Volatile organic compounds (VOCs) emitted in abandoned sulfide mines

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Abstract

Environmental impacts in the vicinity of abandoned sulfide mines is one of the environmental problems that Cyprus needs to face. A significant number of abandoned mines, more than 25, remain on the island as in the past the mining companies were not obliged by law to restore the mines after closure. Cyprus type sulfide deposits consist primarily of pyrite, chalcopyrite and sphalerite. Pyrite (FeS_2) is the most abundant mineral located in these mines. Several environmental problems result from the abandonment of these mines without rehabilitation. Acid Mine Drainage (AMD) generation, degradation and depletion of water resources (surface water and groundwater), soil contamination, enrichment of soil and water by heavy metals and metalloids, acid rain generation, destruction of aquatic life, crops, and livestock, visual degradation of the landscape and risk of slope instability (Gavriel et al. 2014; Stylianou et al. 2014).

Generally, AMD is considered to be one of the most well-documented problem caused by mining activities, and is a result of the oxidation of sulfurous ores and waste material by a combination of water, oxygen and existing bacteria (Johnson and Hallberg 2005). Usually, AMD is characterized by extremely low pH values and high concentrations of heavy and toxic metal ions, as well as sulfur ions, which pollute significantly large areas and the surface/underground water systems (Nordstrom 2000; Foucher et al. 2001).

The present study aims to analyse the volatile organic compounds (VOCs) emitted from solid pyrites and from other oxidised ores found in the abandoned mines, in order to examine possible degradation of the surrounding air quality. For this purpose, different sampling campaigns were performed in order to collect representing ore samples from two mines, that of North and South Mathiatis mine, located in Nicosia district (Cyprus).

Headspace solid-phase micro-extraction gas chromatography-mass spectrometry (HS-SPME-GC/MS) analyses of various pyrites and oxidized form of pyrite samples were performed (figure 1) and the emitted VOCs were identified. The main compounds identified in the majority of the samples were Sulfur Dioxide, Carbon Disulfide, Dimethyl selenide, Carbo selenide, 2,3-Butanedione, 2-Butanone, *etc*. AMD probably enhances the volatilization of compounds, such as selenium (Se); it is a dissipation mechanism in which the gaseous forms of the compounds are redistributed in the environment. The release of chemicals from a surface in the vapor phase through AMD, followed by diffusion into the atmosphere and furthermore air pollution, is controlled by vapor pressure, water solubility, soil adsorption, stability, wind speed *etc* (Karlson et al. 1994). Further measurements are definitely needed in order to understand the mechanism, as well as their impact in the environment.

Figure 1. Pyrite samples for SPME analysis

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