Mineralogy of Se in the continental and submarine oxidation zones of Urals VHMS deposits

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Oxidation of massive sulfides can occur at the ocean floor as well as the Earth's surface [1]. Zoning of continental and submarine oxidation profiles have some similarities.

Clausthalite, naumannite and Se-bearing galena are found in continental and submarine oxidation zones of the Urals VHMS deposits. Native Se, tiemannite, Se-bearing secondary copper sulfides, sulfosalts and chalcopyrite are described only in the continental oxidation zone, whereas Te-bearing naumannite, bohdanowiczite and Se-bearing roquesite are identified in the submarine one.

Se minerals are most characteristic for the lower parts of both oxidation zones. In continental position maximal Se enrichment occur in sulfur sand subzone where Se forms a native phase and various selenides. Also selenides and Se-enriched sulfides occur in cementation subzone. In submarine environment selenides associate with authigenic chalcopyrite, tennantite, galena, sphalerite and bornite in cementation subzone and with barite, pyrite and/or quartz in leaching subzone. More rare Se-minerals were found in continental «iron cap» and submarine gossanites in association with Fe(III) oxides, oxi/hydroxide or siderite.

As shown by our thermodynamic calculations, existence of selenides in the lower part of the oxidation zone is due to their stability under more oxidizing conditions than the corresponding sulfides at the low temperature ambient condition. The formation of selenides and Se-bearing sulfides in assemblage with Fe(III) oxides/hydroxides can be a result of low activity of reduced S, when Se successfully competes with S for the formation of the chalcogenides. Selenides formation in the upper part of the oxidation zone is probably related to the local redox barrier, which is formed due to vital functions of organisms [2].

[1] Herzig *et al* (1991) Gold-rich sea-floor gossans in the Troodos ophiolite and on the Mid-Atlantic Ridge. *Econ Geol* **86,** 1747–1755. [2] Spinks *et al* (2016) Remobilization and mineralization of selenium-tellurium in metamorphosed red beds: Evidence from the Munster Basin, Ireland. *Ore Geol Rev* **72**, 114-127.