Skarn Deposits

Skarn deposits are referred to by a variety of names; skarn, tactite, pyrometasomatic and igneous-metamorphic. The term skarn was coined in Sweden for iron deposits that occurred in rocks adjacent to a pluton. Today the term skarn is used more generally for ore of any mineralogy that lies in country rocks at or near the contact with a pluton. Skarns have been mined for a wide variety of commodities, but due to the small size of most ore zones, have never attracted much interest or study until quite recently.

Distribution

Skarns occur on all continents, but are restricted in both age and petrology of the host. No skarn deposits older than Paleozoic have been mined, and nearly all are of Mesozoic age. This has implications about the depth of emplacement of the typical skarn deposit. Further, skarn deposits occur only in felsic rocks, indicating magmatic water must be an important and necessary constituent of the ore-forming process.

Form

Skarn deposits have very irregular shapes, the irregularity a consequence of the erratic replacability of the host rocks. The ability to replace host rocks is a function of their permeability and porosity as well as bulk chemistry and lithology. Most skarn ore bodies are small, rarely producing more than 10MT. Some giants have produced 60MT, but they are dwarfed in tonnage by the porphyry systems that often lie in close proximity.

![Typical Skarn Deposit](image-url)
Most minable skarn deposits occur in carbonate rocks, since carbonates are the most easily replaced and/or metamorphosed. However, some skarns in sandstones and shales have been productive. The new mineral assemblages that form during the metasomatic process are indicative of the addition of Fe, Mg, Ca, Mn and Si, the latter probably the most important (Figure). Due to this process a new suite of rocks is formed termed calc-silicates.

The host pluton most commonly lies in the range from quartz monzonite to granodiorite, but this is probably because most mined skarn deposits are associated with porphyry coppers. One controlling factor is the necessity for the intrusion to have a significant water content ruling out mafic skarn deposits.

Skarns generally form at shallow depth (1-5 km). Stable isotopic data suggest a major component of magmatic water and a smaller role for circulating meteoric fluids. The latter often manifests itself as an endoskarn zone.

- Endoskarn - Skarnification within the pluton due to retrograde metamorphism
- Exoskarn - Typical skarn zones within the country rocks

Mineralogy of skarns is complex and variable, a function the host rock and the intrusive. Skarns have been mined for Fe, Cu, W, Zn, Pb, Mo, Sn and Au, with the first three elements the most important. Typical ore minerals are magnetite, hematite, gold, chalcopyrite, bornite, scheelite, wolframite, galena, sphalerite, molybdenite and cassiterite. Gangue minerals include garnet, diopside, idocrase, wollastonite, forsterite, talc, tremolite, actinolite and hedenbergite.

Wall rock alteration is a striking feature of all skarn deposits, but the exact nature of the zoning differs
from district to district with differences in the chemistry of the ore fluids. In general, zones near the intrusive/country rock contact are dominated by anhydrous minerals and those farther from the contact by hydrous assemblages.

**Genesis**

Although the actual mineralogy of skarns and the zoning of the deposits can be quite complex, the genetic model is rather straightforward. Emplacement of a water-rich pluton results in contact metasomatism of the surrounding rocks. As the fluids cool metals replace the calc-silicate assemblages. Perhaps the only remaining question is the exact point in time when the minerals are precipitated. Some evidence seems to suggest they are deposited after a period of dehydration followed by rehydration which would seem to imply a much larger role for meteoric fluids than stable isotopes indicate.

**Carr Fork, Utah**

**Location**

Carr Fork, a low grade copper-iron bearing skarn, lies in metasedimentary rocks on the northwest rim of the Bingham Canyon copper pit.

**Geology**

The deposit lies in folded and metamorphosed Paleozoic sandstones and carbonates along the northwestern flank of the Bingham stock. Contact metamorphism occurred during intrusion of the Mesozoic stock. Mineralization is predominantly chalcopyrite, bornite and minor molybdenite.

The series of three accompanying figures show a plan view, cross section and detailed cross section of the geologic relationships. Note especially the close proximity to the Bingham stock, strong zoning of the metals, and in the detailed cross section, the variable mineral zoning and replacability of the country rock.
Figure 11-27. East-west cross section A-A' in Figure 11-28 showing metal and deposit-type zoning in the Bingham, Utah, district. Note the development of skarn ores on both sides of the quartz monzonite intrusion. (After Atkinson and Elmsell, 1978.)
Some Characteristics of Skarn Deposits

1. Largely restricted to Phanerozoic age rocks.
2. Most associated with porphyry-type intrusives and mineralization.
3. Best skarn deposits are in carbonate rocks, but can occur in any rocks adjacent to an intrusive.
4. Form at shallow depth in a range of temperatures from 350 to 800 degrees C.
5. Mineralogy is complex and varies as a function of temperature and composition of the fluids. Mined for Fe, Cu, W, Zn, Pb, Mo and Sn.
6. Have a rather characteristic zoning: