of a minute amount of hydrocarbons to the surface should produce an abnormal content of hydrocarbons in soils, and therefore forecast the location of an oil or gas reservoir underneath.

Several major inconveniences, however, make the hypothesis very difficult to apply, mainly, (1) the exact process of migration is not fully understood, (2) "geochemical noises" due to contamination, hydrocarbons being formed in the soils, *etc.*, are superimposed on migrating hydrocarbons, and (3) different soil lithologies have different powers of retention of hydrocarbons and, conversely, a different aptitude to release the hydrocarbons retained.

Gasmap introduces a method which, although following the basic theory, attempts to eliminate, solve, or bypass the problems, *i.e.*, it attempts to cope with each of the known "geochemical noises." The solution attempted in Gasmap proposes a method in which sampling and desorption of the sample are done under a definite number of principles. Its originality, however, lies basically in the method of interpretation of the results. Samples are listed according to their depths, lithology, chemical markers, and hydrocarbon contents. Through use of a computer, a statistical analysis of the Gaussian type is done and a mean value and a dispersion are derived. Samples are classified in homogeneous sets and anomalous samples are derived according to a probability threshold. Results are plotted on maps for each hydrocarbon. A composite map is produced and anomalies are classified according to their chemical composition and degree of anomaly.

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Using Computerized Well-Data System

Two key ingredients are required for exploitation of geologic data bases and computers: the ability of the questioner and the quality of the library. The necessity of using a file containing reliable information is well known. However, the quality of the questions is the key to useful exploitation of this powerful tool.

The successful retrieval always consists of 3 segments—studying the geology to identify what data and maps are meaningful, retrieving the necessary data, and analyzing the results. A study was performed in the Windfall area of west-central Alberta. Three units were searched—Leduc (Upper Devonian) reefs, the Belloy (Permian) subcrop, and the upper 30 ft of the Mannville (Lower Cretaceous). A part of the retrieved area was machine mapped using only the Leduc data. A residual of a Cretaceous marker ranging 4,000–7,000 ft shallower than the reefs illustrates a pronounced drape effect over known Leduc reefs. By removing the vast amount of repetitious file pulling, correlating, and subtracting, and by allowing data to be manipulated in ways not otherwise possible, the explorationist can do what he was educated and hired to do—interpret.

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Well-Data Files and Computer—Exploration Tools for the 70s

Since the development of well-data files for computer-processing began in 1963, more than 600,000 wells have been included in systems covering most of the United States and Canada. These systems contain information on ownership, location, well classification and status, drilling and completion activities, tests, depths to formation tops, core descriptions, shows, and other data. Data are obtained from the most reliable and complete source for each area and are upgraded by computer editing and the feedback of missing data and corrections from file users.

Well-data files are used at various stages of the exploration process for basin evaluation, for selection of prospective stratigraphic intervals and areas for further study, and for building peripheral files containing proprietary, technical, and economic data. A study of the Muddy Sandstone in the Powder River basin illustrates an exploration application of computer processing of a large well-data file. Prior to the discovery of Bell Creek, data from the file revealed areas in Wyoming and southeasternmost Montana with abundant hydrocarbon shows in the Muddy Sandstone. North and South Dakota and the rest of Montana had no oil shows in the Muddy Sandstone. In the area of abundant shows, geologic maps based on formation tops obtained from the file indicated trends on which subsequent drilling has discovered more than 250 million bbl of reserves. East and West Sandbar, Ute, and Whitetail fields are related to deposition around a pre-Muddy positive feature defined by Skull Creek structure and Muddy isopach residual maps. Recluse and Odekoven fields are related to a channel defined on a Muddy isopach residual map. No commercial production has been found to date in the "no show" area.

At the time of discovery of Recluse and Bell Creek, information was available within the Rocky Mountain Well History Control System to suggest areas favorable for similar types of production from the Muddy. With addition of new well control and proprietary information, the well-data file can aid in the planning of development drilling, analysis of completion practices, and reservoir evaluation. Large data files and proper application of the computer to these data will become increasingly important in the discovery of oil and gas during the 70s.

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Eolian Sand Sheets of Peruvian Coastal Desert

Gemini color photographs of the Peruvian coast reveal fan-shaped patterns of eolian sand sheets emanating from small bays and extending inland 20–40 km. The sand sheets are spaced at regular intervals, and each comprises a distinct sand-distribution system with recognizable components. A 1968 field program investigated form-process relations between sand sheets and the sea-breeze phenomenon.

Most sheets are supplied by marine sand transported from source areas by along-shore currents, deposited on beaches, and blown inland in high-velocity sea-breeze zones. The winds, and consequently the transported sand, are directed and twisted by hills and valleys and in places execute turns of 120°. Locally, sands reach elevations of 2,000 m, forming giant sieflike dunes that "climb" over hilltops. In some places, sands spiral inland toward nuclear areas. Spiral centers coincide with centers of sea-breeze convection cells and form terminal points of sand transport. There dunes reach maximum development.

High-velocity sea-breeze zones are separated by lower velocity zones. In low-velocity zones, dust mantles hills, and eolian sand movement is absent. In some high-velocity zones, marine sand is not available for transport. There bedrock sand and dust, largely a product of intensive marine-desert chemical weathering, are wind transported, resulting in either sand sheets or deflation areas.

