Radical generation and transition metals on chrysotile asbestos surfaces

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Chrysotile [$Mg_3\ Si_2\ O_5\ (OH)_4$] is an asbestiform mineral that is toxic and carcinogenic. On fiber surfaces, substituted Fe interacts with $H_2\ O_2$ to generate biologically reactive hydroxyl radicals ($HO^\bullet$) in Fenton-reactions. We hypothesized that the content and speciation of Fe and other transition metals at fiber surfaces affects radical generation. This was tested in fiber incubation experiments. We demonstrate that, apart from Fe, also Fenton-active Cr, Ni and Mn are present in fibers. The latter was ≈1/4 as abundant as Fe, but exclusively at pristine fiber surfaces. After rapid dissolution of the outermost Mg-layer, the tetrahedrally coordinated Fe^{3+}-content (7% of the bulk-Fe) of the slowly dissolving Si-layers redox-cycled in the presence of ascorbate, without promoting Si-dissolution. This enabled long term $HO^\bullet$-generation. At the physiological pH, chelation of transition metals (including Fe) from Mg- & Si-layers transiently decreased $HO^\bullet$-generation to ≈9% relative to pristine fibers. Further dissolution of fibers then increased $OH^\bullet$-generation to ≈20% due to the exposure of redox active metals from deeper layers.