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Geochronological Constraints for Boundary Shear Zones between Eastern Ghats Province and Bastar Craton: Implication for the Formation of Granulites and Their Exhumation History

Rajib Kar[1], Miguel Angelo Stipp Basei[2], Samarendra Bhattacharya[1], Anwesha Ghosh[1], Sanchari Chatterjee[1]

[1]Department of Geology, University of Calcutta, Kolkata, India
[2]Geoscience Institute, Sao Paulo University, Sao Paulo, Brazil
Email: rajib_kar@yahoo.com

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Abstract

Shear zones in the boundary between Eastern Ghats Province (EGP) and the cratons of Singhbhum in the north and Bastar in the west provide an excellent opportunity to study the tectonics of shear zone development and its timing in relation to the evolutionary history of the granulite suites. Detailed structural, microfabric and quartz C-axis patterns revealed a high temperature shear zone, at the western boundary between EGP and Bastar Craton (BC) around Paikmal. Petrological studies in this shear zone indicated decompression coeval with stretching in the sheared granulites. Geochronological constraints provided here indicate rapid exhumation of deep seated granulites in this boundary shear zone; the timing also is late in relation to the long-lived thermal (granulite formation) event in the EGP. Additionally, our geochronological data demonstrated the ~1600 Ma event in the Eastern Ghats Belt (EGB) involving sedimentation, magmatism, metamorphism and crustal anatexis, as a significant world event.

Keywords

Shear Zone, Extrusion Tectonics, Exhumation, Eastern Ghats Province, Geochronology

1. Introduction

Worldwide shield areas are characterized by occurrence of Precambrian crust with contrasting tectonic units: Archaean cratonic blocks usually made up of granite-greenstone terrains surrounded by Proterozoic mobile belts have a history of preservation of rocks with high-strain and high-grade metamorphism [1]. Kaapvaal Craton-Limpopo Belt of African Shield, Pilbara Craton-Capricorn Belt of Australian Shield and Superior Craton-Kapuskasing Belt of Canadian Shield are the global examples. Dharwar Craton-Pandyan Belt, Mewar Craton-Aravalli Belt, Singhbhum Craton-Eastern Ghats Belt are Indian examples [2]. To understand the evolution of such contrasting crustal pairs, it is important to focus on the boundary areas [3] [4] [5].

From the boundary between Bastar Craton (BC) and Eastern Ghats Province (EGP), around Paikmal, [6] described decompressive reaction textures in the granulitic rocks of boundary shear zone that could relate to exhumation of deep crustal granulites during shearing. Although reaction textures indicative of decompression have been described from several internal segments of the Eastern Ghats Belt (EGB) [7] [8] [9] [10], the kinematics of exhumation in these segments are not well understood. From one internal segment, around Paderu, [11] provided isotopic evidence of partial exhumation (10 to 8 kbar) in about 100 million years. [12] proposed that weak marginal zones, marked by extensional faults or shear zones, should provide evidence of rapid exhumation, compared to the much more slowly uplifted rocks of the core of the thickened mountain belt. In view of the high-temperature shear zone and reaction textures indicative of decompression during shearing, described from the northwestern margin around Paikmal, isotopic data from this domain may attest to the rapid exhumation. In this communication we present isotopic data, using multiple systematics, on rocks both from the EGP and adjoining BC. These may shed new light on the evolution of contrasting crustal pairs.

2. Geological Setting

2.1. Eastern Ghats Belt

Presently it is believed that the EGB is a collage of several provinces/domains having distinctive geological histories [13]. The provinces/domains are said to be separated by structural discontinuities (**Figure 1(a)**) as represented by crustal scale shear zones [14] [15]. These shear zones were described as inter-domainal shear zones. However, a recent work [16] convincingly demonstrated the Mahanadi Shear Zone (part of North Boundary Shear Zone) as an outcome of intra-terranne transpression in response to far field stress generated by collision of EGB with the Singhbhum Craton (SC) and thereby challenged the efficacy of the domainal classification [15].

