**Geochemical Characteristics of Tin-bearing Magnetite-Skarns**

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**Abstract**

Geological and geochemical characteristics of tin-bearing magnetite-skarns are reviewed in this paper, together with the author’s opinion with respect to the mechanism of transport of tin in this environment.

In addition to cassiterite, the most common form of occurrence of tin in nature, three other forms of occurrence are also of interest in tin-bearing magnetite-skarns: (1) tin present in the form of fine exsolution colloidal grains of cassiterite; (2) tin found as independent tin-bearing minerals, such as malayaite, stokesite, nordenskiöldine, Sn-paigeite, Sn-ludwigite and hulsite in a variety of skarns; (3) tin occurring in the lattice of some skarn minerals, such as garnet, pyroxene, spinel, amphibole, epidote, wollastonite and axinite in the manner of ionic replacement.

When Mg~2+ and Fe~3+ bearing minerals, in some cases even sulfides or other mineralizer-containing minerals, replace tin-bearing Fe~3+ and Ti~4+ skarn minerals during the late stage of skarn alteration, tin in the pre-existing silicates may be extracted and remobilized, thus contributing to the formation of associated tin deposits.

**Introduction**

Some geologists have classified tin-bearing skarns as two broad types: magnetite-rich and sulfide-rich, while some others have divided them into tin-bearing magnetism skarn and calcium skarn in the light of their compositions. Tin-bearing magnetite-skarns have been reported from many well-known tin mining districts throughout the world, which are possessed of some similar characteristics, such as the extensive occurrence of tin, low grade of ore, high reserve, undetectable cassiterite and difficult recovery due to the high content of acid-soluble tin. These tin-bearing skarns mostly occur in large tin ore belts or are associated with other types of ore deposit (e.g. cassiterite-sulphide type). Therefore, it is of great significance both in theory and practice to comprehensively understand the forms of existence of tin and the law of cassiterite enrichment in search of tin deposits of economic importance in skarn-exposed terranes.

**Generalization of Geological Characteristics of Tin-bearing Skarns**

Described in Table 1 are the main geological characteristics of typical tin-bearing magnetite-skarn deposits both at home and abroad.
<table>
<thead>
<tr>
<th>Locality</th>
<th>Granite</th>
<th>Wall rock</th>
<th>Ore deposit</th>
<th>Tin distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dading, Lianping, Guangdong(^{22,23})</td>
<td>Porphyritic biotite granite</td>
<td>Sandstone, shale, limestone, dolomite, limestone, dolomite intercalated with volcanic rocks</td>
<td>Magnetite, paigeite, ludwigite, hematite, pyrrhotite, multiple metal sulphides, zinc common; fayalite, magnesium spinel, fassait, humite group, boron–magnesium calc-silicates, garnet group, etc.</td>
<td>Lenticular in the orthocontact zone, stratoid in the out-contact zone</td>
</tr>
<tr>
<td>Huanggang, Zhaomeng, Nei Monggol(^{22,4})</td>
<td>Monzonitic granite, K-feldspar granite</td>
<td>Limestone (marbleization), calcite–pelitic siltstone, hornstone, intermediate–basic volcanic rocks</td>
<td>Magnetite dominant, a little hematite; multiple metal sulphides, zinc common; andradite, diopside, hornblende, tremolite, actinolite, epidote, topaz, chlorite, silification, calcite, fluorite, adularia, skarn-diabase, etc.</td>
<td>Layered, metamorphic ore in marble relics</td>
</tr>
</tbody>
</table>
| Lugu, Mianning, Sichuan\(^{1}\) | Coarse-grained biotite granite, two-mica-tourmaline granite, albite granite | Calcareous dolomite, crystalline limestone, algae–bearing dolomitic marble | Magnetite, pyrite, chalcopyrite, pyrrhotite, arsenopyrite; tremolite, serpentine, phlogopite, talc, fluorite, actinolite, biotite, tourmaline, diopside, | Stratioid, lenticular | 0.7% Sn in magnetite–multiple metal skarn orebody, associated with zinc and copper, cassiterite accounting for 80—88%; grain sizes varying from 0.077 to 0.1 mm and from 0.0045 to 0.009 mm; cassiterite also associated with waterbearing magnetite–skarn and sulphides (Houziyan); 0.579—0.651% Sn in ore.