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Mineralogical analysis of attic dust samples for contamination source identification in an industrial area, Ajka, Hungary

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The post-war centrally directed economy forced massive heavy industry in Hungary, producing huge amount of wastes and pollution. Long-term airborne emissions from mining, coal-fired power plants and alumina industry have left the legacy of widely distributed contamination around industrial areas and nearby settlements in the Ajka region. Recent research suggests that significant amount of airborne pollutants, deposited in the urban environment, can be efficiently studied by attic dust analysis. The sampling strategy followed a grid-based stratified random sampling design and 30 samples were collected in 27 houses (at least 30 years old) in a 8x8 grid of the 64 km2 project area. In order to determine the pollution potential of attic dust samples, geochemical and mineralogical analyses were performed. The main aim of the mineralogical analyses was to study the phase composition of the dust particles and to identify potential anthropogenic sources. The total concentrations of the toxic elements (As, Pb, Cd, Cu, Ni and Zn) were measured with ICP-OES and mercury content was analyzed with atomic absorption spectrometry. Phase analyses of the samples were carried out by the means of scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS) and X-Ray diffraction (XRD) methods. Laser particle size analyzer was used to measure the grain size of attic dust particles. Results showed that the studied attic dust in the Ajka urban area was contaminated mostly by Hg, Pb and Zn with contents ranging between 0.1-2 ppm, 42.5-881 ppm and 90.2-954 ppm, respectively. However, the study of extreme data values (statistical outliers) has shown that at certain points airborne dust can be extremely contaminated also with Cd (0.4-11.7 ppm). The size of the attic dust particles varied between 0.2 and 113 μm. Based on the SEM/EDS and XRD analysis, the most frequently identified mineralogical phases were quartz, calcite, gypsum and Fe- and Al-bearing phases. Fe-bearing phases often occurred as spherical particles and skeletal crystals, indicating melting at high temperatures followed by fast cooling and, thus, their anthropogenic origin. Hollow gypsum phases found in the dust samples referred to anthropogenic sources, too. Spherical aluminosilicates formed mainly during coal combustion were commonly identified. On the other hand, only sporadic heavy metal-bearing phases were found. Detailed phase analysis enabled the identification of origin of airborne dust and concluded that contaminated fly ash from the coal-fired power plant dominates anthropogenic sources, besides the alumina industry, mining and traffic.