The EGB comprises three broad lithological groups, namely metapelitic granulites, charnockite-enderbite gneisses and associated mafic granulites and migmatitic gneisses. NE-SW regional tectonic trend represented by S_1 gneissosity [17] [18] [19], a steep axial planar foliation, and common structural repetitions, are akin to a convergent orogen that evolved under a regional NW-SE

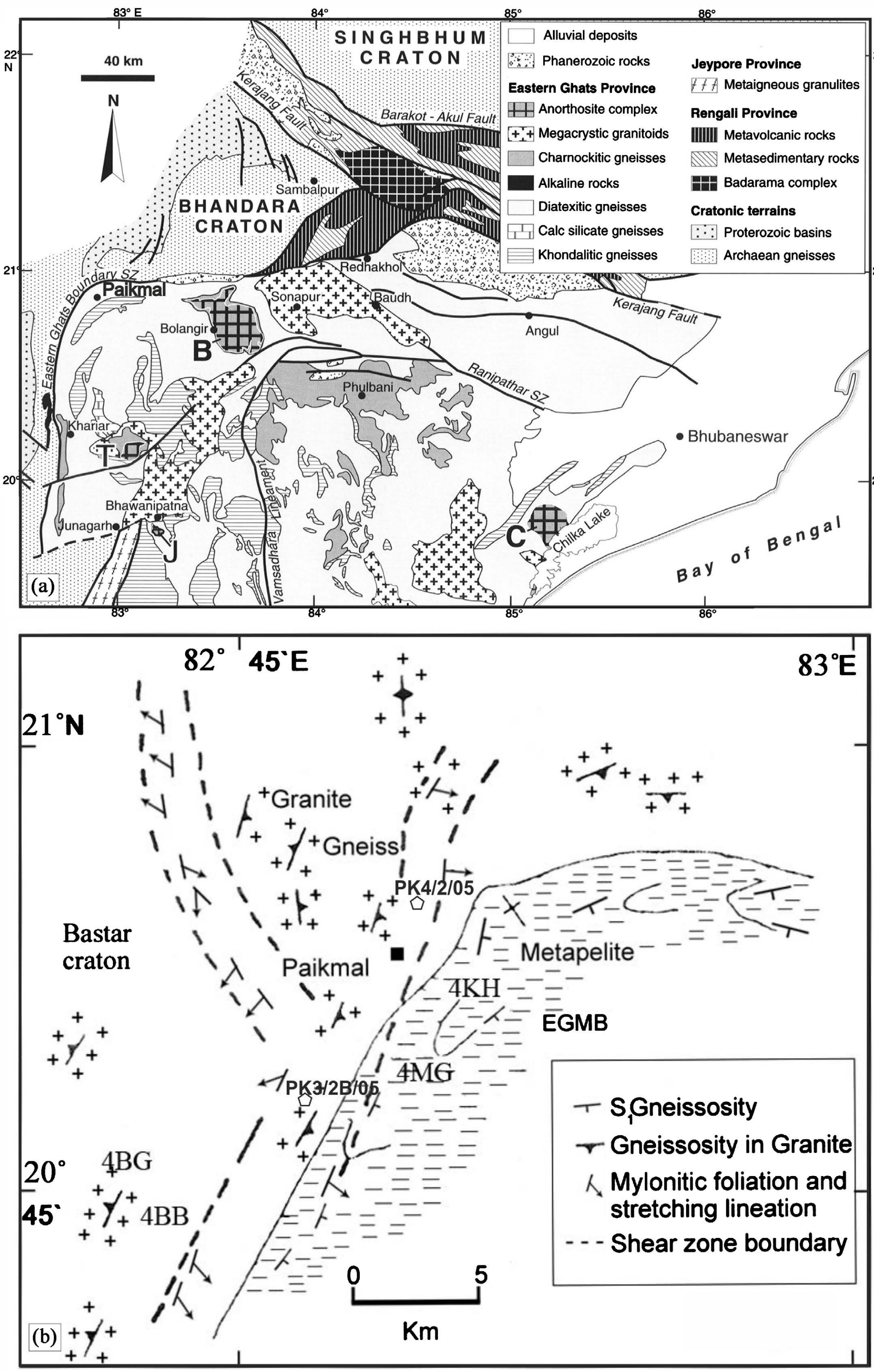


Figure 1. (a) Geological map of the northern part of Eastern Ghats Belt, after [14], with location of Paikmal inserted. (b) Geological map of the area around Paikmal, Odisha, modified after [21]. The analysed sample locations are given in the map.

compression [18]. Oblique collisional juxtaposition of the EGB against the Singhbhum and Bastar Cratons have also been described [20] [21] and was interpreted as a syntaxial bend during oblique collision of an indenter [22]. Complex tectonothermal records include ultra-high-temperature metamorphism, mostly represented by metapelitic migmatites [8] [9] [10] [23] [24]; dehydration melting in different crustal protoliths [10] [25] [26] [27] [28], and complex, possibly distinct P-T paths in different sectors [9] [11] [29] [30] [31]. Recent isotopic data, particularly, Nd-mapping has confirmed that different crustal domains or provinces with unrelated pre-metamorphic history are present in the EGB [14] [15] [18].

