LIFE ON MARS – A TERRESTRIAL ANALOGUE FOR MARTIAN INTERTIDAL STROMATOLITES?.

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Introduction: Future Mars surface exploration missions may seek megascopic evidence of past life, and one of the more obvious organic structures that may be found there is the stromatolite. What potential Mars stromatolites may look like has been a matter of speculation [1, 2]. Because the organic components of stromatolites obtain their energy from the Sun, there is may have been a size limitation on stromatolites. In the early of Earth, the time when anaerobic environmental conditions were most like early Mars [3] was Early to Middle Archean (3.2 to 3.5 b.y. ago). Terrestrial stromatolites from this interval were quite small (up to at most 10 cm) [2]. Photosynthetic organisms in these rare terrestrial Archean stromatolites were adapted to anaerobic conditions and were likely less efficient in using energy than their later aerobic counterparts [2], which is a factor in their small size.

Tabular biostromes (or biolaminations [4]) might be considered as the most likely stromatolite growth form on Mars because they are the most simple. However, the sedimentary environment for Archean biolaminations on Earth (and by extension on Mars as well) was supratidal or shallow interidal [1, 2]. On Mars, predicted high aeolian sedimentation rates may have precluded the development of supratidal and shallow intertidal biolaminations because of the sluggish anaerobic growth rates for photosynthetic microbes. As the more likely growth realm for stromatolites on Mars, we propose deeper intertidal conditions of Mars' oceans and lakes. Using terrestrial deeper intertidal growth forms as a guide [5] digitate stromatolites are more likely on Mars. On Earth, the digitate (gymnosolenid) growth form dominated in the deeper Precambrian intertidal realm [5].

Digitate growth forms on Earth and Mars: On Earth, digitate stromatolites dominated the deeper intertidal realm because this growth form contended well with shifting substrates and kept pace with sediment accumulation in a place where rates of sedimentation are high. Domal masses, more typical of subtidal conditions, could not grow upward fast enough to remain in the photoic zone. On Mars (during Noachian), differing conditions from Earth were influential on stromatolite development, including lower luminosity of the Sun (at 1.52 AU), lower tidal ranges (greater distance from the Sun plus very low mass satellites), and lower fetch (a function of atmospheric density, wind velocity, and water body surface area). For these reasons, in addition to the anaerobic atmosphere, the deeper subtidal realm may have been the best place for Martian stromatolite development and preservation.

Description of discovery site and layer: Digitate stromatolites like those suggested here as potential terrestrial analogues for yet-to-be-discovered Martian stromatolites occur in the dolomitic upper unit of the Middle Cambrian Conasuaga Group of northwestern Georgia. The specific outcrop these stromatolites were collected from is located in Floyd County, Georgia, on the newly constructed Rome bypass highway. At this site, the dolomitic upper unit crops out below the uppermost shale unit of the Conasauga.

The digitate stromatolite-bearing interval is approximately 8 to 10 cm thick. This interval lies upon a fine carbonate mudstone and is overlain by a bioclastic layer that is over 1 m thick. The digitate stromatolites are nearly vertical and arise from one of three sources (Fig. 1): a single digitate form that may or may not have branched as it grew upward; a small domed stromatolite that branched into two or more digitate columns; or an oncolite ('free-rolling' stromatolite (Fig. 2)) that gave rise to one or more digitate columns. The oncolites are generally found in the lower one-third of the digitate stromatolite bed (Fig. 1). The sedimentary material between the digitate columns is bioclastic and clastic material. The top of the digitate stromatolite bed consists of either truncated digitate columns or a coalescence among a few digitate columns into a local biolaminate feature (a thin "capstone" layer (Fig. 3)).

The evolution of depositional environments in this digitate stromatolite bed is interpreted to be: deeper intertidal changing to shallow subtidal over time. Shallowing of water (as indicated by the bioclastic influx above the digitate stromatolite layer) is suggested as the cause for terminal burial of the digitate stromatolite layer.

References: [1] Westall F. et al. (2009) *LPSC 40*, 1759. [2] Allwood A.C. et al. (2006) *Nature 441*, 714-718. [3] Westall F. (2005) *Water on Mars and Life*, Springer. [4] Preiss W.V. (1976) *Stromatolites*, Elsevier. [5] Poiré D.G. et al. (2007) *IGCP 478, 3rd Symposium*.

