THE CLIMATIC CONSEQUENCES OF A RARE ORBITAL ANOMALY AT THE OLIGOCENE/MIOCENE BOUNDARY (23 MYA)

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The late Oligocene to early Miocene (20-26 Ma) is characterized by a complex climate history that includes a stepped transition toward a cooler climate, intermittent partial glaciations of Antarctica, and a transient glaciation, Mi-1, at the Oligocene/Miocene (O/M) boundary. The Mi-1 event is characterized by an anomalous positive oxygen isotope excursion, the magnitude of which suggests the brief appearance of a full-scale ice-sheet on east Antarctica coupled with a few degrees of deep sea cooling. A recent breakthrough in extending the astronomical calibration back to ~30 Ma has provided a unique opportunity to compare the climatic events of the O/M transition relative to Earth's orbital variations. Here, we present an uninterrupted 5.5 My long high-fidelity chronology of late Oligocene-early Miocene climate and ocean carbon chemistry that is based on a composite isotope time series from two deep-sea cores (ODP Sites 926 and 929) collected in the western equatorial Atlantic. This unique isotope record provides a rare window into how the climate system responded to orbital forcing under boundary conditions significantly different from those of the recent past. Time-series analyses reveal climate variance concentrated at all Milankovitch frequencies, but with unusually strong power at the primary eccentricity band periods of 406, 125, and 95-ky. These cycles, which represent in part glacial advances and retreats of Antarctic ice-sheets, show significantly enhanced variability over a 1.6 My period (21.4-23.0 Ma) of suspected low greenhouse gas levels as inferred from the carbon isotope record. Perhaps the most unexpected finding is that of a rare orbital congruence between eccentricity and obliquity that precisely corresponds with the Mi-1 glaciation. This orbital anomaly involves ~ four consecutive cycles of low amplitude variance in obliquity (a node) during a period of low eccentricity. The net result is an extended period (~200 ky) of low seasonality orbits which allow for a step-like expansion of an Antarctic ice-sheet.

Earth System Processes - Global Meeting (June 24-28, 2001)

Session No. T4
Critical Transitions in Earth History and Their Causes
Edinburgh International Conference Centre: Pentland
10:00 AM-4:30 PM, Wednesday, June 27, 2001