The Badak field, with reserves of 7 Tcf of gas and 160 million bbl of oil and condensate in place, now has daily production of 600 MMscf of gas, 15,000 bbl of condensate, and 10,000 bbl of oil.

HUGHES, LYNN N., Attorney, Howard and Hughes, Houston, Tex.

Legal Implications of Consulting Relationship—Professional Liability of Consulting Geologist in Urban-Environmental Context

Providing information upon which others rely involves the consulting geologist being potentially liable to several kinds of claimants under varying standards depending on the legal characterization of the behavior of the geologist.

The broadest liability arises when the geologist participates directly in a scheme that is subsequently determined to have involved misrepresentations of material facts upon which others relied to their detriment.

The geologist in public practice is required to exercise professionally competent judgment for the benefit of those contracting for the geologic services. This raises the problems of the precise standard to which geologists are going to be held, which requires defining the legal nature of the science of geology.

Under particular circumstances a geologist may have a positive duty to disclose knowledge of potential geologic hazards in a project to the public authorities despite the existence of a confidential or contractual relationship with the project's sponsor. A failure to act can result in liability.

A geologist's participation in political action as a citizen, individually or allied with others in somewhat formal groups, may lead to liability for misstatements or improperly prepared public criticism that delays or damages a project. Although a geologist enjoys the same freedom of speech and action as other citizens, there are limits to constitutional liberties beyond which private liability is possible.

The consultant needs to consider the legal implications of the contractual relationship and the opinion given, including conflicts of interest, confidentiality, proprietary rights to data, and qualification of opinions.

HULMES, LEITA J., Univ. Delaware, Newark, Del.

Origin of Hills Beach–Fletcher Neck Tombolo System, Biddeford, Maine

In Cumberland County, on the southeast coast of Maine, two spits connect the mainland to two rock islands. A narrow channel separates the two headlands, kept open by strong currents generated as the bay enclosed by the double tombolo is flooded and drained by 2.5-m tides.

A shallow-marine (Presumpscot Formation) clay was deposited during postglacial time. Following this, crustal rebound in early Holocene time raised the area 65 m above sea level. With later (~5,000 years B.P.) subsidence and continued eustatic sea-level rise, the two spits prograded over the marine clay, forming tombolos to the offshore islands. With further rise of sea level, the two tombolos began migrating toward each other at a rate of at least 500 m in the past 1,000 to 2,000 years, leaving relict marsh exposed on the present beach face.

Subsurface studies of the resulting stratigraphy show five distinct environments: (1) nearshore, intertidal, washover and dune sands of the barriers; (2) tidal-pool muds, deposited in the relative quiet of the bay, currently being transgressed by the barriers; (3) a flood-tidal delta of organic-rich sands and muds; (4) tidal-channel sands; and (5) back-barrier marsh.

With the high energy conditions generated by northeast and southeast storms, and continuing stability of relative sea level, the spits will continue their migration until the bay is completely infilled, resulting in a highly complex stratigraphy created by the "merging" of two tombolos.

HURLEY, NEIL F., Univ. Wisconsin, Madison, Wisc.

Seaward Primary Dip of Fall-in Beds, Lower Seven Rivers Formation (Permian), Guadalupe Mountains, New Mexico

Fall-in beds are shelf carbonate rocks which exist adjacent to the Capitan Limestone in a belt about 1 km wide, and which have basinward dips of 5 to 15°. Sedimentologic and structural-geopetal data gathered in field studies of the lower Seven Rivers Formation in North McKittrick Canyon show that tectonic tilting and/or compactional subsidence can account for only part of the basinward dip of fall-in beds, the remainder being primary depositional dip.

The dominant lithologies of fall-in beds are stromatolitic algal oncolite rudites and sand-sized, mixed skeletal-peloid grainstones. Rocks are tightly cemented with marine phreatic isopachous fibrous magnesium calcite. Fall-in beds lack features of the adjacent, shallower, but generally submerged shelf-crest facies such as fenestral fabric, pisolites, tepees, erosion surfaces, and shoaling cycles. An inferred energetic, subtidal marine depositional environment for fall-in beds is compatible with their significant basinward depositional dip.

Primary geopetal fabrics, although scarce in fall-in beds, have dips not exceeding a few degrees. The dip divergence between bedding planes and geopetal surfaces averages $8 \pm 2°$, a value which is inferred to be equal to the original depositional dip.

Proof of primary seaward dip in fall-in beds lends support to Dunham's marginal-mound hypothesis for the Capitan shelf. Also, primary dip in beds adjacent to the Capitan supports recent interpretations that the Capitan Limestone formed in a relatively deep (30 to 50 m), continually submerged shelf-edge position, and was not a true barrier reef.

ILLICH, H. A., F. R. HANEY, and T. J. JACKSON, Sunmark Exploration Co., Richardson, Tex., and M. MENDOZA, Yacimientos Petroliferos Fiscales Bolivianos, Santa Cruz, Bolivia

Geochemistry of Oils from Santa Cruz Basin, Bolivia—Case Study of Migration-Fractionation

Oils from the Santa Cruz basin, southeastern Bolivia, probably were derived from a common source. These oils, however, are in reservoirs of different ages (Tertiary to Devonian) and have a wide range in gravity (45 to 65° API). The highest gravity oils typically are in Tertiary units. Geochemical analyses show systematic compositional trends in the C^5 to C^{10} molecular weight range of these oils. Isoparaffins and cycloparaffins tend to increase in relative abundance, whereas normal paraffins and aromatics tend to decrease with increasing gravity.

