Långban
- a short geological and mineralogical description

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Introduction

Långban is famous among professional and amateur mineralogists as a prolific source of mineral species. At the most recent count, about 270 different minerals have been found at the Långban mine complex. 67 of these are "type species", first characterized from their Långban occurrence, and nearly 30 are still known only from Långban. New minerals are still being found both on the dumps and lurking in the specimens of old collections. Perhaps half a dozen localities worldwide are comparable in diversity. This article presents a brief introduction to the geological setting in which the Långban mines are found, the minerals of Långban, and a comparison with other mineralogically diverse localities. The primary reference is the new book *Långban: the mines, their minerals, geology and explorers* (eds. Dan Holtstam and Jörgen Langhof, Raster Förlag, Stockholm, 1999) which presents an excellent detailed account and a bibliography of 567 further references. Much of the hard data in this article is abstracted from the book, but coloured by my own experience of Långban rocks and minerals.

Geological Setting

Långban is one of a small group of related localities clustered within about 20 km of each other near the South-Eastern border of the Swedish province of Värmland. The others include the mines at Nordmark, Jakobsberg, Harstigen, Mangruvan and Sjögruvan. Långban is the largest and most diverse of these deposits, and has also tended to yield many minerals in larger and better crystals than the others, but many minerals occur in more than one of these mines. Some are found at one of the smaller mines but not Långban (for instance, harstigite at Harstigen). The features that distinguishes Långban-type deposits are:

(i) The presence of separate pods of both iron-rich and manganese-rich oxide ores. Skarns are derived by reaction between these and the carbonate and silicate host rocks.
(ii) Non-sulphide minerals of heavy metals such as lead, arsenic and antimony. Sulphides are known but are not important constituents of the deposits.

(iii) Minerals containing ”pegmatitic elements” such as tungsten, beryllium, boron and fluorine.

The Långban-type mines form a very small subgroup of a much larger mineralized band called Bergslagen, which extends S.W. - N.E. across central Sweden. The thousands of mines of the Bergslagen include many other iron mines that have been of economic importance in the past, but which do not display the exciting Långban mineralogy. The Bergslagen also has mines in which other styles of mineralization such as Cu-Au-Pb-Bi-S are more important than they are at Långban.

All the rocks of this region are Proterozoic in age, the oldest exposures dating to at least 1.9 billion years ago. There is evidence that a felsic basement existed at the time, but it has not been found to date. The lowest rocks stratigraphically in the Långban region are a thick sequence of pale-coloured, acidic metavolcanics. The older of these are massive, fine-grained rocks, the younger ones show more stratification.

The volcanics are interleaved with and overlain by shallow marine sediments, mainly carbonates. The precursors of the ore bodies were probably laid down as submarine exhalations towards the end of the volcanic activity. Similar rare-earth profiles suggest that the Fe-Mn oxides and the host carbonates share a common origin. Metasomatism of the rocks by reaction with hot percolating seawater probably started at the time of deposition.

All of these rocks were strongly deformed in the Svecokarelian orogeny, 1.86-1.80 billion years ago. As a result, the Långban deposits are now tightly folded in a N.-S. trending synclinal structure, slightly overturned to the East. Several large faults and shear zones cut the area, as do small basic intrusions and three generations of granite intrusion. The latter are the grey, fine- to medium-grained Horrsjö granite (> 1.85 Ga old), small intrusions of the red or grey, fine-grained Hyttsjö granite (1.84 Ga old) and later, very extensive intrusions of the medium-to-coarse, red Filipstad granite (1.78 Ga old). The small Hyttsjö-type intrusions are closely associated with the Långban-type ore deposits.

Field evidence suggests that the unusual elements such as Be, B, Sn, W at Långban were introduced in pegmatites associated with the Hyttsjö granite, and that the younger Filipstad granite was unimportant in supplying these elements (K. Gatedal, pers. comm.). The presence of tilasite and svabite in Hyttsjö pegmatites implies that much of the As may have been supplied by them also, rather than being of sedimentary-exhalative origin.

