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Development and Use of Formation-Tops File System

Over a period of 14 years, a formation-tops file has been developed to the present on-line interactive system which contains information on over 90,000 wells. The file is useful to explorationists and critical feedback from users has influenced evolution of the system.

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Study of Fossil Microbial Borings—New Approach

Resin casting of recent microbial borings with simultaneous embedding of the resident microorganisms was introduced in 1970. Scanning electron microscopy (SEM) of the cast permitted a three-dimensional perception and thus, detailed characterization of borehole morphologies. It also demonstrated the complexity, diversity, and biological specificity of boring patterns. Combined with light microscopy of sectioned, double-embedded resin preparations, SEM images have been identified in terms of their specific microbial origins. These studies constitute a solid basis from which to approach and understand the ancient endoliths.

A new technique for preparation of fossil microborings introduced in 1978 permits SEM resolution of a quality that had not been achieved previously. This technique permits a direct comparison of fossil to recent microborings. The new approach has been applied to Pliocene microborings in oyster shells, Upper Cretaceous borings in belemnite rostra, organically preserved Upper Silurian endolithic rhodophytes, and microborings in Ordovician brachiopod shells. Thus it opens 600 m.y. of microbial endolithic activity to detailed study and interpretation. Examples of microbial borings throughout the fossil record retain a structural fidelity comparable on a submicron level with recent microborings.

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Preliminary Analyses of Brines from Permian Basin of West Texas

Samples of 18 oil field brines were collected from producing wells of Gulf Oil Corp. Most of the wells were small producers not under flood. One was a water well in the Capitan reef. Two of the samples were condensates from deep gas wells. Producing formations range in age from the Permian Capitan to Ordovician Ellenburger Formations at depths of 1,900 to over 17,000 ft (570 to 5,100 m). Geologic environments represented by the host rocks include shelf and reef dolomites, backreef sandstones of the Central Basin platform, and sandstones from the Delaware basin. Older rocks represent shelf limestones and dolomites, and reef dolomites.

Certain chemical properties were determined in the field. Other major and minor constituents were determined in the laboratory. The chemical data are considered preliminary because analyses were not made for certain constituents.

Most of the waters have total dissolved solids of 100,000 ppm or over. The Permian brines are substantially more saline than waters from Gulf Coast Tertiary reservoirs of comparable depths. The brines are in general sodium-calcium chloride waters, with a substantial sulfate content in some samples. Basinal facies rocks produce brines enriched in chlorine, whereas concentrated brines from shelf-facies rocks are lower in chlorine than normal evaporite-depositing brines.

Diagrams show the degrees of variability among samples, and statistical correlations have been attempted. High iodine concentrations appear to be confined to the Delaware basin. All chlorine to bromine ratios are less than 300, which probably indicates brinewater solution of preexisting marine evaporites. Certain samples are anomalously enriched in calcium, sulfate, strontium, and bromine, and in some potassium is notably depleted.

Copper content of most samples was less than 1.0 ppm. Such low values are in agreement with brine compositions from other basins. Lead content ranges from 0 to 2.25 ppm, and zinc from 0.55 to 6.12 ppm. These numbers fall within observed values for other basins. The persistent occurrence of zinc in the brines suggests that favorable rocks in the Permian basin may have been mineralized. Slightly higher zinc-bearing waters appear to come from the Delaware basin or at the shelf edge.

The geochemistry of oil field brines may be used to: (1) identify overpressured zones, (2) correlate lithologic units, (3) locate depositional facies favorable for petroleum generation, (4) estimate subsurface temperatures from silicon analysis, and (5) locate geologic provinces favorable for concentration of lead and zinc as well as barite and associated nonmetallic minerals.

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Pleistocene Meteoric-Vadose Diagenesis of Enewetak Atoll

Six cores from the northeast reef of Enewetak Atoll reveal that 25 to 50 ft (7.5 to 15 m) of Holocene deposits unconformably overlie at least 200 ft (60 m) of Pleistocene limestone. The Holocene-Pleistocene boundary and four other unconformities within the Pleistocene section are distinguished by paleosols. The unconformities record repeated periods of subaerial emergence and death of the Pleistocene reef associated with low sea-level stands. During emergent periods, meteoric-water diagenesis altered the Pleistocene section. The resulting mineralogy and diagenetic textures are characteristic of the meteoric-vadose diagenetic environment. Aragonite generally composes from 30 to 70% by weight of the Pleistocene limestone and is absent only locally; magnesium calcite is not present. Cementation by calcite is variable but generally increases with depth. Much of the section is poorly cemented and retains high primary and secondary porosity. Micrite and mixed micrite-microspar are the most abundant cements throughout the section. They occur as meniscus, uneven-style, and irregularly distributed ("patchy") pore-fill cement. In the

upper parts of depositional units, paleosol-associated cements are common; caliche crusts, rhizocretions, needle-fiber cement, and lath-crystal cement are present. Phreatic-type cements are present, but generally are unimportant volumetrically. A reconstruction of the Pleistocene paleohydrology of the atoll indicates that the section has occupied the meteoric-vadose environment during emergent periods. The similarity of Pleistocene limestones beneath Enewetak and other Pacific atolls studied by drilling suggests that, for many atolls, most alteration of shallow subsurface Pleistocene limestones has occurred in the meteoric-vadose diagenetic environment.

