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U-Th remobilisation in granites, pegmatites and granite gneisses

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Alteration textures in granite, granite gneiss and pegmatite from Shillong Plateau were studied to understand the mechanism of U and Th remobilization. The key features of alteration and deformation textures in the studied samples are 1) formation of patchy and serrated zoning monazite, xenotime and zircon, most likely via dissolution-reprecipitation, 2) crystallization of thorite and coffinite as inclusions and adjacent to altered monazite, xenotime and zircons grains, 3) sericitization of feldspars, 4) alteration of biotite to clay minerals, 5) bulging of quartz grains, and 6) tourmaline formation as veins. Sericitizaion of feldspars, bulging of quartz and alteration of biotite to clay minerals suggest the occurrence of a low temperature alteration event. Mass balance calculations using the volume proportions and compositions of monazite and xenotime suggest that U, Th, Pb and REE remained constant in the alteration locales, suggesting no loss or addition of U and Th. The low Na contents and low *inferred* Fe^{3+}/Fe^{2+} ratios in tourmalines indicate their formation from low salinity reduced hydrothermal fluid. The alteration of biotite to form clay resulted in an increase in Al, decrease in K and Cl, suggesting acidic nature of the ambient condition. Based on the thermodynamic calculations of [1] and our own calculations, we propose that the Cl^- from biotite alteration aided in transportation of U and Th from primary radioactive phases as $UCl_4^0/UO_2Cl_2^0$ and $ThCl_4^0$ complexes in a reduced acidic fluid. Thermodynamic calculations suggest that a drop in temperature and/or an increase in pH may have facilitated formation of thorite and coffinite. Therefore, in addition to hydrothermal parameters such as pH and fO_2, compositions of primary minerals such as Cl content and occurrence of primary radioactive phases are key deciding factors in U-Th mineralization.

[1] Timofeev, A., Migdisov, A.A., Williams-Jones, A.E., Roback, R., Nelson, A.T. and Xu, H (2018). Uranium transport in acidic brines under reducing conditions. *Nature communications*, *9*(1), 1469.