CHEMICAL COMPOSITION OF OCEANIC WATER DURING TERTIARY TIME; EVIDENCE FROM PORE-WATER STUDIES ON JOIDES DRILL CORES

Chemical analyses have been performed on pore solutions from more than 25 drillholes in the North and South Atlantic Ocean. Several holes penetrated Tertiary-Mesozoic sediments and bottomed in basalt. The data indicate that in the central areas of the Atlantic Ocean the salinity and chlorinity of pore fluids approach the values for bottom waters and vary less than about 1–2% with depth, with a few exceptions. Diagenetic changes in major inorganic ions are relatively minor, regardless of depth, lithology, or proximity to basalt bottom. Significant effects include chiefly loss of magnesium, partial loss of sulfate, and corresponding increases in alkalinity. Nearer the continents, fluid compositions range over somewhat wider limits, especially in the direction of lower salinity. With due allowance for molecular diffusion and other disturbing effects, the data offer no evidence that the oceans varied appreciably in either chloride, salinity, or ionic composition during Tertiary time.

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PROCESS APPROACH TO DIAGENESIS OF REEFS AND REEF-ASSOCIATED LIMESTONE

Geologic reasoning commonly is based on analogy rather than on process. In facies studies, geology by analogy generally works. Spatial distribution of sediment types is usually in accordance with a few general rules and is therefore repetitive in the geologic record. However, when one approaches diagenetic problems, geology by analogy runs amuck.

The diagenetic modification of a carbonate sediment is a composite of numerous biological, physical, and chemical processes separated in time. Each limestone unit results from a combination of several or all of these processes operating in varying degrees and in varying sequence. It is therefore proposed that a more fruitful approach to problems of carbonate diagenesis is to identify the processes that produce important diagenetic modification in the Holocene and Pleistocene where processes can be studied first hand, and in ancient rocks where late diagenetic processes can be strongly inferred. Then, systematically review this list of processes with regard to the rock units in question to discover which processes are potentially important in these rocks and which processes can likely be discounted for reasons of sedimentary facies, paleoclimatology, paleogeography, or sea level history.

One process approach to diagenetic problems in ancient rocks, is to study those processes which appear to produce significant modification in Holocene and Pleistocene materials.

Marine cementation is becoming well documented as an important void-filling process in certain environments. Certain generalities concerning the marine environment may enable us to predict the location and importance of submarine cements. Although seawater commonly is saturated with respect to calcium carbonate, the amount of calcium carbonate available from any 1 batch of pore water is small. If cement is to grow in the pore space of the submarine sediment, water must either be pumped through the pore space or calcium and carbonate ions must diffuse into the pore space. These requirements for a pump or a diffusion mechanism may grossly limit the environments in which we shall expect to find submarine cementation to be an important process.

The vadose environment (subaerial and above the water table) is the site of important solution and precipitation processes in Pleistocene rocks. The stabilization of aragonite and high-magnesium calcite to low-magnesium calcite provides a basic driving mechanism for both precipitation phenomena and selective solution. Availability and flow of water, combined with shape and mineralogy of sedimentary particles allow for a wide variety of diagenetic fabrics to be formed within the diagenetic environment. Further, carbonate equilibrium in this environment is a complicated composite of equilibrium between the rock and the water, the water and local PCO_2, and the local PCO_2 and a larger CO_2 reservoir. Finally, seasonal variation allows solution and precipitation phenomena to be superimposed although the sediment remains in essentially the same environment.

The freshwater phreatic environment (pore space completely occupied by fresh water) has several unique features primarily related to the fact that mineralogic stabilization occurs more rapidly in this environment than in the associated vadose environment. Because of the differences in solubility of the 2 mineral phases, massive precipitation commonly occurs when water from an aragonitic vadose environment enters a calcite phreatic environment. Solution processes may operate in close proximity to the phreatic environment attendant to CO_2 evolution as phreatic precipitation occurs.

Caution should be exercised in ascribing observed diagenetic modification to ill-defined "late diagenetic" processes where there are so many well-defined early diagenetic processes from which to choose.

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PATTERN RECOGNITION AS GUIDE FOR ESTABLISHING MINIMUM SAMPLING REQUIREMENTS IN REGIONAL STRATIGRAPHIC STUDIES

The recognition of spatial order for facies defined within a sedimentary depositional framework has been accomplished traditionally by descriptive methods. This approach has limited the progress made at attempts to establish minimum sampling requirements necessary to delimit the major depositional patterns in regional stratigraphic studies. A more quantitative approach can be taken if one considers the spatial arrangement of facies as a problem in multivariate pattern recognition. This has led to the development of a statistical method for analyzing multiphase mosaics expressed in map form. Nearest-neighbor theory has been combined with cross-association analysis to provide estimates of geometric parameters defined for different classes of depositional environments. On the basis of areally sampled data, a derived pattern can be judged either as being random, in which more detailed sampling is indicated, or as being nonrandom, in which the observed pattern is compared with one of several reference patterns whose geometric parameters are specified. The sample size required to attain any desired level of correspondence for any given reference pattern can be established. The Mississippi deltaic plain was chosen as a test example of the method. Based on areal sampling, a 10% random sample is sufficient to delineate the major depositional framework, and a followup 30% systematic sample is sufficient to delineate the major facies trends. Considering the increasing cost of data storage