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.

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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.

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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.

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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 paleo-oceanographic 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) corresponds to increased upwelling associated with intensified cooling in the uppermost Miocene.

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Geophysics—The Next 50 Years

This year marks the beginning of the second 50 years of the Society of Exploration Geophysicists and, effectively, it is also the start of the second half century of what may be termed the modern application of geophysical exploration techniques.

Will there even be a need for geophysics by the year 2030? The answer must be an unqualified yes.

The total worldwide demand for energy and raw materials will increase as population and industrialization grow. Nuclear, synthetic, and renewable energy supplies, such as solar, wind, hydroelectric, and biomass plus conservation efforts, will moderate the demand. Exploration plays will be smaller, deeper, more difficult to locate, and more costly to produce than in the past. As a result there will be a critical need for a strong exploration industry—one that combines the best techniques and efforts of both geology and geophysics—to discover and develop the resources of the future.

What will geophysics be like 50 years from now and what new tools and methods will be brought to bear? This is a difficult question to answer. The key to such long-range prediction is the identification of specific technologic advances. Further refinements in existing techniques will occur, but undoubtedly the application of yet undiscovered principles also will be made.

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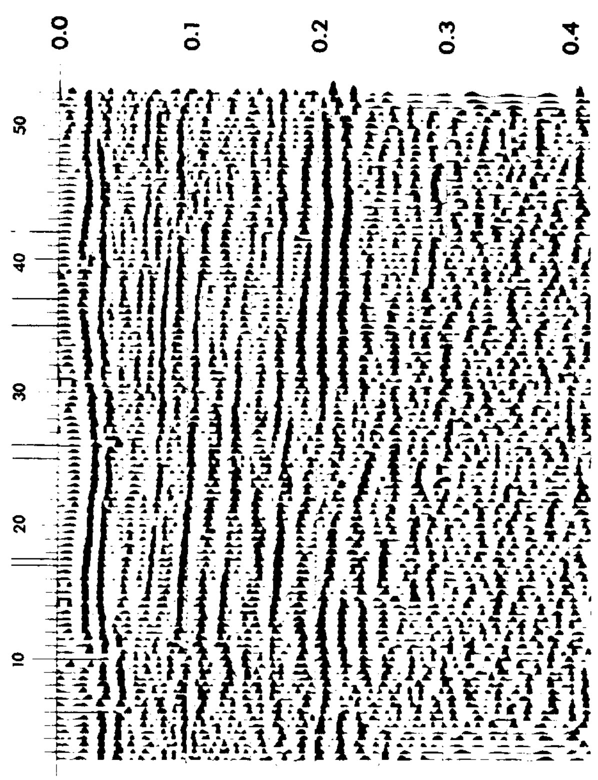
High-Resolution Reflection Seismics at Potential In-Situ Coal Gasification Test Site



Sandia National Laboratories is the technical manager for a Department of Energy project directed toward selection and characterization of a potential in-situ coal gasification site in the State of Washington. Prior geophysical investigations at this site in the Centralia-Chehalis coal district included in-line and broadside refraction surveys, VLF and Turam electromagnetic surveys, in-seam seismic wave propagation, and geophysical logging of exploratory boreholes. The results of these surveys, presented at last year's SEG meeting, indicated several anomalous features which we interpreted as faulting. Detailed description of the existing structure, however, could not be determined from the earlier surveys.

A high-resolution, seismic reflection survey, reported here, was later conducted to detail the site geologic structure and, thereby, determine areal continuity of objective coal seams. Approximately 12,000 ft (3,658 m) of survey line was obtained over this 62-acre (25 ha.) site, seeking to define the first 1,000 ft (305 m) of the subsurface. A 30-ft (9 m) receiver interval was employed; a portable "shotgun" source supplied seismic energy yielding a net stack of 1,200% at 15 ft (4.6 m) CDP spacing.

Analysis of the resulting reflection data verifies the existence of faulting across the site as interpreted from earlier geophysical and borehole data. However, the geologic structure is found to be more complex than indicated by the earlier data above. A sample reflection record section is given in the figure. Here, faulting of the "Big Dirty" seam (approximately 170 msec) is evident as are offsets in both deeper and shallower seam. Correlation of prior data and those most recent lead to total site characterization.

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Feldspar Dissolution Before Advent of Land Plants on Earth

The sedimentary record throughout geologic time shows that, in general, plagioclases alter faster than K-feldspars. Examination of detrital feldspars in Cambrian and Ordovician arenites shows that most K-feldspars are altered very little, whereas plagioclases are either absent or severely altered. This is in sharp contrast to the varying degrees of alteration suffered by all feldspars found in post-Silurian sediments. It is possible that regolithic processes of Cambrian-Ordovician times preferentially destroyed plagioclases while preserving K-feldspars.

Weak organic acids in soils, commonly due to humus, can dissolve all feldspars. In addition, continued uptake of potassium by land plants depletes the K^+ ion concentration in soil waters and favors the dissolution of potassium-bearing phases. During Cambrian-Ordovician times, in the absence of vascular land plants (green algae and lichen notwithstanding), there would be no potassium-chelating agent, and the K^+ ion concentration in soil waters would not have been depleted. Therefore, the composition of Cambrian-Ordovician soil waters could have been within the stability field of K-feldspars but beyond that of plagioclase (assuming that the silicon, aluminum and hydrogen activities did not make all feldspars unstable). Under such circumstances, K-feldspars would not be altered but the dissolution of plagioclases would continue. If so, weathering processes before landplant times must have been responsible for the unusual detrital mineral assemblage (quartz + fresh K-feldspars + no plagioclases) observed in Cambrian-Ordovician arenites.

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Reefal Margins of Pliocene-Pleistocene of Great Bahama Bank