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Early Cretaceous glendonites of Arctic realm: distributions and their paleoclimate implication

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In the middle of 20th century glendonites were purposed as an indicator of cold climate. There is no doubt that unique morphology and sizes of pseudomorphs occurring through Precambrian to Quaternary succession indicate uncommon geochemical environment. Here, we present an overview of Early Cretaceous glendonites distribution across Arctic which widely distributed here despite generally greenhouse climate conditions in Early Cretaceous.

Late Berriasian pseudomorphs are known on northeastern Siberia and Arctic Canada. Valanginian glendonites are the widest ones are described from the Northern and Western Siberia, Spitsbergen and the Arctic Canada. Late Hauterivian concretions were studied on Svalbard. Barremian and lower Aptian glendonites are unknown in this area due to wide distributed continental succession, but late Barremian glendonites were reported from the wells drilled on the Barents Sea shelf. Middle and Upper Aptian glendonites are found on Svalbard, North Greenland, the Arctic Canada and North-East Russia. Lower Albian glendonites are found on Svalbard, islands of Arctic Canada and the Koryak Uplands.

Nowadays it is reliable known that the precursor of glendonites is an ikaite - metastable calcium carbonate hexahydrate, forming in a narrow temperature range from 0-4°C, mainly in near-bottom conditions. Besides low temperature, high phosphate concentrations that occurs due to anaerobic oxidation of methane and/or organic matter; dissolved organic carbon, sulfates and amino acid may favor to ikaite formation as well. However, glendonites associated with terrigenious rocks, often including glacial deposits, that allow to use them as a paleoclimate indicator.

Glendonites show a wide variability in form and size: from single crystal blades to stellate aggregates and rosettes, usually ranged from a few mm to dozens of cm. Mineralogical composition of pseudomorph is represented mainly by three calcite phases determining by CL-light. Both $\delta^{18}O$ and $\delta^{13}C$ of glendonites are characterized by a broad range of values. Oxygen isotope composition ranges from -14 to -0 ‰ Vienna Pee Dee Belemnite (VPDB), whilst carbon isotope composition ranges from -52.4 to – 14 ‰ Vienna Pee Dee Belemnite (VPDB).

Based on received data we suggest that $\delta^{18}O$ reflects the complex processes involved in ikaite-

glendonite transformation, supposing mixing depleted fluids with seawater. Nevertheless, received data coincide with $\delta^{18}O$ values reported from Paleozoic-Quaternary glendonites formed in near-freezing environments. Values of $\delta^{13}C$ of glendonites is the result of both mixing seawater inorganic carbon and sedimentary organic diagenesis and close to bacterial sulfate reduction and/or anaerobic oxidation of methane or organic matter.

To conclude, Early Cretaceous climate was warm generally, however studied pseudomorphs point to cold episodes in Late Berriasian, Valanginian, Late Hauterivian, Middle-Late Aptian and Early Albian.

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