GEOCHEMISTRY OF A SEDIMENTARY PROCESS, GOLFO SAN MATIAS

Geochemical analyses of marginal basin sediments (Golfo San Matias, Argentina) for Ca, Mg, Sr, Co, Ni, V, Ti, Cr, Fe, Cu, Zn, and Mn in the total sediments and their carbonate fractions have yielded distinct halistases, the areal dispositions of which must be controlled by processes operating within the basin. One of the most important of these processes is derived from hydrodynamic forces moving the sedimentary particles and depositing them in rather distinct (at the 1-phi interval) granulometric zones.

For the total sample analyses, there are covariant relations between the dominant granulometric fractions and certain elements (for example, Zn with clay size, Ti with fine-sand size). For other elements, correlations are less definitive (for example, Fe).

Fragmented biogenic material is ubiquitous in the basin sediments but shows strong accumulations in some zones as a result of localized sources and dominant current activity; there is an expected positive correlation between Ca, Mg, and Sr, and the quantity of carbonate material in the sediments, and the distribution of Co appears to be directly influenced by biogenic components.

In the study basin, the disposition and shape of the plotted halistases are determined by the mode of migration of the elements, in solution, as hydrolysates, as resistates, and as biodates. Although homogenization drives exist, localized conditions have been more influential in controlling detrital and elemental distributions and dispersions. Selected elements are examined for their utility in serving as discriminants better to interpret similar data from the geologic column.

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IMAGING RADAR—TOOL FOR PETROLEUM AND MINERAL EXPLORATION

Remote sensing methods have great potential application in geologic exploration for fuel and mineral resources. Unfortunately, many of the more exotic remote-sensing techniques are still in research and development stages, and most surveys must be conducted in the framework of experimentation rather than routine operation. Sidelooking radar (SLAR) is one of the exceptions to this overall categorization. SLAR systems, originally developed as all-weather military reconnaissance sensors, are providing extremely encouraging results in geologic exploration. Although the success of SLAR surveys has not been widely publicized, more than 6 million sq km of radar mapping has been completed during the past 3 years. Three commercial radar-mapping contractors have conducted geologic-reconnaissance surveys in some of the world's most inaccessible and remote terrain. Radar imagery is providing a first look at many cloud-shrouded regions in Brazil, Venezuela, Colombia, Panama, Nicaragua, Indonesia, and Australia.

The fine resolution of aerial photography is not presently available with imaging radars; however, they do offer the distinct advantage of a large swath of ground coverage (typically at least 20 km). This synoptic presentation allows the interpreter to become quickly familiar with the essential features of structural provinces. Minimal scale distortion allows stereoscopic interpretation on imagery strips that can be enlarged to at least 10 times the acquisition scale. Radar-mosaic construction has provided sufficient base-map information to anticipate and evaluate logistic problems to be encountered during seismic operations or when reconnoitering a territory for favorable drilling sites. Sidelooking radar, like any tool, has limitations as well as capabilities for petroleum and mineral exploration.

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PROBLEMS IN CHEMICAL ANALYSIS OF ENVIRONMENT

Several recent comparative studies of analytical results and procedures cast serious doubt on the validity of many of the pollution data now being reported. These comparative studies indicate that both sampling techniques and analytic procedures are at fault. For analysis of trace metals in seawater and of oil spills, methods of obtaining valid or representative samples from the field and design of "foolproof" procedures for carrying out the subsequent chemical analysis have been developed, as have remote or automated monitoring devices for natural systems.

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GEOLOGY OF EASTERN AND CENTRAL NICARAGUA—INTERPRETATION OF SIDE-LOOKING RADAR IMAGERY

In late 1971, the entire country of Nicaragua was surveyed by side-looking radar for the production of a 47-sheet sequence of 1:100,000-scale mosaics. Interpretation of the imagery of the central highlands and eastward toward the Atlantic Coast has contributed substantially to the elucidation of the geology of this previously little-known region. Although little that is new has been added to the stratigraphic column, the distribution of the main stratigraphic units has been clarified, and the principal structural elements established. The work in Nicaragua is an additional example of the quality of side-looking radar for rapid regional geologic interpretation and consequent guidance of ground programs.

