



Cryogenian transpression and granite intrusion along the western margin of Rodinia (Mt. Abu region): Magnetic fabric and geochemical inferences on Neoproterozoic geodynamics of the NW Indian block

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ABSTRACT

The Mt. Abu batholith in NW India comprises variably deformed porphyritic, granophyric to medium-grained granites and granite gneisses. They are intruded by rhyolitic and mafic dykes; the latter also mark the terminal magmatic phase in this batholith. Granitoids and rhyolitic dykes form a coherent group; petrographic and geochemical characteristics indicate high level intrusion of felsic magma generated from high temperature melting of a lower crustal source. Geochemical similarity, spatial contiguity and coeval emplacement (766 to 763 Ma) of Mt. Abu granitoids with the Neoproterozoic (770 to 750 Ma) Malani Igneous Suite (MIS) underline that both are related to the same thermal event with Mt. Abu batholith as southeastern continuity of the MIS.

Anisotropy of magnetic susceptibility data shows parallel fabric orientation in all granitoid types (NE trend, steep SW dip) as well as in a prominent shear zone (Delwara Shear Zone) along the western margin of the batholith with continued deformation during and after the emplacement of granitic magma as inferred from deformation of late-stage mafic dykes. Including coeval shear zones and associated melting in the region NE of Mt. Abu shear-controlled magma generation and ascent along a >50 km NE trending corridor (Mt. Abu–Sirohi fault zone) is inferred. Structural elements and microstructural criteria (steep foliations, vertical lineations, dextral displacement) indicate a transpressional setting for this Cryogenian event.

In regional geodynamic context the Mt. Abu–MIS can be regarded as northeastern continuation of the Neoproterozoic (800–700 Ma) magmatic belt extending from northern Madagascar, the Seychelles into NW India. This magmatic belt, located along the western margin of supercontinent Rodinia, was formed during eastward subduction of the Mozambique Ocean. Transpressional forces responsible for shaping the structural architecture in the Mt. Abu–Sirohi region were most likely induced during closure of the Mozambique Ocean and related translation of the Marwar craton.

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1. Introduction

Neoproterozoic has been hailed as a period of redistribution of continental fragments and subsequent increases in their latitudinal velocities; amalgamation of the supercontinent Rodinia; its subsequent break-up and dispersal (Dalziel, 1991; Unrug, 1998). During the last decade the state-of-the-art models of “making and unmaking” of Rodinia have been extensively reviewed by Li et al. (2008), Meert and Torsvik (2003), and Pisarevsky et al. (2003). In most of the paleogeographic reconstructions (Li et al., 2008; Meert, 2001, 2003; Torsvik, 2003) the NW Indian block is shown to occupy the western margin of the supercontinent Rodinia (Fig. 1a). This is based mainly on paleomagnetic and geochronologic studies on the Neoproterozoic Malani

Igneous Suite (MIS) in NW India (Gregory et al., 2009; Torsvik et al., 2001; van Lente et al., 2009).

The MIS is characterized by rhyolitic flows and granites as the predominant lithologies (Bhushan and Chandrasekaran, 2002). Sporadic geochemical studies carried out on isolated occurrences of the MIS have offered some petrogenetic constraints (Bhushan, 2000; Eby and Kochhar, 1990; Maheshwari et al., 1996; Singh et al., 2006) leading to diverse opinions on the source characteristics and tectonic environment which include melting of the lower crust through extension (Bhushan, 2000) or a rising plume (Eby and Kochhar, 1990). As the MIS has comparable ages with Neoproterozoic magmatic events in Western Australia and China, Li et al. (1999) have ascribed the MIS magmatism to a superplume below South China which initiated the break-up of the supercontinent Rodinia. Yet another model attributes this magmatic event to the eastward subduction of the Mozambique Ocean on account of similarity with the ~750 Ma Andean-type activity recorded from the Seychelles and northeastern Madagascar (Ashwal et al., 2002; Kröner et al., 2000; Torsvik et al., 2001; Tucker et al., 2001).

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that lay close to the western India during that time (Collins et al., 2007; Handke et al., 1999; Meert, 2003).

