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INTERPRETATION OF UNUSUAL GEOLOGIC FEATURES ON CONTINENTAL SLOPE OFF LOUISIANA

Many complex structural features exist on the continental slope off eastern Louisiana that appear to have no land equivalents. Highly contorted near-surface structures overlie complex patterns of deposition. Salt or shale masses apparently intrude into sediments in horizontal planes as well as vertically. The total assemblage may account for new types of oil fields that may be very prolific.

A technique of analysis called "comprehensive interpretation" is used to illustrate structural anomalies. It involves carrying the entire geologic section in color-coded display of the 10–20 most reliable reflections available.

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SEDIMENTARY STRUCTURE ACROSS BOTTOM OF GULF OF MEXICO

A continuous profile shot across the abyssal depths of the Gulf of Mexico shows sedimentary features that could constitute stratigraphic traps for hydrocarbons. Faulting is present but of minor importance. The edges of the abyssal plain are abrupt and difficult to explain. Continuous correlation of beds across the section demonstrates these structural features.

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PROGRESS IN APPLYING POTENTIAL FIELDS TO SEDIMENTARY SECTION

In 1964 a major oil company research laboratory set up a long-range program to improve the usefulness of potential field surveys in reconnaissance exploration. Investigations of field techniques, instrumentation, and interpretation were parts of the long-range program. The results of the program include the adaptation of the helium magnetometer to an air-borne instrument, improved location and data density control, and innovations of interpretation methods.

Specific application of gravity and magnetics to particular exploration problems is used to show that positive definition of subsurface structure can be resolved when proper field techniques and interpretation procedures are used. Exploration Surveys Inc. has incorporated these developments and procedures into its surveys with surprising results. The high sensitivities and location controls now possible allow a direct comparison of gravity and magnetics surveys. The comparisons lead to the determinations of lithologies, depositional environments, and age relations, as well as the delineation of subsurface structure.

Given highly sensitive data and accurate location control, the interrelation of gravity and magnetic anomalies can be used by the geophysicist and the geologist to eliminate many of the ambiguities normally attached to the interpretation of potential fields.

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LATE MISSISSIPPIAN EPEIROGENY AND THE WICHITA OROGENY IN THE MID-CONTINENT

Widespread epeirogeny in Late Mississippian time uplifted elements of the Transcontinental arch and bordering regions. Late Mississippian deposition in the Mid-Continent was confined to the Anadarko, Ardmore, and Arkoma basins where maximum thicknesses of 5,000, 3,000, and 2,000 ft of sediments (respectively) accumulated. Erosional processes accompanied regional uplift and continued after the cessation of Late Mississippian deposition. Consequently, over the Mid-Continent an erosional surface was etched on a terrane of predominately carbonate Paleozoic sediments and igneous Precambrian rocks.

A maximum thickness of 4,000 ft of Morrowan (Early Pennsylvanian) sediments was deposited in the Anadarko basin. From there, northward to southwestern Nebraska, Morrowan beds onlap the Late Mississippian erosional surface and truncate rocks ranging in age from Late Mississippian to Precambrian. This depositional onlap accounts for the limits and much of the thinning of the Morrowan Series from the Anadarko basin toward the north and northeast. Morrowan rocks on the order of 3,000 ft and 5,000 ft in thickness were deposited in the Ardmore and Arkoma basins, respectively. In these basins Morrowan sediments lie on Late Mississippian rocks with minor unconformity.

The post-Morrowan, pre-Atokan Wichita orogeny brought the aligned Criner Hills-Amarillo-Wichita uplift-Cimarron arch into existence through strong vertical uplift accompanied by high-angle faulting with an estimated 10,000–15,000 ft of maximum vertical displacement. Concurrently a foredeep began to form in the Arkoma basin which would subside rapidly and receive phenomenal thicknesses of Atokan rocks—12,000 ft in the western Arkoma basin and 19,500 ft in the eastern part of the basin.

Meanwhile, an area on the western margin of this developing Atokan foredeep became mildly positive, possibly in response to the strong downwarping of the foredeep. From the Criner Hills this area trends northward across the Ardmore basin and the Arbuckle uplift, and turns northeastward toward the Ozark uplift, a distance of approximately 175 mi. This belt was about 125 mi wide and it encompassed the southeastern flank of the Anadarko basin and the northwestern flank of the Arkoma basin. Morrowan rocks were eroded from this positive area with the exception of those in the Ardmore basin, those on the southeastern flank of the Anadarko basin, and those on the northwestern margin of the Arkoma basin. These rocks exhibit an angular, unconformable relation with overlying Atokan or Desmoinesian beds. Elsewhere in the Arkoma basin, and in the Anadarko basin and on its shelf area, the contact of Morrowan and Atokan rocks is nonangular and probably disconformable.

In western Oklahoma, western Kansas, and southwestern Nebraska, the depositional limit of Morrowan sediments is overstepped eastward by Atokan beds, and the depositional limit of Atokan beds is in turn overstepped eastward by Desmoinesian rocks. The uninterrupted advance of these sediments eastward toward and onto the Nemaha ridge and the Cambridge arch-Central Kansas uplift is evidence that the age of these features is pre-Morrowan (Late Mississippian) rather than post-Morrowan, pre-Atokan (Wichita orogeny) as often claimed. In addition Atokan and Desmoinesian rocks of these areas do not exhibit lateral facies changes involving the influx of coarse clastic sediments from the east that would be expected if the Nemaha ridge and the Cambridge arch-Central Kansas uplift experienced post-Morrowan uplift.

