Quantitative mineralogy of mining- and smelter-derived particles in contaminated soils

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We investigated particulates deposited in a highly polluted semiarid area near an operating copper smelter and old mine-tailing disposal sites in Tsumeb (northern Namibia). Heavy mineral fractions were studied by XRD and polished sections were analyzed by optical microscopy, SEM/EDS, autoSEM/EDS and FEG-EPMA. The quantitative EPMA data supplemented the database of the TESCAN Integrated Mineral Analyzer (TIMA) autoSEM/EDS, which was then used for the analysis of modal compositions and for the automated search and identification of metal(loid)-bearing phases. Modal and texture analyses were performed using the "dot mapping mode". Final optimization of the elemental distributions within individual phases was verified by comparisons with the bulk chemical compositions.

The contaminant-bearing particles were mainly represented by spherical grains, which originate from the smelting process and corresponded to quenched droplets of matte (Cu-Fe sulfides) and slag melts (glass, spinels). In addition, angular grains were probably windblown from ore processing facilities and/or nearby mine-tailing disposal sites. These particles contained gangue minerals (carbonates) and various metal-bearing sulfides, sulfosalts and arsenates. Large TIMA-collected dataset (approximately 60 million spot analyses per sample) helped to quantify the percentage of individual phases and to perform partitioning of the studied contaminants (Pb, Cu, Zn, As, Sb, Cd). Whereas As was mainly bound in apatite group minerals, slag glass and arsenates, metals were predominantly bound in oxides, hydroxides, sulfides and slag phases. This knowledge is helpful for better understanding of contaminant binding and mobility in target reservoirs (soils, vegetation) highly polluted by emissions from mines and smelters.

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