There is a prevailing notion that the MIS is a distinctively 'undeformed and subaerial magmatic event' (Bhushan and Chandrasekaran, 2002) and that 'deformed' granitic bodies in the same geographic terrain represent relatively older events (Gupta et al., 1997; Heron, 1953). In this context the status of the Mt. Abu batholith, a large granitic intrusion occurring as the southeastern continuation of the MIS, is intriguing. The central (so called undeformed) part of the batholith has been described as part of the MIS, while the peripheral (ortho-gneiss) one has been related to older granite-gneisses (~830 Ma Erinpura terrain, Gupta et al., 1997). The distinction is based on visual differences in the degree of deformation, however, no studies have been attempted so far on the deformation history of Mt. Abu and mutual relationship of the two granitoid types is also not known. Although some geochemical similarity between felsic dykes in Mt. Abu and MIS has been hinted (Singh and Joshi, 2005), their relationship has not been properly evaluated.

The comparative geochemical analyses presented in this study provide the evidence that the Mt. Abu batholith, including the strongly sheared parts, is a component of the MIS. Field studies in team with magnetic anisotropy mapping and microstructural data offer further evidence for a syn-kinematic intrusion with respect to transpressional movements along a NW trending shear zone. The role of the shear zone in magma generation and emplacement is also evaluated and synthesized.

2. Geological setting

The NW Indian block consists of an Archean basement (Banded Gneiss Complex–Bundelkhand craton) flanked in the west by the

Proterozoic Aravalli and Delhi Fold Belts (ADFB). The Delhi Fold Belt (DFB), younger of the two, can be traced over a distance of more than 750 km as a NE-trending linear orogenic belt (Fig. 1). This structure developed during the ~1 Ga collision of Aravalli–Bundelkhand and Marwar cratons and amalgamation of the Indian Block. The collision caused juxtaposition of arc remnants (Sendra–Ambaji–Ajmer Belt) and metasediments of the Delhi basin (metaquarzites and calc-silicates) with granulite facies terranes (Mangalwar and Sand Mata Complexes) in the southern segment of the DFB during east-vergent thrusting and stacking. The 968 ± 1 Ma calc-alkaline Sendra granitoids (Pandit et al., 2003), 990 ± 6 Ma and 987 ± 6.4 Ma rhyolites (Deb et al., 2001) constrain the age of the arc terrane (Sendra–Ambaji–Ajmer Belt). The crustal convergence also initiated ophiolite obduction (Phulad Ophiolite, Gupta et al., 1980) over the arc setting. MORB like geochemistry in the northern segment of the Phulad Ophiolite Suite (Khan et al., 2005; Volpe and Macdougall, 1990) substantiates an ocean floor setting. Metamorphic overprint (0.95–0.9 Ga–monazite EMP age; Bhowmik et al., 2010; 0.95–0.94 Ga, LA ICP MS zircon ages; Buick et al., 2006; 0.97–0.93 Ga–monazite SHRIMP and EMP ages, Buick et al., 2010) in the high pressure granulite–amphibolite facies Mangalwar and Sand Mata Complexes can be related to continent–continent collision (Bundelkhand–Aravalli craton in the east and Marwar craton in the west).

A late-orogenic magmatic event is indicated by several granitic intrusions parallel to the trend of the DFB and in the terrain further west of the DFB (Marwar craton). Intrusions of this magmatic event are loosely termed as 'Erinpura Granite' (Heron, 1953) and often show a gneissic fabric. Age data are available for the Siwaya granites (836 ± 7.5 Ma, Deb et al., 2001) in the DFB and foreland (873 to 800 Ma; Choudhary et al., 1984; van Lente et al., 2009; Just et al.,

