution of Earth, 180 M.Y. Ago to Present

A series of paleogeographic maps at 20-m.y. intervals (conformal mercator and stereographic projections such that the whole earth is displayed) from 180 m.y. ago to the present are produced with the continents placed in their correct relative positions using sea-floor spreading data and initial continental reconstructions. The absolute location of the reconstructions with respect to the spin axis of the earth is based on averaged paleomagnetic pole positions. The locations of past shoreline positions are based on comprehensive regional paleogeographic analyses. There remain aspects of the reconstructions which are controversial because data do not constrain the models. In addition to providing maps of land-sea distribution through time, the global paleogeographic analysis has several additional interesting results including: (1) a discrepancy in the tectonic evolution of the North Atlantic which is not evident from regional analyses; (2) a revised interpretation of the evolution of the Arctic Ocean; (3) latitudinal variations in land area with important implications for Mesozoic-Cenozoic paleoclimatology; and (4) evidence relating the distribution of evaporites and carbonates to sea level and the distribution of shallow seas, rather than the displacement of climatic zones.

BARRON,* JOHN A., and GERTA KELLER*, U.S. Geol. Survey, Menlo Park, CA

Integration of Diatom and Planktonic Foraminiferal Data for Biostratigraphic and Paleoclimatic Interpretation of Middle and Upper Miocene Monterey Shale

Diatom biostratigraphy developed in the middle to high latitude North Pacific allows detailed correlations within the middle and upper Miocene Monterey Shale, and provides ties to the international time scale. In contrast, planktonic foraminiferal biostratigraphy is severely limited owing to low species diversity caused by climatic deterioration during the middle and late Miocene. Despite these limitations, fluctuating abundances and morphologic variants of planktonic foraminifers provide paleoclimatic information which, taken in conjunction with high resolution diatom biostratigraphy, provides a means for interpreting the paleoclimatic and paleoceanographic history of the California Current and, hence, the Monterey Shale.

Diatom and foraminiferal assemblages were studied from DSDP Sites 173 and 470, from the upper Newport Bay section, and from other selected sections in California. Microfossil assemblages record fluctuations in the intensity of the California Current during warm and cold episodes. During warm to temperate periods, planktonic foraminifers are abundant and exhibit relatively high species diversity and morphotypic variation, whereas diatoms are not very abundant. During colder periods, diatoms are abundant and planktonic foraminifers exhibit very low diversity or may even be absent owing to carbonate dissolution.

Paleoclimatic trends deduced from microfossil and isotope studies of Pacific DSDP material can be recognized in middle and upper Miocene strata from the California area. A cooling trend beginning at about 15.0 Ma and reaching a maximum at about 13.0 Ma is apparent in rocks assigned to the upper Luisian through lowermost Mohnian provincial stages. Diatoms and planktonic foraminifera reveal a further cooling near the middle Miocene–upper Miocene boundary at about 11.5 Ma (middle Mohnian). An inundation of diatoms and near disappearance of foraminifers at about 7.5 Ma (upper Mohnian)