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Dissolution-reprecipitation versus solid state diffusion: mechanism of mineral transformations in sylvanite, (AuAg)2Te4, under hydrothermal conditions.

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The transformation behaviour of the sylvannite ($AuAgTe_4$) under hydrothermal conditions has been explored. At temperatures between 160 and 220 ºC, under autogenious vapour pressure, sylvannite transforms to Au-Ag alloy, calaverite ($AuTe_2$), petzite ($AuAg_3Te_2$) and hessite (Ag_2Te). At the same temperature, in the absences of a hydrothermal fluid, no reaction occurs. The range and proportions of transformation products depends on the hydrothermal reaction conditions. The texturesof the products of the transformation of sylvannite to Au-Ag alloy are consistent with an interface coupled dissolution-reprecipitation reaction mechanism as is the transformation of sylvannite to Ag-rich-Te-depleted calaverite. The break-down of the Ag-rich-Te-depleted calaverite ($(Au_{0.78}Ag_{0.22})Te_{1.74}$) to stoichiometric calaverite and phase X ($Ag_{3+x}Au_{1-x}Te_2$, $0.1 < x < 0.55$) via exsolution. Phase X in turn breaks down to a fine intergrowth of petzite and hessite also via exsolution. Up until the current study, chalcogenide transformations studied under hydrothermal conditions, have been at temperatures such that the mobility of the metal ions, due to self-diffusion, was low and the kinetics of any solid state diffusion driven process was very sluggish when compared to the kinetics of ICDR reactions. It is clear, however, that in more mobile systems, such as some Ag or Cu chalcogenides, solid state diffusion may be significant, and solid state reactions may compete kinetically with the ICDR mechanism. Given that sylvanite melts at 354 °C it is reasonable to expect that cation diffusion in this mineral will be significant at temperatures above 145 °C (two thirds of the melting point in kelvin) for experiments on a laboratory time scale (days to months). One aim of this work is to establish the reaction texture and mechanism of mineral replacement of a gold silver telluride and to compare these to our previous studies on the replacement of calaverite (Zhao et al 2009). References Zhao, J., Brugger, J., Grundler, P., Xia, F., Chen., G., and Pring, A. Mechanism and Kinetics of a mineral transformation under hydrothermal conditions: calaverite to metallic gold. American Mineralogist, 94, 1541-1555, 2009.