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Mineralogy as a critical factor of dust iron solubility and bioavailability

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To estimate impact of atmospheric iron on ocean primary productivity, it is necessary to understand how iron deposited on ocean is soluble. Various previous studies have showed an extremely variable solubility (0,01-80%) and a number of factors influencing this solubility, as suspended particules concentration, chemical and photochemical atmospheric process, aerosol sources (Zhuang et al, 1992; Spokes et al, 1994; Desboeufs et al, 2003,2004; Bonnet and Guieu, 2004)

Recently, Backer et al, (2006) have carried out experiment on the solubility of iron from mineral aerosol collected close to the source (West Africa) and over the Caribbean. They have shown that solubility increase with distance from the source. The increase of solubility is linked with the decrease of mineral aerosol concentration due to preferential removal of large particles. They conclude that the surface area to volume ratio of mineral aerosol is the primary parameter influencing aerosol solubility.

But the surface area to volume ratio is not the only consequence of the preferential removal of large particles. The size segregation during atmospheric transport also induces a splitting up of aerosol mineral composition. Fine particles contain more clay and less iron oxide compare to larger particles (Leinen et al, 1994, Lafon at al, 2003) which can explain this increase of iron solubility.

Experiment on pure phase, clay and (hryd)oxide iron, were carried out to study iron solubility and redox speciation in acidified water. First results show a greater solubility of iron resulting from clays (about 4%) compare to iron coming from oxide (about 0,002 %). Regarding the iron redox speciation, iron(II) represents a major fraction of total dissolved iron, about 60% in iron oxide and about 100% in clay. And nowadays, It is well know that iron(II) is more bioavailable than iron(III) (Martin et al, 1988;

Kieber et al, 2001).

This result indicates that iron solubility is closely linked with the mineralogical composition of aerosol. Iron solubility evolves during atmospheric transport; the lost of large particle induces an increase in aerosol clay contain which impact on the iron solubility that becomes greater during long range transport.