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SALT TECTONICS OF THE CUANZA BASIN, ANGOLA, PORTUGUESE WEST AFRICA

The Cretaceous Cuanza basin is located in northwestern Angola on the Atlantic coast of West Africa. This composite basin, 315 km. long, north-south, and 170 km. wide, east-west, consists of an early Cretaceous carbonate-reef barrier-evaporite sequence succeeded by a late Cretaceous clastic-carbonate sequence. The basement is composed of Precambrian crystalline rocks, Paleozoic metasediments, and post-Paleozoic crystalline rocks. Surface of the basin consists of Upper Cretaceous, Paleocene, Eocene, and Miocene strata, with much of the area covered by a thick, red, lateritic, Pleistocene sandy soil.

The middle Aptian sel massif was deposited to a maximum thickness of about 600 meters in response to an early off-shore tectonic welt or fault in the basement, possibly coupled with early Aptian barrier reef growth to create a semi-locked evaporite basin.

Salt tectonism of early to middle Cretaceous age involves (1) regional lateral salt movement of 1 to 15 kilometers, probably initiated by basement faulting; (2) subregional salt shifts in response to clastic loading from the east and barrier reef loading on the west; (3) local to subregional horizontal salt shift and vertical expansion to form anticlines in response to local reef buildup, as well as basement folding and wrenching, and local trough-like clastic loading; (4) final diapiric salt intrusion in waves with amplitudes of 2,000 meters, initiated in Oligocene time, and operative today; (5) Miocene *fosse* foundering (normal graben faulting) with filling by deltaic clastics; and (6) renewed right lateral wrench-faulting.

An early, low-amplitude Cretaceous regional salt movement, important to initial oil migration and accumulation, was followed by Oligocene diapirism which destroyed several large oil accumulations. Both took place in locales where the initial deposition of the massive salt was the greatest.

Oil exploration of both the pre-salt and post-salt Cretaceous strata in the Cuanza basin today depends upon detailed unravelling of the salt tectonic history.

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DIAPIRIC AND ASSOCIATED STRUCTURES ON THE SABANA DE BOGOTÁ, COLOMBIA

Several diapiric and related salt structures are located on the Sabana de Bogotá, an elevated rolling upland 2,500 to 3,000 meters above sea-level in the central part of the Cordillera Oriental. The structures, which are exposed in locally exploited salt mines, are composed of salt and interbedded euxinic shales of late Triassic or Jurassic age. The association of the salt deposits with Upper Cretaceous formations necessitates a penetration of more than 13,000 meters of predominantly clastic sediments.

The structures, like those in Rumania, are thought to be the result of horizontal stress. It is believed that they had their inception during very recent geologic time, possibly as late as Pliocene or even Pleistocene.

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RESPONSE MODEL DESIGN FOR A RHYTHMIC DELTA-PLATFORM DOMAIN, DEVONIAN CATSKILL COMPLEX OF NEW YORK

Investigation of the physical stratigraphy of the Middle and Upper Devonian of southeastern New York has shown that this sequence of the "Catskill Deltaic Complex" might be separated naturally into a set of sedimentary domains. The North Point (lowermost Upper Devonian), one of these domains, is characterized by rhythmic patterns in sediment color, texture, and petrology; sedimentary structures; sediment transport directions; lithologic sequences; and lithosome geometries. The rhythmically recursive sequence of the North Point consists of (in ascending order): (A) polymictic conglomerate, (B) gray conglomeratic subgraywacke, (C) gray subgraywacke, (D) red subgraywacke, (E) red siltstone, (F) red mudrocks, (G) olive mudrocks, (H) gray mudrocks, and (I) sub-protoquartzite.

Various physical and statistical models of source, distribution, accumulation, and modification realms of the process-response system of the North Point were simulated on an electronic computer. The algorithm for a model of the process-response system of a rhythmic sequence, obtained by integration of relative aspects of these models, may be approximated by six sub-sets of equations; each sub-set is an attempt to characterize the status of process elements in the development of a response phase.

Translated into operational format these phases are: (1) early regressive phase (units A, B,); (2) middle regressive phase (B, C); (3) late regressive phase (D, E); (4) paralic stability phase (E, F); (5) early transgressive phase (G, H); and (6) late transgressive phase (H, I). The general aspect of this model is coarse-grained sediments (A, B, C) passing upward into finer sediments (E, F, G. H), forming a platform sequence which is rhythmically recursive. Homogenization at the strand zone and re-organization on the distal portion of the platform produces an inverted sequence (fines grading upward to coarser units). This model recognizes two components of subsidence, local and regional, as dominant process elements of the accumulation realm. The regional component is decomposed into the effects produced by compaction of the underlying sediment pile and those produced by subsidence of the Devonian subbasin. The local component results from surface and near-surface compaction of sediment deposited during phases 3, 4, and 5 (units E, F, G, H) of a rhythmic sequence. The algebraic sum of the interaction of these two process elements may have profound effects on the character and mode of the response, producing transgression in one part of the domain, while regression or stability characterizes another part.

Within the framework of this model the rhythmic character of the North Point is thought to be the response to the interaction of: (1) source contribution activity; (2) design of transport and dispersal systems; (3) influence of sub-basin and platform dynamics on the character and mode of the accumulation; (4) modification of the accumulation by processes such as compaction, erosion, diagenesis, and structural adjustments.

