New insights on the biogenicity of South Africa's oldest stromatolites

M. HOMANN[1], S.V. LALONDE[2], M. VAN ZUILEN[3], J. GONG[4], L. PATRY[2], J.A. HAYLES[5,6], M. WALSH[7], D.R. LOWE[8], AND G.R. BYERLY[7]

[1] University College London, 5 Gower Place, London WC1E 6BS, UK; m.homann@ucl.ac.uk
[2] IUEM, CNRS-UMR6538, 29280 Plouzané, France
[3] IPGP, UMR 7154 CNRS, Paris, France
[4] MIT, Cambridge, MA 02139, USA
[5] Rice University, P. O. Box 1892, Houston, TX 77251, USA
[6] NASA Johnson Space Center, Houston TX 77058 USA
[7] Louisiana State University, Baton Rouge, LA 70803, USA
[8] Stanford University, 450 Serra Mall, CA 94305, USA

Stromatolites represent the most ancient macroscopic evidence for life on Earth. While the biogenicity of Paleoarchean (>3.2 Ga) stromatolites from Australia is well established (e.g. Allwood et al., 2006), reported stromatolitic structures of comparable age from the Barberton Greenstone Belt in South Africa (Byerly et al., 1986) have received little attention in the last decades, and thus deserve a fresh look (Homann, 2019).

In order to unravel the origin of these enigmatic deposits, we analyzed putative stromatolites of the ~3.3 Ga Mendon Fm. for their sedimentological context and three-dimensional morphology. We also performed μXRF elemental mapping, Raman spectroscopy of preserved carbonaceous matter, and analyzed major and trace element as well as organic carbon isotope compositions. In the field, the stromatolites display domal to pseudocolumnar growth morphologies and occur in distinct carbonaceous chert horizons. They form layers of < 1 to 20 cm thickness and have been identified in several outcrops spread over a lateral distance of ~10 km (Byerly et al., 1986). Internally, the stromatolites are characterized by crinkly, tourmaline-rich laminations that form sideward-inclined columns of several centimeters height. Depostion likely occurred during periods of volcanic quiecence in hydrothermally-influenced shallow-water paleoenvironments, which were perhaps severly effected by distant asteroid impacts (Lowe and Byerly, 2015). A syndepositional origin of the structures is supported by draping of underlying deposits and the occurrence of eroded stromatolite crust chips. Lowe and Byerly (2018) compared these slightly curved chips with evaporitic silica crust precipitates that commonly form around hot spring deposits. This paleoenvironmental interpretation is supported by the newly aquired REE data. Organic carbon isotope analysis of the 3.3 Ga stromatolites yield $\delta^{13}C_{org}$ values between –34.5‰ and –22.1‰ with mean TOC values of 0.2%. Collectively, this new data set further strengthens the bio- and syngenicity of South Africa's oldest known stromatolites.

References: Allwood et al., Nature (2006); Byerly et al., Nature (1986); Homann, Earth-Sci. Rev. (2019); Lowe and Byerly, Geology (2015); Lowe and Byerly, New Astr. Rev. (2018)