

Dust particles in brochoalveolar lavage fluids from coal miners in Quang Ninh province, Viet Nam

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Inhalation is the most important pathway for airborne particles into the human body. The pulmonary system provides an efficient filtering mechanism, which retains most of the coarse particles in the nasal and oral cavities. The fine-particle fraction ($\leq 2.5 \mu\text{m}$ aerodynamic diameter) penetrates deeper into the respiratory tract and reaches the alveolar region. Here, the particles remain for long periods of time and interact with lung fluid and tissue. The deepest part of the lungs, thus, acts a special type of active sampler for atmospheric dust. The deposited particles can be studied in tissue samples or in brochoalveolar lavage (BAL) fluids.

This investigation aims at characterizing mineralogically and chemically the particles in BAL fluids, which were retrieved from coal miners in the Quang Ninh province, northern Viet Nam. The BAL fluids were filtered to recover the solid fraction, which was dried and studied by X-ray diffraction (XRD). The main mineral component is halite, an artefact from the sterile saline solution (0.9 wt% NaCl, heated to 37 °C) used during the lung lavages. One of the samples also contains thenardite (Na_2SO_4) and gibbsite ($\text{Al}(\text{OH})_3$).

To remove halite, all samples were rinsed repeatedly with deionized water, filtered and dried, and then subject to further investigations. These residues contain the following main components (in wt%): C = 3.3-4.8; Al = 1.7-7.4; Si = 24-94; and Fe = 0.7-1.2. Minor amounts of Na, Mg, S, K, Ca, Cr, Zn, Cd, Ba and Pb are also present, whereas Ni, Cu, As, and Sb were not detected.

XRD analysis of the washed residues revealed that they contain primarily quartz and gibbsite. We are currently using scanning electron microscopy, combined with energy-dispersive X-ray spectroscopy (SEM-EDX), to collect quantitative data on the mineralogical composition of these residues. So far, we have detected the following additional phases: clay minerals, Cr-Fe(Ni)-alloys, K-feldspar, Fe-sulfides, Fe-oxides/hydroxides, gypsum, calcite, dolomite, fly ash spheres, and coal particles. One of the residues also contains Mg-silicates, indicating that the coal miner may have worked in a silicate mine in the past.

Through BAL analysis it is thus possible to deduce the occupational exposure of subjects. This technique could also be applied to humans living in areas with high levels of particulate pollution to identify the main particle sources.

Origin of the differences in redox reactivity of iron (oxyhydr)oxides revealed by time-resolved spectroscopy

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The redox chemistry of nanoscale transition metal oxides, hydroxides and oxyhydroxides is of central importance to broad areas of the Earth sciences, including soil and marine biogeochemistry, contaminant remediation, and paleoclimate records. Iron-bearing phases are the most important redox-active minerals in nature and the complex chemistry of these materials exemplifies the challenges in understanding solid phase redox reactions. For example, following the exposure of ferric iron (Fe^{3+}) (oxyhydr)oxides to reducing agents, interfacial electron transfer (ET) can lead to several transformation pathways including release of soluble ferrous iron (Fe^{2+}) (dissolution), formation of alternative ferric or mixed valence phases (transformation), or particle growth. Understanding and predicting such redox processes will require the application of time-resolved methods capable of observing the intermediate species that control reaction path.

We have applied an optical-pump-X-ray-probe method with subnanosecond time resolution to study the fate of ferrous iron sites formed by electron injection at the surface of three phases of ferric iron (oxyhydr)oxides. We used this approach, combined with conventional kinetics studies, to distinguish the timescales for the elementary redox processes occurring during the reductive dissolution of 6-line ferrihydrite, maghemite and hematite nanoparticles. For each phase we quantified the rates of Fe-to-Fe electron hopping, the rates of interfacial electron transfer, the lifetime of kinetic electron trapping within the nanoparticles, and the rates of the full reaction including ferrous iron release into solution. Comparison of these rates which span from the nanosecond to the second scale reveal new insights into the electronic and structural factors controlling the redox reactivity of these phases.