Helium isotopic gradients in a catchment basin: Constraining groundwater flow patterns and residence times

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Fifty-six groundwater samples were collected for noble gases analysis from Ordovician fractured aquifers and Quaternary granular aquifers at the Bécancour Basin. This is one of several basins collecting waters from the Appalachian Mts and discharging into the St. Lawrence River, between Montreal and Quebec, eastern Canada. Multiple goals were at the origin of this extensive survey. The main goals of this study were to identify groundwater flow paths and to estimate groundwater residence times. In particular, helium was coupled to alcanes (CH_4, C_2H_6, C_3H_8) to identify gas seepage potentially originating in the deeper Utica shales, a local target for shale gas exploration.

Helium isotopic data show the occurrence of three components: atmospheric, i.e., an air saturated water (ASW) origin, tritiogenic and terrigenic. Tritiogenic helium is found both in Quaternary granular and Ordovician fractured aquifers. In the eastern border of the basin, a helium isotopic gradient with depth is observed, from values close to atmospheric $^3He/^4He$ (R) ratio of 1Ra at the surface up to 4.5Ra at 60 m depth. Preliminary minimum ^3H-^3He ages range from modern to 32 yrs. Waters show radiogenic ^4He concentrations from 10^{-7} to 10^{-5} ccSTP/g, i.e., up to three orders of magnitude higher than ASW. Interestingly, some of these samples contain tritium suggesting that these are young waters enriched by extraformational ^4He (^4He excess). In these two areas, concentration gradients with depth are apparent, suggesting vertical migration of He from deeper horizons. Using an advective-diffusive model, ^4He fluxes were estimated and range from 3.2×10^{-10} to 1.2×10^{-9} mol m^2 yr^{-1}, flux values that are smaller than the average crustal flux of 1.7×10^{-6} mol m^2 yr^{-1} but closer to a pure flux from *in situ* production of 2×10^{-9} mol m^2 yr^{-1}.

Mineralogy and distribution of Indium and Selenium metals within zinc-rich ore types of the Neves Corvo deposit, Portugal

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The Neves Corvo deposit is located in the Portuguese segment of the Iberian Pyrite Belt (IPB). The deposit is hosted by an upper Devonian to lower Carboniferous Volcanic-Siliceous Complex and embraces six orebodies: Graça, Corvo, Neves, Zambujal, Lombador and Semblana.

The Neves Corvo deposit has important contents of a wide range of high-tech elements, which can be profitable commodities such as the case of Indium (In) and selenium (Se). Indium average grades deposit ranges in between 30 to 215 ppm. Graça, Lombador and Zambujal orebodies have the higher average grades on indium, respectively 215, 152 and 150 ppm. These higher indium grades were observed within zinc-rich ores (MZ) at the Graça and Lombador oredodies and in the copper-zinc-rich ores (MCZ) of the Zambujal orebody. Indium is present as minor element in the structure of major minerals such as chalcopyrite, sphalerite, stannite group minerals and fahlores. Selenium average grades vary in between 10 and 3220 ppm. Lombador and Zambujal orebodies have the highest selenium average concentration, showing 2560 and 3220 ppm, respectively. At the Zambujal orebody the high selenium grades occur in the lead-zinc-rich ores (MZP), while in the Lombador orebody the highest selenium grades were detected at the copper-zinc rich ores (MCZ). Selenium occurs both as Se-minerals and as minor element in the structure of major sulfide minerals. Selenium mineralogy is represented by selenium-bearing galena containing up to 30% of clausthalite (PbSe) end member and junoite ($Pb_3Cu_2Bi_8[S,Se]_{16}$), which is described here for the first time either at the Neves Corvo deposit, or the Iberian Pyrite Belt. Selenium also occurs as minor element in fahlores group minerals and sphalerite.

This os a contribution to project ZHINC (PTDC/CTE-GIX/114208/2009; Foundation for Science and Technology (FCT-MCTES).

DOI:10.1180/minmag.2013.077.5.16