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SOME MAJOR STRUCTURES AND FLUORITE-BARITE DEPOSITS OF MISSISSIPPI VALLEY

No abstract available.

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POTASSIUM AND MAGNESIUM IN CRETACEOUS EVAPORITES OF NORTHEAST BRAZIL

Cretaceous evaporites, consisting of a thick halite facies and economically valuable deposits of sylvite, carnallite, and tachyhydrite ($CaCl_2 \cdot MgCl_2 \cdot 10H_2O$), are present in the Sergipe basin along the northeast coast of Brazil. In the Japaratuba subbasin at least 2 carnallite deposits, 2 tachyhydrite deposits, and 1 sylvite deposit have been outlined by drilling by the Brazilian government. Carnallite and sylvite have also been found in the adjoining Siriri and Treme subbasins. The Sergipe deposits formed in a small embayment connected to a larger evaporite basin which developed in Aptian time during the initial detachment of the South American and African continents.

The Sergipe evaporites are unique in that they are noticeably deficient in both carbonate and sulfate minerals, and contain thick almost pure beds of the rare mineral tachyhydrite. The tachyhydrite appears to be part of a primary depositional sequence which, starting with the least soluble salt, is (1) halite, (2) carnallite, and (3) tachyhydrite. This sequence required a brine enriched in calcium chloride and a super-efficient desiccation system to saturate what was probably an extremely hygroscopic brine. Mixing of incoming sulfate-laden seawater and calcium chloride in the brine, which resulted in precipitation of calcium sulfate outside the basin, may account for the sulfate deficiency. The enrichment of the evaporite brine in calcium chloride may be the result of reaction between magnesium chloride in the original brine and calcium carbonate in the incoming seawater and previously deposited carbonates. This reaction would also explain the lack of carbonate minerals in the evaporites.

The sylvite deposits in the uppermost evaporite cycle occur at depths between 300 and 700 m and seem to be most favorable for exploitation. Carnallite deposits in 2 older cycles are also potential sources of potash and magnesium. In addition the tachyhydrite deposits constitute a new and potentially valuable source of magnesium. The upper deposit is locally more than 100 m thick and contains an estimated 1.5 billion metric tons of magnesium chloride. Preliminary studies suggest that the tachyhydrite deposits have certain advantages over seawater as a magnesium chloride source.

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AULACOGENES: INTRACRATONIC PROTEROZOIC BASINS THAT CONTROL PHANEROZOIC SEDIMENTATION

Aulacogenes are long-lived trenchlike basins first described on the Russian and Siberian platforms. Subsidence in known aulacogenes was mainly Proterozoic, but many persisted as moderate negative structures in the Phanerozoic and others rebounded vertically to become linear ridges. Thus, important facies changes in Phanerozoic sediments may be located by projecting the trends of exposed aulacogenes into the subsurface.

Two lower Proterozoic aulacogenes have been recognized in the northwestern Canadian shield—one with a WSW trend that dips beneath Phanerozoic cover at Great Slave Lake and a second with a NNW trend that dips beneath the cover of Victoria Island from Bathurst Inlet.

Aulacogenes are much longer lived than other intracratonic basins. They are fault bounded, linear, and narrow, commonly 200 mi long but only 25 mi wide. They trend at high angles to the craton margin, where they merge with a contemporaneous orthogeosyncline that borders the craton. Their rock sections thicken outward from the center of the craton to as much as 40,000 ft near the margin. They contain mostly miogeosynclinal and exogeosynclinal facies, but with the addition of basic volcanics and fanglomerate at several levels. Alluvial sediment transport in aulacogenes is mainly parallel with their trends, not transverse as in the geosyncline. The sedimentary beds have mild compressive folds paralleling the boundary faults, but low-angle overthrusts, typical of the geosyncline, are absent.

Aulacogenes, unlike geosynclines, are not accounted for by global plate tectonics. The dipping of laterally adjacent sediments toward aulacogenes, the compressive deformation within aulacogenes, and the abrupt descent of the Mohorovičić discontinuity beneath aulacogenes indicate foundering of a narrow slice of continental crust into the mantle (as opposed to tensional block faulting) to produce aulacogenes. If this interpretation is correct, aulacogenes should be bounded by high-angle reverse faults, rather than by normal faults.

Aulacogenes, characteristic of the Proterozoic, may represent a stage in the evolution of the continental portions of global plates intermediate between the pervasive mobility of the Archean and the persistent true cratons of the Phanerozoic in which only relict aulacogenes are found.

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PROTEROZOIC STROMATOLITES OF CYCLIC SHELF, MOUNDED SHELFEDGE AND TURBIDITE OFFSHELF FACIES, NORTHWESTERN CANADIAN SHIELD

The shelf facies of the Rocknest Formation (lower Proterozoic) consists of almost 200 cycles, each 5–50 ft thick. Each cycle has, in ascending order, a thin transgressive beach deposit of intraclast and ooid packstone, a subtidal graded and rippled dolomitic shale with syneresis dikes, an intertidal dolomite with columnar and elongate-domal stromatolites and edgewise conglomerate, and a cherty black dolomite with microdigitate stromatolites deposited by direct precipitation in supratidal algal marshes. Individual stromatolite beds can be traced for hundreds of miles along strike and tens of miles across strike. On the landward extremities of the shelf, low compound stromatolite mounds are surrounded by silty shale and interbedded with crossbedded quartz sandstone of deltaic origin.

