and anhydrite in certain cases has accentuated and improved pore structure.

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GEOLOGY REACHES COMPUTER AGE

That geology, at least in some areas, has reached the computer age is evidenced in the symposium we are holding at this time. The five symposium papers describe a variety of today's computer applications in geology and exploration. This paper attempts to provide a background of computer information as a framework for the other papers.

In this symposium we are using the word "computer" in its broadest sense to include the actual general-purpose electronic digital computer, its associated data processing equipment such as key punches, sorters, tabulators, and reproducers, and also specialized data-gathering input and graphical output equipment. Actually we are considering whole "systems." Much of geological work may be done on associated machines other than the actual computer.

The electronic computer itself is the core of any system; it is one of the most dramatic and significant developments of our time. Capable of performing arithmetical and logical operations at extremely high speeds and of storing vast quantities of data, the computer provides geologists with opportunities to solve problems unapproachable a decade ago.

It is estimated that there are 10,000 digital computers installed and in use today. Oil companies are well equipped and, in most cases, their computers are available for exploration work. Service bureaus and consultants provide computers and programming help for use of smaller companies and individuals. No geologist is very far from a computer today. These devices are easy to use and should present no learning problems greater than the use of any new exploration technique or equipment.

The computer is not a magic black box; it is thoroughly understandable. We may consider it simply an extension of part of the human mind just as we consider the geology hammer an extension of the hand, the microscope an extension of the eye and the seismograph an extension of the ear. Fear or resentment of the computer decreases as familiarity increases.

There have been raised in some quarters, however, real moral issues involving the dehumanizing effect of computers. These have been in particular reference to military work and should not be of concern in geology.

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FUSULINID ASSEMBLAGES FROM LATE PENNSYLVANIAN AND EARLY PERMIAN OF SOUTHEASTERN ARIZONA

The varied fusulinid faunas of the late Pennsylvanian (Virgilian) and early Permian (Wolfcampian) parts of the Naco Group and the Earp Formation can be divided into five assemblage zones. The lowest zone is characterized by *Triticites cullomensis* and occurs in early Virgilian strata disconformably overlying middle Desmoinesian beds. This early Virgilian sequence is overlain by a zone of middle to late Virgilian fusulinids, *Triticites ventricosus sacramentoensis* and *T.* cf. *T. plummeri*, that occurs in the uppermost beds of the Horquilla Limestone and ranges into the lower 20–235 feet of the Earp Formation. From the fusulinid distribution and the transitional lithologic features it appears that the top of the Horquilla Limestone and the base of the Earp intertongue laterally.

The succeeding 540 feet of the Earp Formation contain a fusulinid assemblage of *Triticites* and *Schwagerina* characteristic of the Bursum Formation of New Mexico, the Admire Group of Kansas, and Pueblo Formation of north-central Texas. Of particular interest is the nearly complete transition from *Triticites* into *Schwagerina* in the lower part of the Earp Formation. Overlying these beds are 1,200 feet of limestone and shale having a *Pseudoschwagerina* and *Triticites* assemblage closely similar to that from the Neal Ranch Formation (early Wolfcampian) of the Glass Mountains, Texas. The succeeding 300 feet of limestone beneath the red shale and cross-bedded sandstone at the top of the Earp Formation have *Pseudoschwagerina* and advanced species of *Schwagerina* that bear similarity to the fusulinid fauna from the Lenox Hills Formation (late Wolfcampian), Glass Mountains, Texas.

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IMPORTANT FACTORS FOR MICROPALEONTOLOGIC INVESTIGATION IN PETROLEUM GEOLOGY

Three factors are vital in successful paleontologic investigations in petroleum geology. These are: (1) collection of the fossil groups by paleontologists with knowledge of the total fauna, its ecologic associations, and lithologies in which preservation is best; (2) processing of samples in laboratories closely supervised by paleontologists to insure effective recovery of fossils of each group; (3) accumulation and evaluation of data employing the whole spectrum of fossil and mineral content of the sediment, gathered by geologically and paleontologically trained personnel.

Diagrams and charts are presented showing (a) the fossils commonly used in petroleum geology grouped into surface and subsurface categories; (b) the environmental, lithologic, and bathymetric interrelations that affect the use of important fossil groups in stratigraphy; and finally (c) a procedure is suggested for paleontologic investigation, and reporting of data in petroleum exploration.

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STRATIGRAPHY, PETROGRAPHY, AND PALEOECOLOGY OF BISTI STRATIGRAPHIC TRAP, SAN JUAN BASIN

Bisti field produces from bar sands of the Gallup Sandstone (Upper Cretaceous), which consists of the following units. The non-productive Main Gallup Sandstone is a regressive sandstone that grades downward and laterally into marine Mancos Shale. The Main Gallup Sandstone contains the offshore sand facies and the beach sand facies. Overlying the offshore sand facies are three productive bar sands with a distinctive low SP interval at their base. The bars have flat bases, convex tops, and form a complex more than 30 miles long, 3 miles wide, and 40 feet thick. Seaward (northeastward) the bar sands grade into the fine-grained fore-bar facies. Landward (southwestward) they grade into the back-bar facies. Overlying the entire Gallup Sandstone is the "Upper" Mancos Shale.

The beach sand facies is medium-grained sandstone that lacks glauconite and primary dolomite grains. The offshore sand facies is very fine-grained sandstone with abundant primary dolomite grains. The low SP interval consists of sandy shale. The bar sands consist of subangular to subrounded medium-grained quartz with minor feldspar, chert, and rock fragments. Glauconite pellets are abundant, but primary dolomite grains are rare. Clay, calcite, and quartz are the principal matrix and cement types.

