Origin of carbonaceous matter in 3,525 Myr-old hydrothermally-altered subseafloor sediments from the Dresser Formation, Pilbara Craton

P. PHILIPPOT[1], K. LEPOT[1] , C. THOMAZO[1], M. ADER[1], M. VAN KRANENDONK[2]
[1] Institut de Physique du Globe de Paris, France, philippo@ipgp.jussieu.fr
[2] Geological Survey of Western Australia, Perth, martin.vankranendonk@doir.wa.gov.au

Pristine diamond drill cores (Pilbara Drilling Project) recently collected in the North Pole Dome of the Pilbara Craton (Western Australia), consists of shallow-water, variably silicified (locally jaspilitic) micritic Fe-carbonate, pyrite laminates with wavy forms (stromatolitic?), sandstone, diamictite and volcanoclastic rocks that are pervasively hydrothermally-altered by a feeder vein network composed of black to grey silica, Fe-carbonate rhombs, barite, pyrite, sphalerite and minor amounts of mica and chlorite. The same hydrothermally-derived component is interstratified with the layered sedimentary horizons, thus arguing for continuous infiltration of hydrothermal fluids/seawater during sedimentation and/or diagenesis, while the sediments where still unconsolidated. Both the hydrothermal feeder dikes and sedimentary/hydrothermal stratified horizons contain abundant carbonaceous material.

Here, we present a detailed study of in situ analysis of carbonaceous material using laser Raman spectroscopy and Synchrotron Radiation Infrared (SR-IR) spectroscopy combined with bulk and punctual carbon stable isotope analysis of organic carbon and host carbonate, reporting degree of structural order and composition of carbonaceous matter as well as $\delta^{13}C$ values of carbonaceous material in individual sedimentary and hydrothermal layers/veins as well as individual carbonate crystals using SIMS technique. We show that most of the carbonaceous matter displays $\delta^{13}C_{PDB}$ values between -28.2 and -33.4 ‰ in agreement with previous studies. Uncertainties remains concerning the origin of this carbonaceous material. Is it abiotic and formed as a result of Fischer-Tropsch Type (FTT) synthesis due to extensive interaction of CO2-bearing aqueous fluids with the underlying Mg-rich metabasalts at high temperature or biotic and associated with the Calvin-Benson CO_2 carbon fixation pathway? Recognition of abundant H_2O-CO_2 ± H_2S ± CH_4 ± hydrocarbon fluid inclusions in the underlying metabasalts supports an abiotic origin. In contrast, however, some horizons contain low fractionated carbonaceous matter showing important aliphatic C-H stretching bands in the 2900 cm^{-1} region (SR-IR spectra) and two broad bands at 1604 and 1350 cm^{-1} (Raman spectra) indicative of weak structural organization and low degree of thermal alteration . This later carbonaceous matter could be truly biotic in origin, hence representing a new window for investigating some of the oldest prokaryote metabolic pathways.