Example of Ore Characterization by the Use of Automated Mineralogical Analyses Using Mineralogic Mining (ZEISS) Technology: Results on the Hakkari Samples (Turkey)

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The Hakkari Zinc Project is a supergene nonsulfide Zn>>Pb deposit located in the southeast of Turkey. Total resources estimated consist of 10 Mt at 15% Zn. The ore concentrations mainly consist of oxidized Zn minerals (smithsonite and hemimorphite) derived from the weathering of sulfides, hosted in shallow-water Jurassic limestone.

This preliminary study is focused on the mineralogical and petrographic characterization of four Hakkari samples in terms of quantitative modal mineralogy and average mineral association. The four samples were taken from different oxidation zones representative of the deposit, in order to characterize and quantify all the occurring mineral phases. The analyses were carried out using a new generation of automated mineralogical analysis systems known as "Mineralogic Mining" (ZEISS), which utilizes modern quantitative EDS technology to allow minerals to be classified based on the % element abundance (stoichiometry).

Previous QEMSCAN (FEI) analyses for the same four samples of the Hakkari mineralization provided a strong basis for the Mineralogic routine, and were used to assess the accuracy and the capabilities of the Mineralogic system. Mineralogic Mining was able to build high-resolution maps and to clearly identify and quantify the major economic phases, such as smithsonite and hemimorphite (up to ~58 and ~67 wt %, respectively, in the analyzed samples), and gangue phases such as goethite (up to 38 wt %). Minor phases such as barite (up to ~6 wt %), dolomite (up to ~7 wt %), calcite (up to ~8 wt %), cerussite (up to ~8 wt %), gypsum (up to ~1 wt %), and traces of pyrite, chalcophanite, hetaerolite, quartz, and coronadite (<0.50 wt %) were also detected in the analyzed samples. It was also possible to identify the "impure" metal-bearing minerals: mainly Zn-enriched goethite (up to ~54 wt %), but also traces of Zn dolomite, Fe dolomite, Mg smithsonite, and Fe smithsonite (<1 wt %). The technique was able to distinguish clearly between two very similar mineral phases (i.e., ankerite and Fe dolomite).

The mineral association of the major mineral phases was also investigated. The results show that smithsonite and hemimorphite are generally associated together and with Zn-enriched goethite (in agreement with previous studies).

The software was also able to automatically calculate the distribution % of Zn in the different mineral phases—information which can be critical during geometallurgical modeling, feasibility studies, and process planning, as it can help to predict metal losses during the treatment. The results on the analyzed samples show that Zn occurs mostly in smithsonite, hemimorphite (as predicted), and goethite (Zn-enriched goethite).

This study revealed the effectiveness of the Mineralogic automated mineralogy system in ore characterization, to be used during the feasibility studies in the exploration stage and processing modeling as an early aid to the evaluation of possible recovery problems.