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LA-ICP-MS U–Pb zircon age constraints on the Paleoproterozoic and Neoarchean history of the Sandmata Complex in Rajasthan within the NW Indian Plate

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ABSTRACT

The Sandmata Complex in Rajasthan within the NW Indian shield represents a metamorphosed volcano-sedimentary sequence incorporated within a late Paleoproterozoic suture zone. Here we report laser ablation ICP-MS age data and REE geochemistry of zircons from four rock types in the Sandmata Complex – a foliated biotite–quartz gneiss, a leucocratic gneiss, a biotite gneiss and a porphyritic granite. The zircons in the biotite gneiss and porphyritic granite show magmatic textures with a single Paleoproterozoic age population, whereas the leucocratic gneiss and biotite–quartz gneiss samples carry zircons with an Archean provenance history and metamorphic characteristics. U–Pb dating of zircon domains in these samples shows two dominant age populations: Paleoproterozoic and Neoarchean, and indicate that (a) granulite facies metamorphism (biotite–quartz gneiss: ca. 1708 Ma) and the granitic magmatism (porphyritic granite: ca. 1733 Ma) were synchronous; and (b) the igneous protoliths of the leucocratic gneiss (ca. 2750 Ma) and biotite gneiss (ca. 2698 Ma) were formed in the Archean. The zircons from both gneisses and granite show high REE contents, prominent HREE enrichment and a conspicuous negative Eu anomaly suggesting a common melt source. We correlate the Paleoproterozoic magmatic ages from Sandmata Complex with a subduction–accretion history prior to the final collisional assembly of the continental fragments in the Neoproterozoic, comparable with a similar history all along the Central Indian Tectonic Zone, as well as from the Eastern Indian Suture, probably indicating the continuity of the suture all along Peninsular India. Our zircon data also reveal the vestiges of Archean rocks within the Paleoproterozoic suture.

1. Introduction

Precambrian terrains preserve records of multiple tectonothermal events which are well recognized to be related to distinct plate tectonic cycles (Kusky and Polat, 1999; Polat et al., 2009; Windley and Garde, 2009; Santosh et al., 2009a,b). Conventional models for metamorphism and the evolution and exhumation of metamorphic belts witnessed radical changes based on recent studies in Phanerozoic orogens and active convergent margins (e.g., Brown, 2010; Omori et al., 2009; Maruyama et al., 2010). In collisional orogenic belts, the formation of metamorphic belts marks the final phase of a prolonged subduction–accretion history with the consumption of intervening large oceans (e.g., Collins et al., 2007; Cawood et al., 2009; Santosh et al., 2009a,b; Santosh, 2010a,b, in press). Continental aggregation witnessed a prolonged cycle of construction and destruction of oceanic lithosphere and continental crust, where Pacific-type subduction–accretion was fundamental in building the major components and in defining the architecture of orogenic belts, prior to final Himalayan-style collision (Kusky et al., 1997; Cawood et al., 2009; Santosh et al., 2009b; Santosh, 2010a; Naganjaneyulu and Santosh, 2010).

Among those Precambrian terranes which preserve the rock records of multiple tectonothermal imprints, Peninsular India provides an example where geological events covering a major part of the history of our planet can be traced (Naqvi, 2005). Recent studies have also revealed that the Indian subcontinent was involved in various Precambrian supercontinental assemblies (Pradhan et al., 2010; Santosh et al., 2009b; Dharma Rao et al., 2010; Chatterjee and Ghose, in press). The major Paleoproterozoic terranes in Peninsular India are represented by the Aravalli – Delhi, Singhbhum and Bhandara domains, as well as the Cuddapah – Eastern Ghats Belt at the eastern margin of the Dharwar Craton (Fig. 1a). Further south, in the crustal blocks constituting the mosaic of the Southern Granulite Terrain, a Late Neoproterozoic-Cambrian event dominates with only vestiges of suspect Paleoproterozoic crust formation events,

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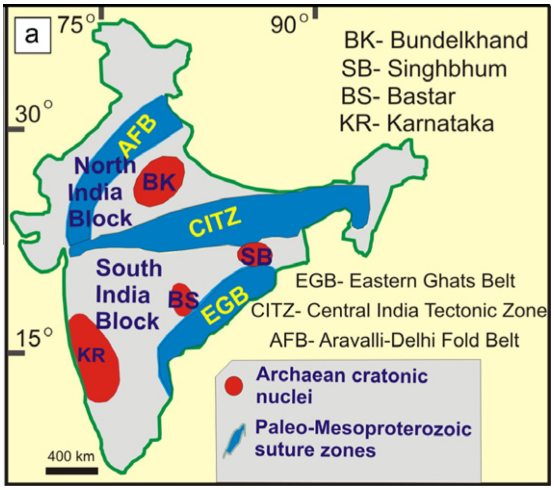

