ical investigations have shown extensive faulting within this crustal block—some of which appears to have locally offset Holocene deposits. Most of the faults within the Salinian block in the Monterey Bay region occur in two major intersecting fault zones; the northward-trending Carmel Canyon fault zone, extending offshore from Point Sur (oriented N25°W), and the northwest-trending Monterey Bay fault zone, extending offshore from the town of Monterey (oriented N50°W). The Carmel Canyon fault zone appears to connect the Palo Colorado fault in the south with the San Gregorio fault in the north. The Monterey Bay fault zone appears to be the offshore continuation of the Sur-Nacimiento fault zone.

Epicenters of many recent earthquakes are concentrated at the intersection of the Carmel Canyon and Monterey Bay fault zones, in the central part of Monterey Bay. First-motion studies of 8 earthquakes indicate right-lateral strike-slip displacement on these offshore faults. The cessation of a 10-day period of rapid tectonic creep along the adjacent San Andreas fault in 1970 coincided with a 4.3-magnitude earthquake in the Monterey Bay fault zone. This, as well as first-motion studies of the earthquakes and mapping of the offshore faults and seismicity, suggests a direct coupling between the San Andreas fault and the adjacent fault zones.

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GEOLOGIC EFFECTS OF CITIES

Human activities in an industrial society are geologically significant in coastal cities because of the amounts of sediment and wastes moved and resulting topographic changes. Small streams are altered or destroyed, many becoming sewers. Large streams are dredged to accommodate ocean-going vessels and nearby river banks are bulkheaded. Shallow areas (including wetlands) are filled to provide space for city growth. Sewer, industrial, and sediment discharges are deposited in navigation channels which eventually require extensive dredging and waste disposal operations. The volume of wastes, and the sediment yield per unit area of the city, equals or exceeds the discharge of many rivers. Dams and public water-supply systems change river flows and dredging can change tidal regimes in the estuaries. Sand and gravel production and construction of groins, bulkheads, and other structures change ocean shorelines and disturb beach processes.

In the future, human activities will extend to the continental shelf where sand and gravel deposits will be exploited, offshore electrical power plants will be built, and port facilities will be constructed for deep-draft vessels requiring extensive dredging across the shelf. Even offshore airport centers have been proposed.

These urban processes and their geologic effects are well documented in the New York metropolitan region.

GUTHRIE, JOHN J., Mandrel Canada Ltd., Calgary, Alberta

PROBLEMS OF A NEW FRONTIER

It is becoming generally accepted that in the near future North America will be faced with a serious energy crisis. The Canadian Arctic will play a most important part in satisfying the Western Hemisphere's energy needs. A new frontier in exploration has opened. Because of its location and environment, it poses new problems. Some of the prevailing exploration methods do not work efficiently in this new environment. The costs of mobilization and demobilization and logistical support have mushroomed to staggering proportions. Inflationary trends have caused further cost increases.

The application of previously accepted geophysical exploration field methods in this high-cost area dictates concerted investigation into improved efficiency of field operations, use of highly portable accommodations, reduction of costs for expendable supplies, and the need for adequate time for preplanning of projects.

Several new approaches have been applied to these inherent problems, with varying degrees of success. New approaches in Arctic transportation, camp accommodations, and surface-energy sources are being developed, and must be considered in relation to today's mushrooming costs, while maintaining man's safety as a prime consideration.

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REPETITIVE CARBONATE-BANK DEVELOPMENT AND SUBSEQUENT TERRIGENOUS INUNDATION; CAMBRIAN CARRARA FORMATION, SOUTHERN GREAT BASIN

Three times during the deposition of the Lower and Middle Cambrian Carrara Formation, shallow-water carbonate banks developed in southern Nevada and southeastern California. Each bank attained a minimum width of 150 km normal to the depositional strike. Eastward the banks were bordered by terrigenous clays, silts, and sands from the stable craton, and westward they were bordered by siliceous "lime" muds lacking shallow-water depositional features. The position of rock units with respect to 5 trilobite faunules within the Carrara suggests that carbonate deposition waxed and waned subsequent to eastward and westward migrations of areas of detrital sedimentation.