As a result of the regional and local deformations, the Långban ore bodies now occur as a multitude of separate E.-W. trending pods arranged in a complex three-dimensional shape, dipping steeply S.W. and embedded in a dolomitic marble.

The regional metamorphic grade attained during Svecokarelian deformation remained rather low in the Långban area (lower amphibolite). The absence of kyanite in the area shows that pressures have never exceeded about 3.5 kbar, and hence that burial depths of the current surface have been less than 10 km. The granites intruded around the deposits have been instrumental in supplying not just additional elements but also heat, which has allowed the original siliceous volcanics, carbonates, and metalbearing sediments to react further, since some of the Långban dolomites partially decarbonated to produce periclase (MgO), which requires temperatures over 600°C.

Minerals at Långban

There is much apparently intact, barren dolomite and meltavolcanite at Långban. The Fe and Mn oxides are likely to have been precipitated initially as fine-grained hydroxides with other elements incorporated (for instance, Ba and Pb in ”psilomelane” minerals), but the oldest ”primary” oxides seen today are hematite (Fe_2O_3) and braunite (Mn_7SiO_{12}) in the Fe and Mn pods respectively. The relatively reduced minerals magnetite (Fe_3O_4) and hausmannite (Mn_3O_4)

crystallized later, tending to form near the edges of the pods.

These oxide minerals all formed during the earliest paragenetic stage at Långban: ”period A” in Magnusson’s 1930 four-stage classification. The next period B is the skarn minerals formed by reaction between early oxides and country rocks. Reaction with the dolomite has produced carbonate skarns that are rich in oxide minerals (magnesioferrite, $MgFe_2O_4$) whereas reaction with silica from the metavolcanics has produced silicate-rich skarns. The iron-rich skarns contain other typical ferromagnesian silicates such as green diopside, andradite garnet, forsterite and tremolite, while the Mn-rich skarns contain tephroite olivine, Mn-rich diopside and richterite and rhodonite. They are more likely than the iron skarns to contain high concentrations of heavy metals, and hence unusual minerals of Pb, As and Sb such as kentrolite ($PbMn_2Si_2O_9$). Where original Fe and Mn rich skarns were in close juxtaposition, Fe+Mn minerals (jacobsite, $MnFe_2O_4$) and associations (red-brown schefferite pyroxene with hematite) can occur.

Another very distinctive type of skarn is ”sköl”, rich in ”manganophyllite” (manganoan phlogopite) mica, which may be derived from acidic metavolcanites, metabasites, or both. This is the typical host for Ti-rich minerals such as black metallic magnetoplumbite, $Pb(Fe,Ti)_{12}O_{19}$ and red platy pyrophanite ($MnTiO_3$).

Magnusson’s period C, ”cavity minerals”, are transitional between the minerals of the massive skarns and the latest stage, the period D ”fissure minerals”. ”Fissures” range in size from microscopic veinlets to a metre in width. The mineralization is dominated by barite and calcite, but it is here that the largest variety of Långban minerals are found, including the various Mn and Pb arsenates. The bigger fissures are the best place to find good crystals of minerals, since those in the massive skarns tend to be anhedral or subhedral grains. The fissure assemblages often indicate very reducing, alkaline low-temperature conditions, as shown by minerals such as widespread native lead, and arsenites such as rare grey prismatic finnemanite ($Pb_5(AsO_3)_3Cl$) and emerald green granular magnussonite ($Mn_5(AsO_3)_3(OH,Cl)$). Pyrochroite, $Mn(OH)_2$, quite common in veins, was originally found underground as pale bluish plates and prisms, but these oxidize readily, and modern dump specimens are more likely to be black. Veins and lumps of native lead are often associated with later oxidation and alteration products such as bright red litharge (PbO), white hydrocerussite, and maybe yellow to green complex chlorides and arsenates such as blixite and sahlinite.

