Proc Indian Natn Sci Acad **86** No. 1 March 2020 pp. 67-79
© *Printed in India.* DOI: 10.16943/ptinsa/2020/49795

Status Report 2016-2019

An Overview of Precambrian Geology of Aravalli Craton and Fold Belt, North-Western India

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(Received on 15 September 2019; Accepted on 29 September 2019)

The Aravalli Craton is situated on the north-western edge of India and has a geological history ranging from the Paleoarchean to the Quaternary. The basement of the Aravalli Craton (Banded Gneissic Complex or BGC) and its supracrustal sequences (Aravalli and Delhi Supergroups) serve as an excellent archive to understand the crustal and geodynamic evolution of continental crusts during the Precambrian period of the Earth's history. Here, we present a brief overview along with the recent developments on the status of its Precambrian geology.

Keywords: Precambrian; Aravalli Craton; Banded Gneissic Complex (BGC); Mangalwar Complex; Sandmata Complex; Aravalli-Delhi Fold Belt

Introduction

India is a very large country having a geological history spanning more than 4000 million years. Five Precambrian cratons (Aravalli, Bundelkhand, Bastar, Singhbhum and Dharwar) constitute the peninsular India. One of them, the Aravalli Craton is situated on the north-western edge of India (Fig. 1) and is composed of varied lithounits of variable ages. Its present stratigraphy is a result of the pioneering works of several workers who made exemplary attempts to study this continental block (*e.g.,* Coulson, 1933; Gupta, 1934; Heron, 1953; Banerjee, 1971; Sinha-Roy, 1985; Roy and Jakhar, 2002). A generalized lithostratigraphy of the Aravalli Craton is presented in the Table 1. Earlier, the Aravalli Craton and the Bundelkhand Craton were regarded as a singular lithotectonic block and were collectively called either as Rajasthan Craton, Bundelkhand Craton or Aravalli-Bundelkhand Protocontinent (*cf.* Roy and Jakhar, 2002; Sharma, 2009; Meert *et al.*, 2010). This was in part due to the fact that these two cratons are adjacent to each other, both lie to the north of the CITZ (Central Indian Tectonic Zone) and share similar Precambrian geological history (Naqvi and Rogers, 1987; Mondal *et al.*, 2002; Roy and Jakhar, 2002; Sharma, 2009; Meert *et al.*, 2010; Ahmad *et al.*, 2016; Saha *et al.*, 2016). Such clubbing of the two cratonic blocks was mainly based on probabilistic approaches, but now it is well-established that mostly all the Archean cratons have similar lithological association and geological history. Recent studies focused on these two cratons have also confirmed that their lithounits have different ages and evolution histories (Gopalan *et al.*, 1990; Wiedenbeck and Goswami, 1994; Roy and Kroner, 1996; Wiedenbeck *et al.*, 1996; Mondal *et al.*, 2002; Deb and Thorpe, 2004; Buick *et al.*, 2006; Dharma Rao *et al.*, 2011; Roy *et al.*, 2012; McKenzie *et al.*, 2013; Kaur *et al.*, 2016, 2019; Saha *et al.*, 2016; Verma *et al.*, 2016; Ahmad *et al.*, 2018).This communication presents a status report of the scientific studies carried out recently (during 2014-2019) on the Precambrian Aravalli Craton (BGC + Aravalli Delhi Fold Belt).