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AGGREGATE PARTICLES IN SEDIMENTS OF YUKON RIVER, ALASKA

A study of the particle size and mineralogic characteristics of bottom and suspended sediment from Kwikluak Pass of the Yukon River revealed that iron oxide and organic material act as binding agents. The binding agents appear to be equally responsible for the presence of aggregate particles which constitute a minimum of 14% of the sediment weight. The mean and standard deviation of the sediment in the aggregate state was $\bar{x}$ = 8.2 phi and σ = 2.0 phi as suspended material and $\bar{x}$ = 5.4 phi and σ = 1.5 phi as bottom material. These distributions are coarser and less variable than those measured after removal of iron oxide and organic binding agents: $\bar{x}$ = 8.6 phi and σ = 2.3 phi as suspended sediment and $\bar{x}$ = 6.4 phi and = 2.6 phi as the bottom sediment. The proportion of aggregates as a function of grain size increases from 10% at 4.0 phi to 50% at 12.0 phi. The size distribution of particles composing an aggregate grain is distinctly bimodal indicating the binding of fine particles to larger grains. However, aggregates also may be composed entirely of fine grains. There was no evidence of mineralogic selectivity within these aggregates. This supports a probabilistic mechanism of formation, whereby the mineralogy of the aggregates is controlled by the frequency of the mineral type in the discrete state. The similarity of aggregates in the bottom and suspended sediments supports the hypothesis that the aggregates were formed in the soil horizon within the Yukon River basin.

The presence of aggregate particles within river sediments can significantly alter conclusions concerning grain-size parameters and resulting mineral-transport characteristics unless proper analytical procedures are utilized.

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BOULDER BEDS IN TESNUS AND DIMPLE FORMA-

TIONS (MISSISSIPPIAN-PENNSYLVANIAN), PAYNE HILLS, MARATHON REGION, TEXAS

Boulders of sedimentary rock are present in shale units in the Tesnus and Dimple formations near the western margin of the Marathon uplift in the Payne Hills, a terrane underlain by imbricate thrust plates. Although, locally, boulders have been rolled along the thrusts as "ball bearings," a sedimentary origin as submarine-slope deposits for the beds is inferred because (1) most boulders are unlike rocks involved in thrusting, (2) boulders are not brecciated, and (3) many boulders do not occur along thrust faults.

Boulders range from 1 to 24 ft long and are unevenly distributed along strike. Large boulders lie with their long dimension in the plane of bedding of the host rock. The boulder-bearing unit in the Tesnus is from 5 to 50 ft above the base of the formation; that in the Dimple is about 100 ft above its base. Common boulders are light-colored dolosparite and dolomicrite, mottled, dark-green chert, and chert sharpstone conglomerate; a few boulders are limestone, sandstone, novaculite, and porphyry (Dimple Formation only). The chert resembles, but is not identical with, beds in the Caballos Novaculite, although the other rocks are unlike indigenous Paleozoic strata in the uplift. Early Ordovician, Silurian(?), and Middle Devonian conodonts occur in the carbonate boulders.

The boulders were derived from a positive, tectonic element northwest of the basin that was active intermittently throughout Paleozoic time. The lack of fine debris in the boulder beds suggests that the boulders rolled or slid into place and outdistanced finer detritus.

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STATISTICAL ANALYSIS OF FLYSCH SEQUENCE REGARDED AS SERIES OF POINT EVENTS

Bed-thickness distributions of alternating coarse and fine layers in flysch sequences can be regarded as the realization of a stochastic point process. The study is similar to that of earthquakes, if the log thickness of the coarse layer is treated as earthquake magnitude and the linear thickness of the fine layer is considered as the waiting time between earthquake events. A set of 489 sandstone-shale couplets measured in a flysch sequence totalling 420 ft in thickness from the Upper Cretaceous Cedar District Formation in southwest British Columbia, demonstrates that the frequency-log-thickness diagram for the sandstone beds is similar to that observed for magnitude-frequency diagrams of present-day earthquakes. Sandstone beds greater than 2 in. in thickness are essentially Poisson distributed over the interval studied, whereas beds less than 2 in. are nonrandomly distributed. The lack of correlation in thickness between successive sandstone-shale, shale-sandstone, and shale-shale beds is indicative of a renewal rather than a Markov process. The process is nonstationary, however, in that the sandstone/shale ratio decreases systematically from a value of approximately 2 to a value of approximately 1, although the number of sandstone beds per unit thickness of shale essentially triples from older to younger strata. The data are consistent with the hypothesis of a progressively deepening basin and a progressively diminishing sand supply, with sand being delivered from more widely distributed source areas.