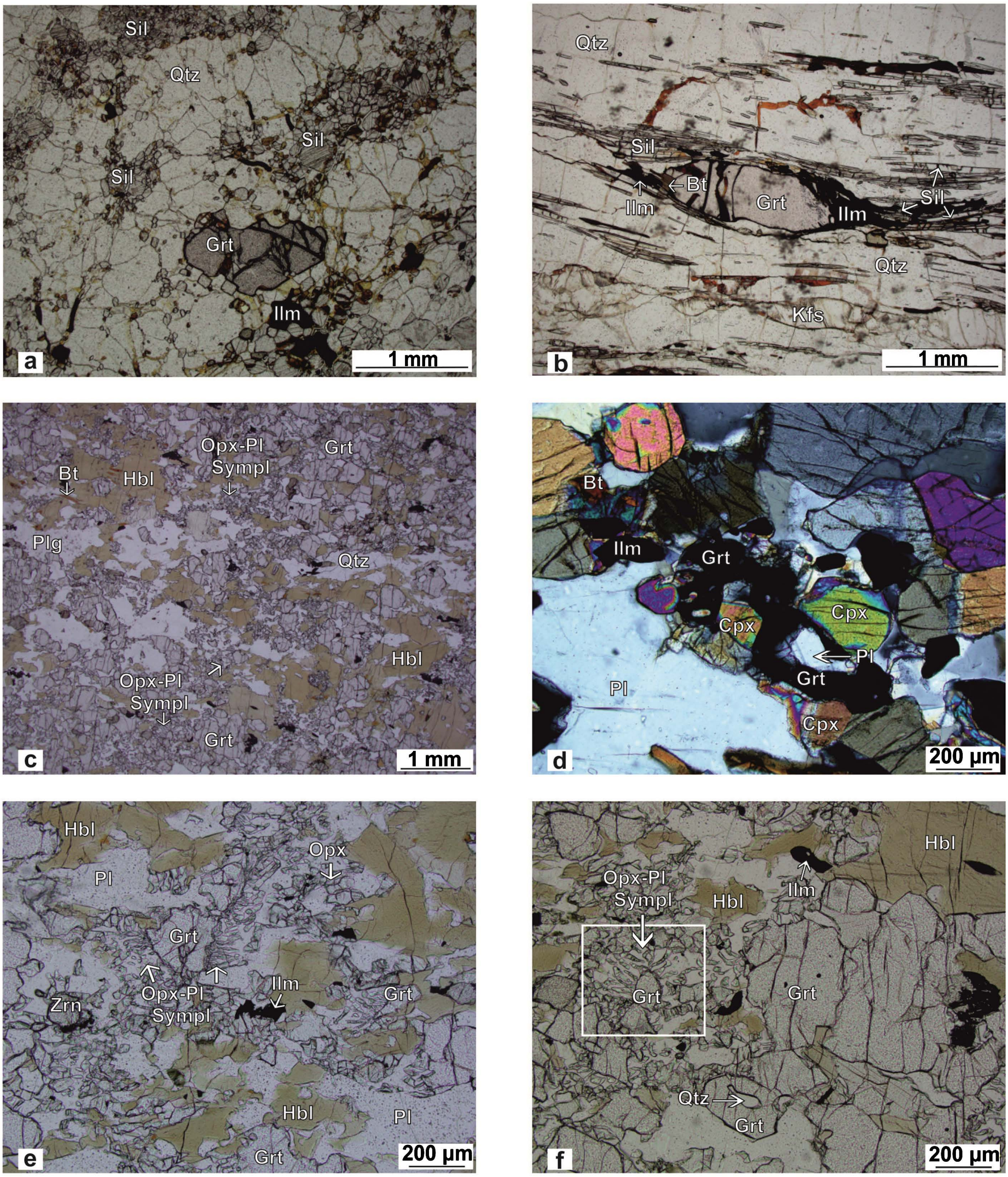
2.2. Study Area

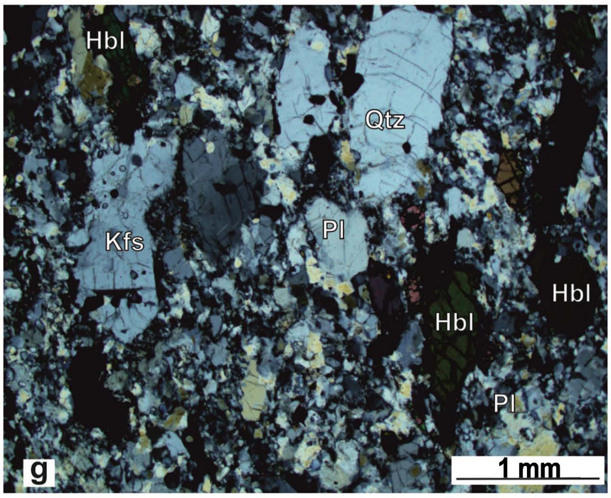
The present study area around Paikmal, at the northwestern margin of the EGB, belongs to the Western Khondalite Zone (WKZ) of [32] and EGP of [14]. The area exposes dominantly metapelitic granulites (khondalites), with minor bands of mafic granulites of the EGP and granite gneisses of the BC with some mafic enclaves [21]. The pervasive gneissosity in the metapelitic granulites and axial traces of F_2 folds describe a bend from E-W in the northeast to NNE-SSW in the southwest (**Figure 1(b)**). Besides the quartzite mylonites, mylonitic fabrics are also observed in metapelitic granulites in the boundary shear zone. The granitoids of the BC have a crude gneissosity, which is at a high angle to the boundary. [6] described microstructures and quartz C-axis fabrics, attesting to a high-temperature shear zone separating the craton from EGB. Also, the rocks of BC are affected by the shear deformation.

3. Petrological Background

The dominant rocks in this boundary region of the EGP are khondalites and have the assemblage: quartz-garnet-sillimanite-K-feldspar-ilmenite±rutile, with zircon as the main accessory mineral. Garnet-sillimanite and quartz-feldspar segregations define a foliation (**Figure 2(a)**), corresponding to the gneissic foliation in the field. This rock is represented by the sample 4KH, for