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Carbonaceous cherts of the Barberton Greenstone Belt, South Africa

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Some of the oldest traces of life on Earth have been found in chert horizons occurring in the lower 3.5 Ga Warrawoona Group (eastern Pilbara Craton, Western Australia), and in the 3.4-3.2 Ga Onverwacht Group (Barberton Greenstone Belt, South Africa). The validity of these claims strongly depends on the geological context, and especially on the process of chert formation. The origin of chert units in the Warrawoona Group has been controversial, since several deposits previously recognized as sedimentary in origin were reinterpreted as hydrothermal feeder dikes. It has been suggested that serpentinization of ocean floor basaltic crust by circulating CO_2-rich fluids could have prompted hydrocarbon formation by Fischer-Tropsch (FT-) type reactions leading to the emplacement of carbonaceous feeder dike cherts. Alternatively, chemolithoautotrophic organisms may actually have been present in such seafloor hydrothermal systems. These two possibilities highlight the need for detailed geochemical studies of the various carbonaceous cherts in Archean greenstone belts in which traces of life have been reported. Here a study is presented of carbonaceous chert deposits from the Barberton Greenstone Belt (BGB), South Africa. In situ analysis by laser Raman spectroscopy and ion microprobe have been used to determine the degree of structural order, carbon isotope ratio and nitrogen-to-carbon ratio of individual carbonaceous structures. This study shows that the N/C-ratio faithfully records the total degree of alteration that an individual carbonaceous structure has experienced during multiple episodes of metamorphism/metasomatism. Some of the best preserved carbonaceous structures occur in the Footbridge Chert in the upper part of the Kromberg Formation, and have a N/C-ratio of 0.006 and a δ^{13}C value around -35 ‰. Rigorously different theories for chert emplacement in Barberton exist, ranging from purely

sedimentary to purely hydrothermal processes. Several lines of evidence are discussed here to show that in case of the Footbridge Chert hydrothermal circulation in underlying volcanic rocks was an important process, but that FT-reactions were an unlikely source for carbonaceous material. Instead, it is argued that hydrothermal circulation formed the basis for a hydrogen- and/or Fe(II)$_{aq}$-dependant Archean ecosystem living in the water column above. The intriguing question arises whether Fe-oxidizing anoxygenic photosynthesis did occur in the early Archean. This type of photosynthesis must have preceded the more highly evolved oxygenic photosynthesis. Iron isotope systematics can likely solve this problem, as strong positive iron isotope shifts have been observed during Fe-oxidizing photosynthesis. First results of positive δ^{56}Fe in Fe-mineral phases and low δ^{13}C of associated carbonaceous matter would then demonstrate the potential of a double biomarker in these cherts. These preliminary results of Fe-isotope analysis will be discussed.