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High but balanced sedimentation and subsidence rates (Moodies Group, Barberton Greenstone Belt), followed by basin collapse: Implication for Archaean tectonics

Christoph Heubeck (1), Donald R. Lowe (2), and Gary R. Byerly (3)

(1) Institut fuer Geologische Wissenschaften, Freie Universitaet Berlin, Germany (cheubeck@zedat.fu-berlin.de), (2) Department of Earth and Environmental Sciences, Stanford University, USA (drlowe@stanford.edu), (3) Department of Geology and Geophysics, Louisiana State University, USA (GLBYER@LSU.EDU)

Archaean tectonophysical models distinguish between thick, rigid and thin, mobile crust; from these the major mechanisms and rates for continental growth are derived. Archaean sedimentary rocks, preserved in metamorphosed and highly deformed greenstone belts, can contribute to constrain these models by estimating subsidence rates, derived from the combination of facies changes and precise age dates.

Largely siliciclastic strata of the Moodies Group form the topmost unit of the Barberton Supergroup of the Barberton Greenstone Belt (BGB), South Africa, represent one of the world's oldest unmetamorphosed quartz-rich sedimentary sequences, and reach ca. 3500m thick (Lowe and Byerly, 2007). Large parts of the Moodies Group were deposited in apparent sedimentary continuity in alluvial, fluvial, shoreline and shallow-marine environments (e.g., Eriksson, 1979; Heubeck and Lowe, 1994). Distinctive sources and variations in facies indicate that Moodies deposition occurred at times in several basins. In several now tectonically separated regions, a regional basaltic lava (unit MdL of Anhaeusser, 1968) separates a lower unit (ca. 2000m thick and possibly representing an extensional setting) from an upper unit (ca. 1500m thick and characterized by progressive unconformities, rapidly changing facies, thicknesses, and sandstone petrographic composition).

Single zircons separated from a felsic air-fall tuff of the middle Moodies Group and immediately overlying the basaltic lava in the Saddleback Syncline were dated on the Stanford-USGS SHRIMP RG. Out of 24 dated grains, two near-concordant groups have mean ages of 3230,6+-6,1Ma (2σ; n=9) and 3519+-7 Ma (2σ; n=9), respectively. We interpret the former age as representing the depositional age of the tuff, the latter as representing inherited zircons from underlying Onverwacht-age basement.

The interpreted depositional age of the Moodies tuff is indistinguishable from numerous similar ages from felsic and dacitic volcanics at the top of the underlying Fig Tree Group (Schoongezicht Fm.; Byerly et al., 1996), implying that ca. 2000m of Moodies sandstones and subordinate siltstones and conglomerates were deposited in not more than a few (0-6) Ma. Their comparatively low degree of facies variation and lithological change implies a balance between rates of sediment supply and of subsidence, creating thick stacked units. Ferruginous shales and thin BIFs of the upper Moodies Group suggest that background "Fig-Tree-style" sedimentation continued during Moodies time but was mostly overwhelmed by the apparently brief but massive influx of medium- to coarse-grained quartzose sediment. Because two progressive unconformities, marking Moodies basin uplift and onset of renewed overall BGB shortening, occur only 50 m above this dated unit, they are likely of a similar age and imply that dominant NW-SE-directed shortening in the BGB began shortly after 3230+-6 Ma.

The combination of these new data with published information thus suggest that the Moodies Basin formed after 3225+-6 Ma (i.e., at the earliest at 3231) but was already largely filled and began to be deformed by 3231+-6 (i.e., at the latest by 3225). Moodies deposition thus happened geologically nearly instantaneously following the end of Fig Tree volcanism, took very little time and deposited large volumes of sediments on a rapidly subsiding basement just prior to large-scale BGB deformation.

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