Geophysical Research Abstracts, Vol. 7, 11190, 2005
SRef-ID: 1607-7962/gra/EGU05-A-11190


# Geosystems: probing earth's deep-time climate & linked systems

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Climate research in "deep" (pre-Quaternary) time has experienced a decade of intense discovery aided by a revolution in analytical techniques. An emerging theme is that Earth has experienced numerous episodes of extreme climatic states, ranging from near-global freezing, to extreme "hothouse" conditions. These events had profound effects on life and the global carbon cycle. GeoSystems is an interdisciplinary, community-based initiative stemming from the growing recognition that a full understanding of Earth's climate system –and our climate future– lies in examining this wealth of "alternative-Earth" climatic extremes.

A multitude of powerful new models and proxies and sharp increases in the precision and resolution of chronology have energized deep-time climate research. Combined, these advances enable extensive reconstruction of Earth's paleoenvironments, with accurate estimates of rates and magnitudes of past global change. The geologic record is an archive of the full magnitude of extreme climate events—from onset through peak and recovery. Our modern climate state – that of a relatively stable interglacial phase of an icehouse with glaciation at both poles – is representative of only 80,000 yrs, or 0.015%, of the Phanerozoic Eon (last 540,000,000 yrs). Earth's climate changes perpetually, far beyond the limits known from the modern and near-modern world. Only through knowledge of Earth's full range of climatic possibilities can we fully grasp the cause-and-effect relationships between climate and civilization and, thereby, prediction of future climate states.

A large community of geoscientists who hail from a variety of subdisciplines has assembled around the *GeoSystems* initiative, which arose from U.S. National Science

Foundation-sponsored workshops on “deep-time” in 2003 and 2004. This community recognizes and embraces the importance of the deep-time perspective for understanding the complexities of Earth’s atmosphere, hydrosphere, biosphere, and surficial lithosphere using climate as the nexus. Our collective vision in GeoSystems is to create synergy among earth-, ocean-, and atmospheric geoscientists in pursuing research that spans diverse analytical, numerical and field-based approaches in striving to achieve a holistic understanding of Earth’s climate and linked systems. This initiative has garnered widespread support, resulting in a cohesive set of needs that cross the artificial boundaries that have historically limited climate research. Among other needs, research in GeoSystems will require an ambitious continental drilling program to acquire pristine records in key successions, and a concerted effort to synthesize large datasets. On the latter challenge, GeoSystems will benefit from strong linkages from allied efforts such as CHRONOS, which is an established initiative funded by the U.S. National Science Foundation and dedicated to development of a dynamic, interactive, and time-calibrated network of databases and analytical methodologies for understanding Earth processes through time.

Progress in GeoSystems is continuing with a variety of networking activities intended to grow the community and stimulate interdisciplinary collaboration. Ultimately, the focus on climate in deep time demands participation from a multidisciplinary, multinational and committed cross-section of the geoscience community.