Intrusion-related mineralization in the Palaeoproterozoic Jörn Granitoid Complex, northern Sweden.

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Abstract: Immediately north of the Skellefte mining district, northern Sweden, the early orogenic-synvolcanic Jörn granitoid complex hosts several mineral deposits. The Jörn granitoid batholith intruded into a continental margin arc or island arc volcanic succession during the early Proterozoic, and comprises a composite, I-type, calc-alkaline batholith, ranging from granite to gabbro in composition. Several mineral deposits occur in the heterogeneous margin of the complex, i.e. the Tallberg porphyry Cu-Au-Mo, the Älgträsk Au and the Älgliden Ni-Cu-Au deposits in the south and the Näsberg Fe±PGE and Granberg porphyry Cu mineralization in the north. The known deposits indicate that the intrusion is fertile for further exploration activities and that Palaeoproterozoic synvolcanic intrusions close to VMS districts should be studied more closely to further develop genetic models which can be used to reconstruct the ore forming environments and tectonic evolution. This knowledge might be used as guidelines when exploring for new districts with economic potential in Palaeoproterozoic terrains.

Keywords: intrusion-related mineralization, Skellefte district, gold, copper, Palaeoproterozoic.

1 Introduction

The Skellefte mining district in northern Sweden (Fig. 1) is well known for its many economic and sub-economic VMS deposits, eg. the Boliden, Renström, Petiknäs, Kristineberg and Maurliden deposits (Allen et al. 1996; Barrett et al. 2005; Bergman Weihed et al. 1996; Montelius et al. 2007; Årebäck et al. 2005). Less known are the intrusive hosted mineral deposits north of the Skellefte district. These mineral deposits are hosted by the marginal and oldest out of four (GI-GIV) magmatic phases in the Jörn granitoid complex (JGC). The JGC is a complex, calc-alkaline, I-type intrusion of which the oldest phase, the GI, is the least fractionated and heterogeneous by character, with compositions ranging from gabbro to granodiorite (Wilson et al. 1987). The JGC was emplaced into the coeval c. 1.89 Ga Skellefte Group volcanic succession, which is interpreted as a remnant of an early Proterozoic island arc or continental margin arc succession (Allen et al. 1996; Weihed et al. 1992). In the southern part of the JGC there are three known deposits, the Ålgräsk, Tallberg and Älgliden deposits. The Ålgträsk Au-deposit is structurally controlled and associated with zones of strong alteration (Bejgarn et al. 2008), and constitutes a major gold exploration target with, at present, an inferred mineral resource of 1.6 Mt grading 3g/t Au (Boliden 2007). The Palaeoproterozoic Tallberg porphyry Cu-Au-Mo deposit (Weihed and Schöberg 1991) is situated three km to the west of the Ålgträsk deposit and close to these two deposits, the mafic-ultramafic Älgliden dyke with Ni-Cu-Au mineralization occurs. In the northern part of the JGC, the Näsberg Fe±PGE mineralization is hosted by a layered gabbro. The Granberg Cu-mineralization is situated SW of Näsberg and shares many characteristics with the Tallberg porphyry deposit in the south.

In this abstract we present a summary of the geology and mineralization, discuss a possible relationship between of the intrusive-related deposits in the JGC and discuss the exploration potential for similar intrusive hosted base and precious metal deposits in Palaeoproterozoic terrains.

2 Regional geology

The Skellefte district (Fig. 1) situated in the northern part of the Fennoscandian shield developed during the early Proterozoic and has been interpreted as the remnant of an ancient volcanic arc behind a northward dipping subduction zone (Allen et al. 1996; Lundberg 1980; Weihed et al. 1992).

The district consists of a complex volcanosedimentary succession which historically has been divided into three major stratigraphic groups; the Skellefte, Vargfors and Arvidsjaur Groups (Allen et al. 1996; Lundberg 1980; Rickard and Zweifel 1975; Weihed et al. 1992). The lower stratigraphic units are dominated by juvenile volcaniclastic rocks, lavas, porphyritic intrusions with intercalated sedimentary rocks such as mudstone, siltstone, sandstone and breccia-conglomerate (Allen et al. 1996). The oldest unit, the Skellefte group, has been dated at 1884 ± 6 Ma by U-Pb in zircon (Billström and Weihed 1996). The VMS deposits are hosted within the Skellefte group. The overlying Vargfors Group is dominated by fine and coarse grained sedimentary succession with intercalated volcanic rocks (Allen et al. 1996) yielding a U-Pb zircon age of 1875 ± 4 Ma (Billström and Weihed 1996). Subaerial volcanic rocks such as ignimbrites, ash-
fall tuff and volcaniclastic rocks characterize the Arvidsjaur Group which yield a U-Pb zircon age of 1876 ± 3 Ma (Skiöld et al. 1993).

