Skarn-Porphyry Transition

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Skarn and porphyry styles of mineralization may occur in the same deposits hosted in carbonates, in various proportions from almost pure skarn to almost pure porphyry. This study attempts to address the industry need of using skarns to find porphyry deposits, and the need of predicting the porphyry potential of an existing skarn. The skarn-porphyry transition at various skarn-porphyry Cu and/or Au deposits are examined in this study. It is found that the transition occurs inside fertile intrusions and starts from massive to semi-massive endoskarn at the intrusion margin. Such endoskarns grade to endoskarn veins or disseminated skarn minerals inward in the intrusions, followed by a zone with mixed endoskarn vein and porphyry-style veins with K-alteration halos, and eventually to only high temperature porphyry veins in the interior of the intrusions. The endoskarn features garnet with red to dark red color, which indicates high formation temperatures. Other endoskarn minerals include pyroxene, minor wollastonite, and rare scapolite, plus various amounts of the typical retrograde minerals such as the early retrograde assemblage of epidote-amphibole-vesuvianite-quartz-Fe oxides, and later retrograde assemblage of quartz-carbonate-chlorite-sulfides. This transition is proposed to be controlled by the supply of Ca, mainly from the dissolution of carbonate wall rocks by weakly acidic magmatic hydrothermal fluids, and high temperatures. The magmatic hydrothermal fluids are typically saturated with SiO2, and contain abundant Fe, evidenced by Fe-Cl daughter minerals in fluid inclusions, and up to ~22 wt% Fe measured in single fluid inclusions. With the supply of Ca at intrusion margins, skarn minerals have to form at high temperatures (e.g., >500 °C) and relatively low CO2 fugacity. When the Ca supply diminishes inward, quartz-dominant veins of typical porphyry style (e.g., EDM – early dark mica veins; quartz-biotite-magnetite veins) will form. The implications to exploration will be discussed based on the understanding.