Fig. 1a. Geological framework of Peninsular India showing the major Archean cratonic blocks, Proterozoic belts and major Paleoproterozoic sutures in Peninsular India.

although there is robust evidence that the metasedimentary units in some of the blocks were sourced from Paleoproterozoic provenances (Collins et al., 2007; Santosh et al., 2009b; Santosh, in press). The major Paleoproterozoic orogenic belts in India extend from the northwestern through central to the eastern part of the peninsula with some suspect terranes further south (Fig. 1b). These belts, often referred to as mobile belts surrounding Archean cratons, preserve a broadly similar tectonic history with regard to magmatism, metamorphism and sedimentation (reviewed in Naqvi, 2005; Valdiya, 2010).

Considerable attention has been drawn to the 800 km long Aravalli–Delhi fold Belt (ADFB) in the Aravalli Mountains because of the interesting rock records and the regional development of high-grade granulite-facies rocks. The Aravalli Mountains of Rajasthan are the largest tectonic feature in the NW Indian plate, situated between the late Proterozoic platformal Marwar Basin (MB) in the west and the Vindhyan Basin on the east. The ADFB comprises a collage of Proterozoic fold belts developed on an Archaean sialic basement (Roy and Jakhar, 2002; Sinha-Roy et al., 1998) and exemplifies sequential events of ensialic rifting, generation of oceanic crust and its consumption. Dispersed within these younger fold belts are Archean remnants whose relative antiquity has been a subject of debate. The ADFB defines the NW margin of the Archaean Bundelkhand Craton (Fig. 1b) and may also link with the Central Indian Tectonic Zone that separates the Bundelkhand Craton from the Bastar and Singhbhum Cratons further to the south (Fig. 1a; Deb and Chattopadhyay, 2004). The oldest cratonic nucleus (3.3 Ma) of ADFB is the Banded Gneissic Complex (BGC), which has been reclassified into the Sandmata and Mangalwar Complexes (Sinha-Roy et al., 1995). Previous studies have noted that the Archaean rocks of the Mewar Gneiss south and east of Nathadwara (Fig. 1b), designated as the BGC-I (Gupta, 1934), exhibit distinct Archaean ages (3.3 Ga to 2.5 Ga) (Gopalan et al., 1990; Weidenbeck et al., 1996a,b; Roy and Kröner, 1996). In comparison to BGC-I, a direct evidence for Archean components have not so far been constrained well from the Sandmata Complex (BGC-II of Gupta, 1934).

According to Roy et al. (2005), the portion of the BGC-II in the present study area (Fig. 1c) represents Archaean crust reworked

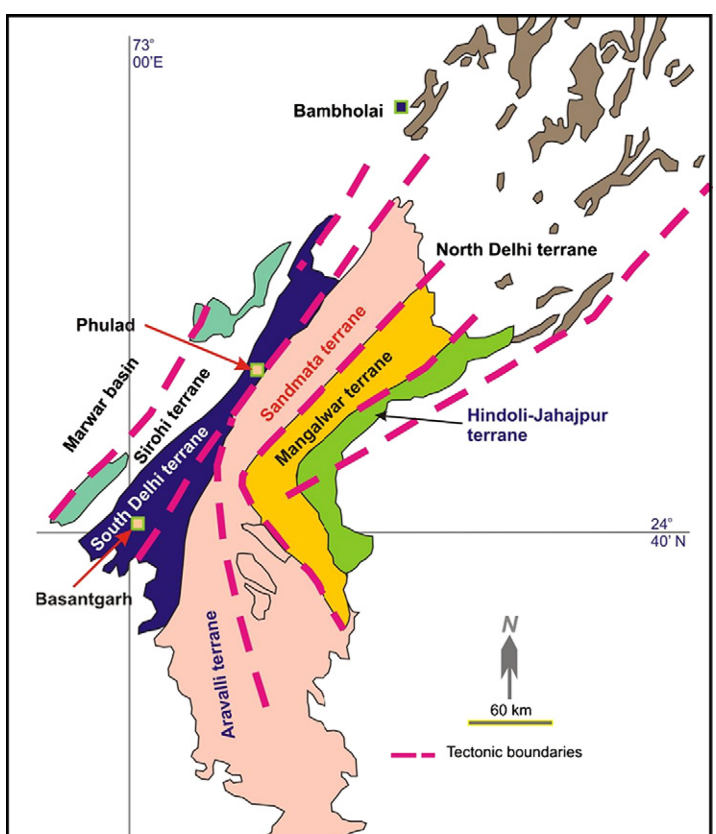

Fig. 1b. Generalized tectonic framework of the Aravalli–Delhi domains showing the major geological units, defined as belts (modified from a compilation by Singh et al. (2010).