

Geophysical Research Abstracts,
Vol. 11, EGU2009-2131, 2009
EGU General Assembly 2009
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Trace elements release from volcanic ash to seawater. Natural concentrations in Central Mediterranean sea

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Distributions and concentrations of many minor and trace elements in epicontinental basins, as Mediterranean Sea, are mainly driven to atmospheric fallout from surroundings. This mechanism supplies an estimated yearly flux of about 1000 kg km⁻² of terrigenous matter of different nature on the whole Mediterranean basin. Dissolution of these materials and processes occurring at solid-liquid interface along the water column drive the distributions of many trace elements as V, Cr, Mn, Co, Cu, and Pb with contents ranging from pmol l⁻¹ (Co, Cd, Pb) to nmol l⁻¹ scale in Mediterranean seawater, with some local differences in the basin.

The unwinding of an oceanographic cruise in the coastal waters of Ionian Sea during the Etna's eruptive activity in summer 2001 led to the almost unique chance to test the effects of large delivery of volcanic ash to a coastal sea water system through the analyses of distribution of selected trace elements along several seawater columns. The collection of these waters and their analyses about V, Cr, Mn, Co, Cu, and Pb contents evidenced trace element concentrations were always higher (about 1 order of magnitude at least) than those measured concentrations in the recent past in Mediterranean seawater, apart from Pb. Progressive increase of concentrations of some elements with depth, sometimes changing in a "conservative" behaviour without any clear reason and the observed higher concentrations required an investigation about interaction processes occurring at solid-liquid interface between volcanic ash and seawater along water columns.

This investigation involving kinetic evaluation of trace element leaching to seawater, was carried out during a 6 months time period under laboratory conditions. X-ray investigations, SEM-EDS observations and analyses on freshly-erupted volcanic ash evidenced formation of alteration clay minerals onto glass fraction surfaces. Chemical analyses carried out on coexisting liquid phase demonstrated that trace element leaching occurs through a first quick followed by a slow second step that attains to an apparent equilibrium after 6 months. Amplitude of kinetic rate constant measured for SiO₂ release during the first step and behaviour of Ti/Si and Cr/Si ratios in primary volcanic minerals, glass fraction and leaching solutions during the first 1 month stage of the experimental interaction allowed to demonstrate that trace element release mainly occurs from glassy materials and Ti-rich magnetite.