Multiple phases of the early orogenic JGC and the Gallejaur type magma intruded the volcanosedimentary succession at c. 1.89-1.87 Ma (Wilson et al. 1987) and c 1.87 Ma (Skiöld et al. 1993) respectively. Mafic dykes cutting the JGC are tentatively correlated with the younger Gallejaur magmatism (Kathol and Weihe 2005). The JGC is composed of I-type, calc-alkaline, early orogenic granitoids, which evolved from at least three different initial magmas (Wilson et al. 1987). The GI outer zone is heterogeneous in composition, though dominated by a coarse-grained grey granodiorite-tonalite. Younger units of the JGC are more felsic in character, ranging from granodiorite to granite in composition (González Roldán et al. 2006; Wilson et al. 1987). The intrusions have been dated with the U-Pb zircon method at 1888±40-14 Ma (GI), 1874±45-26 Ma (GII) and 1873±18-14 Ma (GIII) (Wilson et al. 1987). The intrusion of the GII-GIV phases into the GI unit likely caused metamorphism, hydrothermal alteration and deformation of the GI (González Roldán et al. 2006; Wilson et al. 1987). Similarities in composition and age led many authors to suggest that the volcanic rocks of the Skellefte Group are comagmatic with the JGC (Claesson 1985; Lundberg 1980; Wilson et al. 1987).

Two major phases of folding have been proposed for the central Skellefte district; tight to isoclinal upright folds with variably plunging fold axes (D2) formed during E-W shortening at 1.87-1.82 Ga, and a set of later open folds (D3) with steep north to north-east striking axial surfaces and fold axis that are coaxial with earlier folds (Bergman Weihe 2001). Generally, west-northwest striking shear zones are correlated with the D2 event and the north-north east trending shear zones correlated with the D3 event (Bergman Weihe 2001).

3 Intrusive hosted mineral deposits

3.1 Southern area

The porphyry Cu deposit in Tallberg (Fig. 1, a) is hosted by a medium-grained equigranular tonalite, associated with mainly propylitic and phyllic alteration and quartz-feldspar porphyritic dykes dated at c. 1.88 Ga (Weihe and Schöberg 1991). The deposit is characterized by disseminated pyrite, chalcopyrite, molybdenite, pyrrhotite, magnetite and quartz vein stockworks with similar sulphide assemblage.

The Ålgträsk deposit (Fig. 1, b) situated approximately 3 km east of the Tallberg deposit, is mainly hosted by a coarse-grained quartz-porphyritic granodiorite. It is characterised by several steeply dipping, sub-parallel, NW-SE striking zones of varying width with disseminations and veins of pyrite locally enriched in chalcopyrite, sphalerite, arsenopyrite and accessory Te-minerals and Au. The mineralized zones are structurally controlled and accompanied by intense proximal phyllic-silicic alteration and distal propylitic alteration in the host rock. The mineralization crosscuts gabbroic rocks and quartz-feldspar porphyritic dykes similar to the dykes in Tallberg, but is in turn crosscut by mafic dykes.

A steeply dipping, NE striking ultramafic-mafic dyke (Fig. 1, c) crosscut the JGC at Ålgträsk (referred to as the Ålgträsk dyke), just northeast of the Tallberg and Ålgträsk deposits. The dyke is approximately 50 m wide and 3 km long. The dyke contains mainly disseminated magnetite, pyrrhotite, chalcopyrite and pentlandite with minor pyrite and gold. Pyrite is more common within 10 m from the contact, subsequently replaced by pyrrhotite towards the centre of the dyke. A 0.5 m massive lens of sulphides is present in the central-lower part of the dyke. The Ålgträsk dyke is in turn crosscut by mafic dykes with similar characteristics as in Ålgträsk.

3.2 Northern area

The Näsberg Fe+PGE mineralization is hosted by the Näsberg gabbro (Fig. 1, d) in the northern part of the JGC. The Näsberg intrusion exhibit cryptic and rhythmic laminatons (Filén 2001; Årebäck et al. 2006). The Fe-
mineralization was mined periodically for iron from the 1830’s to c. 1910. The mined magnetite occurs in veins cross-cutting the gabbro, associated with actinolite+quartz+feldspar+apatite± sulphides (Årebäck et al. 2006). A boulder found by Swedish Geological Survey in the southern part of the intrusion contained 1.2 ppm Pt, 3.9 ppm Pd and 0.2 ppm Au (Filén 2001).

The Granberg Cu-mineralization (Fig. 1, e) is situated in the northern part of the GI, and is similar to the Tallberg deposit in the south (Weihed 2001). It comprise disseminated chalcopyrite, pyrite and molybdenite, hosted in a granodiorite an in a quartz feldspar porphyry.

4 Discussion

The Palaeoproterozoic JGC hosts several different types of mineralizations, among them porphyry Cu-Au-Mo deposits, Au only deposits (Bejgarn et al. 2008) and ultramafic-mafic hosted Cu-Ni±Au±PGE. All these mineral deposits are situated in the outer, older parts of a synvolcanic composite intrusion. In the southern part, the mineralization predates the last magmatic phase of the JGC. The role and timing of the mafic magmatism and its related Fe-PGE-Au and Cu-Ni-Au mineralizations needs to be further investigated. In this model the VMS deposits formed in a rifted volcanic arc environment with the porphyry type deposits in on the continent side of the arc (Weihed et al. 1992). Porphyry Cu-Au and VMS deposits thus seem to occur in the same tectonic environment, are temporal and spatially related in the Palaeoproterozoic. Faster moving plates, same tectonic environment, are temporal and spatially related in the northern part of the GI, and similar to the Tallberg deposit in the south (Weihed 2001). It comprise disseminated chalcopyrite, pyrite and molybdenite, hosted in a granodiorite an in a quartz feldspar porphyry.

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References