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Transition from Fluviatile to Marine Sediments in Coomhola Group (Upper Devonian-Lower Carboniferous) of West Cork, Ireland

At the head of Bantry Bay, southwest Ireland, the conformable transition between the nonmarine Old Red Sandstone facies and the marine Carboniferous clastic sequence occurs in the Coomhola Group. Within its 4 formations, 4 important partly repetitive facies are distinguished: (1) cyclic facies that become finer toward the top, interpreted to be stream deposits; (2) fine facies of rippled siltstone and mudstone, either separate or complexly interleaved, considered to be alluvial flood plain or interdistributary deposits; (3) burrowed facies, having variable proportions of wave-rippled siltstone interlaminated with mudstone, usually burrowed, thought to represent interdistributary bay deposits; and (4) parallel-bedded sandstone facies of parallel or cross-bedded sandstone units, in places having scoured surfaces, interpreted to be submarine-bar deposits.

The basal Yellow Rocks Formation (450 m) consists of the cyclic facies variably interleaved with the fine facies, its base being the highest redbed. Paleocurrents indicate a northerly provenance, and the general environment is interpreted to be an alluvial plain. In contrast, the lowest part (40 m) of the overlying Ardaturrish Formation consists of the fine facies and the burrowed facies in equal proportions. The latter is interleaved with the cyclic facies in the upper part (560 m). This facies association indicates a transgression over the alluvial plain, the environment changing to a coastal plain and then to an interdistributary area partly affected by south-flowing distributaries. The cyclic facies persists into the overlying Reenagough Formation (160 m) before giving way to the parallel-bedded sandstone facies indicative of an offshore bar deposit. The burrowed facies then dominates, and within the overlying Ardnamanagh Formation (80 m) shows cycles that become coarser at the top, suggestive of an advancing shoreline, before being succeeded by fine-grained marine sediments (Tournaisian). This facies sequence implies a deltaic advance before the marine transgression was established.

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Deposit Feeders Limit Development of Stromatolites

Filamentous sediment-binding blue-green algae, principally *Scizothrix*, are present throughout the tide flats of the west coast of Andros Island, Bahamas, from storm-tide levels to below low tide, a range in excess of 3 m. However, extensive flat-laminated stromatolitic deposits are restricted to about ½ m in the upper intertidal and supratidal zones. A similar restriction is known from other areas, notably Florida Bay and the Persian Gulf.

Two small gastropods which feed on algae-coated surface-sediment particles are the principal cause of this restriction, but deposit-feeding polychaetes are also responsible. The gastropods, *Cerithidea costata* and *Batillaria minima*, in concentrations of 500–2,000/sq m, intermittently are exposed on the margins of shallow subtidal ponds. When flooded they feed so voraciously that about 100 fecal pellets are excreted per individual per hour. On the basis of the size of pellets (0.026 mm^3), rate of feeding (almost equivalent to the rate of excretion), number of individuals (1,000/sq m), and the percentage of time spent feeding (50%), I calculate that the topmost millimeter of sediment is reworked over the entire surface in 1 month.

If the gastropods and other deposit feeders were absent from Bahamian environments, the vertical range of stromatolitic deposits could be extended there from ½ m to several meters. Restriction or absence of deposit feeders could be caused by extreme salinity or temperature in other Holocene or Phanerozoic environments. Complete absence of deposit feeders in Precambrian time should have allowed stromatolites to develop to their maximum vertical range.

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Silurian Reef in Michigan Basin—Stratigraphic-, Facial-, and Reservoir-Properties Analysis

The Belle River Mills gas field (China Twp., St. Clair Co.), discovered in 1961 and since 1965 utilized as an underground gas-storage reservoir, is one of 42 known reefs of Niagaran (Middle Silurian) age in southeastern Michigan, 36 of which are oil or gas producers. The reef is an elongate pinnacle structure, about 2 mi long and 0.75 mi wide. It attains a maximum relief of 420 ft with slopes ranging from 10 to 30°.

Three major growth phases are recognized: (1) biohermal, consisting of skeletal (crinoid, bryozoan, coral, and tabular stromatoporoid) wackestone and packstone rudites and arenites; (2) organic reef, consisting of a reef core (massive stromatoporoids, corals, and algae?) and associated interbedded and interfingering lithofacies of "backreef" skeletal wackestone rudite, burrowed mudstone and laminite, and coarse skeletal forereef talus; and (3) supratidal cover complex, composed of stratified algal stromatolites, flat pebble conglomerates, oncolites, and burrowed pelletal mud.

The mound developed to a height of 150 ft in quiet, relatively deep water. The reef grew in turbulent water, attaining a height of 300 ft above the surrounding sea floor. Reef growth stopped as a result of shallowing and increased salinity, which led to the deposition of the supratidal complex.

A conglomerate composed of algal stromatolite pebbles and boulders derived from the supratidal complex phase is present 400 ft below the reef crest at the base of the offreef Salina Group. It is covered by the A-1 anhydrite (15 ft) and the A-1 carbonate (120 ft) which both wedge out toward the reef walls.

The A-1 carbonate is finely laminated, finely crystalline dolomite devoid of fossils, in places pelletal with algal mats, birdseye, and desiccation features and having an abundance of various textural forms of anhydrite. It is indicative of a very shallow-marine, partly supratidal environment. The conglomerate and the environmental interpretation of the A-1 carbonate demonstrate that the offreef sequence is post-reef in age and that the reef was subaerially exposed during the deposition of the overlying units. Dolomitization and diagenetic processes of leaching and reprecipitation as-