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PRECIPITATION OF SULFATES AND CHLORIDES BY MIXING SEAWATER BRINES

Experiments using artificial and seawater brines indicate that gypsum, halite, and sylvite can be precipitated by mixing brines at differing stages of evaporation, as well as by the previously recognized mechanisms of direct evaporative crystallization and crystallization by temperature changes. A modification of existing geologic models is proposed to show how brine mixing might work in an evaporite basin. Conclusions based on the experiments and their relations to the geologic model are as follows:

1. Precipitation of salts can occur in a marine evaporite basin by mixing brines of different composition and specific gravity.
2. Precipitation occurs without further water loss by evaporation.
3. Precipitation can occur from brines that were undersaturated before mixing.
4. Brine mixing could cause different salts to be deposited in different parts of a basin depending on the stage of the evaporite cycle.
5. Sylvite could be precipitated as a primary mineral.
6. Hopper crystals (cubic and tabular) of sodium chloride can form as a result of brine mixing in water of any depth.

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SHALLOW-MARINE ENVIRONMENTS IN LATE PRECAMBRIAN OF FINNMARK, NORTHERN NORWAY

Processes operating in present shallow seas suggest that shallow-marine clastic sediments are the result of 4 types of current: (1) tidal, (2) waves, (3) semipermanent, and (4) river. Usually one or two current types dominate. However, the effect of each type of current depends on whether it is operating under normal (fair weather) or catastrophic (storm or flood) conditions and the grade of sediment available. The Skalnes Sandstone shows the effect of alternating fair weather and storm conditions on a combination of semipermanent and wave currents. Other parts of the late Precambrian sediments of Finnmark show the dominance of river, tidal, and wave currents.

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GEOLOGIC ANALYSIS OF REMOTE SENSOR DATA, BONANZA PROJECT

The NASA-supported Bonanza Project of the Colorado School of Mines and Martin Marietta Corporation has as its principal objectives (1) education in the geologic applications of remote sensing, (2) development of techniques for the geologic interpretation of remote sensor data, and (3) specification of the most useful parts of the electromagnetic spectrum for geologic remote sensing. The ultimate goal is to provide a test site over which to calibrate spaceborne remote sensors and from which to extrapolate interpretations of remote sensor data into surrounding areas. Research to accomplish these objectives is carried out in the field in the Bonanza test site (an area of approximately 10,000 sq mi in west-central Colorado) and in laboratories at CSM and MMC. Airborne remote sensor data, including aerial photography, infrared imagery and radiometric data, microwave radiometric data, and radar imagery and scatterometric data are acquired (by NASA) and interpreted. Detailed ground measurements are made during overflights, and extensive ground investigations to assist in the interpretation of the airborne data have been carried out. Measurements include surface and subsurface temperatures, soil moisture, atmospheric characteristics, and incoming solar radiation. Ground investigations include detailed geologic mapping, studies of physical properties of rocks and soils, spectral reflectances of natural materials, and relation of vegetation to geology. To date, the research has added to structural and stratigraphic knowledge of the Sangre de Cristo and Sawatch Ranges and San Luis and upper Arkansas valleys, and to knowledge of structure, rocks, and geologic history of the Bonanza volcanic field.

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MINERALOGY OF DEEP-SEA SEDIMENTS FROM CRETACEOUS TE HOLOCENE

The mineralogy of the Cretaceous to Holocene sediments of the Pacific and Atlantic basins has close affinities to present sedimentation patterns. Carbonate sediments dominate equatorial and shallow oceanic areas. Turbidites are common close to continental margins. Siliceous radiolarian and diatomaceous sediments are abundant in zones close to the carbonate compensation depth.

One of the more striking features of the deep sea is the common occurrence of an amorphous metal-oxide basal facies. Many areas of both the Atlantic and Pacific show high iron- and manganese-content sediment facies at, or close to, the contact with basement basalt. This basal facies grades upward into the biogenous and detrital lithogenous overlying sediments. Some areas of the basal facies have high copper and zinc contents, and in other places manganese is prominent. In a few places, this facies is essentially hematitic. The carbonates present in the deep sea include, in addition to calcite and aragonite, dolomite, siderite, rhodochrosite, and ankeritic dolomite. An unusual palygorskite and sepiolite and bentonite associated with dolomite is well developed in the vicinity of the Cape Verde Islands in the eastern Atlantic. Basaltic volcanic glass usually alters to montmorillonite plus a zeolite which is usually phillipsite or clinoptilolite. Erionite has been discovered in the western Pacific for the first time in the deep sea. Biogenous opaline silica dissolves and reprecipitates to form crystobalite cherts. These in turn are recrystallized to form quartz cherts in pre-Cenozoic sediments.

The range of mineral facies available suggests that clay mineral diagenesis is slight but the *in situ* formation of zeolites and clays from recrystallization of volcanic ash is important.

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VARIABILITY OF GEOTECHNICAL PROPERTIES OF LUTITE IN WILKINSON BASIN, GULF OF MAINE, AS MEASURED IN PLACE FROM SUBMERSIBLE *Alvin*