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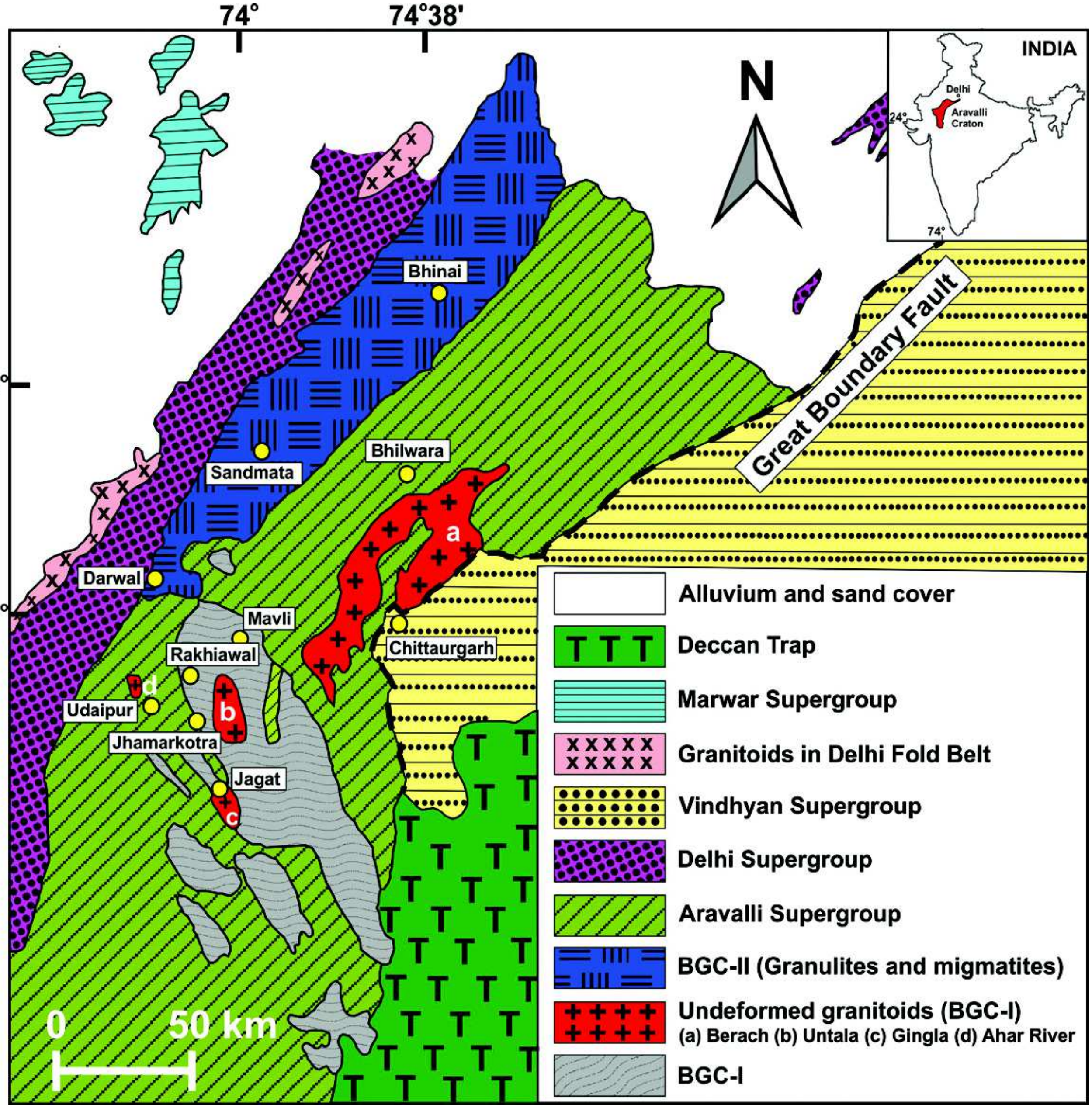

Fig. 1: Generalized geological map of the Aravalli Craton (*after* Heron, 1953; Roy and Jakhar, 2002). Inset shows position of the Aravalli Craton in India

Aravalli Craton: A brief introduction

The basement of the Aravalli Craton is commonly referred to as the "Banded Gneissic Complex (BGC)" because of prominently noticeable and intricate gneissic bandings (Gupta, 1934; Heron, 1953). It is composed of a variety of rock types and is classified into two separate lithotectonic domains, *i.e.*, BGC-I and BGC-II (Gupta, 1934; Heron, 1953). The BGC is overlain by two Proterozoic sedimentary sequences (Aravalli and Delhi Supergroups). Gupta (1934) opined that the BGC occurring in the southern Rajasthan (east and southeast of Nathdwara; Fig. 1) represents the basement of the overlying Proterozoic sedimentary successions. Based on his observations, he assigned this domain of the basement rocks as the BGC-I. He observed that the basement-cover relationship in the central Rajasthan is not indubitable, and thus named

Table 1: Lithostratigraphy of the Aravalli Craton

Marwar Supergroup	703 Ma[19]	
Malani Group (Volcanic rocks, granitoids, sedimentary rocks)	780-660 Ma[16,17]	
Erinpura Granites	850 Ma[8]	
Sirohi Group (metasediments)	920-820 Ma[13]	
Synorogenic granites in Delhi Basin	1450 Ma[8]	
Delhi Supergroup (metasedimentary and metavolcanic rocks)	1.7-1.0 Ga[14]	
BGC-II TTR* & Granulite exhumation	1729 to 1625 Ma[9,10,11,12,13]	
Synorogenic granites (Darwal Granite)	1850 to 1900 Ma[8,9]	
Aravalli Supergroup (metasedimentary and metavolcanic)	~1.8 to ~1.4 Ga[6]/2.4 to 1.6 Ga[7]	
Undeformed Granitoids (Gingla, Untala, Ahar R. & Berach)	2562 to 2440 Ma[3,4,5]	
Metasedimentary / Metabasaltic Rocks	2.83 Ga[1]	**BGC-I**
Basement gneisses	3310 to 2548 Ma[1,2,3,4]	

