Origin of non-equilibrium uranium 
$^{234}\text{U}/^{238}\text{U}$ in Barents Sea

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Within the Arctic marine expedition “Transarctic-2019” (research vessel «Mikhail Somov», Arctic and Antarctic Research Institute, St.Petersburg, Russia) the isotopic composition of uranium $^{234}\text{U}/^{238}\text{U}$, stable isotopes ($\delta^2\text{H}, \delta^{18}\text{O}$) and chemical parameters of seawater of the Barents Sea were studied. The data indicate the multicomponent of dissolved substance sources and seawater. Measured uranium isotope ratios $^{234}\text{U}/^{238}\text{U}=0.97–1.73$ differ significantly from the average for the World Ocean $1.145\pm0.003$ [1]. Ratios $^{234}\text{U}/^{238}\text{U}<1.13$ in the Barents Sea are due to the contribution of the Arctic Ocean water masses and river runoff. The maximum ratio $^{234}\text{U}/^{238}\text{U}>1.3$ were found near the western coast of Severny Island of Novaya Zemlya covered with an inner ice cap.

Probable source of $^{234}\text{U}$ excess is groundwater containing meltwater from permafrost. The mechanism of its anomalous enrichment in uranium-234 may be as follows. During the Weichselian glaciation, secular equilibrium in the $^{238}\text{U}$ chain for mineral lattice could be upset only due to $^{234}\text{Th}$ recoil. But this process is negligible if the mineral grain size is $>0.1$ mm. As the liquid water was absent in the permafrost zone, the $^{234}\text{U}$ could leave lattice only due to diffusion into the non-freezing water film the host rocks and sediments, which has a small chemical capacity. After the start of permafrost thawing, liquid water appeared and leached $^{234}\text{U}$ from the water-bearing rocks predominantly in comparison to $^{238}\text{U}$ due to the high geochemical mobility of $^{234}\text{U}$.

In continental conditions confirmation of this mechanism was obtained in the study of groundwater, including the determination of $\delta^{18}\text{O}, \delta^2\text{H}, ^{234}\text{U}/^{238}\text{U}$ and helium dating [2, 3]. Detection of increased $^{234}\text{U}/^{238}\text{U}>1.3$ ratios in modern seawater correlates with an increase of $^{234}\text{U}$ excess in corals and carbonate sediments of the Arctic Seas during warm periods [4].


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