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# Characterization of bottom ashes from incineration process by means of XRF mapping and XANES spectroscopy

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The proper management of waste is among the key aspects of the transition of our society to become as environmentally neutral as possible. In Italy, about 30 million tons of urban waste are produced yearly, of which roughly 5 are disposed in incinerators; the incineration process then produces about one million tons of ashes [1].
In general, ashes from municipal solid waste incinerators (MSWI) are made by bottom ashes (BA), and fly ashes (FA), which corresponds to about 20% and 4% by weight of the original waste, respectively [2]. Whereas FA are classified as dangerous waste, BA can be recycled and are the main secondary raw material from incineration processes.
Recycling BA represent an interesting, environmentally friendly, alternative solution to landfill disposal which helps to save natural resources and contributes to the circular economy. Indeed, several processes have been proposed, like inclusion in ceramics or in concrete [3] in addition to the opportunity to recover precious metals, which strongly reduces the CO2 emissions compared to primary metal production [4].
Nevertheless, any form of recycling requires an assessment of the potential pollution for environment and health risk, which can be achieved only through a detailed characterization of the chemical and mineralogical composition followed by specific tests to determine the evolution after ageing, leaching and weathering [5].
BA are mainly composed by Si, Al, Fe, Ca, Mg, K, Na, S, Cl. However, they also contain potentially dangerous elements (PTE) such as Zn, Pb, Cu, Cr and Ni. The actual danger depends on the mineralogical environment in which they are found, which controls the potential release in the environment, so for any potential reuse it's important to determine their speciation.
For this reason, on few grains (sized 0.5 - 1 mm) of BA from a waste-to-energy plant, SEM-EDS, XRF mapping and XANES spectra from different elements (Zn, Cu, Cr, Ni and Pb) were collected. XRF maps evidenced that PTE are present with different oxidation states and structures, like in metallic form, amorphous phases, silicates and carbonates. A preliminary look to the XANES data collected at the Cr K-edge permits to exclude the presence of Cr6+ (the most dangerous form) whereas data collected at Pb L3-edge seems to indicate that Pb is oxidized in all the clasts. Cu and Ni appears to be present both in metal and oxidized form. The precise oxidation state and coordination geometry of all the investigated chemical elements will be determined through linear combination fit (LCF) analyses.

**Primary author:** POLLASTRI, Simone (Elettra Sincrotrone Trieste)

**Co-authors:** Ms DE MATTEIS, Chiara (Università di Parma, Dip. di Scienze Chimiche, della Vita e Sostenibilità Ambientale, 43124, Parma, Italy.); Ms MANTOVANI, Luciana (Università di Parma, Dip. di Scienze Chimiche, della Vita e Sostenibilità Ambientale, 43124, Parma, Italy.); Prof. TRIBAUDINO, Mario (Università di Torino, Dipartimento di Scienze della Terra)

**Presenter:** POLLASTRI, Simone (Elettra Sincrotrone Trieste)

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