*TTR: Tectonothermal reworking

1. Gopalan *et al.* (1990)
2. Wiedenbeck and Goswami (1994)
3. Roy and Kroner (1996)
4. Kaur *et al.* (2019)
5. Wiedenbeck *et al.* (1996)
6. McKenzie *et al.* (2013)
7. Wang *et al.* (2019)
8. Choudhary *et al.* (1984)
9. Roy *et al.* (2012)
10. Sarkar *et al.* (1989)
11. Fareeduddin and Kroner (1998)
12. Buick *et al.* (2006)
13. Dharma Rao *et al.* (2011)
14. Deb and Thorpe (2004)
15. Purohit *et al.* (2012)
16. Roy (2006)
17. Torsvik *et al.* (2001)
18. Tucker *et al.* (2001)
19. George and Ray (2017)

it as BGC-II. The information regarding the ages and dating methods of various lithological units of the BGC are provided in the Table 2.

The BGC-I is composed of grey gneisses, metasedimentary rocks, metabasaltic rocks (amphibolites), undeformed granitoids and minor ultramafic rocks (Roy and Jakhar, 2002; Sharma, 2009; Ahmad and Mondal, 2016). The crystallization ages reported for the protoliths of the basement gneisses range from Paleoarchean (*ca.* 3310 Ma) to Neoarchean (2545 Ma) (Gopalan *et al.*, 1990; Wiedenbeck and Goswami, 1994; Roy and Kroner, 1996; Kaur *et al.*, 2019). The intrusion of the undeformed granitoids into the older basement rocks marks the timing of stabilization of the Aravalli Craton (Wiedenbeck *et al.*, 1996). Using Pb-Pb isotope systematics in robust minerals ($^{207}Pb/^{206}Pb$ in zircons), studies reported Neoarchean to Palaeoproterozoic ages (2.6-2.4 Ga) for these undeformed granitoids (Roy and Kroner, 1996; Wiedenbeck *et al.*, 1996). Outcrops of the metasedimentary rocks in the BGC-I are scanty and, in most cases, not mappable (Upadhyaya *et al.*, 1992; Roy and Jakhar, 2002; Ahmad *et al.*, 2016). Mafic rocks (amphibolites) of Archean ages form only a minor constituent of the BGC-I; and they represent a component of dismembered greenstone belt (Sinha-Roy, 1985; Upadhyaya *et al.*, 1992; Roy *et al.*, 2000, 2001). Gopalan *et al.* (1990) obtained emplacement age of 2828±46 Ma for these amphibolites using Sm-Nd isochron (whole-rock–mineral). The BGC-II underwent tectonothermal reworking during Proterozoic (Roy *et al.*, 2005; Bhowmik and Dasgupta, 2012). The lithocomponents of the BGC-II yield largely Proterozoic ages (~1.7 Ga) (Buick *et al.*, 2006; Dharma Rao *et al.*, 2011); Archean ages from the gneissic rocks have also been obtained (Dharma Rao *et al.*, 2011; Roy *et al.*, 2012; Ahmad *et al.*, 2018, Dey *et al.*, 2019). The BGC-II is

Table 2: Ages of various lithounits of the BGC-I, Aravalli Craton

Locality	Lithology	Technique	Material analysed	Age (Ma)	Reference
Ahar River	Granitoid	Rb-Sr isochron	Whole-rock - Mineral(s)	*ca.* 2275	Crawford (1970)
	Granitoid	Rb-Sr isochron	Whole-rock	2026±54	Guha and Garkhal (1993)
	Granitoid	^{207}Pb/^{206}Pb ion microprobe	Zircon	2562±6	Wiedenbeck *et al.* (1996)
Berach	Granitoid	Rb-Sr isochron	Whole-rock - Mineral(s)	*ca.* 2585	Crawford (1970)
	Granitoid	TIMS (multigrain)	Zircon	*ca.* 2610	Sivaraman and Odom (1982)
	Granitoid	^{207}Pb/^{206}Pb ion microprobe	Zircon	2440±8	Wiedenbeck *et al.* (1996)
Jagat	Leucogranitoid	^{207}Pb/^{206}Pb evaporation	Zircon	2658±5	Roy and Kroner (1996)
Gingla	Granitoid	Rb-Sr isochron	Whole-rock	2950±150	Choudhary *et al.* (1984)
	Granitoid	^{207}Pb/^{206}Pb evaporation	Zircon	2620±5	Roy and Kroner (1996)
	Granitoid	^{207}Pb/^{206}Pb ion microprobe	Zircon	2600-2400	Wiedenbeck *et al.* (1996)
Untala	Granitoid	Rb-Sr isochron	Whole-rock - Mineral(s)	955±50	Crawford (1970)
	Granitoid	Rb-Sr isochron	Whole-rock	2950±150	Choudhary *et al.* (1984)
	Granitoid	Rb-Sr isochron	Whole-rock	2900±100	Sastry (1992)
	Granitoid (grey)	^{207}Pb/^{206}Pb evaporation	Zircon	2666±6	Roy and Kroner (1996)
	Granitoid (pink)	^{207}Pb/^{206}Pb ion microprobe	Zircon	2505±3	Wiedenbeck *et al.* (1996)
Mavli-Rakhyawal	Gneiss	^{207}Pb/^{206}Pb evaporation	Zircon	2666±6	Roy and Kroner (1996)
	Amphibolite	Sm-Nd isochron	Whole-rock	2828±46	Gopalan *et al.* (1990)
Vali (near Jagat)	Gneiss	^{207}Pb/^{206}Pb evaporation	Zircon	2887±5	Roy and Kroner (1996)
	Gneiss	^{207}Pb/^{206}Pb ion microprobe	Zircon	2506±4	Wiedenbeck *et al.* (1996)
Jhamarkotra	Foliated granite	^{207}Pb/^{206}Pb ion microprobe	Zircon	2532±5	Wiedenbeck *et al.* (1996)
	Gneiss	Sm-Nd isochron	Garnet-Whole rock	2450±17	Gopalan *et al.* (1990)
	Gneiss	^{207}Pb/^{206}Pb Evaporation	Zircon	3228±4-3232±5	Roy and Kroner (1996)
	Gneiss	^{207}Pb/^{206}Pb ion microprobe	Zircon	3281±3	Wiedenbeck and Goswami (1994)
	Gneiss	Sm-Nd isochron	Whole-rock	3307±65	Gopalan *et al.* (1990)
	Gneiss	LA-SF-ICP-MS	Zircon	3315.5±6.7	Kaur *et al.* (2019)