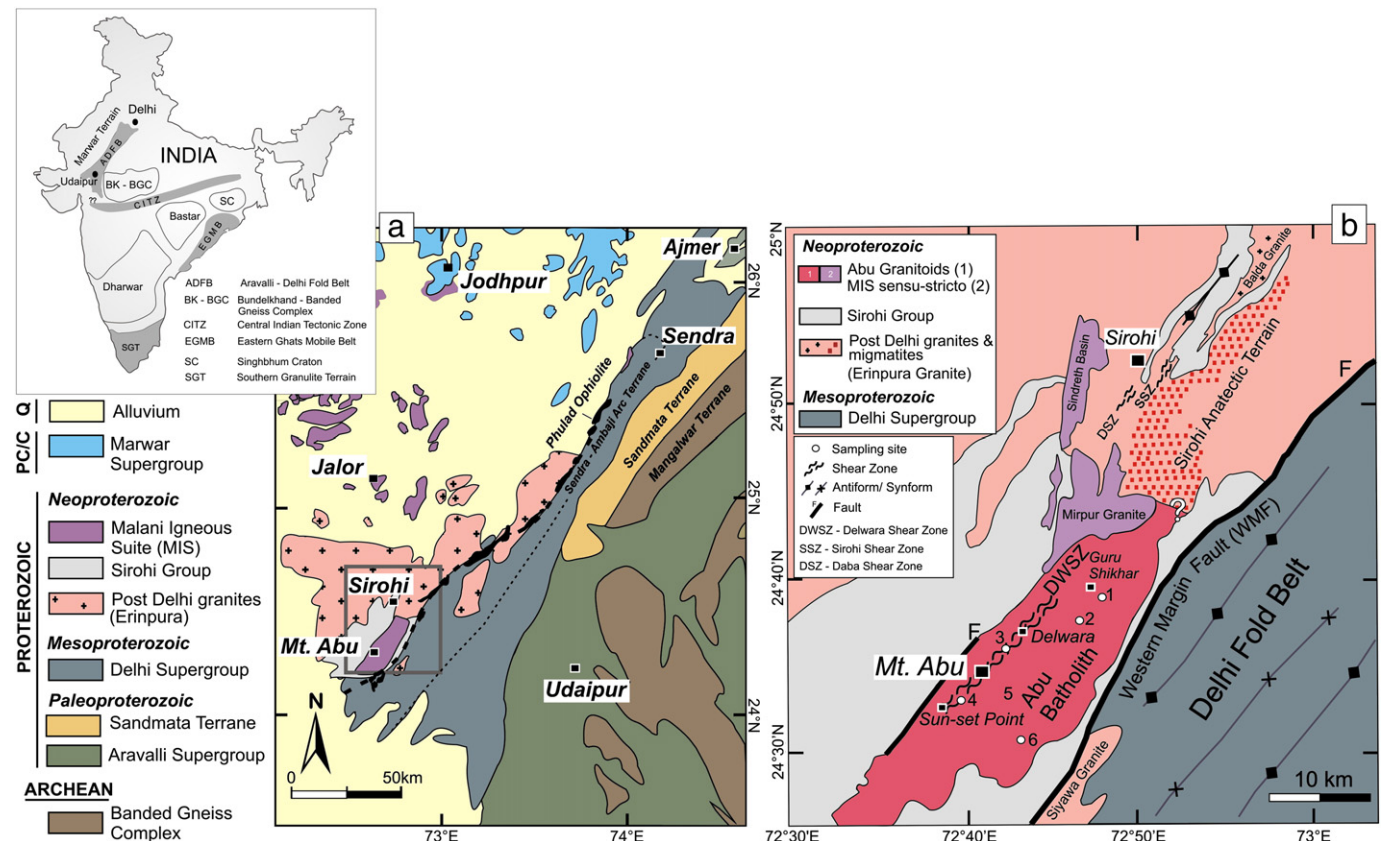


Fig. 1. a) Simplified lithostratigraphic map of the Aravalli–Delhi Fold Belt (adapted from Heron, 1953; Gupta et al., 1997; Buick et al., 2006) within the tectonic framework of NW India. The box (study area) refers to panel b and the inset map of India shows Precambrian cratons and mobile belts. b) Geological map of Mt. Abu and surrounding areas showing shear zones and other structural features. Sampling sites: 1 – south of Guru Shikhar, 2 – Achalgarh, 3 – Delwara Shear Zone, 4 – Nakki Lake, 5 – Abu toll section, and 6 – down drive toward Abu Road.

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