Compaction Phenomena in Gypsum and Anhydrite

Anhydrite can be precipitated from natural brine in the presence of gypsum in the temperature range of 60°–70°C. Below this temperature range and within the anhydrite stability field, the rate of growth is extremely slow. Growth of gypsum in brine in the presence of anhydrite within the gypsum stability field is rapid. Recent anhydrite in the Persian Gulf in general occurs above the free-water level in supratidal sediments. It is postulated that this anhydrite is formed in the dark sediments during the hottest summer days and is preserved throughout the year in the partly dry sediments because of lack of water. However, at temperatures below approximately 23°C. in the presence of sea water which has been evaporated to precipitate halite, or at higher temperatures in less concentrated brine, the anhydrite will be dissolved and gypsum will precipitate. Thus, with burial of a few feet below the free-water level, any surface anhydrite should be dissolved easily and gypsum precipitated, at least during winter, at any known mean annual temperature. Only gypsum would be carried into the subsurface, despite the fact that anhydrite may have formed at or near the surface. This gypsum, and all original gypsum, will be replaced by anhydrite with burial to a depth of 500–2,000 feet, depending on the salinity of the subsurface water and on the geothermal gradient. During this stage, there will be at least a 38-per cent volume reduction of the solid. It is unlikely that this volume will be compensated by addition of anhydrite from an outside source because of the generation of abnormal fluid pressure and, thus, outward water flow during the gypsum-anhydrite replacement. Anhydrite in the subsurface commonly is devoid of pore space, indicating additional compaction. Therefore, ancient anhydrite sections must represent approximately one-third of their original depositional thickness. Because much of the volume reduction is delayed, the compaction and any dissolution of evaporites provide a mechanism for increasing and perpetuating the subsidence of an established evaporite basin in addition to and after its tectonic history.

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Diagenesis in Estuarine Sediments

Diagenesis in estuarine sediments is affected by broad physical and chemical environmental patterns, the nature of which is becoming clear. The bottom environment is influenced most fundamentally by physical conditions, such as the pattern of water movements and the stability of the water column from place to place. Physical parameters are distinctly different in three major regimes of estuaries, the distributary reaches, the mixing zone, and the saline basin. Location and extent of each of these regimes are determined in any system by the interaction among fresh-water discharge, tidal range, channel geometry, and wind effects. The Rappahannock River estuary and the Po River delta illustrate contrasts in such physical differentiation.

In estuaries the environment for diagenesis is imposed by a determining physical background and the supplemental operation of chemical and biological processes. Variations in pH, Eh, and in dissolved silica and attainment of sulfide equilibrium illustrate the interaction between physical milieu and bottom chemistry. There is a class of chemical interactions (pH adjustment, ion exchange) which proceed instantaneously when fresh-water sediment enters the marine zone. There is another class that requires physical stability in the bottom sediments before equilibrium is approached (dissolution of silica, sulfide equilibrium). This latter class of reactions is the starting point for diagenesis. The initial stages of diagenesis begin just below the sediment-water interface in estuaries.

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Paraconformities

The stratigraphic succession is the net result of sedimentary deposition, non-deposition, and erosion within constantly changing environments. Consequently, rock strata are heterogeneous and interrupted by countless discontinuities, many of which are not readily apparent. The radiometric scale of geologic time firmly supports Joseph Barrell's theoretical conclusion that sedimentary rocks of any locality represent a small fraction of the time spanned by the formation of those rocks. Parallel evidence is supplied by the fossil record. In other words, the aggregate stratigraphic hiatus, recognized or concealed, greatly exceeds the preserved rock and fossil record.

The term *unconformity* (and its variants, disconformity and discordance) is employed generally for physically conspicuous stratigraphic discontinuities with inferred hiatuses. Existing confusion may be avoided if the antonym *conformity* is applied only to probably rare examples of strictly continuous deposits free from diastems, paraconformities, and disconformities. A preferred structural designation for indicating parallel bedding planes is *concordance,* whereas angularity of sedimentary contacts may be referred to as *discordance.*

The writer's observations of paraconformities in craton areas of the Colorado Plateau, Rocky Mountains, Mid-Continent, Mississippi Valley, Ohio Valley, Sweden, Andes of Peru, Salt Range of India, and elsewhere have led to the conclusion that present-day configurations of erosion and sedimentation do not yet provide an obvious explanation of ancient paraconformities. There is a surprising lack of evidence of protracted subaerial erosion such as soil profiles, sinks, and channels along paraconformities. This suggests extensive planar erosion or non-deposition near, or below, sea-level for long spans of time. Evidently, relative sea-level for long intervals rarely fell far below the land surface of the cratonal areas.

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Conodont Zones in Salamonie Dolomite and Related Silurian Strata of Southeastern Indiana[1]

Conodont zones recognized in the Brassfield Limestone and the Salamonie Dolomite (includes the Osgood and Laurel as members) in southeastern Indiana and adjacent Kentucky generally are comparable with Zone-I, the *celloni-* and *amorphognathoides*-Zones, and probably the *patula*-Zone established by Otto Walliser in the Carnic Alps. Differences in generic composition of the European and Midwestern faunas and apparent range extensions suggest a more complex zonation than that established by Walliser.

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