Metal sulfates in PM emissions from a coal-fired power plant

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Coal combustion facilities represent a major source of fine particulate matter (PM) in the atmosphere. The particle-capture efficiency of air pollution control devices is size-dependent, and is considerably lower for particles with diameters <2.5 micrometers ($PM_{2.5}$) than for larger ones. These particles are thus emitted preferentially and, moreover, exhibit relatively long atmospheric residence times. To assess the environmental and health impacts of such PM, it is necessary to obtain information about its mineralogical composition.

We report results from SEM, TEM and XRD investigations on PM emitted from a stoker boiler. The samples, collected on filters placed in the smokestack above all air pollution control devices, represent PM that would have escaped into the atmosphere. Our study demonstrates that these fugitive particles in the $PM_{2.5}$ fraction consist of amorphous material (Al-Si-glass, soot, native Se) and a variety of crystalline phases, including lime, mullite, and various euhedral metal sulfates. Electron diffraction patterns and chemical compositions obtained by quantitative analytical TEM revealed the presence in the PM of the following sulfates (Gieré *et al.* 2006): anglesite ($PbSO_4$) as main host of Pb; anhydrite ($CaSO_4$); gunningite ($ZnSO_4 \cdot H_2O$); and yavapaiite ($KFe(SO_4)_2$), a mineral that is exceedingly rare in the geosphere. In the larger size fraction, we have identified the following additional phases: voltaite and zincovoltaite - $K_2(Fe^{2+},Zn)_5(Fe^{3+},Al)_4(SO_4)_{12} \cdot 18H_2O$, millosevichite - $Al_2(SO_4)_3$, meta-aluminite - $Al_2(SO_4)(OH)_4 \cdot 5H_2O$, and tamarugite - $NaAl(SO_4)_2 \cdot 6H_2O$.

It is concluded that most of these metal sulfates were precipitated from the flue gas, that large quantities of these phases may be emitted globally into the atmosphere through combustion processes, and that they have, through hydration and dissolution, a major environmental and health impact.

Reference

Gieré R., Blackford M., and Smith K. (2006), *Environmental Science and Technology* **40**, 6235-6240

Comparative apatite fission track study of conventionally versus selFrag Lab fragmented samples

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Geochronological dating methods like apatite fission track analysis require an efficient liberation of single mineral grains for analysis. The selFrag Lab machine (produced by Amman AG, Langenthal, Switzerland) disaggregates geological materials by releasing short pulsed high-voltage discharges to an in water immersed sample. The produced, fast-expanding plasma channel induces shockwaves, similar to an explosion, that propagate through the sample. Refraction at discontinuities like grain boundaries, crystal internal surfaces or fluid inclusion trails results in selective break-up of the aggregate, yielding natural shaped homogeneous grains (Gnos *et al*., 2006 and references therein). However the HV-discharge may also produce local temperature peaks of up to 10’000°C of very short duration within the narrow plasma channel. Does this heat production affects fission tracks in apatite? Test were conducted to control whether this very localized heat production leads to partial fission track annealing starting at approximately 60°C. Prolonged exposure to temperatures exceeding 110°C would result in a complete reset of the apatite fission track record. Hence, any temperature impact on the apatite during processing could change the resulting fission track data.

Therefore a comparative study using two different samples, prepared by conventional and selFrag Lab processing, has been performed in order to investigate a possible influence of the selFrag Lab disaggregation method on apatite fission tracks.

Both investigated samples, a granitoid gneiss from Madagascar, and the Fish Canyon Tuff, a frequently used age standard in geochronology, yield statistically identical track length distributions when comparing conventional and selFrag Lab separation methods. This study yields a first confirmation that selFrag Lab processing does not cause annealing under the applied machine settings and seems to provide an alternative method for rock disaggregation for apatite fission track analysis.

Reference

Gnos E., Kurz D. and Eggenberger U., (2006), *4th Swiss Geoscience Meeting, Bern*. 78-79.