Investigations on the high-T Behavior of Natural Quartzphyllites and the Comparison to the Sacrificial Burning site of Goldbichl/Igls (Tyrol, Austria)

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Prehistoric sacrificial burning sites have been studied in the Alpine area for the past 40 years. Unfortunately, due to the lack of surfacial characteristics, these burning sites are very hard to identify and indeed their identification mostly happens accidentially. These sites were identified based on the presence of pottery-, metal- and bone fragments and none of these sites has ever been investigated from a mineralogical point of view. Two burning sites, where the link to ritual fires has firmly been established in Tyrol are the prehistoric burning sites at the Goldbichl, Igls near Innsbruck and in Ötz in the Ötztal approximately 50 km W of Innsbruck. In this study we report extremely P-rich olivines from partially molten quartzphyllites from the presumably La-Tène (450-15 B.C.) age sacrificial place at the Goldbichl near Innsbruck, Northern Tyrol, Austria, where immolation of ritual offerings took place. The pyrometamorphic rocks contain the mineral assemblage olivine + orthopyroxene + plagioclase + spinel + glass. Phosphorus-rich olivine was found in an apatite-rich domain, coexisting with graftonite $(Fe, Ca, Mg, Mn)_3(PO_4)_2$ and shows a wide range in composition with P ranging from 0.3 to 0.55 apfu, which corresponds to up to 21 wt.% P_2O_5! The systematics of Mg, Fe, Si, and P concentrations in olivine indicates that phosphorus is incorporated into olivine via the coupled substitution 2P + M1,2 = 2Si + (Mg, Fe)M1,2. Olivine forms by incongruent melting of biotite at $T>1000°C$ through the reaction biotite + quartz = olivine + Ti-magnetite + K-rich melt or by breakdown of chlorite along the reaction chlorite = olivine + spinel + H_2O. P was provided to olivine either from added bone material to the fire or by mineral reactions involving apatite from the protolith rock. To place constraints on the temperature of the firing processes, melting experiments at 1 bar will be conducted in a box furnace similar to the investigation of Tropper et al. (2006). To be as close as possible to the observations, we conducted simple experiments, where fO_2 is either not constrained or only approximated to the CCO buffer but not fixed. The experimental investigations on natural quartzphyllites, high-*T* X-ray diffraction, differential thermal analysis (DTA-TG) of biotite and chlorite and application of relevant phase equilibria from the *ACerS-NIST (2004)* database suggested that temperatures in excess of 1000 – 1100°C and strongly reducing conditions were necessary for the formation of phosphoran olivine in the burning sites. In summary chemical and experimental data presented above point to rapid olivine growth under disequilibrium conditions, which is a prerequisite for the incorporation of large amounts of P into olivine. Finally, these data provide important *T*-constraints on the firing history of sacrificial burning sites, which are investigated in the course of the Sonderforschungsbereich (SFB) HiMAT at the University of Innsbruck.

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