classified into two domains *viz.* the Mangalwar Complex (amphibolite facies) and the Sandmata Complex (granulite facies) (Gupta *et al.*, 1980; Guha and Bhattacharya, 1995). Two greenstone sequences, *viz.* Sawadri Group and Tanwan Group, have been identified to occur as ghost stratigraphy within the Mangalwar Complex (Mohanty and Guha, 1995).

The Aravalli-Delhi Fold Belts (ADFB) represent the sedimentary successions overlying the BGC. They extend from Delhi in the north to Gujarat in the south with a stretch of ~700 km and a NE-SW trend (Deb *et al.*, 1989). Stratigraphically, the ADFB comprises lower Aravalli Supergroup (Paleoproterozoic) and upper Delhi Supergroup (Mesoproterozoic). There are several stratigraphic subdivisions proposed for the Aravalli Supergroup (Banerjee, 1971; Gupta *et al.*, 1980; Banerjee *et al.*, 1986; Roy, 1988; Sinha-Roy *et al.*, 1998). However, most authors generally follow a three-fold classification which subdivides the Aravalli Supergroup based on the presence of unconformity or abrupt change in lithological characters into Lower (Delwara), Middle (Debari) and Upper (Jharol) Groups. The Lower and Middle Aravalli Groups are dominated by pelite-carbonate-quartzite association suggesting shelf depositional environment. The Upper Aravalli Group (Jharol) is dominated by turbidite facies siliciclastic rocks formed in deep-sea sedimentary environment. The Aravalli Supergroup developed in intra-cratonic rift basins formed under the influence of regional rifting along the northwestern boundary of the Aravalli Craton. It has undergone polyphase deformations and lower greenschist facies metamorphism. The Aravalli Supergroup is best exposed in its type area around Udaipur and south of it (Fig. 1). The Delhi Supergroup constitutes volcano-sedimentary associations primarily formed of deep-water to platform-type sediments (Sinha-Roy *et al.*, 1998; Roy and Jakhar, 2002). It is divided into two terranes – North Delhi Fold Belt (NDFB) and South Delhi Fold Belt (SDFB) (Gupta *et al.*, 1980, 1997; Sinha-Roy, 1984; Roy, 1988; Singh, 1988; Sinha-Roy *et al.*, 1998). The NDFB is further divided into three groups – lower Raialo, middle Alwar and upper Ajabgarh – separated from each other by unconformities. The Raialo Group is a carbonate-arenite-volcanic association, the middle Alwar Group is arenitic with volcanics and the uppermost Ajabgarh Group is commonly pelitic with volcanics. Similarly, a two-fold classification is proposed for the SDFB – lower Gogunda Group and upper Kumbhalgarh Group (Gupta *et al.*, 1997).

