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Anomalous uranium enrichment in coals from Odeř, Sokolov Basin, Czech Republic

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Contents of uranium in coals from Odeř in the northernmost part of the Sokolov Basin, Czech Republic, reach extremely high values, up to several wt%. The coal seam is situated in the vicinity of well known St. Joachimsthal uranium ore deposits. The coals from Odeř can be classified as xylitic to detritic brown coal orthophase. The present study has been aimed at investigation of this uraniferous mineralization by detailed characterization of the anomalous coals in comparison with a representative set of Czech coals. The characterization included proximate and ultimate analyses, multielement analysis by neutron and photon activation analyses, structural characterization by infrared microspectroscopy, and micropetrographic analysis.
Contents of uranium in the studied Odeř coals ranged from 45 ppm to 6 wt%, contrary to common contents in other Czech coals not reaching a ten ppm level. The anomalous uranium levels seem to be associated with organic matter as indicated by positive correlation between uranium and oxygen (dry, ash free) contents in Odeř coals, contrary to other coals where the uranium content is correlated rather with the mineral (clay) fraction. The infrared microspectroscopy showed that the uranium enrichment was accompanied with decrease in aliphatic C-H bonds and slight increase in oxygen functional groups. The observed uranium microclusters are not formed by uranyl species, but probably by uraninite. These clusters with signs of strong thermal or radiolytic alteration of surrounding coal matter were clearly observed also by micropetrography.
The study has confirmed previously proposed explanation of uraniferous mineralization in sedimentary carboniferous substances by the mechanism of fixation and reduction of soluble uranyl species (e.g., humic, carbonate/hydroxo complexes) by sedimentary organic matter under diagenetic or hydrothermal conditions, and formation of uraninite. The process is accompanied with oxidation of alcohol functional groups and dehydrogenation of aliphatic C-H bonds, and release of molecular hydrogen and protons.

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