It is proposed that these compositional trends result from fractionation during migration by accommodation in water. This origin requires that normal paraffins essentially be excluded at the onset of the migration event while aromatics are "swept" through the reservoir site. The enhanced isoparaffin and cycloparaffin content of the most fractionated oils is attributed to their intermediate solubilities. Exsolution of these hydrocarbons is attributed to solubility reduction caused by temperature and pressure decreases and the probable presence of a gas cap. Processes such as thermal fractionation and biodegradation fail to account satisfactorily for observed compositional trends of these oils.

The wide range in reservoir ages and gravities of the oils in the Santa Cruz basin, coupled with the likelihood that the oils were derived from a single source, provide a natural laboratory in which the chemical effects of migration-fractionation can be studied.

ILLICH, H. A., F. R. HANEY, and T. J. JACKSON, Sunmark Exploration Co., Richardson, Tex.

Oil Geochemistry As Exploration Tool

Oils represent a final product of physical and chemical processes within a basin. As such, they contain compositional attributes that can be utilized to describe the conditions through which they evolved. Data obtained from high-resolution gas-liquid chromatographic and mass-spectrometric analyses of whole oils substantially reduce exploration risk by providing information concerning fluid characteristics. Some of the information that can be deduced from the analysis of oils is: the number of sources, alteration during migration or after accumulation, and mixing of oils derived from one or more sources. Oil geochemistry assists in evaluating the probable numbers of potential reservoir zones, the possibility of encountering "cross-stratigraphically" migrated oils, and the probable value of potentially exploitable reservoirs.

The effective use of oil geochemistry depends on the availability of accurate and precise analytic data. Some significant applications involve whole-oil, gas-liquid chromatography, distribution of sulfur-bearing organics, distillation curves, and mass-spectral data. The efficient treatment of data obtained from oil analyses is central to the problem of producing a succinct interpretive statement meaningful to management. Data reduction and manipulation techniques are also important.

The occurrence of oils within a region is the ultimate demonstration of the presence of source beds and the dynamics of migration and accumulation. Oils should be exploited to obtain a view of the potential of a region because, in nonfrontier areas, samples are often available before major exploration commitments are required.

INDEN, RICHARD F., and HENRY KOEHN, Superior Oil Research Lab., Houston, Tex.

Dolomitization of Offshore Carbonate Deposits in Hammett Shale, Lower Cretaceous, Texas

The Hammett Shale (Lower Cretaceous) represents the offshore marine equivalent of overlying carbonate beach (Cow Creek Limestone) and alluvial (Hensel Sandstone) deposits of Aptian age which prograded shelfward off the southeast margin of the Llano uplift in central Texas. Interbedded and intermixed dolomites and limestones compose most of the upper part of the Hammett Shale and, within this section, dolomites decrease in abundance upward. Dolomites are primarily echinoid-oyster wackestones with clay-rich, medium crystalline dolospar matrix. Limestones are mollusk packstones-wackestones with clay-poor microspar and pseudospar matrix. The dolomites were most likely deposited on a grass or algally stabilized seafloor, whereas the limestones represent units deposited in higher energy environments.

Dolomitization probably took place during shallow burial as the beach sequence prograded eastward, and the regional, fresh-groundwater flow system invaded the marine sediments. Carbonate packstones resisted dolomitization because of original differences in mineralogic composition, and because they were semilithified. They were fractured prior to dolomitization, and have sharp contacts with dolomite. Carbonate wackestones underwent dolomitization because they initially contained more magnesium (high-magnesian calcite, mixed-layer illites, and chlorite), and fine detrital dolomite which acted as seed crystals. Dolomites often display flow-aligned bioclasts parallel with their contacts with limestones, indicating that they were somewhat fluid at the time of limestone lithification, thus allowing the dolomitizing waters to pass through more effectively. Although the marine interstitial water, the fresh water draining Llano uplift Paleozoic dolomites, and the hydrodynamics of the zone of water-mixing provided the means of dolomitization, original sedimentologic differences were a key factor as well.

INGERSON, EARL, and S. VALASTRO, JR., Univ. Texas, Austin, Tex.

Geochemistry of South Texas Uranium Deposits

During the past several years attempts have been made to unravel the geochemistry of south Texas uranium deposits by analyzing core samples obtained from several localities within the mineralized province and from various prospective mines.

The core samples were taken from three different sections of the geochemical cell—the oxidation, ore, and protore zones. All samples selected for analysis belong to the same stratigraphic interval as the ore zone.

Measurements of pH and Eh taken in the field range as follows: oxidation zone, pH 7.2 to 5.6 and Eh −60 mv to +50 mv; ore zone, pH 4.1 to 3.6 and Eh +210 mv to +155 mv; protore zone, pH 2.6 to 4.2 and Eh +210 mv to +180 mv.

Analyses of total organic carbon, pyritic sulfur, and uranium have also been conducted. The total organic