EVOLUTION OF HYDROTHERMAL FLUIDS OF THE SEDIMENT-HOSTED CU DEPOSITS OF NUSSIR AND ULVERYGGEN, REPPARFJORD, NORTHERN NORWAY.

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The hydrothermal sediment-hosted Cu Nussir and Ulveryggen deposits are situated in the Repparfjord Tectonic Window (RTW), one of several exposures of Paleoproterozoic basement within the Norwegian Caledonides in Northern Norway. The mining at the Ulveryggen deposit occurred in the period of 1972-1978/1979 and the Nussir deposit was discovered in late 1970's. Inferred resources of Cu at the Ulveryggen and Nussir are 3.7 Mt and 5.8 Mt, respectively. By-products are Au and Ag (Nussir, 2017).

Due to the lack of information on the origin of mineralizing fluids at the Nussir and Ulveryggen deposits as well as the processes that triggered the ore deposition, in this study we discuss the evolution of ore-bearing hydrothermal fluids at both deposits applying petrography and microthermometry of fluid inclusions, sphalerite geothermometery, geochemistry of host rocks and stable isotope data.

Fluid inclusion studies revealed the presence of several inclusion types: Type 1) L+V+S; Type 2) L+S and Type 3) L+V, indicating a complex hydrothermal system. Salinity of trapped fluids was calculated using salt dissolution and last ice melt temperatures (Bodnar and Vityk, 1994). The salinity varies from 0.35 up to 36 wt. % NaCl equivalent. The total homogenization temperatures, which in many cases were equal to salt dissolution temperatures, are recorded within the temperature interval from 102 to 520°C at the Ulveryggen, and from 135 to 350°C at the Nussir deposit. The extremely wide ranges of salinities and homogenization temperatures suggest intensive mixing and/or gradual cooling under the constant pressure.

Sphalerite-chalcopyrite geothermometer (Barton and Toulmin, 1966; Hutchison and Scott, 1981) suggests the precipitation temperature between 320 and 350°C. Combination of the fluid inclusion and geothermometry data reflects the formation pressure in the interval from 150 to 175 bars. Torgersen (2015) interpreted that the formation of ore-bearing veins in the RTW was under the compressional regime. Therefore, we suggest that the inferred pressure is lithostatic and the depth of vein formation was about 550 m.

Overlapping $\delta^{13}C$ and $\delta^{18}O$ values from the vein carbonate and the underlying dolostones of the Nussir deposit reveals that carbon was derived from the host carbonate rock. The hydrothermal system was rock-buffered with minor or no magmatic contribution of carbon.

The host rock lithogeochemistry reveals that Cu, Mo, Pb, Sn, Bi, Ag, and Be were brought into the system during the hydrothermal activity at the Nussir deposit, while Co, Zn, Ni, Ba, and V were leached out. The same tendency was observed at the Ulveryggen deposit with the only difference that Zn was introduced into the system.

The circulation of basinal brines at the Nussir and Ulveryggen deposits occurred under the compressional regime. A wide range of total homogenization temperatures (102-520°C at the Ulveryggen and 135-350°C at the Nussir) is an evidence for an intensive mixing and/or gradual cooling at a constant pressure, which resulted in fluid separation: highly saline brine precipitated first; the subsequent drop in salinity was followed by gradual precipitation of the remaining fluid. Our data shows directly proportional decrease in salinity with a decrease in temperature. Close $\delta^{13}C$ and $\delta^{18}O$ values from vein and host carbonate rock indicate a rock-buffered system, without significant magmatic source of carbon. The host rocks were hydrothermally altered resulting in a change in elemental composition: Cu, Mo, Pb, Sn, Bi, and Ag were introduced with the hydrothermal fluids, while Co, Ni, Ba, and V were leached out. Zn was leached out from the Nussir host rocks and introduced into the Ulveryggen host rocks.

References

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