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Hydrothermal alteration and permeability changes in granitic intrusions related to Sn-W deposits : case study of Panasqueira (Portugal)

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The Panasqueira Sn-W deposit occurs as a dense network of flat wolframite and cassiterite-bearing quartz veins concentrated in the vicinity of a hidden greisen cupola, and to a lesser extent as disseminated cassiterites in the greisen. Previous studies (Thadeu 1951; 1979) have suggested that the Panasqueira deposit is genetically related to magmatic activity for which the most part is unexposed, and being only represented by the greisen cupola. Hydrothermal fluid circulation during the final stages of granite crystallisation has probably led to the greisenisation of the cupola followed by the deposition of the mineralization in the veins system. Mineral replacement reactions that occurred during the greisenisation could affect rock properties (porosity, density and permeability) which control fluid circulation in the granite.

This study aims to investigate effects of greisenisation reactions on the dynamic (time varying) permeability that ultimately leads to fluid circulation in the greisen cupola. To do so, petrological study and experimental determinations of hydrodynamic features (porosity and permeability) for different granite alteration levels and petrographic types (unaltered granite to greisen) are combined and then integrated in coupled numerical models of fluid circulation around the granitic intrusion.
Greisen occurs in the apical part of the granitic body and results in the pervasive alteration of the granite along the granite-schist contact. This greisen consists mainly of quartz and muscovite formed by the replacement of feldspars and bleaching of biotites of the initial granite. Otherwise, greisen is generally vuggy which suggests a porosity increase of the granite during hydrothermal alteration processes. This porosity increase has a positive effect on the permeability of the granitic system. Indeed, experimental measurements of permeability with the Paterson press indicate that the initial granite is impermeable (10-20 m^2) whereas the greisen is characterized by a much higher permeability (10-17 m^2). The presence of cassiterites and sulphides in some vuggs suggests that the neoformed porosity participate and enhance the circulation of the hydrothermal fluid in the granite. These results suggest a positive feed-back between greisenisation and fluid circulation.
Results of numerical models show that the dynamic permeability in the apex and along the roof of the intrusion increases significantly during the hydrothermal circulation. This permeability increase enhances the fluid circulation in the granitic intrusion and causes the enlargement of the pathways of fluid circulation while focusing sites of mineralization in the apical part of the granite.
These results can explain how hydrothermal fluids flow within granitic cupolas and the mineralization of the greisen.