Recent Developments in the Geological Status of the Aravalli Craton

BGC-I (Southern Rajasthan)

In the recent years, very few yet significant researches have been carried out on the lithounits from both the domains of the BGC. Ahmad *et al.* (2019) highlighted that all the grey gneisses of the BGC-I are not TTG (sodic) and classified them into TTG (sodic) and transitional-TTG (potassic) types. They proposed that the TTG rocks of the BGC-I have formed by the partial melting of an enriched source (*e.g.*, oceanic plateau) at variable depths in a subduction setting. Kaur *et al.*(2019) using U-Pb-Hf isotope analyses of zircon and whole-rock geochemical data of gneisses and undeformed granitoids proposed: (i) TTG gneiss precursors were emplaced during Paleoarchean (3310 Ma) and Neoarchean (2563-2548 Ma), whereas the granite-granodiorite-quartz diorite gneiss precursors were emplaced between 2545 and 2485 Ma; (ii) metamorphic events at 2450 and 520 Ma; (iii) the Paleoarchean TTGs have formed by partial melting of a deep-seated mafic crust derived from a CHUR-like mantle; (iv) Neoarchean TTGs formed by partial melting (at a shallower depth) of a younger oceanic crust derived from a depleted mantle source; (v) Neoarchean granitoids (2540-2485 Ma) formed from partial melting of heterogeneous felsic crust of Paleo-, Meso- and Neoarchean ages; and (vi) Neoarchean quartz diorite (2545 Ma) formed from mixing of enriched mantle-derived mafic magma with felsic magma (formed by the anatexis of Paleoarchean crust). Rahaman and Mondal (2015) studied the undeformed granitoids of the BGC-I and reported that they exhibit calc-alkaline to potassic nature. They classified them as sanukitoid (high-Mg granitoids) and high-K granitoid suites. These granitic rocks of the BGC-I domain have radiometric ages ranging from Neoarchean to Paleoproterozoic (Roy and Kroner, 1996; Wiedenbeck *et al.*, 1996). Further, Rahaman *et al.* (2019) classified the Late Neoarchean-Early Paleoproterozoic granitoids into high-Mg (HMG) and K-rich granitoids (HKG) suites. They suggested sanukitoid-like petrogenesis for the HMG suite and partial melting of heterogeneous older crust as a probable mechanism for the HKG suite formation. The metasedimentary rocks of the BGC-I have been studied and classified into mature metasedimentary rocks (quartz dominant mineralogy; average SiO_2: 95.3 wt%; Ahmad *et al.*, 2016) and immature metasedimentary rocks (quartz and plagioclase dominated mineralogy along with minor amounts of muscovite, biotite and mafic minerals; SiO_2: 56.1-80.3 wt%; Ahmad *et al.*, 2016). Further, Ahmad (2017) proposed that the mature metasedimentary units represent metamorphosed chert units. The Archean mafic rocks of the BGC-I are classified into two groups: (i) *mafic xenoliths* – the older mafic unit occurring as enclaves within the gneissic body; and (ii) *metabasaltic rocks* – the younger mafic unit occurring associated with the metasedimentary rocks. Based on field relationships, the mafic xenoliths have been suggested to represent undigested precursors of the basement grey gneisses (Ahmad, 2017; Ahmad *et al.*, 2019). The metabasaltic rocks occur associated with the metasedimentary rocks; and this volcano-sedimentary association occurs in a linear belt within the basement grey gneisses mainly confined on the western margin of the BGC-I (Ahmad *et al.*, 2016). Another unit of mafic rocks even younger than the undeformed granitoids (2440 Ma), has been reported within the BGC-I which intrudes all the basement units. This younger mafic rock, referred to as *mafic dykes* (Upadhyaya *et al.*, 1992; Ahmad, 2017), is suggested not to represent the basement complex and is correlated with the basal Aravalli volcanic rocks (Upadhyaya *et al.*, 1992; Roy and Jakhar, 2002). The basal Aravalli volcanic rocks are tholeiitic to komatiitic in composition, but Ahmad and Rajamani (1991) and Ahmad *et al.* (2008) referred these mafic volcanics as picritic because of absence of textural features by metamorphism.

