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Contamination Pathways and Remediation Strategies in a Thallium-Contaminated Geological Environment (Valdicastello Carducci area, Tuscany, Italy)

MATTIA FERRARI[1], ALESSANDRO BRAGAGNI[2], CRISTIAN BIAGIONI[3], MATHIAS SCHANNOR[4], PHILIPP GLEISSNER[5], FRANK WOMBACHER[6], SANDRO CONTICELLI[1], CLAUDIO NATALI[7] AND SIMONE TOMMASINI[8]

[1]University of Florence
[2]CNR-IGG
[3]University of Pisa
[4]Federal Institute for Materials Research and Testing (BAM)
[5]FREIE UNIVERSITÄT BERLIN
[6]University of Cologne
[7]CNR - Institute of Environmental Geology and Geoengineering
[8]Dept Earth Sciences, University of Firenze, Italy

Presenting Author: mattia.ferrari@unifi.it

Stable thallium isotopes (^{205}Tl and ^{203}Tl) have emerged as a key-tool to investigate geochemical processesand, in particular, to trace the origin of thallium in polluted sites [1]. Thallium is recognized among the 13 priority pollutants of the environment due to its increasing contamination levels in industrialized country.

The southern sector of the Apuan Alps (Central Italy) is characterized by the occurrence of baryte-pyrite-iron oxide orebodies with a high thallium content (up to 4200 µg/g on primary pyrites;[2]). Notably, historical mining sites of Mt. Arsiccio and of Pollone mine [3,4] near Valdicastello Carducci have attracted attention due to alarming levels of Tl detected in drinking water that are above the U.S.EPA threshold of 2 µg/l.

In this study, we aimed to enhance our understanding of the Tl geochemical cycling from the orebodies to the spring and surface waters. We selected various samples to trace contamination pathways from the source (i.e.,pyrite) to sulfosalts and sulfates and, ultimately to waters and sediments. Thallium concentrations along with other heavy metals were determined as well as thallium isotope compositions following established chromatographic separation routines [5]. The results allowed to obtain paramount information on the fate of this contaminant from its origin to the variety of matrices analysed (sediments and spring and surface waters).

Furthermore, we suggest a method for Tl remediation from polluted water following the study of [6], who found a secondary source of Tl in the public distribution system pipeline at Valdicastello area due to the addition of chlorine-based oxidants. This method, based upon [7], takes into account the pH-Eh stability field of Tl specie(Tl_2O_3). Starting from natural water conditions originating from acid mine drainage, we modified the pH using NaOH and then adjusted the Eh using NaClO, achieving a 98% ± 1% removal rate of thallium from water.

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