The Steep Rock group lies unconformably on a granite complex. The basal unit is a conglomerate succeeded by the Dolomite, Orezone and Ashrock formations. Intense deformation is indicated by steep dips, brecciation, shear folds, and numerous faults and dikes, but thermal effects are negligible, and Precambrian limonite and bauxite have remained unaltered.

The Orezone formation has three members. The lowermost of these, the Manganiferous Paint member, is up to 1,000 feet thick, is mainly below ore grade, and represents a residuum derived from the Dolomite formation which it overlies disconformably. The middle, or Goethite, member is up to 300 feet thick, is dominantly goethitic iron ore, but includes minor aluminous and cherty sediments and, in a few places, lenses of ferruginous bauxite. The uppermost, or Pyrite, member occurs sporadically along and near the contact of the Orezone with the overlying Ashrock formation. Microcolloform structures in the pyrite, paucity of trace elements, and association with carbon and banded chert indicate a sedimentary origin for this member.

Valency changes in iron and manganese within the Steep Rock group suggest that deposition spanned a critical period in atmospheric evolution about 2 billion years ago.

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Size and Distribution of Oil and Gas Fields

In any decision concerned with the strategy and tactics of oil and gas exploration, a key variable is the *size* of hydrocarbon deposits in barrels of oil or in MCF of gas. The size of pool or field discovered in a particular wildcat venture determines the degree to which the venture is an economic success. Since the pool or field size that will be discovered is almost always unknown before a prospect is drilled, an important question is: What functional form should be used to characterize the probability distribution of field sizes in a petroleum province? By "functional form" we mean a mathematical formula which defines a family of distribution functions.

Two types of functional forms are particularly adapted to use in this context—the Lognormal and Pareto-Levy—for several reasons: (1) because they give a good empirical fit to histograms of reported field sizes in barrels of oil or MCF of gas; (2) because they are in concordance with some concepts of the origin of mineral deposits; (3) because stochastic models of the discovery process built on reasonable assumptions about the process lead to these functional forms; and (4) because the Lognormal distribution in particular is analytically tractable and rich enough to capture most reasonable oilmen's quantitative judgments about reported field size.

The Lognormal distribution is highly suited for use in analysis of exploration decision problems, for a particular Lognormal density function is fully specified by only two numbers.

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Primary Structures in the Middle Jurassic Great Oölite Series, Southern England

Primary structures observed in the Great Oölite Series include planar, wedge-shape and lenticular cross-stratification, current and interference ripples, micro cross-lamination, dunes, pseudonodules, loadcasts, graded bedding, mudcracks, groove casts, current lineation, prod marks, and bounce casts. These structures are grouped into two environmental and petrographic combinations.

High-energy, channelled, shelly-oölitic limestones (grainstones) are characterized by vertical sequences consisting of a basal zone of imbricated shell fragments, a middle zone of thick sets of planar and lenticular cross-stratification, and an upper zone of interference and current ripples and wavy beds. The cross-strata show two dip directional maxima which are 180° apart, possess a high dip angle (26° average) and contain thin (1–1.5 in.) graded beds. These graded cross-strata consist of a shell chip zone which grades upward into coarse-grained oölite and fine-grained oölite. The shelly base of such a graded bed thickens and increases in particle size downslope. The oölites were deposited by normal flow in a lower flow regime, whereas the shell chips were deposited by counter eddies eroding the basal channel shell lag concentrate. The primary structures in the channelled limestone were formed in a lower flow regime operating in intertidal zone channels.

Low-energy, even-bedded, oölitic clayey limestone (packestone and wackestone) are characterized by thick (1–5 ft.) graded beds, load casts and cross-stratified grainstone lenses. These cross-strata are low angle (average dip is 18°) and are current lineated if the limestone contains 15–25% quartz sand. The graded beds grade upward from coarse-grained oölite to clay-size carbonate particles. The top of each graded bed is bored and plastered with oyster shells in life position. These graded beds were formed by periodic sea-level oscillations which transgressed subtidal deposits across low and then high tidal flats. The cross-stratified grainstone lenses represent a beach or barrier bar marginal to the intertidal zone.

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Petrology of the Simsboro Formation (Eocene) of Northeast Central Texas*

The lower Eocene Simsboro formation of the Wilcox group, between the Trinity and Brazos Rivers, Texas, was deposited as a braided stream-floodplain complex. It consists of: (a) very fine-grained to medium-grained sand: immature, clay pellet-bearing subgraywacke bordering on an orthoquartzite; (2) illitic-kaolinitic, silty clay; (3) fine sandstone: siliceous, bimodally mature orthoquartzite; and (4) kaolinitic, silty clay.

The fine- to medium-grained, kaolinitic, clay pellet-bearing subgraywacke occurs as channel deposits and exhibits pronounced trough or festoon cross-bedding. The round kaolinitic clay pellets are detrital. The matrix consists of particles of kaolinite worn from the clay pellets and pellets mashed by the harder detrital grains. Thinly laminated (5–20 mm.) silty clay, in lenticular beds up to 20 feet thick, is laterally associated with the festoon cross-bedded channel deposits. Angular pebbles, cobbles, and boulders of this clay, derived from the nearby flood-plain, are locally incorporated within these channel sands. Hard, siliceous orthoquarzite, consisting of fine-grained quartz in a matrix of quartz silt, forms a massive ledge 2–20 feet thick throughout the area. The exact relation of the orthoquartzite to the rest of the Simsboro is not known. A persistent bed of thinly (1 mm.) laminated, white, kaolinitic, silty clay 20 feet thick occurs at the top of the formation.