During each of the 3 episodes of carbonate deposition, a sequence of 4 lithologic changes is repeated as follows: (1) upward fining and thinning of terrigenous clastic deposits; (2) the beginning of carbonate deposition, first as scattered skeletal grainstones, later as oolitic grainstone, oncolite packstone, and "lime" mudstone accumulating as a shallow subtidal bank; (3) the deposition of loferites, bird's-eye and mudcracked limestones, cryptalgal laminites, and stromatolites as low carbonate islands on the western half of the banks; and (4) the relatively abrupt termination of carbonate deposition with renewed sedimentation of detrital clay and silt. Each sequence is repeated farther east during succeeding episodes of carbonate sedimentation.

HANSEN, C. P., U.S. Senator (Wyoming), Washington, D.C.

GOVERNMENT AND THE ENERGY CRISIS: COLLISION OR COLLABORATION

In recent years the Federal Government has begun to recognize and come to grips with our national energy crisis. Contributing to improved government understanding of the problem was the National Petroleum Council's report released last December.

The National Fuels and Energy Study being conducted by the Senate Interior Committee, on which I serve, has made great progress in attempting to develop our own recommendations for national energy policy. We have been especially assisted by the expert testimony of The American Association of Petroleum Geologists.

President Nixon earlier this year announced his proposals for abating our energy crisis. The Congress has been asked to act. However, the question remains whether the Congress will cooperate with the President, as I believe it should, or whether a matter as important to our national security and economic well-being as our energy supply will be turned into a political football by an uncooperative Congress.

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KEYS TO RECOGNITION OF CARBONATE RESERVOIR ROCKS

A 4-step procedure has been developed that provides key information for recognizing the reservoir facies in carbonate sequences. The procedure is used in conjunction with standard methods of environmental and diagenetic analysis, both in petrographic description and reservoir-map construction.

The first step in the procedure is largely petrographic in nature. The pore network is examined to determine the critical rock properties that influence hydrocarbon volume and productivity, pore type, pore arrangement, pore abundance, and pore size. Samples with similar pore networks are grouped together for use in the next step.

In the second step, representative samples are selected from each pore network group for porosity, permeability, and capillary-pressure measurements. The 3-dimensional and quantitative characteristics of the pore network are established in this way and basic data are obtained for reserves calculations.

The petrophysical data are interpreted in the third step by means of porosity-permeability cross plots and capillary-pressure graphs. The use of well logs at this point is recommended as an additional reference base. The output from this step is the identification of the reservoir facies and the determination of its range of quality. The development of a set of reference samples at this time aids cuttings description later on.

Finally, the reservoir and nonreservoir rock groups just identified are linked with their environmental facies counterparts (step 4). When this is accomplished for cored wells, the relations are extended to uncored wells by means of the reference set established previously. Cuttings samples, and even additional cores, can usually be described adequately with a low-power microscope once the reference set is available.

Because the procedure is based on experimental pore-size studies as well as on subsurface and surface studies of several areas and rock types, the system of description should have general application. Studies of fine-grained carbonate sequences are aided particularly with this approach, and helpful information commonly is obtained for evaluating well-test and pressure-production history data.

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AEROMAGNETIC SURVEYS IN LABRADOR BASIN

The combined study of a detailed aeromagnetic survey and available geologic, seismic and other geomagnetic data has indicated the presence of grabens, perhaps of late Paleozoic or early Mesozoic age. The study suggests the presence of salt, defines 3 important trends associated with Appalachian or post-Appalachian orogeny, and appears to support the present concepts of plate tectonics, although this latter point has not yet been studied in detail. Much of the information has been interpreted from detailed aeromagnetic data.

