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Incipient basin inversion of the Middle Archean Moodies Basin, Barberton Supergroup, Barberton Greenstone Belt, South Africa

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The Moodies Group of the Barberton Greenstone Belt is one of the oldest and best-preserved quartz-rich sedimentary sequences on Earth. Its strata, approx. 3 km thick, record an initial extensional setting, followed by a strong shortening pulse which resulted in the dominant large-scale final deformation of the greenstone belt. We investigated the apparently rapid transition from Moodies extensional to compressive setting through detailed mapping, correlation of measured sections and the analysis of a prominent basaltic lava which extends for approx. 60 km along strike, in order to constrain the tectonic and depositional setting of some of the earliest stable life-providing habitats on Earth.
In the middle Moodies Group, large-scale cross-bedded coarse-grained sandstones, interpreted as an offshore dune field, are abruptly overlain by a discontinuous cobble and boulder conglomerate of up to 4 m thickness, possibly representing local small alluvial fans above a cryptic disconformity. A basaltic lava, reaching approx. 50 m thick, regionally exists above this unit and forms the most prominent marker unit in the Moodies Group. In most places, the lava is metasomatically altered to a fine-grained mesh of illite, sericite, chlorite and very fine-grained quartz. In its upper third, it contains abundant amygdules approx. 0.5 – 1 cm in diameter. We did not record significant thickness changes hinting at eruption centers, feeder channels, flow markers nor pillows. Two thin but regionally continuous dacitic tuffs overlying the lava yielded concordant single-zircon ages of 3229+-6 Ma (Heubeck et al., in prep.) which are statistically indistinguishable from underlying Fig Tree Group volcanics and suggest high depositional and subsidence rates (mm/yr or higher) of intervening Moodies Group strata. Overlying clastic sediments up to 1 km thick show a very high lateral and vertical variability in grain size and petrography. Their facies ranges from alluvial conglomeratic wedges, fluvial gravelly sandstones, nearshore cross-bedded sandstones, tuffaceous shales to thin BIFs; sandstones show isolated occurrences of laminated curly biomats. The rapid facies changes attest to the termination of a uniform sedimentation regime and suggest the incipient breakup of the basin in numerous subbasins.
The boulder conglomerate below the base of the basaltic lava likely represents the tectonic turning point in the evolution of the Moodies Basin by marking a pronounced increase in local depositional slope, the subsequent initiation of horizontal shortening, basin margin uplift and erosion, and final tight greenstone belt shortening. The eruption of the basaltic lava may be related to brittle segmentation of the basement, causing small-scale faulting, alluvial fan development on a former shelf, and allowing magma ascent.