THE STRUCTURE AND ORIGIN OF CAMBRO-ORDOVICIAN THROMBOLITES WESTERN NEWFOUNDLAND

by

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ABSTRACT

An integrated scheme to systematically analyse the structure and interpret the origin of thrombolites is proposed on the basis of detailed field and petrographic analysis of Cambro-Ordovician thrombolites in western Newfoundland. This scheme utilizes a three-tiered analysis of microbial buildups: 1) megastructure, the overall bed form, 2) mesostructure, the internal fabric, and 3) microstructure, the microscopic fabric. This scheme has proved equally applicable to Cambro-Ordovician thrombolites, stromatolites, *Epiphyton-Renalcis-Girvanella* "microfossil" boundstones, and mixed microbial-metazoan buildups in western Newfoundland, elsewhere in North America and central Australia, and highlights differences between these types of buildups.

Megastructure records the growth relationship between a buildup and its enclosing strata, is independent of mesostructure and microstructure, and reflects the sum of environmental factors acting on the buildup. Mesostructure records the spatial relationship between framework and interframework components, is governed by the shape and lateral continuity of the formative microbial community, and reflects a balance between biological and environmental factors. Microstructure is directly controlled by biological factors, and commonly yields clear evidence of specific sediment-forming processes (biologically influenced calcification,

trapping and binding of detritus), and the gross morphologic composition (coccoid or filamentous) of the formative microbial community.

Microstructural analysis indicates that Cambro-Ordovician thrombolites were most commonly constructed by relatively complex coccoid or coccoid-dominated microbial communities, and that the dominant process involved in their formation was *in situ* calcification of the microbial community. This calcified community formed a rigid framework between which autochthonous and allochthonous sediment accumulated. In contrast, co-occurring stromatolites were most commonly constructed by internally well differentiated filamentous or filament-dominated communities, and the dominant process involved in their formation was mechanical trapping and binding of detritus, either alone or in combination with *in situ* calcification of the microbial community. Thrombolites are commonly associated with a diverse and abundant metazoan fauna, whereas metazoans are rarely associated with stromatolites.

Zoned microbial buildups result from ecologic successions of microbial communities, and provide diagnostic evidence of shoaling versus deepening sedimentation; thrombolite or "microfossil" boundstone passing up into stromatolite indicates shoaling (regressive) conditions, and the reverse zonation indicates deepening (transgressive) conditions.

A broad zonation of microbial buildups is evident across Cambro-Ordovician platforms: stromatolites within

intracratonic and inner-platform peritidal environments, thrombolites within intracratonic and platform-interior subtidal environments, and calcified "microfossil" boundstones which are largely restricted to platform margins.

Critical evaluation of the temporal and spatial distribution of thrombolites indicates that they are essentially an Early Cambrian to Early Ordovician "Sauk Sequence" phenomenon, and were restricted to warm sub-equatorial climates. Their appearance can be attributed to the initial calcification of cyanobacteria at the onset of a world-wide marine transgression in latest Proterozoic-earliest Cambrian time, an event that was probably triggered by environmental rather than evolutionary changes. Their abrupt decline in Early Ordovician time, and continued limited occurrence today, probably resulted from niche competition by newly evolved skeletal metazoans, calcareous algae and non-calcareous algae, and increased predation by molluscs.