BGC-II

Using geochemical data of basement gneisses from the BGC-II, Ahmad *et al.* (2018) have shown that this domain is devoid of gneisses with TTG composition (sodic). The gneisses of the BGC-II are exclusively potassic in nature (not TTG) and show affinity for sanukitoids and high-potassium granitoids. Based on Sm-Nd isotopic study, Ahmad *et al.* (2018) proposed the presence of Archean geological history of the BGC-II gneissic rocks. They obtained depleted mantle Nd-model ages ranging from 3.54 to 2.69 Ga from the basement gneisses which suggests that the BGC-II crust formed during the Archean but has been extensively reworked during the Proterozoic tectonothermal reworking. Using mineral chemistry and Rb-Sr isochron method, Basak and Ghosh (2015) attempted to constrain the pressure-temperature conditions and ages of lithounits from the Sandmata Complex of the BGC-II. They reported P-T conditions of 780-850°C and 7-8 kbar for the formation of metamorphic garnets in migmatites, leptynites and quartzo-feldspathic gneisses. Retrograde biotites in these rocks formed at P-T conditions of 500-600°C and 3.5-4.5 kbar. The authors also obtained whole-rock Rb-Sr isochron age of 1715±24 Ma for the intrusive granitoids and 1735±150 Ma for the migmatites of the Sandmata Complex. These ages have been interpreted to indicate the timings of granitoid emplacement and migmatitization, respectively (Basak and Ghosh, 2015). Kaur *et al.* (2015) reported a low-temperature (350-400°C) infiltration metasomatism caused by metamorphic fluids in the Ajitgarh intrusive granitoids which lead to the formation of two distinct replacement fronts. They proposed two stage metasomatic processes: (i) formation of microcline-albite granite from grey granite through the transformation of oligoclase to albite, biotite (annite-rich) and hastingsite (amphibole) to hastingsite with low X_{Fe} values, coupled with dehydration, gain in Na, and losses in Fe and Rb; and (ii) white albite granite from the microcline-albite granite by almost complete conversion of microcline to albite and complete or nearly complete disappearance of amphibole.

Ahmad and Mondal (2016) and Guha (2019) favour a terrane accretion model for the amalgamation of BGC domains and different greenstone sequences of the BGC-II, respectively. Guha (2019) suggested that the forceful intrusive plutonic granitic bodies acted as stitching joins of craton-terrane parts. He also proposed that the complexly deformed and metamorphosed high-grade granulite terranes occurring as tectonic wedges between greenstone-granite cratons in Bhilwara Supergroup can be explained by deep crustal asymptotic ductile shear zones whereby the granulite gneisses have been excavated from deeper levels of the crust. Erickson *et al.* (2015) reported that they have integrated geochronology and microfabrics to calculate the ages of crystallization and deformation (recrystallization) in high-temperature metamorphic rocks for the first time. Using electron back scattered diffraction, they studied monazites from the Sandmata Complex to quantify the crystal-plastic deformations and link the microstructures with *in situ* U-Th-Pb ages of the deformed grains. They reported development of deformation twins within the monazite in {100}, {001} and $\{12\bar{2}\}$ orientations along with the development of low-angle (<10°) boundary associated with dislocation creep, and formation of new grains by dynamic recrystallization. Erickson *et al.* (2015) carried out U-Th-Pb analyses of monazites using Sensitive High-Resolution Ion Microprobe (SHRIMP) and reported *ca.* 1720 Ma and 970±14 Ma as the ages of crystallization and deformation, respectively. Erickson *et al.* (2015) consider crystal plastic processes of monazite as the only deformation mechanisms that could completely reset the U-Th-Pb age. However, this novel attempt of dating monazite deformation has been challenged by Wawrzenitz and Krohe (2016). Wawrzenitz and Krohe (2016) argued that (i) dissolution precipitation creep (DPC) is the prevalent deformation mechanism at high- and low-temperatures involving monazite in the presence of a chemically active fluids; and (ii) syn-deformative monazite crystallized during DPC has already been successfully used for direct dating of HT (high temperature) rock deformation since the past decade. Guha *et al.* (2019) studied the processes of melt generation and the origin of the Anjana Granite (Mangalwar Complex). They carried out geological mapping of the area, geochemical analysis of whole-rocks and electron microprobe analysis (EPMA) of minerals. According to them, the major proportion of the protolith of granitoid-gneiss and migmatites are mafic-ultramafic and pelitic rocks. They also suggested that the partial melting of these protoliths produced anatectic melt which upon homogenisation and differentiation produced the Anjana Granites. Dey *et al.* (2019) dated the Jahazpur Granite and Mangalwar Gneiss from the Deoli-Jahazpur Sector, Rajasthan using U-Pb SHRIMP (IIe) data from zircons to re-ascertain the stratigraphy. They reported that the Jahazpur Granitoids were emplaced at 2538±5 Ma, whereas the timing of high-grade metamorphism and anatexis of the Mangalwar Gneiss took place at 2520±37 Ma. They proposed that the Neoarchean Jahazpur granitoid emplaced concurrently with the Berach granite; and the Jahazpur granitoid and the Mangalwar Gneiss are constituents of the BGC.

