Origin of MoSC phases in Lower Cambrian black shales (Southern China)

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Experimental studies on MoS_2 and graphite showed that the biomolecule adenine ($C_5H_5N_5$) strongly adsorbed to the surfaces of MoS_2. As it contributes to metabolic and genetic processes, this might represent an early step in the emergence of life. The Chinese black shales are exceptionally rich in Mo (~7wt.%) and represent the famous biological explosion at the Cambrian/Precambrian boundary. Thus this study gives new insights on Mo rich black shales as a suitable paleobiotope. Mo-phases occur as 'pebbles' or euhedral grains arround framboidal pyrite, and as inclusions in diagenetic pyrite. FIB-TEM and Raman spectroscopy showed that they are nanometric intergrowths of MoS_2 and poorly ordered graphite of onion shape structure (MoSC). They contain (on average) : 25 wt.% Mo, 23 wt.% S, 5.6 wt.% Fe, 2.5 wt.% Ni, 0.12 wt.% Cu, 0.8 wt.% As, 0,4 wt.% Se, 0.16 wt.% Sb, 0.09 wt.% Pd, 0.08wt.% Zn and 0.02 wt.% Co, 33 wt.% C, 1.5 wt.% O and 0.6 wt.% N. A biogenic origin in a diffused low temperature (~100°C) hydrothermal vent system is supported by : (1) C/N ratios (mean 57), similar to that reported from zooplankton at hydrothermal vents, (2) Se/S : $10^{-2/-3}$ at sulfide and whole rock scale typical for a volcanogenic environments, (3) preferential incorporation of biophilic elements (Se, As, Pd, N, C). Seawater Mo might have been fixed by mesophilic or moderately hyperthermophilic species containing Mo enzymes and Fe-S clusters, which may have reduced nitrate and precipitated Mo_2 and pyrite with intercalated organic matter, now disordered graphite.