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How trace element distributions can be used to probe human exposure to atmospheric fallout

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Medical literature recognised several effects of human exposure to inhalation of air dispersed particles that could induce pulmonary diseases, but the hypothesis that reactions occurring between inhaled particles and human respiratory fluids could involve trace element leaching was poorly understood and only a scarce literature about in-vitro experiments suggested it.

The present research was carried out on a group of volunteer patients exposed to the natural inhalation of atmospheric particles in a highly anthropized area close to Mt. Etna under explosive volcanic eruption in Summer 2001. Collected data shoed, for the first time, that the dissolution of inhaled solids influenced the chemistry of pulmonary fluids also under in-vivo conditions. Furthermore our data demonstrated that:

i. Trace element distributions in bronchoalveolar fluids could be treated as usually occurring in a classical geochemical investigation of solid-liquid interface processes and this treatment was used to investigate the origin of inhaled atmospheric dust particles.

ii. Rare Earth (RE) distributions (apart from Sc and Pm) in bronchoalveolar solutions could represent a diagnostic tool to evidence early stages of pulmonary microlithiasis.

Analyses of enrichment factors (EF) for several elements measured in bronchoalveolar lavages (BAL), collected from investigated individuals, indicated that people living in the studied area were exposed to inhalation of large amounts of suspended atmospheric dust. This atmospheric particles consisted of a mix of volcanic ash, road dust and suspended particulates originated from oil refinery materials emitted by closely located industrial areas.

Shale-normalised RE patterns in studied BAL samples evidenced strong fractionations along the lanthanide series with enrichments in Y, La, Ce and Pr, depletions in elements from Nd to Eu and then progressive enrichments in lanthanides from Gd to Lu. The impressive similarity of these features with respect to those observed in shale normalised patterns of natural waters during crystallization of newly-forming phosphates suggested that crystallisation of phosphatic microcrysts in intraaveolar spaces occurred in the lungs of investigated people. Moreover, the reliability of this suggestion was confirmed by model calculations (EQ-3/6 version 7 software package) that evidenced how Rare Earths in bronchial fluids could effectively co-precipitate as RE-phosphates. Evidence of pulmonary microlitiasis was known in medical literature and was considered difficult to recognise under in-vivo observations, whereas their occurrence was usually evidenced only after authoptic examination.

We propose that the study of trace element distribution in BAL solutions can represent a powerful tool for environmental and medical investigations. The data obtained could corroborate medical investigations for the assessment of lung diseases observed in patients after prolonged exposure to atmospheric fallout.