Aravalli-Delhi Fold Belts (ADFB)

Wang *et al.* (2018) attempted to constrain the depositional history of the Aravalli Supergroup using integrated detrital zircon U-Pb-Hf data, whole-rock geochemistry and detrital sedimentary data of its clastic sedimentary rocks. They proposed that the sedimentation in the Aravalli Supergroup was protracted and episodic that spanned between 2.4-2.0 Ga, 2.0-1.72 Ga and ca. 1.65 Ga over a passive-margin platform, active-margin back-arc basin, and finally back to a passive-margin platform, respectively. They suggested that an abrupt transition from Jhamarkotra carbonate sequence (*ca.* 2.2-2.0 Ga) to upward-coarsening siliciclastic-dominated Udaipur Formation (*ca.* 1.79 Ga) marks a major shift in detrital zircon age signatures – from dominantly cratonic input to an Aravalli-age magmatic arc source. Further, they also proposed that an abundant rift-related (*ca.* 1.72-1.65 Ga) sediments in the mature sandstones of the Upper Aravalli Supergroup represents the transition from an active margin to a rift-induced passive margin. Bhattacharya *et al.* (2019) reported an occurrence of well-preserved tidalites in the upper part of the Bayana siliciclastic succession (one of the oldest records of tidal depositional systems within the Aravalli cratonic area). Tidalites are sedimentary facies that bear signatures of ancient tidal activities. Absar and Sreenivas (2015) studied the greywackes of the Middle Aravalli Group and suggested that they have been deposited in an active tectonic regime (similar with sediment derivation from a young differentiated continental margin type arc). They have also suggested that the sediments have undergone post-depositional K-metasomatism with 0-25% extraneous addition of K. The Middle Aravalli continental arc is underlain by a thick continental crust (~70 km) similar to the Central Volcanic Zone of the modern Andes (Absar and Sreenivas, 2015). A number of isolated basins such as Punagarh, Sindreth and Sirohi have been developed in the Trans-Aravalli terrane. These basins have preserved volcano-sedimentary sequences. Based on detailed structural work on Punagarh basin, Bhardwaj and Biswal (2019) have suggested that continental extension subsequent to Delhi Orogeny has produced this basin. Meert and Pandit (2015) presented a brief account of the Precambrian basins of India and proposed that the basin opening, and closure can be linked to three discrete supercontinent cycles (Columbia, Rodinia and Gondwana). They suggested that the Purana-I, Purana-II and Purana-III basins developed during the 2.5-1.6 Ga, 1.6-1.0 Ga and Neoproterozoic-Cambrian intervals, respectively. Ozha *et al.* (2017) have correlated the uranium-mineralization event in the Samarkiya area (central Aravalli-Delhi Fold Belt) to the Rodinian amalgamation. They studied geochemical and temporal evolution of uraninites (uranium mineralization) in the area (central Aravalli-Delhi Fold Belt) and reported two major events of uraninite formation (in addition to ~1.88 Ga event) at ~1.24-1.20 Ga and 1.01-0.96 Ga. Sallstedt *et al.* (2018) studied the ancient phosphatic stromatolites (oncoid cone like) from the Jhamarkotra Formation, Aravalli Supergroup. These phosphatic stromatolites contain abundant mineralized bubbles enmeshed within tufted filamentous mat fabrics. The construction of tufts because of filamentous bacteria gliding within microbial mats led Sallstedt *et al.* (2018) to propose strong indication of cyanobacterial activity in the Aravalli mounds. They suggested that the role of oxygenic phototrophs was significant for the apatite formation in the stromatolites.

Ray *et al.* (2015) studied the geochemical characteristics of the Sewariya and Govindgarh granitoids which are intrusive into the Delhi Supergroup along the western margin of the South Delhi Fold Belt. They suggested that both the granitoids are highly evolved and show calc-alkaline nature. Based on the geochemical signatures of the granitoids, Ray *et al.* (2015) proposed: (i) the granitoids have crustal signatures and are derived from a metasedimentary protoliths (infracrustal melting) with little contribution from the mantle source; (ii) both granitoids formed in different anatectic conditions with the Sewariya Granitoids forming in dehydration conditions, whereas the Govindgarh Granitoids in fluid-present conditions. Yadav *et al.* (2015) reported new albitite lines and albitized rocks within the BGC and East Khetri basin of the Delhi Supergroup and described that the new albitite occurrences represent an intracontinental rift zone and host significant uranium, rare earth elements, Y and Sc. Kaur *et al.* (2017) studied *in situ* U-Pb-Hf isotope composition of zircon and geochemical data of the Paleoproterozoic A-type granitoids of North Delhi Fold Belt to reveal that: (i) the granitoids intruded in an extensional setting at 1.73-1.70 Ga; (ii) the granitoids are derived from two distinct sources (1.85 Ga old calc-alkaline granitoids, and mixing of felsic magma with mafic magma); (iii) the Archaean-Palaeoproterozoic (3.1-2.3 Ga), and late Palaeoproterozoic (1.85 and 1.77 Ga) crust underwent substantial reworking at 1.73-1.70 Ga. Kaur *et al.* (2017) obtained *in situ* U-Pb zircon and monazite ages, zircon *in situ* Lu-Hf isotope data, whole-rock Nd-Sr isotope data and geochemical compositions of granitoids from north-central parts of the Aravalli-Delhi Fold Belt. They aimed to understand the pre-, syn- and post-magmatic evolution of these granitoids. They constrained that the granitoids span an age range of 1860-1810 Ma and were generated in a continental arc setting. Based on geochemical features, Hf-Nd model ages (3.0-2.6 Ga), inherited zircon ages (3.3-2.5 Ga) and significant isotopic variations among the granitoids, they suggested: (i) the granitoids were generated from garnet-free and plagioclase-rich sources at shallow depths; and (ii) the Archaean crust underwent abundant reworking which was not completely homogenized during the Palaeoproterozoic. Mukherjee *et al.* (2017) obtained mineral chemistry of magnetite and apatite occurring within the Bhukia Gold Deposit of the Aravalli-Delhi Fold Belt (ADFB). Based on mineral chemistry, they proposed a strong hydrothermal input for the deposition of magnetite. They further proposed that the apatite in Bhukia deposits is of fluorapatite variety with high F and low Cl content. They suggested that the apatite shows magmatic hydrothermal character and is derived from meta-volcanosedimentary source in a highly oxidized environment. They inferred that the Bhukia deposit is a possible IOCG (iron-oxide copper gold)-IOA (iron-oxide apatite) type gold deposit typically associated with sulfides and graphite.

