Tungsten Skarn Deposits and Their Association with Porphyry Geologies

Tungsten skarn deposits are a significant source of tungsten and often form in geological settings associated with porphyry deposits. Both deposit types originate from similar magmatic-hydrothermal systems, particularly around large, felsic to intermediate igneous intrusions, such as granites or granodiorites.

Geological Association:

1. *Igneous Intrusion:* Tungsten skarn deposits typically form when a magma body rich in metals intrudes into carbonate-rich sedimentary rocks, such as limestone or dolomite. The heat and fluids from this intrusion initiate the metasomatic process that leads to the formation of skarn minerals.

2. *Proximity to Porphyry Systems:* Tungsten skarns are frequently found on the margins of or in close proximity to porphyry systems. Porphyry deposits, which are characterized by disseminated and vein-hosted mineralization of metals like copper, molybdenum, and sometimes tungsten, form within or adjacent to the intrusive body. The same fluids that form these porphyries can migrate outward into the surrounding carbonate rocks, creating skarn deposits.

3. *Hydrothermal Fluid Interaction:* The fluids responsible for porphyry mineralization are often metal-rich and can lead to tungsten skarn formation when they encounter carbonate rocks. These fluids facilitate the exchange of elements, replacing the original carbonate minerals with tungsten-bearing minerals such as scheelite ($CaWO_4$), along with other skarn minerals like garnet, pyroxene, and amphibole.

Tungsten Skarn and Porphyry Connections:

- *Metal Zoning:* In a typical porphyry-skarn system, the central porphyry might host copper, molybdenum, and tungsten mineralization. The tungsten skarn deposits, which form at the intrusion's margins, can contain high concentrations of tungsten, sometimes accompanied by other metals like zinc, copper, or gold.

- *Temporal Sequence:* Tungsten skarn deposits may form slightly earlier or simultaneously with the porphyry system, as the first pulses of hydrothermal fluids begin to interact with the surrounding carbonate rocks. Over time, these fluids can evolve and lead to central porphyry mineralization.

- *Economic Importance:* The association of tungsten skarns with porphyry systems is economically significant because it allows mining operations to target multiple valuable metals in the same district. Tungsten skarns, in particular, are critical sources of tungsten, a metal essential for hardening steel and other industrial applications.

Examples of Tungsten Skarn-Porphyry Associations:

- *Pine Creek Mine, California, USA:* One of the most famous tungsten skarn deposits, located near a granitic intrusion. This deposit also shows some connection to a larger porphyry system.

- *Cantung Mine, Northwest Territories, Canada:* This deposit features both tungsten skarn and porphyry-related mineralization, with skarn zones rich in scheelite.

- *Damang Mine, Ghana:* While primarily a gold porphyry system, associated skarn mineralization contains significant amounts of tungsten.

In summary, tungsten skarn deposits are closely associated with porphyry geologies due to their formation from the same magmatic-hydrothermal systems. The skarns typically form at the contacts between intrusions and carbonate rocks, where the first mineralizing fluids deposit tungsten-rich minerals, while the porphyry deposits are generally found within or near the intrusion itself. This relationship highlights the complex and interconnected nature of mineral deposits within a magmatic-hydrothermal environment.

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