Paper Number: 5016

Carbonates from the ~3.4 Ga old Buck Reef Chert of South Africa: testing potential microbial activity in an Archean hydrothermal system

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The ~3.4 Ga old Buck Reef Chert (BRC) from the Barberton Greenstone Belt of South Africa is one of the best preserved marine sedimentary sequence in the Paleoarchean record and accounts for some of the oldest evidence of microbial occurrence on Earth [1]. Here we present a mineral-petrographic and geochemical characterization of the BRC sedimentary carbonates from the BARB3 core, drilled during the ICDP-sponsored Barberton drilling project. Preliminary results provide insights into microbial activity in a marine hydrothermal setting.

The BARB3 carbonates consist of Mg-bearing siderite forming irregularly laminated layers (Fig. 1A) enriched in carbonaceous matter (CM). Two types of carbonaceous laminations have been identified: (a) CM-rich mat-like structures (Fig. 1B) embodying Ni-Cu-Fe-sulphide crystals and tiny pyrite grains; (b) thin CM-rich laminae found mostly along the rim of spheroidal structures. The spheroids are defined by an external rim of siderite crystals enriched with the carbonaceous lamina and frequently show a CM-dense core (Fig. 1C). These frameworks show strong affinities with microbial structures reported from the Archean fossil record [e.g. 2] and from modern hydrothermal carbonates [3]. The presence of pyrite and Ni-Cu-Fe-sulphides, in tight association with the CM-rich laminations, may reflect the occurrence of potential chemotrophic microbial activity involving sulphur-based metabolisms supported by hydrothermal fluid circulation [4]. Evidence of hydrothermal veining and alteration have been found in the BARB3 core and documented after field observations on the BRC.

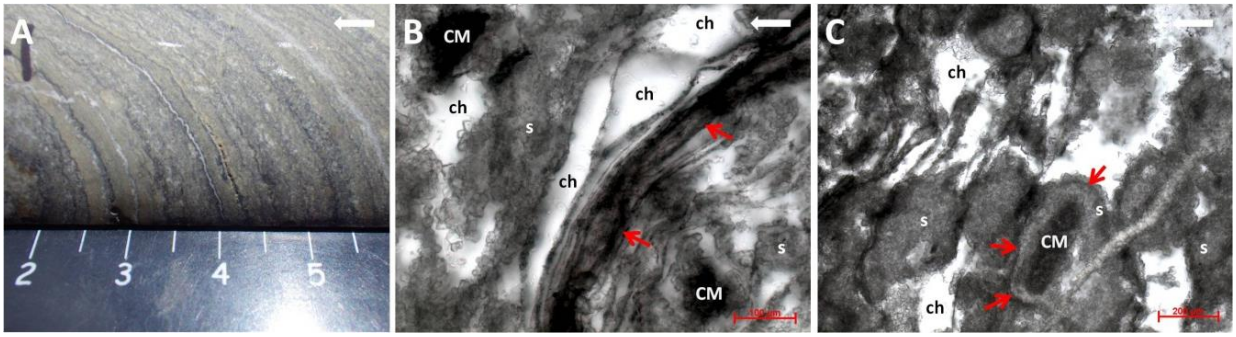

Figure. 1: A) *Irregularly laminated CM-rich siderite layers, BARB3 core.* ***B-C)*** *Microphotographs of CM-rich mat-like structure (red arrows) and CM laminations (red arrows) defining spheroidal structures, respectively.* ***s*** *, siderite;* ***CM****, carbonaceous matter;* ***ch,*** *chert. White arrows point the stratigraphic up.*

Presented findings are consistent with the phylogenetic antiquity of sulphur-based microbial life and with the suitability of marine hydrothermal environments as a habitat for early life [4], endorsing a potential microbial origin for the carbonaceous laminations. Preliminary results suggest that an early Archean biologically active marine hydrothermal environment may be preserved in the BRC.

Further high resolution, *in situ*, analyses (e.g., C and S stable isotopes) will elucidate the nature of the above described structures and investigate signatures of microbially induced precipitation of carbonates, in a marine hydrothermal setting, potentially preserved in the BARB3 siderite.

References:

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