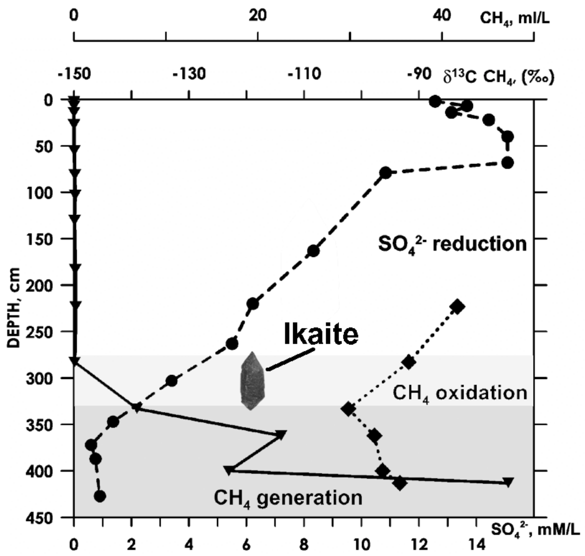
Autigenic carbonate mineral ikaite originated from biogenic methane in the Kara Sea sediments.

L.A. KODINA, E.M.GALIMOV

V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences (galimov@geokhi.ru)

Various modifications of autigenic carbonates have been found during German-Russian expedition on board r/v “Akademik Boris Petrov” (2001) in Holocene sediments of the Kara Sea between the latitudes of 73 to 77° N, situated mainly along the Yenisei ancient channel. Among them there are carbonate concretia (nodules), dispersed carbonates (cement) and crystalline mineral ikaite ($CaCO_3 \cdot 6H_2O$) specific to low-temperature (near zero) environments. Ikaite is a metastable mineral at the room temperature: it transforms to calcite and water. The all studied antigenic carbonates are characterized by depletion in the heavy carbon isotope. The ikaite carbon isotope composition varies from -24‰ to -49‰.

Figure 1: Kara Sea, St. BP-00-37



The pore water composition and methane concentration have been studied along with carbon isotope analysis. (Fig.1). Biogenic methanogenesis manifests itself by high content of isotopically depleted methane (_^{13}C= -102 to -104‰). Methane appears to be a source of isotopically depleted CO_2, which involves to ikaite precipitation. The methane transformation to CO_2 (“anaerobic CH_4 oxidation”) resulted from sulphate reduction, with the methane being used as a hydrogen source.

The role of dust in climate cycles

K. E. KOHFELD

MPI-Biogeochemistry, Jena, Germany (kek@bgc-jena.mpg.de)

Although atmospheric dust contributes significantly to the modern atmospheric aerosol load, even the sign of the direct radiative impact of dust on modern climate is unknown. Our ability to quantify the impacts of dust on the climate system depends on our understanding of (a) processes controlling the contributions and properties of naturally varying and anthropogenic dust emissions, (b) how these contributions change through time, and (c) how atmospheric dust then interacts directly and indirectly with the earth system.

The geologic record of dust from ice cores, marine sediments, and terrestrial records demonstrates that the glacial world was significantly dustier than today, suggesting that the climate impacts of dust were larger in the past. Glacial dust deposition rates downwind of tropical to subtropical regions were ~1-3 fold higher than today. Glacial areas of dust deposition were expanded in midcontinental regions, with highest glacial dust accumulation rates (~5000 $g/m^2/yr$) in the midcontinental USA. Dust accumulation rates across the Chinese Loess Plateau were 2-4.5 times larger overall, with regional median deposition rates of 310 $g/m^2/yr$.. Combined with vegetation and lake status records, these data suggest that arid-to-semi-arid regions were expanded at the LGM.

Although the overall magnitude of high latitude glacial dust deposition rates remained small, they nevertheless increased 2-20 fold, and pose several interesting problems. First, dust provenance studies suggest that the most likely source for dust reaching the Greenland and Antarctic ice cores are Asian and Patagonian deserts, respectively. Second, the accompanying micronutrients in this dust may have been sufficient to impact marine biota and atmospheric [CO_2] uptake in key iron-limited oceanic regions.

Attempts to simulate these glacial-interglacial changes in dust have resulted in several advances of our simulation of the dust cycle. First, emissions in the most recent global dust models depend on changes in climate (i.e., winds and moisture balance) as well as land-surface conditions (e.g. vegetation cover, soil wetness, and preferential dry lake bed sources). Incorporation of these feedbacks results in a significant increase in global glacial dust emissions, in particular in Asian deserts at the LGM. Higher atmospheric dust concentrations at the LGM are also expected to have an impact on the global radiative budget. Although the high-latitude mean change in radiative forcing (LGM minus modern) is small relative to the forcing associated with ice sheets, the glacial decrease in radiative forcing in the tropics is of the same magnitude as the radiative cooling effect of low atmospheric [CO_2]. Finally, ocean biogeochemistry models show that the simulated impact of high LGM dust deposition rates in today's iron-limited regions produce a drawdown of atmospheric [CO_2] ranging from 8 to 40 ppm, suggesting that dust could provide a significant contribution to glacial-interglacial cycles of [CO_2] changes.