The shelfedge facies of the Rocknest and the Pethei Group (lower Proterozoic) consists of compound columnar stromatolite mounds, each up to 60 ft thick. The mounds are elongate and separated laterally by relatively narrow anastomosing channels oriented normal to the trend of the shelfedge. The channels are filled with bimodally crossbedded, intraclast grainstone and their floors were less than 8 ft below the crests of adjacent mounds. The mound-and-channel belt is only 2 mi wide and marks the outer limit of surf zone deposits on the shelf.

The offshelf facies of the Pethei contains shale with abundant stromatolitelike digitate growth structures of poorly laminated limestone. They are rhythmically interbedded with graywacke turbidites, thin evenly bedded calcareous mudstone with shale partings (rhythmite) and beds of cherty limestone submarine-slide breccia. The growth structures certainly formed below surf-base and probably below the photic zone of muddy water. They may be bacteriagenic.

The mere presence of stromatolites in Proterozoic carbonates cannot be used to infer a specific depositional environment, but by mapping different types of stromatolites and their associated sediments, paleogeographic facies can be established as in any Phanerozoic succession.

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ALGAL MATS, CRYPTALGAL FABRICS, AND STRUCTURES, HAMELIN POOL, WESTERN AUSTRALIA

Stromatolitic sediments and structures in Hamelin pool, Western Australia, are formed by interactions between blue-green algae (which trap and bind sediment particles) and a variety of mechanical and diagenetic processes. The algae form a cohesive mat that tends to cover intertidal, supratidal, and some shallow subtidal surfaces. The mat is differentiated into 7 intergradational types as an expression of variations in algal species present, ratio of filamentous to unicellular forms, quantity of mucilaginous matrix, life habits, and quantity and nature of the host sediment. The distribution of mat types is controlled by environmental factors such as elevation of substrate, drainage, depth and nature of interstitial groundwater, and sediment influx. In tidal flats with gentle gradients there is a broad zonation of mat types, whereas on headlands and locations with irregular topography the mat is highly differentiated with a condensed, patchy development of types.

The sediments trapped and/or bound by the algal-mat communities commonly are imprinted with distinctive fabrics. These fabrics, which can be related to specific mat types, reflect a complex interaction between the algae, and processes of sedimentation and diagenesis. Important factors in the development of fabric are surface texture and internal structure of the mat, rate and frequency of sediment influx, and processes such as oxidation, cementation, and lithification. Changes in mat type with changes in environmental conditions (*e.g.*, shoaling and sediment influx) lead to the development of successions of fabrics in the sediment pile.

The mat-sediment complex is shaped by physical factors into a variety of structures ranging from extensive flat-lying sheets through linked ellipsoids and columns to discrete ellipsoids and columns. The size range of structures is variable from a few centimeters to several meters; confluent and branched structures are also common. The gross morphology of the structures is largely independent of the mat type (or types) involved in the primary trapping and/or binding processes. Major environmental factors involved in shaping of structures are waves, currents, substrate gradient, and long-term sea-level change; minor factors include burial, exhumation, growth of epiphytes, activity of browsing organisms, gas evolution, corrosion, precipitation, desiccation, and variation in sediment type. These factors also influence the external surface texture of structures.

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STROMATOLITES: CHARACTERISTICS AND UTILITY

Stromatolites are laminated biosedimentary structures usually attributed to the trapping and binding action of nonskeletal algae in shallow-water environments. They have a geologic record dating back from the Holocene to the Archean, with an acmic development during the Proterozoic. The structures are generated by successive stacking of laminae, whose particular shapes are more or less uniformly maintained during the accretion process that yields the final gross morphologies. The laminae and their synoptic morphologies represent not only the microbathymetries at past instants in time, but also the preserved record of successive surfaces of equilibrium between interacting physical, chemical, and biologic factors in the environment. Analysis of the geometric, material, dimensional, and positional attributes of these active interfaces, as well as the final morphology of the stromatolite, provides information useful in classification of stromatolites and in the interpretation of environmental conditions during their formation. Changes in their morphology and microstructure through geologic time reflect evolutionary changes in stromatolite-building biotas and their environments, and are the basis for the correlation of stromatolitic Precambrian sequences. Stromatolites also have been used to determine paleolatitudes, to gauge ancient tidal ranges, to shed light on past rates of rotation of the Earth, and to date the apparent capture or closest approach of the Moon, but conclusions reached in these respects are not yet sufficiently firmly based.

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GEOLOGIC RESERVOIR ANALYSIS OF KIRKWOOD SANDSTONE, ILLINOIS

The Mississippian Kirkwood reservoir is a 30-ft thick alluvial or deltaic crossbedded sandstone, overlain and underlain by shale. Measurements of grain diameter and sorting, clay content, porosity, permeability, and capillary pressures were made on cores from 5 wells in the reservoir.

The lower part of the reservoir is coarser grained and more permeable than the upper part. Also, feldspar grains in it have been partially altered to kaolin. The upper part is finer grained and less permeable. In contrast to the lower part, it contains illite and minor amounts of kaolinite and generally exhibits calcite cementation and quartz overgrowths.

Measurements of absolute pore size and average pore entry radius disclose larger values of these parameters in the lower part of the sandstone than in the upper. However, surface area and irreducible water saturation have smaller values in the lower part of the sandstone than in the upper. Pore entry size distribution data are in qualitative agreement with Kozeny's analysis and show that pore tortuosity is apparently reflected in the shape of the pore entry distribution curve. Those rocks which have platykurtic pore entry distributions have a more tortuous pore network than those with skewed distributions. A theoretical 2-dimensional model of the pore network involving cubic packing of spherical grains closely describes rock/fluid behavior.