Orthoclase and microcline grains severely weathered

* Publication authorized by the director of the Bureau of Economic Geology, The University of Texas, Austin.

to kaolinite and books of authigenic kaolin are common in the subgraywacke and kaolinitic silty clay. Overgrowths of authigenic quartz are present and act as a cement in the orthoquartzite. Chert is rare in the orthoquartzite but is common in the subgraywacke.

The non-opaque heavy mineral suite consists of tourmaline, zircon, and rutile with a smaller amount of kyanite, staurolite, garnet, and euhedral biotite.

The Eocene sediments of the Texas Gulf Coast were derived from multiple sources and the Simsboro is no exception. Quartz types, chert varieties, K-feldspar, phyllitic rock fragments, and heavy minerals indicate that older sedimentary rocks, low-rank metamorphic rocks, granitic or gneissic rocks, and volcanic ejecta furnished detritus for the Simsboro.

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THE COMPUTER IN GEOLOGY: THE STATE OF THE ART

The past several years have seen a marked expansion in computer applications in geology. Universities, governmental agencies, the oil industry, and the mining industry all share in this activity. Although much work is still research-oriented, increasing effort is being made to extend computer facilities to exploration for oil, gas, and ore. Five aspects of computer utilization are woven through this activity; these are data acquisition, data storage and retrieval, data processing, presentation of results, and use of decision functions as an aid to interpretation.

Data acquisition is represented by new instrumental ways of obtaining data automatically, including remote sensing devices. Storage and retrieval are perhaps best known in the oil industry's activity in developing well-information systems, although much interest also centers on machine handling of scientific bibliographies. Data processing is the most active aspect of machine use, with new computer programs being developed for statistical processing of data, systems analysis, linear programming, and various applications of operations research. Spectacular developments in presentation of map data automatically, and in machine analysis of maps for trends (regionals and residuals), have occurred in the past few years. Development of decision functions (related closely to operations research) is evident, though perhaps less publicized than other aspects of computer utilization.

A major problem in this rapid expansion of computer use is the development of channels for publishing or exchanging computer programs. A center for earth science programs, tentatively called GEOCOMP, is being looked into. This center, whether located in a university, a research organization, or a governmental agency, could issue copies of programs, newsletters on current activities, and perhaps act as a training center for college teachers and geologists in industry. There is no doubt that computer activity in geology, which only a few years ago seemed still to be beyond the horizon, is now actively growing in our midst. Such rapid expansion calls for sound judgment in computer use, inasmuch as indiscriminate applications can produce very large mistakes very rapidly.

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SEDIMENTARY STRUCTURES AND PALEOCURRENTS IN THE LOWER NEW RED SANDSTONE, DEVONSHIRE, ENGLAND

Permo-Triassic redbeds, consisting of mainly breccias and sandstones exceeding 6,000 feet in thickness, are well exposed in coastal cliffs in South Devonshire. They are disposed in semi-circular or elongate basins or cuvettes, margined by ridges of metamorphic rocks which supplied the bulk of the detritus.

The breccias show typical torrential bedding features. Low-angle cross-bedding units, festooned perpendicular to the direction of derivation, are interwoven with generally flat but lenticular beds of breccia and sandstone. Shallow channeling is common, deeper where sandstone is predominant. Mapping of pebble imbrication shows a basically centripetal transportation pattern in the cuvettes, consistent with derivations indicated by cross-bedding, channeling, and fragment composition. Roundness measurements of limestone fragments in the same rocks reveal sub-circular roundness contours increasing in value towards the cuvette centres, and approximately perpendicular to imbrication directions. All features indicate deposition on sub-montane alluvial fans in a semi-arid climate, with converging directions of sediment transport in semi-confined cuvettes.

Sandstones in the upper part of the sequence show clear eolian cross-bedding, with wedge-shaped units and some festoon cross-beds. Attitude measurement indicates deposition by a uni-directional wind from the SSW. Interbedded breccias show truncation and channeling of dune surfaces.

Quicksand injection structures occur in fine-grained silty breccias interbedded with sandstones (distal fan deposits). A saturated sand layer, sealed under an impermeable silty breccia, was mobilized and injected upward through desiccation cracks or other weak spots, forming sand dikes with elongate particles aligned parallel with the walls. Sun-cracked silt layers may show strongly upturned edges on desiccation polygons due to injection (extrusion) of quicksand, which may also be fragmented and dislocated.

Annelid burrows occur in some basal breccias, mostly fine-grained. Where elongate fragments constitute the breccia, the burrow filling shows a distinct internal fabric or "meniscus" particle arrangement. Commonly up to one inch in diameter with circular cross section, in coarser breccias they are ovoid and up to 7 inches wide. These large burrows branch, ascend through strata, and avoid large fragments; together with the consistent meniscus fabric, these features indicate organic origin.

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DEVONIAN PALEOECOLOGY OF NORTHEASTERN ALBERTA

Shallow, epicontinental seas of Middle and Upper Devonian time in Alberta contained abundant microfauna and megafauna which can be used to interpret the environment at the time of deposition. Enough variation exists to differentiate supralittoral, littoral, sublittoral, arid lagoonal, humid lagoonal, and epineritic environments. A series of paleoecological maps for the Middle and Upper Devonian in northeastern Alberta illustrates the detailed paleogeographic history. The transitional boundary between the Givetian and Frasnian stages is explored and a contact postulated that is considerably higher stratigraphically than previously indicated. This paleoecological approach should be equally applicable to similar problems in any area and for almost any geological period.

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