Characterizing sources of airborne mineral dust, in Iraq

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The purpose of the Enhanced Particulate Matter Surveillance Program (EPMSP) was to provide scientifically founded information on the chemical and physical properties of airborne mineral dust and other particulates sampled in the Middle East. Aerosol [1, 2] and bulk soil [3] samples were collected during a period of approximately one year at 15 Middle East sites – including Djibouti, Afghanistan, Qatar, United Arab Emirates, Iraq, and Kuwait.. Collocated low volume particulate samplers, one each for the total suspended (TSP), less than 10 μm in aerodynamic diameter (PM_{10}) and less than 2.5 μm in aerodynamic diameter ($PM_{2.5}$) particulates were deployed at each of the sites and operated on a "1 in 6 day" sampling schedule. The filters were chemically analyzed for their elemental and ion contents, as well as for their elemental (EC) and and organic carbon (OC) fractions.

This presentation reports on the data mining of chemical results - by applying Principal Components Analysis (PCA) and Positive Matrix Factorization (PMF) to chemical data from Teflon membrane and quartz fiber filter sets collected at six sites in Iraq (Balad, Baghdad, Tallil, Tikrit, Taji and Al Asad).

From the PMF modelled results it is evident that there are substantial differences in mineral dust compositions amongst the six Iraq sites and between the PM_{10} and the $PM_{2.5}$ size fractions. This is related to dissimilarities in the local geology and soil types, as well as different particle size distributions. Although regional mineral dust sources are similar for all six sites, the aerosols at the height of the sampler inlets are substantially modified by local dust representative of the local soils at or close to the sampling sites, exacerbated by dust from agricultural activities, roads, and other local dust sources.

[1] Engelbrecht *et al*. (2009a) *Inhalation Toxicology* **21**, 297-326. [2] Engelbrecht & Derbyshire (2010) *Elements* **6**, 241-246. [3] Engelbrecht *et al*. (2009b) *Inhalation Toxicology* **21**, 327-336.

Allanite petrochronology in high-pressure rocks

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Allanite is a REE- and Th-rich epidote widespread in greenschist to eclogite facies rocks. Its prograde mineral reactions commonly produce distinct growth zones, which can be directly related to PT-conditions. In favorable cases, Th-U-Pb isotope analysis (by LA-ICP-MS or ion microprobe) allows such growth zones to be dated.

Improved LA-ICP-MS analysis (line raster laser ablation, ^{204}Pb-based common lead correction) yields accurate Th-Pb and U-Pb ages with no need for matrix-matched standardisation. The analytical errors imply realistic 2σ-age uncertainties of ~1%.

A multicomponent solution model formulated for allanite was tentatively calibrated, based on the limited experimental data available as well as select natural phase relations. Phase diagrams calculated for a range of typical compositions comply with mineral reaction sequences and established PT-wisdom from various metamorphic systems. The stability limits obtained confirm that allanite is very useful for blue-schist and eclogite facies rocks. Computed REE-partitioning with other REE-phases agrees reasonable well with distribution coefficients observed in high-pressure samples.

Several case studies in LT-eclogite facies metagranitic and -sedimentary samples from the Sesia Zone (Western Alps, Italy) are presented. These demonstrate the potential power of allanite petrochronometry [e.g. 1], but also indicate limits and possible pitfalls: Detailed petrography is needed to define which stages and PT-conditions are dated, and microstructural observations should be integrated where possible. It is critical to obtain REE-patterns for each allanite growth zone and to characterize all mineral inclusions. Common lead contents can be so high as to make dating unrealistic.

Allanite recystallisation behaviour is not well understood, and relics (e.g. igneous cores) commonly occur. Microchemical characteristics (Th/U, Sr) help to distinguish their origin. In relatively dry lithologies, the robust mechanical properties of allanite can preclude recrystallisation, even in high strain shear zones. By contrast, allanite has excellent potential as a chronometer for mylonites, where hydrous fluid commonly leads to recystallisation even at T as low as 400°C.

[1] *Rubatto et al*. (2011) *Nature Geosci*., 10.1038/NGEO1124