

THE SETTING AND FORMATION OF MASSIVE SULPHIDE DEPOSITS IN THE LOWER AND MIDDLE KÖLI NAPPES, HATTFJELLDAL, NORDLAND, NORWAY

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Geological Survey of Norway has over the last three years carried out geological bedrock mapping in a nearly 1000 km² large area to the east and south of Lake Røssvatnet in the Hattfjelldal municipality in the county of Nordland. The main purpose of this work is to assess the potential for economic deposits of metallic ores and industrial minerals. High resolution helicopter-borne geophysical survey was carried out in 2014 and provides a good basis for the geological work in the area.

The lithologies in the mapped area belong to the Köli Nappe Complex (KNC) in the Upper Allochthon of the Caledonides. KNC is divided into the Lower, Middle and Upper Köli Nappes. In the Hattfjelldal area massive sulphide deposits are mainly occurring in the Joesjö Nappe of the Lower Köli and the Atofjället Nappe in the Middle Köli Nappes, and are the topic of this presentation.

The Joesjö Nappe is dominated by metasediments; mainly pelitic to psammitic schists, calcareous schists, graphite schists and extensive units of greenschist and greenstone. Parts of the Atofjället Nappe are also dominated by metasediments of phyllitic/pelitic character, which often are graphitic. In addition, ultramafic rocks, mainly serpentinised peridotites, make up several pronounced knolls and mountains, including the trademark for Hattfjelldal - the mountain Hatten. Associated with and underlying most of these ultramafic bodies are extensive units of greenstone/greenschist with minor gabbroic bodies. Very extensive layers of felsic metavolcanite ("quartz keratophyre") are associated with the greenstone units.

Geochemical data shows a different origin for the greenstones of the Joesjö and Atofjället Nappes. The Joesjö greenstones have an arc signature, whereas the Atofjället greenstones have a signature of metabasalts formed in a mid-ocean ridge or a major back-arc basin regime. Also, the chemistry of the felsic metavolcanites identify them as formed in an ocean ridge to arc regime with a rhyodacitic/rhyolitic composition. The chemical compositions of the felsic and mafic volcanics points to an origin in a spreading ridge regime for the Atofjället unit. The spatial relationship of the ultramafic rocks with the gabbros and greenstones, strongly suggest that they have a mantle origin, formed beneath the seafloor. However, the abundance of clastic sediments shows that this extensional regime must have been close to a continental or arc source.

The massive sulphide (VMS) deposits are hosted by greenstone/greenschist units in the Joesjö Nappe and mainly by felsic metavolcanites in the Atofjället Nappe. In the latter a minor Zn-Pb-As deposit occurs in calcareous to carbonaceous phyllites. The composition of the sulphide ores is very different in the two nappe units. The deposits in the Joesjö nappe contains 1-3 % Cu and 1-2 % Zn with very low contents of Pb, Ag and Au, as well as other trace metals. The contents and ratios between the metals are as expected from a source of basaltic composition. The felsic-hosted deposits in the Atofjället Nappe are very different and are characterised by being strongly enriched in Zn, Pb, Ag and Te, and are also partly Cu, Au-rich, as well as enriched in Mo, Sb and Se. The most significant deposit is the Raudvatnet deposit, and exploration companies identified a possible resource of 0.365 Mt of Zn-Cu-Pb-Ag-Au ore. However, it may be more extensive and connected to the Svarthammaren deposit outcropping 3.5 km to the west along the same ore axis. The strong enrichment of elements like Au, Te, Se, Mo and Sb points to a direct magmatic source and high sulphidation system. Au-rich, high Te-Se deposits are abundant in the present Kermadec Arc Ridge in the Western Pacific (e.g. Brothers Volcano). By analogy, we suggest that the Atofjället units may have a similar origin.

There is a good potential for large and rich VMS deposits associated with the felsic metavolcanics in Hattfjelldal, possibly in the Raudvatn area. Other lithologies are regarded as having minor potential.