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Bottom ashes from a hazardous waste incinerator: temporal variability in mineralogical and chemical compositions

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Among various solid residues from solid waste incineration plants, bottom ashes are the most abundant ones. Whereas municipal waste incineration bottom ashes have been extensively studied, bottom ashes from hazardous waste incineration (HWI BA) received much less attention. Here we studied a 1-year composite samples and additional 19 samples of HWI BA collected from three different incineration lines of a hazardous waste incineration plant over six months. Bottom ashes were examined for their mineralogical composition (XRD, SEM/EDS, EPMA) and trace elements contents (XRF, acid digestion and ICP-OES/MS analyses).

Trace elements composition indicated substantial differences between individual samples, likely reflecting changes in the furnace feed or burning conditions. The concentration ranges were the following (mg/kg TS): Cu: 945-8050, Ni: 773-7260, V: 311-2820, Cr: 878-3860, Zn: 789-18020, and Mo: 95-893. Examined samples display very similar main phase assemblages: quartz [SiO_2], clinopyroxene [$Ca(Fe, Mg)Si_2O_6$], spinels [$(Fe, Mg, Zn)(Fe, Al, Cr)_2O_4$], hematite [$Fe_2O_3$], cristobalite [$SiO_2$], apatite [$Ca_5(PO_4)_3(F, Cl, OH)$] and perovskite [$CaTiO_3$]. Other minor phases (e.g. titanium oxides, metal sulfides) were also detected in several samples. Apart from crystalline phases, amorphous glass is ubiquitous in all samples. Concentrations of Cr (up to 14.8 wt.% Cr_2O_3) and Zn (up to 2.89 wt.% ZnO) were detected in the spinel family oxides. Nickel was mostly bound in metallic Fe and/or Fe phosphide phases (with concentrations even up to 7.06 wt.%), occurring in iron sulfides and secondary hydrous ferric oxides as well. Vanadium was detected in numerous Ti-bearing phases (e.g. up to 1.2 wt.% V_2O_5 in rutile [TiO_2], up to 0.84 wt.% V_2O_5 in perovskite). Molybdenum and copper were mainly bound in sulfides or metallic droplets.

The mineralogical and geochemical compositions help to understand leaching properties of the bottom ashes and choose suitable experimental strategy protocol for further metal recovery tests.

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