

Sorption removal influence on the transformation of dissolved uranium (VI) runoff in the river water – seawater mixing zone

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Special attention is paid to radio ecologic research, when studying chemical transformation of continental runoff in river mouth areas. Sorption-desorption processes are especially important for trace elements characterized with low coefficients of biologic accumulation. Experimental simulation of interaction between waters of various salinity which contain uranium (VI) and terrigenous clay minerals was provided aimed at revealing the role of sorption-desorption processes in transformation of runoff of dissolved uranium in the river water – seawater mixing zone.

The resultant action of sorption-desorption processes was estimated based on experimental parameters of isotherms of uranium sorption at natural clays of different composition. Calculations showed that sorption removal of essential amounts of dissolved uranium occurs when river suspended solids interact with saline waters. These amounts approach 0.07–0.08, 1.5–2.9, and 0.13–0.16 nmole/g at sea-side boundary of mixing zone for kaolinite, montmorillonite, and polymineral Gzhel clay varieties, respectively.

The relative abundances of clay minerals in the sample of polymineral Gzhel clay correspond to average abundances in suspended solids for rivers of the world, with only exception for montmorillonite. When accounting of correction coefficient for difference in total amounts of clay minerals in the Gzhel clay (53%) and in the global solid runoff (67%), the value of specific sorption of uranium at the Gzhel clay rises from 0.13–0.16 nmole/g up to 0.16–0.20 nmole/g or 39–48 ng/g at transition from river water to seawater. The total amount of suspended solids removed to the Ocean was estimated varying from 15.7 to 18.5 billion ton per year [Walling, Webb, 1987; Lisitsyn, 1978]. Consequently, the amount of sorption removal of uranium values 610–890 ton per year at the river–sea barrier, when applying the Gzhel clay as the analog of suspended solids in continental runoff.

Values of uranium sorption at montmorillonite clay are an order of magnitude higher than values for the Gzhel clay (1.5–2.9 nmole/g). As the result the presence of montmorillonite in suspended solids causes essential increase of uranium removal from solutions. River suspended solids contain ~3% of montmorillonite, thus additional removal of uranium was estimated at 170–380 ton per year. Hence the total amount of uranium removed by sorption at terrigenous solids is equal to 780–1270 ton per year. The amount of dissolved uranium entering seawater with river runoff was estimated at 20 000 ton per year. Considering this estimation the sorption removal of uranium is insignificant (4–6%).

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Li-Sr-Lu-Hf isotope and trace element systematics of eclogites from Bulgaria

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Eclogites from the Sredna Gora Terrane and the Rhodope (UHP) Massif lie in southern Bulgaria and northern Greece and are part of the Alp-Himalayan orogenic belt. Two groups of eclogites were studied. Group 1 eclogites (Verila Mts., Ograzden Mts., E. Rhodope Mts.) have 1-10 x chondrite (CI) HREE concentrations and $[La/Sm]_N = 0.2-1$ and variable $^{87}Sr/^{86}Sr$ (0.7035-0.7098). This group also shows MORB-like trace element systematics and Nb/Zr (0.07-0.26), Nd/Pb (~1), Hf/Yb (0.22-0.48) and Nb/U (~29) ratios. Group 2 eclogites (Central Rhodope Mts.) have 30 x (CI) chondrite HREE abundances, $^{87}Sr/^{86}Sr$ ratios between 0.7057 and 0.7077; enriched LREE ($[La/Sm]_N = 1.1-2.5$), elevated LILE contents and Nb/Zr (0.25-0.94), Nd/Pb (~9.5) and Nb/U (~32) ratios, but relatively low Hf/Yb (0.17-0.20). One interpretation of the data is that group 1 eclogites represent metamorphosed altered oceanic crust and group 2 eclogites record interaction with crustal melts/fluids possibly in an arc crust environment. In situ analyses by SIMS (*Cameca 6f*) of garnets and omphacites show depleted LREE and little core to rim trace element variations. The Li abundances of all garnets (1-2.5 ppm) and omphacites (45-56 ppm) are in the typical range for eclogites [1]. Mineral separates and bulk rocks from group 1 have extremely light δ^7Li (+1.2 and -12.9 ‰) compared to group 2 ($\delta^7Li = -0.26$ to +5.7 ‰). Our data confirm earlier studies reporting very light δ^7Li in eclogites from the Alps [1].

The Lu/Hf isotope systematics of omphacite-garnet pairs suggest that eclogites from Central Rhodope Massif are of Late Proterozoic (Pan African) age [Beden eclogite = 567 Ma], almost identical to ophiolite successions throughout the basement of the Balkan Terrane to the north. Eclogites from Ograzden Mts. and Verila Mts. record Carboniferous metamorphic overprint [Gega eclogite = 293 Ma; Krainitsi eclogite = 320 Ma]. The Variscan orogeny in Bulgaria was established based on stratigraphy and abundant 300-315 Ma granitic intrusions [2]. The reported Lu/Hf age of eclogites from the Ograzden and Verila Mts. (in addition to zircon metamorphic rim geochronology [2]), implies the existence of previously not known high-grade metamorphic event similar to the one recorded in western and central Europe. These results on well-preserved Bulgarian eclogites provide a sensitive record of the pre-Mesozoic subduction events in the southern margin of the European continent.

References

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- [2] Carrigan, C. *et al.* (2005), *Lithos*, 82, 125-147.