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Analysis of Hydrocarbon Distribution and Finding Rates Throughout United States Sedimentary Basins

These are interim results of a comprehensive long-range study of hydrocarbon distributions in the various sedimentary basins of the United States utilizing the computerized LORENDAS exploration data base. This data base, developed over the last 5 years, includes an exploratory well file, an oil field file, and a gas field file; together, they contain the principal statistical elements of exploration histories, as well as sedimentary volumes by depth zones, for each sedimentary basin in the United States. These data have been used to investigate correlations (1) between exploratory drilling density and observed oil field and gas field size distributions, accounting for depth and geologic setting; and (2) between cumulative exploratory drilling and discovery rates.

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World Oil Resource Assessments and Relation to United States Oil History

Over the last 30 years, there have been about 2 dozen assessments of world oil resources. These may be reduced to about a dozen independent assessments, based on various methods such as historical statistics, geologic analogy, etc. In 1977, there was a major contribution, the Delphi study (27 experts), for the Conservation Commission of the World Energy Conference. A detailed analysis of the answers to the Delphi poll leads to better understanding of the many factors which influence future world oil availability.

The role and relation of the United States are of particular interest. First, most of the assessments have been made by U.S. experts, and a major share of the world geologic expertise belongs to major U.S. companies. Second, because of its maturity, U.S. oil history is most often used as a model for other countries and/or world regions (this was implicitly used in the conclusions of the Delphi results to calculate possible world oil production curves). So, the opinion we have of real long-term oil potential of the United States heavily influences all the assessments regarding world oil resources.

However, it is also interesting to investigate what could be the results of various values of world oil resources on the future U.S. oil situation.

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Current Estimates and Methods of Potential Gas Committee

The Potential Gas Committee is the only group specifically organized for the exclusive purpose of estimating the potential future supply of natural gas in the United States. It is composed of about 120 people—geologists, engineers, and others from industry, government, and academic institutions. They have developed methods, definitions, and guidelines for making the estimates. The genius of the committee is the expertise of its individual members and their access to highly classified information not available elsewhere. No other group—corporate, academic, or governmental—has the experience, insights, and specific knowledge of the geology and future gas potential that this committee possesses collectively.

The potential gas supply is that volume of gas believed to exist in addition to proved reserves—gas not yet discovered by the drill. The Committee's estimates are based on intensive investigations covering the lower 48 states and Alaska. All potentially productive areas and geologic formations are considered. All available geologic data are included in the studies.

The basic technique is the comparison of factors that control known occurrences of gas with factors present in prospective areas. The estimates are divided into three categories—probable, possible, and speculative—which reflect the relative degree of geologic knowledge and exploratory data available.

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Gas Versus Oil in Far East and Middle East

The Far East, including Australia, is largely a gas province (the USSR and China are excluded from our study). The Middle East is largely an oil province with respect to Tertiary and Mesozoic reservoirs, and a gas province with respect to lower Mesozoic and Permian reservoirs. The geologic and geochemical parameters which determine the predominance of gas over oil or oil over gas are well known. They include type of source rock, source rock position in the total sedimentary sequence, burial history, temperature gradients, timing of hydrocarbon generation, and trap formation, retention, and related geologic factors. In the Far East, the relation between coal or coaly matter as source rocks and the occurrence of natural gas is obvious. Australia is a striking example. In the Middle East, the Sargelu formation is one of the most prolific source rocks. It is of Middle to Late Jurassic age, kerogenous and fully marine, which, in combination with other factors, explains the predominance of oil in Tertiary and Mesozoic reservoirs in and around the Arabian Gulf. At deeper stratigraphic levels, huge quantities of gas are ascribed to Paleozoic sources, the nature of which has not yet been fully assessed. Much of this gas, especially in southwest Iran, can be regarded as thermally degraded oil.

In areas of intense Neogene deformation (Tertiary basins of Indonesia and Burma), a large part of the gas phase has probably escaped, whereas the oil phase was largely retained. Many examples illustrate the validity