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Laboratory dissolution of natural aerosol and photochemically activated dust

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Sequential leaching of true collected aerosol from pH 5 to 1. Aerosol were collected at St Jean Cap Ferrat, South East of France on cellulose acetate filters (47 mm diameter) pumping arount 20 cubic meter of air.











Blue bars are sample with a strong anthropogenic origin, yellow with a strong crustal origin and red with a mix. Abstract: Bioavailability of elements (including iron) in aerosol particles is the amount that can be extracted by the biota from the deposition. The solubility of the elements is the part which is extracted by water from the solid phases, but may strongly vary following the chemistry of the weathering water. Despite some aspects of bioavailabilty function versus solubility are still unknown, solubility studies give interesting informations on the behaviour of the aerosol particles. Measurements of iron and other elements in "natural" aerosols exhibit much larger solubility than expected if we consider the solubility of the main source particles, e.g. desert aerosol. We present here results of sequential leaching with increasing acidity of aerosol particles collected at St Jean Cap ferrat (South East of France) with various amount of anthropogenic and Saharan parts. The elements are dispatched in two groups: the first group where all the solubility is immediately reached at highest pH and the second group where the solubility increases continuously as the pH decreases. The origin of the collected airmass also play a role larger than the origin of the aerosol itself: for example, the unique source of Al is Saharan dust but the Al solubility strongly increases (from 3 to 7%) if the air mass is mixed with anthropogenic air. The increases of the solubility is suspected to be induced by atmospheric transport. We have conducted laboratory experiments where we have



Dissolution experimental device including photochemical effect







Light do not affect solubility of elements except transition metals



shown that the atmospheric photochemistry during the transport can enhance the solubility of transition metals in an irreversible way.

Almost all dissolved at	Remaining solubility
pH = 5	
P, Sr, Mn, Fe, Mg, Ca, Sr, V, Ni, Co, Zn, Li, Ag, Cd	Pb, Al, Ba, Ti, Cu

Successive leaching with decreasing pH nitric acid solutions are made: 3 at pH=5, 3 at pH=3 and 3 at pH=1. Total amount deposited on the filter was previously analyzed by XRF fluorescence

Iron, P, and other elements are very quickly dissolved by almost pure water and the remaining insoluble part stays insoluble even at pH 1. But other elements (including aluminum) dissolves itself more and more as pH decreases.

Fe solubility	China	Capo-Verde	Niger
s _{dark} (%)	0,19	0,19	0,05
s _{irradiated} (%)	0,2	0,21	0,15
Ratio s _{irradiated} / s _{dark}	1,05	1,11	3,00

Iron solubility is much lower for the dust collected at the emission point, but light effect increases as solubility decreases



k (min⁻¹)	Kinetic 1	kinetic 2
Dark	8,4 10- ²	1,3 10 ⁻²
Irradiated	8,3 10 ⁻²	0,9 10 ⁻²
Irradiated/Dark	1	0,7

Mn solubility First order rate constant (k)

X (%)	Kinetic 1	kinetic 2
Dark	4%	4,7%
Irradiated	7,3%	11,2%
Irradiated/Dark	1,8	2,4

Mn soluble stock (X%)

Conclusions: This work conducted on different kinds of particles have demonstrated that the light may have a strong influence on dissolution rate of transition metals such as Fe and Mn, but not on non-transition elements. A kinetic study on manganese shows that irradiation does not affect the kinetic apparent first order rate constant k but increases the potentially soluble material, probably by the way of fast photoreduction of Mn(IV) into Mn(II).

Light contribute to make transition metals more labile. Previously dissolved TM that precipitate at the surface of the particle during cloud evaporation will be very easily mobilized for a next dissolution. One can expect that the light enhanced solubilization of TM is gained until the deposition of the particle.

Light do not increases solubility rate constant but soluble stock