Anomalous abundances of He and mobile metals in surface media over the deeply buried Millennium U deposit, Athabasca Basin, Canada

MICHAEL J. POWER[1]*, KEIKO HATTORI[1], DANIELE L. PINTI[2] AND ERIC G. POTTER[3]

[1]Department of Earth Sciences, University of Ottawa, Ottawa, Canada (correspondence: mpowe102@uottawa.ca)
[2] GEOTOP, Université du Québec à Montréal, Montréal, Canada
[3] Geological Survey of Canada, Ottawa, Canada

We examined soil and noble gas geochemistry over the Millennium uranium deposit, Athabasca Basin, SK, Canada. It has indicated resources of 68.2 million lbs U_3O_8 at ~750 m depth, along a major fault in granites & metamorphosed pelites of Archean to Paleoproterozoic age below the Athabasca sandstones.

110 soil samples along two transects 503 and 333 m long over the deposit yielded anomalous values in U (≤0.6 ppm), Pb (≤35 ppm) and Cu (≤15 ppm) in aqua regia digestion of humus, when compared to the $\mu \pm 2\sigma_x$ for metal values. Anomalous values were also detected for U (≤102 ppb) Pb (≤2100 ppb), and Cu (≤220 ppb) in B-horizon soils leached by ammonium acetate compared to the $\mu \pm 2\sigma_x$ of metal values. Most anomalies were directly above the ore zones and surface traces of major faults, including the ore-hosting Marker fault. Gas samples were collected in monitoring wells and drill holes by submerging diffusion samplers at 10 to 42 m below the surface for 3 days. The ^{4}He, ^{22}Ne, ^{36}Ar, ^{40}Ar, ^{84}Kr and ^{132}Xe were measured by quadrupole mass spectrometry at GEOTOP. Analytical uncertainties range from 1.5 to 4.6% of the measured amount. Measured ^{4}He concentrations in water ranges from 6.89 x 10^{-8} to 4.23 x 10^{-5} ccSTP/g. The lower amount is identical to that expected by equilibration with the atmosphere (Air Satured Water value or ASW). The higher amount is clearly related to radiogenic ^{4}He produced by the U ore and released in the water. Indeed, three samples yielded anomalous $^{4}He/^{36}Ar$ ratios, 715, 239 and 108 times the ASW value, clearly indicating the addition of radiogenic ^{4}He. Ratios of $^{4}He/^{22}Ne$ (790, 340 and 130 times ASW value), $^{4}He/^{84}Kr$ (690, 240 and 110 times ASW), and $^{4}He/^{132}Xe$ (580, 210 and 95 ASW) were also observed, confirming the results.

Broad geochemical anomalies in soil and gas at the property show that fault-controlled redistribution of elements and gases possibly exists over the deposit. Our results suggest upward migration of metals and He to surface through these geological features – detectable by geochemical exploration methods for U using two different surface media.

Isotope geochemistry of Wayang Windu geothermal field, Indonesia

R. PRASETIO*[1], B. WIEGAND[1], M. SAUTER[1] AND D. MALIK[2]

[1]GZG, Universität Göttingen, Goldschmidt Str. 3, 37075 Göttingen, Germany (* rasi_prasetio@yahoo.com)
[2]Star Energy, Ltd. Jl. Letjen S. Parman Kav. 62-63, 11410 Jakarta, Indonesia

Wayang Windu geothermal field is located in West Java, Indonesia, associated with Quaternary active volcanoes. The geothermal system is transitional between liquid and vapor dominated systems [1]. Naturally occurring isotopes, i.e. δD, $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ were combined with gas compositions and chemical data of the fluids to characterize fluid-rock interaction and properties of the reservoir. Several samples were collected from thermal manifestations and deep wells.

Most of the thermal manifestations and deep well fluids are bicarbonate type and have neutral pH values, except for steam heated waters, which are acid sulphate type waters. Deep brine fluids are of mature chloride type. Gas-mineral (i.e. pyrite and iron oxides [2]) equilibria indicate that reservoir temperatures vary between 230-300°C. δD and $\delta^{18}O$ compositions suggested that although fluids from thermal manifestations and deep fluids are of meteoric origin, deep fluids may have recharged from a lower elevation than fluids of the thermal manifestations. Furthermore, deep fluids show a strong oxygen shift, indicating water-rock interaction, while $\alpha D_{l\text{-}v}$ and $\alpha^{18}O_{l\text{-}v}$ model calculations indicate steam separation (boiling) at ~200°C. $^{87}Sr/^{86}Sr$ ratio vary between 0.7046-0.7058 and are similar to $^{87}Sr/^{86}Sr$ ratio of Sunda arc calc-alkaline volcanic rocks [3].

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www.minersoc.org
DOI:10.1180/minmag.2013.077.5.16