Mahadani *et al.* (2015) carried out strain estimation (shortening) studies using wavelength/arc length ratio of different markers including folds, orbiculites and quartz phenocrysts from greenschist facies rocks of the Ambaji Basin in the Aravalli-Delhi Mobile Belt. They estimated *ca.* 65% and 55% shortening during F1 and F2 folding, respectively; they also estimated 10-23% volume loss due to flattening strain in the orbiculites (metabasalt) and quartz phenocryst (metarhyolite and granite) (Mahadani *et al.*, 2015). Based on strain estimation, Mahadani *et al.* (2015) proposed that buckling coupled with moderate shortening and low volume loss are responsible for the deformation in the rocks of the Ambaji basin during the evolution of the South Delhi Terrane. Mehdi *et al.* (2015) carried out metamorphic studies (including geothermometry) on the metabasic rocks of the Lalsot-Bayana sub-basin of the North Delhi Fold Belt (NDFB). In contrast to the previous studies, they report that this sub-basin has been metamorphosed in the sub-greenschist facies conditions (~300°C temperature); the other two sub-basins of the NDFB (Khetri and Alwar) display medium grade metamorphic assemblages. They further suggest that the lithopackage and metamorphism of this sub-basin suggests it to be a pre-Delhi intra-cratonic rift related volcano-sedimentary sequence.

Recently, Pathak *et al.* (2017), based on high resolution aeromagnetic data, showed the presence of E-W trending magnetic anomaly extending for more than 35 km in length and cross-cutting the Aravalli Supergroup. They proposed that the anomaly manifests the presence of undeformed basic dyke intruding into metasediments of the Aravalli

Supergroup. They also suggest that the dykes, which are emplaced sympathetic to the axial plane of F_3 folding, post-date Aravalli mafic magmatism based on their E-W trend and undeformed nature. Using microtremor method, Joshi *et al.* (2018) reported a discordant granitic pluton (shallow and deep) below the Narukot Dome of the Champaner Group, Aravalli Supergroup. They suggested that the presence of the pluton at a shallower depth implies a steep easterly plunge within the Champaner metasediments, whereas a deeper level pluton implies a gentle westerly plunge.

Future Scope of Study in the BGC

The Aravalli Craton and its supracrustal sequences represent a complete Precambrian lithological package. The basement of this craton (BGC) shows evidence of partial reworking by tectonothermal event. So, its constituent lithounits provide an excellent opportunity and can be studied to understand the evolution of continents through time, particularly during the Precambrian. The nomenclature of the BGC and/or its constituents have been changed numerous times. We propose that the nomenclatures suggested by Gupta (1934) and Heron (1953) (*i.e.*, BGC-I and BGC-II for the southern and central BGC domains, respectively) should be adopted and used uniformly. This can help to distinguish the BGC based on their response to an earlier Proterozoic tectonothermal events. Most lithounits of the BGC remain unstudied for their geochemical characteristics, particularly isotopes. An extensive study on the geochemical and isotopic makeup of the lithounits/minerals needs to be carried out to constrain the processes involved in their genesis, understand the geodynamic evolution, and delineate various lithounits. A precise dating of various lithological types is needed to constrain the timings of their emplacement and metamorphism, and to ascertain the probability of participation of the Aravalli Craton in various supercontinent cycles.

Acknowledgements

We thank Prof. D.M. Banerjee and Prof. Somnath Dasgupta for the invitation to contribute this paper on Precambrian geology of the Aravalli Craton. IA thankfully acknowledges fruitful discussions with J.S. Ray, Oinam Kingson Singh, Bivin Geo George, Ikshu Gautam and Milan Kumar Mahala.

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