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Abiotic *vs* biotic carbonaceous matter in 3,525-Myr-old hydrothermally-altered subseafloor sediments (Pilbara Craton, Western Australia)

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Pristine diamond drill cores (Pilbara Drilling Project) recently collected in the North Pole Dome of the Pilbara Craton (Western Australia), present a unique opportunity to constrain microbial ecosystems in subseafloor Early Archaean environment. The Dresser Formation at North Pole consists of shallow-water, variably silicified (locally jaspilitic) micritic Fe-carbonate, pyrite laminates with stratiform and wavy (stromatolitic?) forms, 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. U-Pb zircon SHRIMP dating of zircon isolated from a volcanoclastic tuffaceous layer yielded an age of 3525 $\pm$ 2 Ma for the formation of the sedimentary-hydrothermal system (Van Kranendonk et al., this volume).

Both the hydrothermal feeder dikes and sedimentary/hydrothermal stratified horizons contain abundant carbonaceous material occurring either as dispersed clots throughout individual layers or dikes, or as minute films at interfaces between sedimentary beds and interstratified hydrothermal precipitates. Carbonaceous films resembles typical "microbial mats" described in the literature in similar types of environments but could also represent detrital/hydrothermal organic compounds remobilized along anisotropy

planes such as dissolution/precipitation fronts, compaction structures and/or thermal boundaries.

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 carbon stable isotope analysis of organic carbon, reporting degree of structural order and composition of carbonaceous matter as well as δ^{13}C values of carbonaceous material in individual sedimentary and hydrothermal layers/veins. We show that most of the carbonaceous matter displays $\delta^{13}C_{PDB}$ values between -28.2 and -31.5 ‰ 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 $\pm$ H_2S $\pm$ CH_4 $\pm$ hydrocarbon fluid inclusions in the underlying metabasalt and chert-barite veins and Cr-bearing minerals at the top of the hydrothermal system 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.