geochronological analysis in the present study. The khondalite sample, PK4/2/05, occurs in the shear zone, has the same assemblage, but record reaction texture, ubiquitous presence of ilmenite rim on sigmoidal garnet and characteristic fibrous sillimanite growth along shear fabric (**Figure 2(b)**). This texture indicates the garnet breakdown reaction, garnet + rutile = sillimanite + ilmenite + quartz. Along the shear zone, this reaction texture (**Figure 2(b)**) strongly suggests decompression and tectonic exhumation. Petrologically the reaction was studied to quantify the degree of exhumation related to shear zone development. Other granulite lithological type, mafic granulite only occurs as minor bands in the khondalites and rare occurrence in the shear zone. The assemblage in this rock includes clinopyroxene, orthopyroxene, plagioclase, garnet, ilmenite±quartz and in the shear zone sample hornblende is present but is mostly secondary and define a crude alignment, probably representing the shear deformation (**Figure 2(c)**).

This sample displays reaction textures, namely, clinopyroxene + plagioclase = garnet + quartz and clinopyroxene-plagioclase-garnet triple point junction (Figure 2(d)). The sample, PK3/2B/05, occurs in the shear zone and displays reaction texture, namely, orthopyroxene-plagioclase symplectitic growth at garnet margin (Figure 2(e)) and on resorbed garnet (Figure 2(f)) in presence of