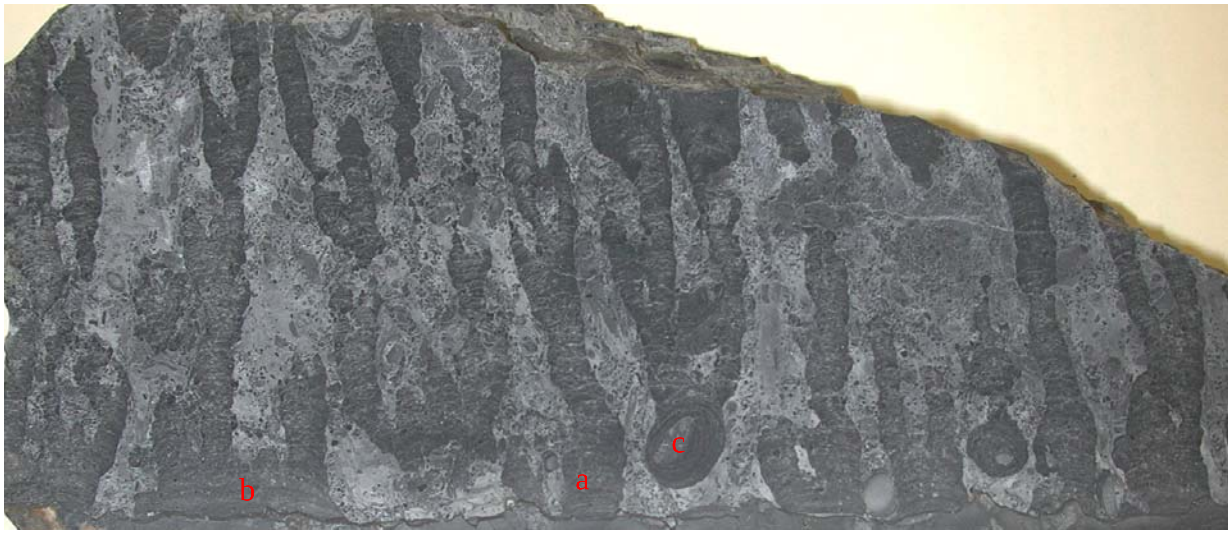

Figure 1. Etched slab of digitate stromatolites from the dolomitic upper unit of the Conasauga Group, near Rome, Georgia. Vertical dimension is 8 cm. Initial growth sources: (a) a single digitate form that may or may not have branched as it grew upward, (b) a small domed stromatolite that branched into two or more digitate columns, (c) or an oncolite (free-rolling stromatolite) that gave rise to one or more digitate columns.

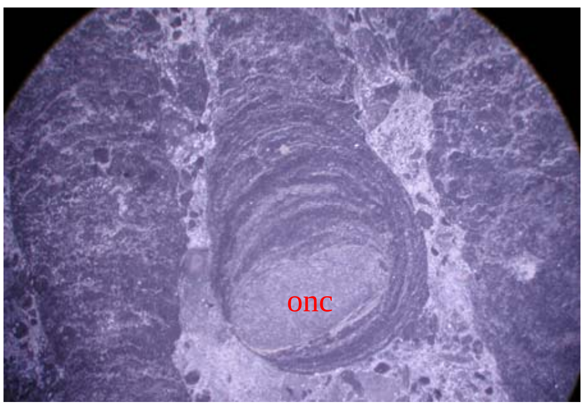

Figure 2. Close-up view of a Conasauga oncolite (onc) with sedimentary clast core, which grew upward as a single digitate column. Digitate columns not originating from oncolites are adjacent on both sides. Width of field of view is 2.5 cm.

Figure 3. Close-up view of the local biolaminate feature or "capstone" layer at the top of the digitate Conastromatolite layer of the Conasauga. The four digitate columns seen here coalesced first into three wider columns and then further coalesced into one biolaminate feature (cap) at the top of the layer. Bioclastics without stromatolites cover this "capstone" layer. Width of field of view is 4 cm.