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A SEDIMENTARY MODEL OF THE CONTINENTAL MARGIN OFF OREGON

The continental margin west of Oregon consists of a generally convex-upward surface 35 to 60 nautical miles wide. The continental shelf, which forms the upper part of the surface, slopes seaward at less than one degree and ranges irregularly in width from 9 to 35 miles. Several elongate hills or banks rise above the general shelf level. The lower part of the continental margin (continental slope) increases in average declivity from about 1° to 10°, and is modified by numerous ridges, hills, benches, and valleys.

Stratigraphic, structural, and geophysical data suggest that during the Tertiary as much as 20,000 feet of sediment accumulated off the central coast of Oregon in the area of the present continental shelf.

Recent sediments in this region consist of well-sorted, fine to very fine, detrital sands on the inner shelf, grading to poorly-sorted glauconite-rich clayey silts on the outer shelf. Continental slope sediments are primarily clayey silts containing small percentages of Foraminifera, radiolarians, diatoms and sponge spicules.

Lithologic and faunal similarities of the Recent sediments to sedimentary rocks exposed along the coast and on the shelf and slope indicate that deposition during late Tertiary time occurred in shelf and slope environments. The fossil faunas also indicate that parts of the continental margin may have been uplifted as much as 4,000 feet since the late Tertiary, and that there has been a general westward shifting of the sites of sediment accumulation.

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Palynology of Modern Sediments, Gulf of California and Environs

Several hundred bottom samples from the Gulf of California, distributed systematically over its entire area, and comparable samples from streams and arroyos in all surrounding areas, have been analyzed for spore and pollen content and for qualitative and quantitative relationships of various groups of these palynomorphs to each other and to other associated organic entities of comparable size.

Some of the more conspicuous concentration patterns of these palynomorphs indicate distance from shoreline, current patterns, depth of water, coarseness of sediment, seasonal wind patterns, and some source-vegetation distribution areas. Other distribution patterns are complicated by unidentified factors or combinations of factors among which the principal controlling agency is not discernible.

Conspicuous concentrations of spores occur off the months of the major tributary streams, adding evidence to the conclusion that stream transportation plays an important role in spore distribution. Spores from the mainland, particularly from the slopes of the Sierra Madre Occidental, reach the Gulf principally by way of the streams because the prevailing winds would not contribute extensively from this direction. A heavy concentration of palynomorphs off LaPaz is due in part to the effects of wind distribution from the tropical vegetation on the southern tip of the Baja Peninsula and in part to the interruption of the long-shore currents by the configuration of the structurally controlled southern tip of the peninsula and by the position of some offshore islands.

There is generally an increase in total number of palynomorphs seaward from very low amounts in the narrower belt of shallower coastal waters, and then a gradual diminution toward the center of the Gulf. The pollen frequency is less in the very shallow areas and in the very deep basins. Relative frequencies of spores are about the same for the various types of sediments except the coarser types. Some correlation of patterns of palynomorphs and radiolarians is indicated, but there is no clear relation of spore patterns to the distribution of diatoms and some other organisms.

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Defining a Gradient in a Sample of Sedimentary Rock

Three orthogonal planes (two vertical and one horizontal with respect to the recognizable bedding structure) of a core sample of apparently graded graywacke sandstone have been petrographically analyzed in order to determine the characteristics of the lithologic gradients in the specimen.

Compositional and textural properties were sampled in thin section according to an orthogonal grid pattern on each of the three faces.

Variability among rows and columns (plus interaction) with respect to each petrographic variable was tested by analysis of variance using a two-cross classification. A larger number of properties show significant variability among rows (in a vertical direction) in the two vertical planes of the specimen than in the horizontal plane.

Quality control models with confidence limits which expose graphically the trends displayed by individual constituents indicate that feldspar proportion, mica proportion, and quartz grain size show significant gradients in the vertical direction perpendicular to the bedding. Quartz proportion oscillates in a non-systematic fashion, and quartz grain shape shows no trend in the vertical planes of the specimen. The petrographic variability observed in the horizontal plane of the bedding is generally trendless. Independence of the individual gradients is apparent, reflecting the influence of explicit processes on the spatial distribution of the petrographic variables in the rock.

Partial trend surfaces show the trends in quartz grain size to be dominant, according to the comparative amounts of variance accounted for by each fitted surface. Again, the major portions of variability are explained by the surfaces in the planes perpendicular to the bedding. The textural homogeneity of the rock in the horizontal (bedding) plane is reflected in the minor trends defined by the surfaces in this direction.

These results indicate that only apparent gradients in the lithologic properties of the rock are detectable by these methods. To assess accurately the "real" gradients, rotational transformations, which would bring the faces into complete orthogonality with the trend, and criteria (such as maximum variance explained) should be employed.

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Diapiric Structures and Upper Proterozoic to Lower Cambrian Sedimentation in the Flinders Ranges, South Australia

During deposition of the Adelaide System (Upper Proterozoic) and Lower Cambrian Series, which together exceed 50,000 feet in thickness, an incompetent dolomite-siltstone sequence (Callanna beds) formed piercement structures which influenced sedimentation.

More than thirty discrete diapiric structures occur along fairly well-defined trends which are regarded as a basement fault system. Surface diameters of the eroded cores of the domes range up to several miles but the injection of carbonate-siltstone breccia has caused complication of some folds and resulted in irregular bodies with dike-like tongues.

[1] Published with the consent of the Hon. Minister of Mines for South Australia.