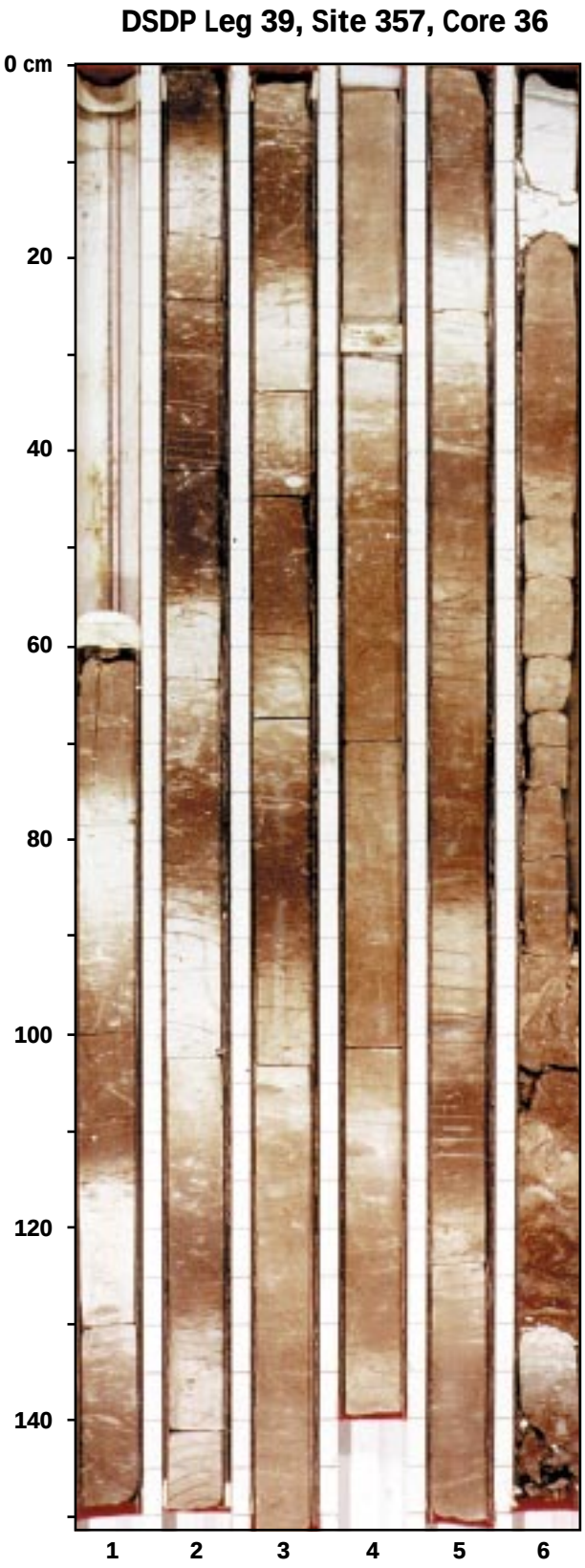
CLIMATE PERIODICITY IN "ICEHOUSE" AND "GREENHOUSE" WORLDS

Timothy D. Herbert, Department of Geological Sciences, Brown University



Deep-sea sedimentary records show shifts between glacial and warmer climates that are surprisingly periodic, and even predictable, over the last two to three million years of so-called "icehouse" conditions on Earth. Statistical analyses link these climatic cycles to periodic variations in seasonal heating resulting from, and indeed paced by, subtle changes in Earth's orbital geometry. These results beg the question, "What kind of cycles are observed in the much more ancient past, when factors controlling the climate system were operating in a significantly different manner?" To address this, we analyzed DSDP cores from the late Cretaceous (84 - 65.5 Ma), a time of warm "greenhouse" conditions, when Earth was essentially ice-free. Variations in Cretaceous climate modulated the types of sediment that formed, thus affecting sediment color (see photo). We measured variations in light intensity of these colors and observed a dominating cycle with a 23,000-year periodicity. This cycle, which closely matches Earth's precessional orbital cycle, is also observed in geologic records from the more recent "icehouse" world. The causal link between the sedimentary and orbital cycles is supported by the fact that this Cretaceous cycle shows amplitude modulations — patterns of constructive and destructive interference — that are characteristic of Earth's precessional cycle. These oscillations have been observed continuously for stretches as long as 20 m.y., and have been correlated among widely disparate drill sites using magneto- and biostratigraphy. Such observations tell us that Earth's ancient climate was sensitive to small changes in incoming solar radiation, even without the amplifying effects of continental ice sheets that exist in today's "icehouse" world. In addition, the cycles act as celestial "clocks" enabling geologists to measure time in the rock record at high precision, and across critical events, such as the biological upheaval at the Cretaceous-Tertiary mass extinction [*Herbert and D'Hondt,* 1990].

Reference:
Herbert, T.D., and S.L. D'Hondt, Precessional climate cyclicity in late Cretaceous-early Tertiary marine sediments: A high resolution chronometer of Cretaceous-Tertiary boundary events, *Earth & Planetary Science Letters, 99,* 263-275, 1990.

Campanian age (circa 75 Ma) carbonate cycles at DSDP Site 357 (Rio Grande Rise, Atlantic). Sediment variability reflects periods of enhanced carbonate production (light beds) and clay mineral deposition (dark beds) paced by Earth's 23,000-year precessional cycle.