Secondary U bearing minerals in granitic technosoils. (Massif Central, France)

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U deposits in France are essentially granitic-related deposits. Uraninite-coffinite mineralization occurs at the plutonic intrusions contact in veins or is disseminated in the periphery. The U deposits in the Massif Central 324 Ma leucogranite formed from late, moderate, hydrothermal fluids (270-280 Ma). Away from the mineralized zone, U is incorporated principally in primary accessory minerals such as monazite and zircon that are resistant to weathering.

The 50 years of mining created over 160 Mt of waste rocks that were discarded in locations adjacent to the mining area. These waste rock piles consist of decimetric to metric blocks submitted to weathering, and are predominantly sterile rock that was removed to access to the ore body with typical U geological background content in granite, e.g. 20 ppm. A minor constituent of these piles contains higher U concentrations that are below the economic cut off, i.e. ~ 100 ppm. This study focuses on the long term reactivity of these rocks with the higher amounts of U. Relative to massive granite the waste rock piles have a much higher specific surface area, which promotes arenisation and protosol occurrence. Micromophology, mineralogy, and geochemistry analyses from the metric to the nano/molecular scale have elucidated the speciation of uranium in the protosols on the top and technosoils or paleotechnosoils occurring under the waste rock piles. A reference site was defined in Fanay Limousin for such technosoil, at the base to the pile in proximity to a peat bog. Mechanical and chemical alterations drive the first steps of U mobility. Monazite, zircon, and rare uraninite included in weathered feldspar or biotite may be remobilized. However, prevalent oxidizing conditions cause the formation of $U^{(VI)}$ phases observed in these studies. These secondary minerals such as autunite, submicrometric uranyl phosphates, and U sorbed on Fe oxy-hydroxides and smectites contribute to the retention of U, even in oxidizing conditions known to enhance the mobility of U.