MEETINGS

HGS LUNCHEON MEETING—MAY 30, 1990

MATT MATTHEWS—Biographical Sketch

Dr. Matthews joined Texaco Exploration and Production Research in 1984 as a Senior Research Consultant where he has been involved with predictive stratigraphy, dynamic modeling, fractures, and unconventional techniques. He received a BS from Allegheny College in 1960, a MS from West Virginia University in 1967, and a PhD from Northwestern University in 1973. Prior to joining Texaco he was an Assistant Professor of Geology at Washington State University and held several positions with Gulf Oil. He has been co-director of the industry side of the Geosat-NASA Test Case Program and director of the Oil and Gas portion of that study.

CLIMATE AND PREDICTIVE STRATIGRAPHY

The effect of climate on stratigraphy, while well-recognized, is generally misunderstood and under utilized by explorationists. While we all recognize that tropical climates tend to produce mature quartz-rich sands and arid climates result in immature arkosic sands, we often tend to consider climate as stable and geographically stationary over long periods of geologic time. This bias forces us to interpret entire stratigraphic sequences as being laid down under similar climatic conditions. In fact, climatic change is responsible for the dynamics of the depositional processes, and explains much of the richness of the stratigraphic record resulting from changes in weathering, runoff, and the water balance of the basin system.

Climatic change over periods of thousands to hundreds of thousands of years has been documented as far back as the Precambrian. These climatic changes are well-recorded by glaciation/deglaciation cycles in the Pleistocene. They are also suggested by parasequences, which imply eustatic cycles that are most easily explained by storage of water on continents as ice. This conclusion is supported by isotopic stratigraphy.

An example of the range of this climatic change is the climate of the northern Amazon basin, South America, which has changed from tropical/arid to tropical/humid since the last glacial maximum. Certainly the characteristics of the weathering products, the efficiency of the transport system, and the style of depositional environments have undergone associated changes and resulted in dramatic changes recorded in the stratigraphy of the basin. These short-term climatic fluctuations, caused by variations in insolation due to orbital and rotational oscillations of the earth, are called Milankovitch cycles.

Most stratigraphic thinking and models ignore these relatively short time variations; instead they concentrate on the much longer time frame of the tectonic evolution of basins and associated provenance areas. They also ignore the interaction of climate and tectonics and the different time scales within which each of these factors works. As a result, the capacity to interpret geology and forecast stratigraphy away from points of control is compromised and limited in its resolution. To increase our predictive ability, we integrate Milankovitch-scaled climatic oscillations with the long-term trends of tectonic basin evolution in a concept called Global Cyclostratigraphy.

Global Cyclostratigraphy assumes the principal controls on a depositional system to be: (1) global climatic pattern and continental configurations for a specific time interval, (2) climatic change with time, (3) petrology of the provenance area, (4) regional elevation, and (5) change in topography and subsidence with time.

Climate, interacting with provenance and tectonics, controls and varies: (1) weathering processes and rates, (2) volume of sediment delivered to a basin, (3) percentage of sediment that is coarse, sandy material, and (4) configuration of the depositional surface. These factors control sediment distribution within a basin.

Defining sedimentation in the terms described above permits short-term depositional changes to be interpreted and contrasted with long-term tectonic and climatic conditions. The pattern of the stratigraphic record can then be estimated based on the sedimentologic response to a predictable set of climatic changes.

The application of these principles to exploration will be demonstrated by examples from the San Julian Basin of Argentina (an offshore continental rift basin in the pre-exploration data analysis phase), the Anza Graben in Kenya (onshore, relatively early in the exploration process), and a reinterpretation of sediment timing in the Gulf of Mexico.