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UNDERWATER IMAGERY BY MAPPING SONAR

The unique long range of the mapping sonar now allows sea-bottom imagery to be obtained which is comparable to air photography or radar imagery on land. The sonar scans out to a 0.5 mi on each side of a towed fish, making the instrument practical for regional geologic sea-floor mapping. When the sonar is used in conjunction with a vertical-profile sparker, submarine geologic interpretations can be made that are superior to photogeologic interpretations on land. There are 2 modes of operation of the sonar. (1) With proper placement of ship traverses, continuous imagery can be obtained comparable to a stapled air-photo mosaic. (2) The sonar fish can be pulled behind a seismic vessel, producing mile-wide strip-type control. For use in this fashion, the increase in cost per mile is small. There are many geologic and geophysical benefits in this use of the sonar. Practical development of the wide-scan-mapping sonar heralds the beginning of sea-floor mapping comparable to aerial photographic land mapping.

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TRANSPOSITION—A SOMEWHAT NEGLECTED MECHANISM OF SEDIMENTARY EMPLACEMENT

Transposition is the mechanism of postdepositional or syndepositional intrastratal sediment movement caused either by gravitationally unstable stratification or by liquefaction. Movement may be upward, downward, or lateral. Transposition structures include sand dikes, sand sills, and sand plugs (formed by injection), sand and mud volcanoes and water-expulsion pipes (formed by ejection), and some convolute stratification and load structures. Slump structures or structures formed by fluid-drag action on the sediment surface are not included.

All of the above structures previously have been described as separate phenomena. They are, however, genetically interrelated; they commonly are found together and form a spectrum of secondary inorganic sedimentary structures. Rapidly deposited, alternate water-rich muds and fine sands in alluvial, lacustrine, deltaic, and turbidite sequences seem to be most suitable for their occurrence.

The similarity of some transposition structures to common primary sedimentary structures is striking. However, they may easily be confused. For example, polygonal patterns of sand dikes may resemble sand-filled mudcracks; cross-stratification caused by ejection may resemble current-formed cross-stratification; some sand dikes may resemble vertically walled channels; downward collapse structures may resemble wave-excavated scoops.

Well-exposed examples of transposition structures are present in the Mississippian Horton Group of Nova Scotia and in the late Precambrian Cabot Group of eastern Newfoundland.

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EFFECTS OF POSTDEPOSITIONAL SUBAERIAL WEATHERING AND INTRASTRATAL SOLUTION ON PALEOCLIMATIC AND PALEOTECTONIC INTERPRETATION

In the nonlithified Cretaceous and Tertiary sediments of eastern and southeastern United States, two different, readily recognizable mineral assemblages are nearly ubiquitous. One, termed a "full" suite, generally contains the following minerals: (1) epidote, garnet, staurolite, zircon, kyanite, hornblende, sillimanite, tourmaline, rutile, and monazite among the heavy nonopaque minerals; (2) quartz, muscovite, and feldspar among the light minerals; and (3) the clay minerals montmorillonite and kaolinite. The other mineral suite contains an impoverished or "limited" assemblage: (1) the heavy, nonopaque minerals zircon, tourmaline, staurolite, kyanite, rutile, sillimanite, and monazite; (2) the light minerals quartz and muscovite; and (3) the clay mineral kaolinite.

The full assemblage is characteristic of sediments of distinctly marine origin, whereas the limited suite commonly is associated with sediments interpreted as originating in a fluvial or littoral environment.

Analysis of outcropping sediments demonstrates that, upward in a section, a full assemblage may change to a limited assemblage where the strata are porous, permeable, and stand topographically high. Fluvial or littoral sands in outcrop or in the shallow subsurface contain limited assemblages, whereas their downdip marine equivalents contain a full suite. These two distinctly different mineral suites are not necessarily the result of changes in provenance, source-area climate, or tectonic stability. Instead, they should be attributed in large part to postdepositional subaerial weathering and intrastratal solution.

Reevaluation of mineral analyses of Cretaceous and Tertiary sediments in the eastern and southeastern United States to include consideration of postdepositional subaerial weathering