

ACTINIDES IN GEOLOGY, ENERGY, AND THE ENVIRONMENT

Radiation damage in sulfides: Radioactive galena from burning heaps, after coal mining in the Lower Silesian basin (Czech Republic)

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ABSTRACT

The isotopic composition of lead ($^{207}\text{Pb}/^{206}\text{Pb}$, $^{208}\text{Pb}/^{206}\text{Pb}$, and ^{210}Pb) in a recently formed galena from burning heaps after coal mining in Radvanice, Markoušovice, and Rybníček, the Lower Silesian basin, Czech Republic, was studied in detail. ^{210}Pb activity in galena varied from 135 ± 9 to 714 ± 22 Bq/g and calculated integral doses ranged from 2.21×10^{11} to 6.11×10^{11} α/g . The radioactivity of the galena causes micro-deformations in its crystal structure as indicated by the Williamson-Hall graphs, showing that the level of micro-strain depends on the length of time that galena samples were exposed to the radiation. However, the crystal structure of galena is affected very inhomogeneously; according to TEM investigations there are domains of fully crystalline, polycrystalline, and fully metamict galena within one crystal. Inductively coupled plasma-mass spectrometry (ICP-MS) was used to determine the isotopic composition of the studied galena. The stable isotope ratios of Pb varied for $^{207}\text{Pb}/^{206}\text{Pb}$ from 0.8402 to 0.8435 and for $^{208}\text{Pb}/^{206}\text{Pb}$ from 2.0663 to 2.0836. The average ratios $^{207}\text{Pb}/^{206}\text{Pb} = 0.8312$ and $^{208}\text{Pb}/^{206}\text{Pb} = 2.0421$ were obtained for coal from the same localities. These isotope ratios show that there is no isotopic fractionation taking place during the coal burning and subsequent galena crystallization from hot gases.

Keywords: Galena, radiation, lead-isotopes, radiation effects, metamict state