The fore-bar and back-bar facies are similar lithologically, but are differentiated by paleoecology. The fore-bar facies has an open marine fauna of *Inoceramus*, fish-bone fragments (collophane), and calcite-filled planktonic Foraminifera. The back-bar facies lacks the open marine fauna but contains pyrite-filled benthonic Foraminifera, indicating a restricted marine environment caused by the barrier effect of the bars.

Depositional history of Bisti stratigraphic trap began with the regressive Main Gallup Sandstone. This regression was interrupted by a pulse of subsidence, and possibly a minor disconformity, after which sandy mud of the low SP interval was deposited. Wave action winnowed the mud and concentrated the sand as bars, with a restricted marine environment on the landward side and an open marine environment on the seaward side. Basin-wide subsidence caused an abrupt marine transgression which buried the bar complex beneath "Upper" Mancos Shale.

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North-South-Trending Submarine Ridge Composed of Coarse Sand Off False Cape, Virginia

A narrow north-south-trending submarine ridge composed of coarse brown sand lies seaward of False Cape, Virginia. The ridge joins the present coast at the Virginia-North Carolina boundary (36° 33′ N.) and extends northward approximately 8 miles to a point southeast of Little Island Coast Guard Station (36° 40′ N.). The ridge is well defined by the 30-foot depth contour. Depths of 16–20 feet are common along the crest of the ridge; the water deepens to 30 feet or more on both its landward and seaward sides. The bottom sediment consists of fine gray sand in the deeper water landward and seaward of the ridge and also north of it.

The surface of the coarse-grained sand on the ridge consists of symmetrical ripples with wave length of 50 cm. and height of 10 cm.; these ripples were active on a day when the height of the swell was 2–3 feet. The fine-grained sand landward of the ridge showed symmetrical ripples of 10 cm. wave length and 2–4 cm. height under the same swell conditions where the depth was less than 25–30 feet. In water of greater depth, no ripples were present and the bottom consisted of mounds and pits and other organic structures.

The ridge is only one of a series of north-south-trending linear sand bodies that occur both landward and seaward of the modern shoreline. These ridges are tentatively interpreted as ancient coastal dune-beach complex which formed at various Pleistocene stands of the sea but have been truncated by the present shoreline, whose trend is approximately N. 30° W. from Cape Hatteras, North Carolina, to Cape Henry, Virginia. The origin of this change in trend of shoreline orientation is not known at the present time.

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Modern Coastal Swamp Sediments of Southwestern Florida, and Their Usefulness in Recognizing Ancient Coastal Swamp Deposits

Calcareous, quartzose and organic-rich (peaty) sediments accumulating in two modern mangrove estuarine swamps, the Ten Thousand Islands and the Whitewater Bay areas of southwestern Florida, were studied to derive criteria that would aid in recognizing similar ancient coastal swamp deposits. Both areas are at the seaward margin of the Everglades and are associated with an imposing coastal mangrove forest. The sediments forming in these two coastal swamps are modern analogues of ancient limestone, quartzite, and coal beds, and the coastal mangrove forest is the modern counterpart of ancient coal forests of cratonic and miogeosynclinal areas.

Evaluation of results yields three principal criteria which may be useful in distinguishing ancient coastal swamp deposits.

1. Organic matter and carbon/nitrogen ratio: The content of organic matter and the ratio of organic carbon to nitrogen in surface sediments (upper 0.25–0.50 foot) along the southwestern Florida coast increases toward land on the open marine shelf and attain their highest values (organic matter ranging from 6 to more than 50 per cent and C/N ratio ranging from 17 to 37 per cent) within the coastal swamps. The increase in organic matter and C/N ratio in a shoreward direction is due to a progressive increase in the amount of organic matter contributed to surface sediments by terrestrial plants (mangrove trees) compared with that supplied by plankton and benthos. Fossil coastal swamp deposits, therefore, may be recognized by their exceptionally high organic matter content and C/N ratio with respect to laterally adjacent sediments.

2. Faunal assemblages: The areal distribution of molluscan faunal assemblages in the vicinity of the coastal swamps of southwestern Florida suggests that biofacies of ancient coastal swamp deposits would trend parallel with the coastline and delineate a direction of decreasing average water salinity toward the land area supplying run-off waters to the coastal swamps.

3. Grain size of carbonate and detrital minerals: Calcareous particles and detrital quartz along the southwestern Florida coast decrease in grain size from the open marine shelf toward and into the estuarine mangrove swamps. Hence, with support by criteria 1 and 2, fossil coastal swamp sediments may be differentiated by their tendency to be noticeably finer-grained than adjacent sediments.

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Russian Palynology Today: Literature and Application to Exploration

A survey of available literature shows the result of a tremendous Soviet effort in the field of palynology. Russian work in this field was initiated in the early 1930s and began to be summarized in publications at about the time of the 1937 International Geological Congress in Moscow. The work has been extended and expanded many times since then. During the last ten years, palynological publications in Russian have appeared *en masse*. An analysis of available practices in palynology and policies regarding nomenclature and taxonomy in the literature are presented, even though conclusions must be regarded as tentative and personal. Any American viewpoint about the present development of palynology in the U.S.S.R. must be both incomplete and inadequate. However, the literature reflects tremendous effort and a large source of information applicable to general paleontologic, paleogeographic, and paleoecologic problems.