Environmental effects of the Zarand coal mines and coal washing plant in Kerman Province, Southeast Iran

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The Zarand coal mines are located 80 Km northwest of Kerman, southeast Iran. The coal seams are situated in a large synclinal structure and the age of the coal based on their fossil contents is late Triassic to early Jurassic. Several openings in this mining area are presently operating with various names such as Pabdana, Babnizu, Khomrud, etc. In the vicinity of the Zarand coal mines there is a coal washing plant that reduces the amounts of coal ash to 10-12 percent. The excess amounts of the ashes are sent to a pool that was constructed near the plant.

At present more than 6 million tons of waste materials are piled up in the dumping areas and the sedimentary basins near the coal washing plant. Every year the amounts of the additional wastes are estimated to be more than 400000 tons.

In this investigation water, soil, mines wastes of the coal washing plant (ancient and recent), coal concentrates, and the coals from various active and abandoned mines were sampled. After accurate sampling, the samples were precisely prepared for laboratory examinations.

The results of different chemical analyses on the waste materials of the coal washing plant indicated that the amounts of As Pb, Cu, Fe, K, Mn, Mg, Ni and Ca are higher than the standard amounts of these elements in the coal mining industries of other parts of the world. The amounts of As, Cu, Fe, Mo, Mn, Pb and Zn are also high in the coal samples of the of the coal mines. The abundance of these elements in coal during mining and coal washing processes could be considered as the source of contamination of soils and water(underground) in the mining areas. So, the water from the wells located in the areas downwards the coal washing plant are contaminated with the several toxic and semi toxic elements and should not be used for drinking purposes.

Direct (U-Th)/He dating of native metals

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Relatively quick migration of helium from crystal structures has been known for a long time. However, there is a group of minerals – native metals – where the stability of helium is anomalously high: (a) native metals have the highest volume density, therefore helium migration is hindered in comparison with other minerals; (b) helium, due to its very low solubility in metals, assembles in atomic clusters - "bubbles" of nanometre size. Migration of helium "bubbles" as a whole from the crystal structures needs relatively high temperature near the melting point of metals [1].

Native metals contain $\sim 10^{-7}$ g/g of uranium in average. Nevertheless, the concentration of radiogenic helium in native metals is sufficient for detection.

In our work we used the following experimental setup: mass-spectrometer complex MSU-G-01-M ("Spektron-Analit", Russia) with a constant magnetic field. The sensitivity of the spectrometer for ^{4}He determination is $\sim 10^5$ atoms. It allows us to reliably detect radiogenic ^{4}He in the samples of microgram weight. The concentration of U was determined by the isotope dilution analysis with ^{235}U tracer. The results of U analyses in parallel aliquots are reproduced within the accuracy of 0.5%. The blank level did not exceed 1 pg of U. Isotopic composition of U was determined on Finnigan MAT-261 multicollector mass-spectrometer.

Due to a strong heterogenity of uranuim distribution in native gold we have performed the measurements of uranium and helium concentrations in a single gold granule. In order to avoid uranium loss during the helium extraction, the gold sample was put in a sealed pumped out quartz tube.

We are going to discuss the first results and draw a conclusion about the possibility of using (U-Th)/He method for the direct dating of native gold and other native metals.

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[1] Shukolyukov, Yakubovich, Rytsk (2010), *Doklady Earth Sciences*, **430**,1, 243-247