Mineralogical characterization of the Hakkari nonsulfide Zn(Pb) deposit, Turkey: Does QEMSCAN® make the difference?*

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The mineralogy, petrography, and geochemistry of nonsulfide Zn(Pb) deposits are quite complex. This complexity could generate time consumption and money losses during processing stages, without an accurate knowledge of the deposit. Therefore, the first step when approaching these mineral concentrations is to gain a characterization of the ore, in order to mitigate many (if not all) issues related to the their mineral and geochemical composition. Nonsulfide ores are generally investigated using several traditional methods (optical microscopy, chemical analyses, XRD, SEM). A recent attempt of characterization of this deposits type with another analytical methodology (QEMSCAN®- Quantitative Evaluation of Minerals by Scanning Electron Microscopy) is being conducted by our research group. The method is a fully automated microanalytical system generally used for sulfide ore studies, because of its ability to output detailed information useful for metallurgical applications.

The Hakkari zinc project is a supergene nonsulfide Zn>>Pb deposit located in southeast Turkey, currently owned by Ebullio Resources and Mining A.S. Total resources estimated consist of 10 Mt @ 15% Zn, with potential for more. The ore concentrations, mainly consisting of oxidized Zn minerals (smithsonite and hemimorphite), are hosted in shallow water, brecciated Jurassic limestone. To obtain an accurate mineralogical and petrographic characterization of the Hakkari deposit, we focused our attention on the minerals occurrence, textural parameters, quantitative modal mineralogy, and average mineral association of the occurring mineral species.

Thirty-one core samples were subjected to whole-rock chemical analysis (ICP-MS, AAS) and XRPD. Polished thin sections were first observed by optical microscopy, cathodoluminescence and then analyzed by SEM-EDS and WDS technologies. Ten selected samples were subjected to QEMSCAN® analyses, in order to obtain the quantitative modal mineralogical and the average mineral association of the mineral species. The samples were incorporated in resin blocks and on them QEMSCAN® analyses in Fieldscan mode were carried out with 10 µm image resolution. The formulation of a Species Identification File (SIP) was necessary to discriminate the mineral species. The SIP file was validated by EDS analyses, and comprehends both pure and impure mineral phases.

The results show that smithsonite is the main ore mineral, occurring in two generations: one (FeO and PbO bearing) replaces previous sphalerite and host carbonates, and another (CaO bearing) is concretionary in cavities. Hemimorphite occurs in cavities or replaces smithsonite in a network of veinlets. Fe-(hydr)oxides can be enriched in Zn, Pb, As and SiO₂. Mn-Fe-(hydr)oxides (Pb>>Zn enriched) are rare. Remnant sulfides have also been detected.
QEMSCAN® analyses have seldom been used for nonsulfide ore characterization. In the current study they allowed obtaining maps of all the mineral phases occurring in the deposit, and quantitative analyses of the modal mineralogy: smithsonite is the most abundant economic phase (up to to 51 vol.%), followed by hemimorphite (up to 47 vol.%). Fe-(hydr)oxides (up to 56 vol.%) are most common. Zinc-bearing Fe-(hydr)oxides, Cd-calcite, Zn- (≤ 10%) and Fe-dolomite (≤ 5%) were also identified and quantified, as barite, cerussite and mixed phase comprehending pyrite, Fe-(hydr)oxides and jarosite. The latter phase was seen as “amorphous” in previous XRD analyses.