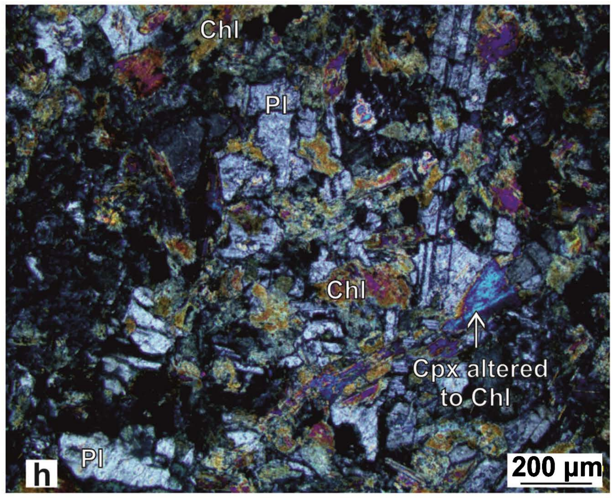


Figure 2. Photomicrographs: (a) garnet-sillimanite and quartz feldspar segregation define a foliation in khondalite, corresponds to the gnessic foliation. (b) Ilmenite rim and sillimanite at the margin of sigmoidal garnet and fibrous sillimanite representing the stretching lineation in khondalite in the shear zone and indicating reaction Grt + Rt = Sil + Ilm. (c) Secondary hornblende in mafic granulite in the shear zone defining a crude foliation. (d) Clinopyroxene-plagioclase-garnet triple point junction and garnet forming reaction texture; Cpx + Pl = Grt + Qtz in the mafic granulite interbanded with the khondalite. ((e), (f)) Orthopyroxene-plagioclase symplectitic growth at garnet margin (e) and on resorbed garnet (f) in mafic granulite in the shear zone, indicating reaction Grt + Qtz = Opx + Pl. (g) Granitic rock with overall granoblastic fabric; amphibole fish and recrystallized matrix show the effect of shear deformation. (h) The mafic enclave displays a relict subophitic texture with plagioclase and clinopyroxene (mostly altered to chlorite). Mineral abbreviations used after Kretz (1983).

quartz suggests the breakdown reaction: garnet + quartz = orthopyroxene + plagioclase, indicating decompression and tectonic exhumation, presumably at the time of shear zone development.

Two samples from the adjoining BC were used in this study. The granite sample, 4BG, is of granitic composition with the assemblage: K-feldspar-plagioclase-quartz-amphibole-opaque ± biotite and a granoblastic fabric and displays effect of the shear deformation, namely, amphibole fish and recrystallized matrix (Figure 2(g)). The mafic enclave sample, 4BB, is a retrogressed amphibolite with the assemblage: plagioclase-clinopyroxene (mostly altered to chlorite)-opaque and displays a relict subophitic texture (Figure 2(h)).

4. Mineral Chemistry

4.1. Analytical Procedure

The electron microprobe analyses (EPMA) were undertaken at the Geological Survey of India, Kolkata using CAMECA SX 100 machine. Operating conditions for the electron microprobe were 15 KV accelerating voltage, 0.2 nA sample current and 2 μm beam diameter.

4.2. Analytical Results

EPMA analytical data is given in Table 1. Pressure-temperature estimates for these equilibrations were derived using multi-equilibrium calculations [33]. P-T estimate for the mafic granulite outside the shear zone was reported as 9 Kbar,

Table 1. Mineral compositions in granulite suite, Paikmal, Eastern Ghats Province, India.

Rock	Mafic granulite in the shear zone			Khondalite in the shear zone	
Sample No	PK3/2B/05 (Figure 2(f))			PK4/2/05 (Figure 2(b))	
	Plagioclase	Garnet	Orthopyroxene	Garnet	Ilmenite
SiO_2	60.21	37.5	51.28	38.54	0.05
TiO_2	-	-	-	-	45.84
Al_2O_3	22.55	19.56	0.58	21.86	-
FeO	-	33.56	34.51	28.15	52.08
MnO	-	1.1	0.33	2.09	0.66
MgO	-	3.74	13.91	7.82	1.11
CaO	6.12	3.6	0.32	1.45	-
Na_2O	8.84	-	-	-	-
K_2O	0.15	-	-	-	-
Total	**97.88**	**99.03**	**100.95**	**100.06**	**99.74**
Si	2.74	3.05	2	2.99	-
Ti	-	-	-	-	0.99
Al	1.21	1.87	0.03	2	-
Fe^{2+}	-	2.28	1.13	1.83	0.96
Fe^{3+}	-	-	-	-	0.01
Mn	-	0.08	0.01	0.14	0.02
Mg	-	0.45	0.81	0.91	0.03
Ca	0.3	0.31	0.01	0.12	-
Na	0.78	-	-	-	-
K	0.01	-	-	-	-
Cat. total	**5.05**	**8.03**	**3.99**	**7.99**	**2.01**
P-T estimate	5.1 Kbar, at 600˚C			4.7 Kbar at 600˚C	

