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Coastal Stratigraphic Sequences

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Introduction

When James Hutton formulated the Law of Uniformitarianism, “the present is the key to the past,” he based his hypothesis on the assumption that forces and processes operating on the earth’s surface were the same in the past as in the present. This single hypothesis has been the key to most geologic studies that ensued during the past two centuries. Most geologists today agree that present processes and forces are very similar to those that operated throughout geologic time. However, the geologic-tectonic setting must have varied greatly, and the organisms, which potentially may have interacted with the processes and forces of action, have changed greatly over the Phanerozoic era.

Much of the stratigraphic-sedimentologic record of shoreline development through geologic time is observed from rocks that have not necessarily been formed in tectonic-geologic settings similar to those of today’s coasts. For example, a great portion of the stratigraphic record may be attributed to depositional settings ranging from the margins of continents to their interiors. In addition, complexities of past plate tectonics actions preclude our fully understanding the relationship of paleo-shorelines and their true positions relative to the continents of their time from at least the end of the Mesozoic Era back toward the origin of the earth. However, shoreline sediments and their sequences of facies interrelationships must have had much in common throughout all of geologic time, given that wave energies and nearshore water depth and sediment regimes were somewhat similar to those of the present. The study of modern shorelines and their ancient equivalents or analogs then becomes an exercise in reasoning based on the partial information available to us in the stratigraphic record. It is also an exercise in ontologic
methodology based on observation of present interrelationships of sedimentary depositional body shapes and structures versus the forces impinging upon, molding, and constantly reforming the present shorelines. After two centuries of development of the science of geology, the Doctrine of Uniformitarianism may well be better stated to include the variant: The present is the key to the past but the past is equally a key to the present and to the prediction of the future.

The Doctrine of Uniformitarianism is one of several conceptual tools that aid in the interpretation of coastal stratigraphic sequences. Other aids include an understanding of the physical processes of coastal change, knowledge of the frequency and magnitude of sea level change, and the vertical relationship of coastal sedimentary facies. Using a combination of such conceptual tools allows coastal stratigraphic sequences to be "read" to better understand past and present coastal evolution, and to predict future trends in coastal change. This chapter presents a general discussion of the concepts and principles applicable to the interpretation of coastal stratigraphic sequences. It also presents several stratigraphic models and actual stratigraphic records from coastal environments where there are contrasting sequences because of different processes influencing the coastal evolution.

 Processes of Coastal Change

The world's coastal areas might be depicted in terms of the morphology of sedimentary bodies and erosional features that are created by the forces and processes influencing the coastal area. Along depositional coasts the internal sedimentary parameters and the organic contributors to the sediment are dependent on these forces and processes. These sediment characteristics are significant in the interpretation of coastal stratigraphic sequences and in identifying the areal distribution of coastal sedimentary environments. Thus it is important to develop an understanding of the large number of processes that may influence the coastal area resulting in coastal change. Table 9-1 lists some of those factors that most importantly influence a shoreline configuration and the nature of the sedimentary bodies and erosional forms that may be developed.

In studying coastal sedimentary bodies or coastal stratigraphic sequences, an important perspective to maintain is that the unit being examined is the result of a depositional environment that is not fixed in time and space. Rather, this depositional environment will migrate laterally and vertically depending on the net effect of influential processes acting on the coastal area. A shoreline is a stable feature only if there is a balance of all forces and processes that are tending to move the shoreline landward or seaward. If a balance is not achieved, a marine transgression or regression may result, and