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Mesoarchaean (3.2 Ga) crust in the Aravalli Craton: Deformation history and zircon-monazite geochronology of the Bhilwara basement gneisses and Pur-Banera belt, Rajasthan, northwestern India

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The Banded Gneissic Complex (BGC) of the Aravalli Craton (Rajasthan, northwestern India) is considered to have evolved through the amalgamation of several crustal terranes. The BGC has been previously divided into an older, Archaean, BGC-I (exposed south of Nathdwara and roughly equivalent to Mewar Gneiss) and a younger, Proterozoic, BGC-II (exposed north of Nathdwara). However, the poorly documented deformation history and insufficient geochronological work limit our understanding of BGC evolution. To understand this, we combine detailed structural analysis of basement gneisses (traditionally considered to be BGC-II) and a metasedimentary cover sequence (the Pur-Banera belt) exposed in the Bhilwara region, with U–Pb zircon and U–Th–total Pb monazite geochronology. Resorbed zircon cores from the basement gneisses yield a 207Pb–206Pb age of 3159 $\pm$ 8 Ma (1σ). This oldest analysed population, giving a minimum crystallization age, is hitherto unreported from BGC-II. The basement gneisses experienced four phases of deformation, D1 through D4, each of which developed a tectonic fabric. Textural evidence and U–Pb zircon ages indicate the D1 deformation to be 2.9 Ga in age. A NNW–SSE-directed shortening event (D2) at 2.5 Ga formed upright folds on early gneissic foliation (S0//S1), with syn-tectonic granite emplacement. Subsequent NNE–SSW-directed deformation (D3) at 1.8 Ga produced NW–SE-trending vertical folds. Asymmetrical folds developed due to N–S-trending dextral shearing at 1.3 Ga constitute the last phase of deformation (D4) in the basement gneisses. The Pur-Banera sequence shows NNE–SSW-directed shortening on primary foliation, forming S1 foliation along WNW–ESE direction. These metapelitic supracrustals also show tight crenulations on S1 foliation, with pervasive axial planar fabric (S2), typically observed in high-strain zones formed at 1.3 Ga. This suggests that the two deformation events experienced by the Pur-Banera sequence correspond to the D3 and D4 deformation events affecting the basement gneisses. The ubiquitous record of older age populations (3.2–1.3 Ga) in zircon grains, with younger age populations (1.3–0.8 Ga) mostly preserved in monazite grains, indicates that monazite growth was associated with younger tectonic events that reworked large parts of the basement gneisses and supracrustal rocks. Our results demonstrate that BGC-I and BGC-II, with Mesoarchaean ages and known similar geochemical signatures, are not different. The BGC thus represents a coherent crustal entity formed during the Archaean and reworked several times during the Proterozoic.

Keywords: Aravalli Craton, Rajasthan, Banded Gneissic Complex, Geochronology, Crustal evolution