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High Frequency Paleoclimate Change: Impact on Exploration Strategy and Climate Research

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ABSTRACT

Orbital cycles alter insolation, which produces climate, sediment yield, lake and sea level cycles. The greatest insolation changes occur at the scale of precession (~20 kyrs) during periods of high eccentricity. Within a hemisphere, the climatic response of a specific region is a function of the phase of the insolation cycle and the paleogeography of the region. Some areas can become wetter while others become drier at the same point in an insolation cycle.

Climate cycles affect the type and rate of sediment weathering and transport, the sediment produced, grain sizes, and yield. Analysis of yield as a function of climate indicates that volume can vary by more than an order of magnitude depending on the conditions. Therefore, a climate cycle can produce a distinct sediment supply cycle whose nature is dependent on the regional climate succession. An added complexity, similar in some respects to the systematics of annual seasonality, is that precession-scale insolation cycles cause the warmest (or coolest) conditions in the Northern and Southern Hemispheres to be about 10 kyrs out of phase. This is significant because the affects of glacioeustasy, also a function of insolation and climate, are global. Prior to the Plio-Pleistocene, the common glacial state was a unipolar icecap. Under this condition, eustasy tended to track the precession-scale insolation cycle of the glaciated hemisphere. The results were that similar climatic successions in opposite hemispheres had yield cycles with distinctly different phase relationships to glacioeustasy. Such differences would not exist in an ice-free world.

Understanding the inherent paleoclimatic and stratigraphic variability of a system helps improve depositional models and interpretation and reduces the uncertainty associated with exploration analyses. For example, by taking into account the interaction of sediment yield and sea level, exploration areas that are prone to the development of sand-rich submarine fans or deltas can be forecast and high graded. The same approaches can be used for lacustrine regimes.

Additionally, evaluating the stratigraphic record and recognizing that these types of variability occur and mapping them in an accurate chronologic framework will greatly assist paleoclimate modelers by ensuring that simulations are run with the appropriate input parameters and by validating their simulations at the appropriate timescales.