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Element redistribution by greisenization in rhyolite, Zinnwald/Cinovec

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The Zinnwald/Cinovec Sn-W-Li deposit on the border between Germany and Czech Republic in the eastern part of Krušné Hory/Erzgebirge represents a fluorine-rich hydrothermal alteration of a granite-rhyolite association. The host rock can be divided into two parts: 1) zinnwaldite granite (upper part) with massive greisen body and various hydrothermal veins and 2) homogeneous protolithionite granite (lower part). The basement is the Krušné Hory/Erzgebirge crystalline complex with different metamorphic grades, overlain by the Teplice rhyolite, which also contains greisen veins and is the focus of this study.

In this study, we focus on the effects of fluid-rock interaction on distal rhyolites of the deposit. We combine whole rock chemistry with petrological data to constrain mass gain or loss of economically interesting elements. The samples were selected from the upper contact zone between granite and rhyolite. Three distinct zones of high- and low-degree greisenization (HG and LG) and albitization (A) developed with different textures, mineral assemblages and mineral compositions. Beyond the albitization zone, a continuous transition to the least altered rhyolite was observed. In the greisen part, the predominant minerals are quartz (~80 vol%) and topaz (~10 vol%) with minor biotite (~5 vol%). The albitization zone contains mostly albite (~40 vol%), quartz (~25 vol%), orthoclase (~25 vol%), and biotite (~10 vol%). In comparison to the composition of the rhyolite wall rock, mass balance calculations show that the greisen has 50%-100% loss of LILEs, 15%-20% loss of HREEs, and 7%-11% gain of LREEs. The Th/U, Zr/Hf, Y/Ho, and La/Yb ratios are similar between the rhyolite and the greisen zone but very different for the albitization zone. This suggests a dynamic dissolution/precipitation process in the albitization zone caused by the particularly high F- and Na-activity in this zone compared to the unaltered rhyolite but also the greisen (where F is precipitated as topaz and fluorite whereas Na is lost to the fluid). The chemical changes show that the F-rich fluid carried LILEs and LREEs to the greisen, and also resulted in the loss of HREEs and alkaline elements.