The commonest arsenates, typical of Långban in that they are widespread there but rare or unknown at other localities, are probably berzeliite-manganberzeliite, $NaCa(Mg,Mn)_2(AsO4)_3$, a colourless to orange arsenate garnet, and hedyphane, $Pb_3Ca_2(AsO_4)_3Cl$, a normally grey, greasy member of the apatite family. Both are usually mas-sive. Allactite, $Mn_7(AsO_4)_2(OH)_8$, forms plat pinkish brown crystals which can grow quite large (several mm) and can show an ”alexandrite effect”, being redder in incan-descent light and greyer in daylight. It is often associated with lead, and the As may be supplied by reductive breakdown of hedyphane. Tilasite, $CaMgAsO_4F$, isostructural with titanite, was easy to find on my 1998 visit as a pink granular mineral intergrown with mustard yellow richterite and colourless svabite, $Ca_5(AsO_4)_3F$, detectable by its bright yellow-orange fluorescence under SWUV. It is worth mentioning that the tilasite-rich rocks are also one of the most frequent hosts for Be minerals such as barylite ($BaBe_2Si_2O_7$) a white platy mineral which fluoresces blue, providing a nice contrast with any svabite that is present!

Another rock type in which Be minerals should be looked for is the fine granular, steely blue-grey hematite rock with white and brown carbonate veins. The white calcite veins can contain prisms of blue-fluorescent swedenborgite ($NaSbBe_4O_7$). These rocks also host exotica such as the Pb-Be amphibole joesmithite ($PbCa_2(Mg,Mn,Fe)_5Be_2Si_6O_{22}(OH)_2$) and the Sb-Be aenigmatite relative welshite ($Ca_2Mg_4FeSbBe_2Si_4O_{20}$).

Although antimony is less abundant in the Långban assemblages than arsenic, it forms the relatively common red-to-yellow pyrochlore minerals bindheimite-romeite, $(Pb,Ca)_2Sb_2O_7$ as grains and occasional octahedra, the commonest Långban halide, nadorite, $PbSbO_2Cl$, as yellow plates, and a wide range of Mn-bearing oxide-silicates including brown platy katoptrite, $(Mn,Mg)_{13}(Al,Fe)_4Sb_2(SiO_4)_2O_{20}$ and of course the eponymous mineral långbanite, $(Mn,Ca)_4(Mn,Fe)_9Sb(SiO_4)_2O_{16}$. This steely blue-black mineral is not uncommon, but perfect hexagonal prisms like the one on the cover of the new monograph would be a rare find!

How unique is Långban?

The other Långban-type deposits in the Bergslagen show a strong affinity in their mineralogy, but there are differences. The Mn-Be silicate harstigite, for instance, is known only from a tephroite-andradite skarn at Harstigen, and does not occur at Långban. Further afield, the Franklin-Sterling Hill deposits of New Jersey show many minerals and associations in common, but a major difference is that zinc is a much more important component in New Jersey, so the wide range of Långban Mn-Mg-Fe-Zn spinels are replaced by the single species franklinite, and species such as willemite (Zn_2SiO_4) are common rather than rare. More distant similarities can be seen with most of the other highly diverse mineral localities. In all cases, the main feature in common is extreme amounts of fractionation and refluxing in fissure systems. The Pb-Cu-Zn dominated ore deposit at Tsumeb, Namibia, for instance, has produced a very large number of arsenate and reduced arsenite secondary minerals, although few of these are the same as the Långban species. Fractionation of rare elements out of primary sphalerite at Tsumeb has produced chemically bizarre Ga- and Ge- and Cd-dominant species such as gallite, germanite and otavite, but the wide range of Mn minerals such as are found at Långban are missing at Tsumeb itself (although some appear at Kombat nearby).

Conversely, Broken Hill, Australia, which resembles a less fractionated Tsumeb, evidently had more Mn in the precursors of the ore bodies. Ores of Zn, Cu, Pb and Ag are intergrown there with carbonates and a suite of Mn silicates (rhodonite, bustamite, inesite, garnet, clinopyroxene) which can have a strong resemblance in texture to similar minerals from Långban or Harstigen.

So yes, Långban is unique, but it has both close and more distant relatives. The study of any one locality may yield clues as to what to look for in the others, be it new species or models for the paragenesis.

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