Simulation of glacial-interglacial atmospheric CO_2 variations using a comprehensive Earth system model of intermediate complexity

A. GANOPOLSKI[1]*, V. BROVKIN[2] AND R. CALOV[3]

[1]PIK, Germany (*correspondence: andrey@pik-potsdam.de)
[2]MPI-M, Germany (victor.brovkin@zmaw.de)
[3]PIK, Geramny (calov@pik-potsdam.de)

The mechanisms of strong glacial-interglacial variations in the atmospheric CO_2 concentration (the so-called "80 ppm problem") and the role of CO_2 in driving glacial cycles still remain debatable. Here using the model of intermediate complexity CLIMBER-2 which includes all major components of the Earth system – atmosphere, ocean, land surface, ice sheets, terrestrial biota, eolian dust and marine biogeochemistry – we performed simulation of the last glacial cycle using variations in the Earth's orbital parameters as the only prescribed climatic forcing. The model simulates rather realistically temporal and spatial dynamics of the Northern Hemisphere glaciation and temporal variability of the atmospheric CO_2 concentration. The initial drop in CO_2 concentration by about 40 ppm during the glacial inception is related primarily to the physical mechanisms – increase of the ocean solubility and relative volume and the age of the Antarctic bottom water masses. The latter is related to increased sea ice formation in the Southern Ocean and lowering of the surface salinity in the northern North Atlantic. At the time around the Last Glacial Maximum (ca. 21,000 years before present), approximately half of simulated 80 ppm drop in CO_2 is explained by the well-known physical mechanisms (ocean temperature, circulation and sea ice) and another half - by an increase of biological productivity in the Southern Ocean which is directly related in the CLIMBER-2 model to increase of eolian dust supply into the Southern Hemisphere via the iron fertilization mechanism. With the onset of the glacial termination, initial rise in the atmospheric CO_2 concentration is explained by a weakening of the Atlantic thermohaline circulation due to increased freshwater input into the northern North Atlantic. The model is able to simulate the return of CO_2 concentration to its interglacial value after termination of the glacial cycle but simulated CO_2 concentration still lags considerably behind the reconstructed one which indicates either some missing mechanisms or inadequate representation of some mechanisms explicitly described by the model.

Metallogenesis of Dongsheng sandstone hosted uranium deposits in Ordos Basin

B. GAO*, W. ZHANG AND Z. SUN

East China Institute of Technology, Jiangxi Province 344000, China (*correspondence: bgao@ecit.edu.cn)

The Dongsheng uranium deposits are located in the northern part of Ordos Basin which is an important base of mineral resources in NW-China.

The stratigraphic configuration studies indicate that Cretaceous, Jurassic and Triassic are major periods for the formation of uranium deposits in Dongsheng area. The sandstone-type uranium deposits are hosted by Jurassic sandstone formations and formed in the paleo-interlayer oxidation zone. Uranium ore bodies were mostly located at or near the contact zone between gray sandstones and gray-greenish sandstones.

The metamorphic rock and granite with higher content of uranium distributed in northern Ordos basin were denudated and transported to the Dongsheng area during the Jurassic and the Cretaceous periods [1]. Uranium-ore forming fluid was formed by rich oxygen-containing meteoric water-rock interactions. The fluid transported into the paleo-interlayer oxidation zone and uranium precipitated from the solution in reduction barrier by the secondary reduction. In addition, the uranium deposits were controlled by the sand bodies formed in paleo-braid-type stream channels, sedimentary sequences of Jurassic Formation [2], sand bodies' heterogeneities [3], and deep-source gases [4]. Moreover, the later-coming solution with rich oxygen dissolved uranium ores again and continually re-transported and re-precipitated in different redox environments. Therefore, the mineralization process included pre-concentration during diagenesis period, interlayer infiltration mineralization from Late Jurassic to Paleocene time, re-concentration, and re-precipitation with changing of redox conditions.

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