Geochemical parameters and age of U ores related to sodium metasomatism in the Ukrainian Shield

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The first U deposits related to sodium metasomatism in Ukraine were discovered in 1946 in the Kryvy Rig-Kremenchug syncline zone filled with iron metasedimentary formations. Since that time around 20 deposits with actual resources over 200 000 t of U were discovered westward in the gneiss-migmatite-granite formations of the Ingul megablock of the Ukrainian Shield.

Albitite bodies were developed along with crystallization of aegirine and Na-amphyboles as major femic minerals but U mineralization is predominantly represented by uraninite and brannerite. Albitization was supported by dequartzification of the host rocks (silica ejection) with formation of episiyenites around albitites when in the host granites or aegirinites and reibeckitites when in the iron formations. Ca metasomatism is also widely spread in the deposits and is the major factor controlling U ore position.

U-bearing albitites are enriched in Na, Ca, Sr, P, F, Be and Zr but dramatically depleted in Si and K in comparison with the host rocks. Hondrite-normalised REE distribution in the host rocks and U ore bodies is in general similar although depletion in LREE connected with the hydrothermal alterations is often detected. Uraninite and brannerite irregularly contain isomorphic Th but Th content in the host rocks and in the ores scatters similarly in low amount from 0.6 to 70 ppm. La/Yb index varies from 1 to 105, progressively decreases with increasing Th content in the host rocks of the Kirovograd megablock whereas both in the metamorphic rocks of the Kryvy Rig-Kremenchug syncline and in all ore samples positive correlation between Th content and La/Yb ratio is observed. This effect suggests synchronous leaching of La and Th during albitization and U ore deposition.

U/Pb dating was performed for uraninite crystals of the Zhovta Richka U deposit using CAMECA 3F SIMS (CNRS, Nancy). Uraninite contains impurities of non-radiogenic ^{204}Pb but corrected for the corresponding radiogenic lead U/Pb isochronic age is 1760±22 Ma (10 points solution).

Vanadium: A new biomarker of ancient life

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Carbonaceous microstructures from the 3.5 billion year old Apex Chert have been proposed as the oldest evidence of life on Earth [1, 2]. However, they have also been described as abiotic material formed by Fischer-Tropsch-style reactions within a hydrothermal depositional environment [3, 4]. Several analytical techniques have been applied to these microstructures [5, 6], but it is still unclear if abiotic or biotic processes were the dominant mechanism of formation [7].

New Data for an Old Problem

To obtain a new perspective on the issue, we isolated carbonaceous microstructures from the Apex Chert and analyzed them with synchrotron-based x-ray flourescence. The data collected reveal that the concentration of vanadium is significantly greater in the carbonaceous microstructures than in the host cherts. Vanadium is a biologically important element, and is used by many organisms, including nitrogen-fixing bacteria [8]. Proxy data, including the concentration of vanadium found within Archean shales, indicate that the Archean oceans were depleted in vanadium [9, 10]. Additionally, as vanadium is not adsorbed by organic material [11], its enrichment in these carbonaceous microstructures is best explained by biological concentration. Thus, these new data indicate that these controversial carbonaceous microstrucutres are of biological origin, and that vanadium, therefore, is a good biosignature for prospecting for signs of life in the Archean Apex chert, as well as in other ancient deposits.

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