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Arsenic contamination in groundwater: natural sources and release mechanisms

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Inorganic potentially toxic elements in groundwater may derive from both natural processes and anthropogenic activities. Among the natural phenomena which may affect the type and amount of dissolved substances, water-rock interaction is recognized as a possible cause of the important presence of As in the aquifers of Central Italy.

The aim of this work is to investigate the origin and processes that determine the presence of As in groundwater through a local scale investigation on a transect located north of Rome, a small area representative of the typical volcanic-sedimentary geological context of central-northern Latium. The identification of the possible mineralogical sources of arsenic in the aquifer and the main mechanisms that govern As release have been investigated through different types of laboratory tests and analysis, performed on a representative solid matrix (Via Tiberina Yellow Tuff).

The mineralogical analysis highlighted the presence of various As-bearing compounds, such as zeolites, iron oxides, calcite and pyrite. Microwaves acid digestion showed As total concentrations up to about 40 mg/kg, most of which is linked to Fe oxy-hydroxides. In particular, the selective sequential extraction highlighted that low crystalline type represents a small portion of the examined samples but can contain up to 70% of the total arsenic. However, this important fraction of arsenic seems unlikely mobilizable by the groundwater circulating in the investigated area, whose pH values are close to neutrality, with mostly oxidizing conditions.

Other significant extracted fractions include specifically adsorbed As, bound with calcite and linked to sulfides. Batch tests have shown a fast As mobilization also in oxidizing conditions, which suggests that arsenic in the investigated groundwater mainly derives from desorption phenomena in presence of specific exchangers (e.g. phosphates) and/or from calcite. Fe oxy-hydroxides maintain a key role for As mobility in other possible natural conditions, such as alkaline (arsenate desorption/adsorption, probably also from the prominent zeolites) and reducing environments (Fe-oxides reductive dissolution).