Multistage ilvaite-bearing assemblages from the Galinge skarn Fe deposit, western China: a record of retrograde alteration

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The Galinge deposit, the largest skarn Fe deposit in the Qiman Tagh porphyry-skarn metallogenic belt (western China), is noteworthy for its well-developed Ca-rich retrograde alteration. The ilvaite-bearing skarn mineral assemblages were studied to determine their physicochemical formation conditions. Phase relationships for the early retrograde (Stage I) mineral assemblage garnet + hastingsite + ilvaite + magnetite suggest that the alteration may have occurred at ca. 400°C – 500°C under moderately high oxygen fugacity ($\Delta\log fO_2$(HM): ca. 3 – 3.5) at a pressure of 3 kbar. The continuous reactions of ferro-actinolite formation occur in the late retrograde stage (Stage II) that contains the ilvaite + ferro-actinolite + quartz + magnetite assemblage. The reactions occurred at about 400°C – 450°C under moderate fO_2 (ca. 3.5 – 4 log units below HM). In Stage III, the occurrence of the ilvaite + calcite + pyrite + ferroactinolite assemblage indicates their formation at ca. 275–375°C under low fO_2 (up to 4.5 log units below HM), and the reaction is significantly affected by $X(CO_2)$. The thermodynamic model for continuous evolution from Stage I to Stage III completely records the conditions of the retrograde alteration. Although Mn is absent, the presence of substantial Fe and Mg strongly affects the stability field of ilvaite in the skarn system. Therefore, the petrography and phase relations of ilvaite are useful indicators of reaction conditions in various skarn deposit types.