

## Toward an *in-situ* bioremediation strategy for acidic *in-situ* leach uranium mining

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In Kazakhstan, *in-situ* leach (ISL) mining of uranium utilizes the oxidizing power of pH < 2 sulfuric acid solutions to liberate and mobilize uranium from the ore's naturally reducing conditions. Although ISL has the potential to be less environmentally impactful than physical mining techniques, it includes the risk of groundwater contamination. A detailed geochemical and microbiological analysis and comparison of pre-, mid-, and post-mining conditions is warranted in order to assess and potentially mitigate that risk.

A theoretically ideal remediation strategy for ISL would be one that re-equilibrates the pH, immobilizes uranium as U(IV) precipitates, and does not require physical disruption of the surface. The strategy proposed here is *in-situ* biostimulation. The injection of carbon-based electron donors into the subsurface would, in theory, promote the growth of indigenous bacterial communities able to reclaim the subsurface. The proposed mechanism is that stimulated sulfate and/or iron reducing bacteria can return the pH to its original value and re-establish reducing conditions more rapidly than the commonly practiced strategy of natural attenuation. Biostimulation could also utilize the existing configuration of pumps and pipes, originally used to inject acid.

The objectives of this study are: 1) to characterize the impact of the injection of sulfuric acid on the subsurface geochemistry, 2) to probe changes in the subsurface microbial communities as a result of mining operations, 3) to identify through laboratory-based studies which electron donors may promote Fe- and/or sulfate-reducing microbial communities post-mining, and 4) to ascertain the composition of the microbial community post-remediation. The results presented here represent the initial stages of a pioneering study to understand the effects of uranium ISL on the environment and to design and implement an *in-situ* bioremediation strategy in Southern Kazakhstan.

## Geochemistry of Biotite of The Vila Nova Plutonite (Central Portugal)

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The Vila Nova plutonite intruded phyllites and metagraywackes of Neoproterozoic-Cambrian Beiras Group in Central Iberian Zone of Iberian Massif which is the SW segment of the European Variscan Belt and occurs in a group of seven plutonites of similar age and particular features related to a major strike slip shear zone.

The Vila Nova plutonite has a compositional variability of tonalite-granodiorite-granite. Its a rock of fine to medium grained, muscovite>biotite. The  $\delta^{18}\text{O}$  values are 11.09<sub>tn</sub>-11.54<sub>gd</sub>-12.65<sub>gt</sub> ‰. The plagioclase An(%) contents are 13.2<sub>tn</sub> - 13.6<sub>gd</sub> - 14.6<sub>gt</sub> and feldspar Or(%) contents are 86.2<sub>gd</sub> - 93.2<sub>gt</sub>. The tonalitic lithotype do not contain feldspar.

Biotite is often altered to chlorite associated with acicular rutile and opaque minerals such as pyrite and is absent in granitic composition with tourmaline.

They are magmatic except in microgranular enclaves where they are reequilibrated, the  $X_{\text{FeO}}$  is 0.74<sub>tn</sub> - 0.71<sub>gd</sub> - 0.73<sub>gt</sub>[1] and are ferriferous biotites[2] with aluminopotassic trends[3] evidence of peraluminous magma.

The biotite in surmicaceous xenolithes, stretched on alternated reeds with muscovite, occur in the tonalitic composition and have less content of Si, Ca, Na and higher content of Al<sup>IV</sup> and Zn and, in the microgranular enclaves in the granodioritic composition the dispersed and subhedral biotite have less content of Ti, Zn, K and higher contents of Fe<sup>3+</sup>, Ca and Na than others biotites. In these textural heterogeneities some elements have opposite behavior from center to rim. The biotites in the evolutionary trend have a decrease of Fe<sup>3+</sup>, Fe<sup>2+</sup>, Mn, Li, Ca, Rb, OH, Li/Mg, Rb10<sup>3</sup>/K and Fe<sup>2+</sup>/Mg and an increase of Mg, Na, Cs, F, Si/Ca.

[1]Nacht, H.; Ibhi, A.; Abia, E. H.; Ohoud, M. B. (2005) Discrimination between primary magmatic biotites, reequilibrated biotites and neofomed biotites. *C.R. Geoscience*, 337, 1415-1420. [2]Tischendorf, G.; Förster H.-J. and Gottesmann, B. (1999a) The correlation between lithium and magnesium in trioctahedral micas: Improved equations for Li<sub>2</sub>O estimation from MgO data. *Mineralogical Magazine*, 63, 57-74. [3]Nacht, H.; Razafimahefa, N.; Stussi, J.M.; Carron, J.P.; (1985) Composition chimique des biotites et typologie magmatique des granitoïdes. *C. R Acad. Sc. Paris*, 301 ( 11), 813 – 818.