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SEDIMENTATION AND SEDIMENT-MASS BALANCE IN EASTERN MEDITERRANEAN SEA

Detailed studies of cores taken in the eastern Mediterranean Sea by the Woods Hole Oceanographic Institution and other institutions have enabled lithologic and time-stratigraphic correlations to be made between these cores, thereby contributing to an understanding of the sedimentation history of this basin during the Quaternary. The deep-sea stratigraphic section is a complex sequence of sapropels, turbidites, oozes, volcanic ashes, detrital and biogenic sands, and detrital silt beds. Integrated sedimentation rates since the Pliocene have averaged 10-20 cm/10^3 years and ranged from less than 1 to more than 100 cm/10^3 years. Rates during the Quaternary are slightly less, although variations do occur, primarily as a result of glacial/nonglacial climatic controls. Patterns of sedimentation also have been affected by these climatic changes, with only relatively minor variations reflecting tectonism and changes in provenance.

Volumetrically, the Nile River system is and has been the largest contributor of detrital material. Additional detritus is derived from Anatolia and from the Aegean Sea, the latter contributing predominantly finer material. The other borderlands do not supply large amounts; eolian material from north Africa is noticeable, however. Variations of this detrital input and in carbonate deposition have occurred primarily in response to climatic changes during the Quaternary.

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BIG PINEY-LA BARGE PRODUCING COMPLEX, WYOMING

The Big Piney-La Barge complex has been the major gas producing area in Wyoming since 1957, and during the past 10 years it also has become a leading oil producing area. Recoverable natural gas is estimated at 3 Tcf and recoverable oil exceeds 100 million bbl.

The area is along the western margin of Wyoming's Green River basin, occupying a zone of transition between the overthrust belt and the basin. This position of transition typifies much of the depositional history for this part of Wyoming, whose stratigraphic record reflects both the influence of the craton on the east and the Cordilleran geosyncline on the west.

Productive reservoirs include the Triassic-Jurassic Nugget Sandstone, the Cretaceous Dakota, Frontier, and Mesaverde Formations, and sandstones of Paleocene age. Trapping mechanisms are diverse, and structural, structural-stratigraphic, and purely stratigraphic accumulations are represented.

Commencing in Late Triassic and extending into Early Jurassic time, the Nugget was deposited as a massive blanket of largely eolian sand. In Early Jurassic time, seas spread southward across the Cordilleran front and the Wyoming craton during a major marine pulse that deposited the Twin Creek Limestone on the west, and Gypsum Springs and Sundance Formations on the east. The Gypsum Springs appears to be recognizable, but the Twin Creek terminology is better applied at La Barge.

Jurassic time closed with continental deposition of the Morrison sequence. On the Wyoming shelf the transition from Jurassic to Cretaceous is commonly a straightforward transition from continental Morrison through transitional Lakota-Dakota and into marine Thermopolis Shale. La Barge appears to have been a hingeline in Early Cretaceous time and relations are not clear cut. All shelf units are recognizable and shelf terminology may be applied on the east side of the complex, but in a distance of 12 mi these units become nearly unrecognizable.

In early Paleocene time the platform underwent folding, thrusting, and erosion. The Hogsback thrust was moving eastward and the newly formed La Barge anticline was deformed further. North of the platform a major drainage system developed that flowed southward and southeastward through the Green River basin. As Paleocene progressed, the Hogsback thrust reached its present position and aggradation commenced across the Big Piney-La Barge area. Deposition was dominated by a coarse, commonly conglomeratic facies adjacent to the Hogsback thrust, which graded abruptly through an alluvial, piedmont, and small stream fluvial unit. This low-energy facies graded basinward into a high-energy fluvial and paludal facies