from a depth of 13,900 ft (4,237 m). CDP seismic data were acquired and, after considerable experimentation in processing with orientation to the appropriate geologic model, showed that the key well was on the flank of what is now called the Strachan reef. In 1968, Banff and Aquitaine drilled a full reef buildup of 900 ft (27 m) in Lsd. 10-31-37-9 W5M with a pay section of 540 ft (165 m). A separate pool, the Ricinus reef, was discovered in 1969 by Banff and Aquitaine in Lsd. 6-25-36-10-W5M. The well showed a reef buildup of 800 ft (245 m) and a maximum pay of 690 ft (210 m). Remaining reserves of marketable natural gas at Strachan and Ricinus, after 6 years of production, are approximately 1 Tcf.

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Uranium Deposits of Texas Gulf Coastal Plain—Trend, Exploration, and Production

Uranium in the Texas Gulf coastal plain occurs primarily in two types of deposits: (1) in sandstone-type deposits of Goliad, Oakville, Catahoula, Frio, and upper Jackson, and (2) in Tertiary Wilcox, Yegua-Jackson, and upper Jackson lignite. Total potential resources of uranium in the coastal plain have been estimated to be about 0.25 million tons, ranking third in the United States.

Analyses of several thousand samples from the coastal plain show the following results.

1. In the sandstone-type deposits, uranium is both roll type and nonroll type. Most uranium concentrates are in reduced ores. Uranium is closely associated with (a) lignite or disseminated organic matter, (b) clays, particularly smectite, (c) zeolites, particularly with clinoptilolite, and (d) carbonate rocks and calcite. Uranium minerals present are uraninite, coffinite, carnotite. Adsorption of uranium by clays is largely dependent on pH.

2. In lignite, the concentration of uranium decreases with geologic age. Uranium is generally concentrated at the contacts of lignite seams with sandstones or shales rather than in the middle of the seam.

Recovery of uranium has been either by surface or in-situ mining. However, development of in-situ leaching has gained new impetus because of the unique situation of south Texas uranium deposits. Results of laboratory tests show that hydrochloric acid is the most effective solvent to recover uranium from either oxidized or reduced sandstone-type ore deposits, and from lignite without the addition of oxidant (e.g., H_2O_2).

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Twenty Years of United States Petroleum Estimates

In 1956, after 96 years of petroleum exploration and production, the United States had produced 52.4 billion bbl of crude oil. Industry opinion and all available evidence were in agreement that the ultimate amount of crude oil to be produced in the lower 48 states would probably fall between 150 and 200 billion bbl, with future production from two to three times that of the past. The high estimate for natural gas was about 850 Tcf. At that time, the writer showed that if the ultimate crude oil production should be between 150 and 200 billion bbl, and if the ultimate amount of natural gas to be produced should be about 850 Tcf, the peak of crude oil production should occur during the period 1966 to 1971, and the peak of natural gas production at about 1970.

That was the end of consistency in the estimates of the ultimate amounts of crude oil and natural gas to be produced in the United States. During the next 5 years petroleum-industry estimates escalated to 400 billion bbl for crude oil and about 1,500 Tcf for natural gas, while estimates by the U.S. Geological Survey reached 590 billion bbl for crude oil and 2,630 Tcf for natural gas. Furthermore, these higher estimates persisted until well into the 1970 decade.

In the meantime, successive estimates by the writer, based on analyses of publicly available petroleum-industry data, led consistently to about 165 to 175 billion bbl as the ultimate amount of crude oil, and 1,000 to 1,100 Tcf for natural gas, with the crude oil production peak due to occur during 1967-70, and that of natural gas in the mid-1970s. These estimates were predictions of the future, and that future has now elapsed. The peak of crude oil production was reached in 1970 and that of natural gas in 1973. By the end of 1972, the evidence was consistent with 170 billion bbl for the ultimate amount of crude oil and 1,000 to 1,100 Tcf for natural gas. However, since 1972 proved reserves and discovery and production rates of both oil and gas have been declining more rapidly than originally estimated. Should this continue, the ultimate quantities of oil and gas may be less than those estimated in 1972.

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Discovery and Development of Badak Field, East Kalimantan, Indonesia

The Badak field is located on the east coast of the Island of Kalimantan (Borneo), Indonesia, about 35 km south of the equator. The Badak 1 discovery well was spudded November 27, 1971, and completed on February 11, 1972. The well penetrated more than 900 ft (274 m) of net gas sand and about 300 ft (91.5 m) of oil sand.

Drilling of Badak 1 was preceded by an intensive exploration program, which started in December 1968 and which included aerial photographic and magnetic surveys, geologic field work, and reflection and refraction seismic surveys.

Geologically, the Badak field is a part of the Mahakam delta, a 6,000-m thick wedge of upper Tertiary clastic sediments, laid down in the major Kutai basin.

Badak reservoirs are coarse to very fine-grained quartz sandstones with an average porosity of 22% and average permeability of 200 md. The individual sand bodies are either channel-mouth or finger-bar sands deposited in a deltaic environment.

Structurally, Badak is one of several culminations formed on a long (60 km) north-trending structural axis, which also connects the Nilam and Handil fields on the south. The Badak culmination is a gentle anticlinal uplift with no known faults.

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.

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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.

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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.

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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.

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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 (Ter-