850˚C [6]. In the shear zone khondalite, using garnet-sillimanite-ilmenite-rutile barometer, pressure was estimated at ~4.7 kbar, at 600˚C; and in the mafic granulite using the garnet-orthopyroxene-plagioclase-quartz barometer, the estimated pressure is ~5.1 kbar at 600˚C. Hence, a minimum of 4 kbar exhumation (from 9 to 5 kbar) could be assigned to the shearing event. This comes out to around 15 km of exhumation.

5. Isotopic Study

5.1. Analytical Procedure

5.1.1. U-Pb Isotopes in Zircon and Monazite

The isotopic analyses were undertaken at the Geoscience Centre of Sao Paulo University, using a VG-354 multi-collector mass spectrometer (TIMS). For the

U-Pb analytical work, the measured ratios of the NBS982 standard were $^{204}Pb/^{206}Pb = 0.02732 \pm 0.00003$; $^{207}Pb/^{206}Pb = 0.46656 \pm 0.00003$ and $^{208}Pb/^{206}Pb = 0.99783 \pm 0.00005$. The laboratory blanks for the chemical procedure during the period of the analysis yielded maximum values of 15 pg for Pb and 2 pg for U. Details of the analytical procedure were the same as given in [11].

Lately, we have also undertaken in situ zircon geochronology by LAICPMS (Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry), at the Centre of Geoscience, University of Sao Paulo, Brazil. GJ-1 zircon reference standard was used for LAICPMS analysis. GJ-1 reference age, 608 ± 0.4 Ma [34] and GJ-1 concordia age during analysis was 605.6 ± 1.2 Ma. The detailed procedure is given in [35].

5.1.2. Whole Rock Rb-Sr

The measured ratio of $^{87}Sr/^{86}Sr$ obtained for NBS 987 standard was 0.710254 ± 22 (2σ) and the laboratory blank for the chemical procedure during the period of analysis yielded maximum value of 4 ng for Sr.

5.1.3. Whole Rock Sm-Nd

The measured ratio of $^{143}Nd/^{144}Nd$ obtained for La Jolla standard was 0.511857 ± 0.000046 (2σ) and the laboratory blanks for the chemical procedure during the period of analysis yielded maximum values of 0.4 ng for Nd and 0.7 ng for Sm.

5.1.4. K-Ar Isotopes

Analytical procedure as reported in [36].

5.2. Isotopic Results

U-Pb isotopic data for zircon and monazite in Khondalite (**Table 2**) by TIMS (Thermal Ionisation Mass Spectrometer) provide the following constraints on the time relation between granulite metamorphism and shear zone development, in this boundary shear zone. The three zircon fractions dated 948, 1036 & 1056 Ma could be interpreted as a long-lived thermal (granulite-formation) event, as reported by [24] from the different areas in the EGP. The two older populations, 1244 and 1355 Ma could represent partially modified detrital zircons [37]. Two monazite fractions dated 918 & 1096 Ma would further corroborate the long-lived thermal event. Monazite fraction dated 865 Ma on the other hand, could signify the beginning of the Rodinia break-up [38]. Monazite fraction dated 541 Ma, could represent the late Neoproterozoic thermal event in East Gondwana, which is believed to have been completely assembled by around 600 Ma [39]. It is important to note that though no extensive areas or rock suites of this age are recorded in the EGP, this Pan-African imprint only sporadically appears in several areas in the EGP [40], as also in this presentation and has no significance in the context of an orogenic event.

Zircon U-Pb isotopic analysis by LAICPMS is presented in **Table 3** and **Figure 3**. Here also, two zircon populations could easily be identified. Concordant zircon population of the Grenvillian orogeny ranges between 1040 & 920 Ma and

Table 2. U-Pb isotopic data for zircon and monazite by TIMS in Khondalite (4KH), Paikmal, Eastern Ghats Province, India.

Mineral	TIMS analytical data							
	Fraction	Pb (ppm)	U (ppm)	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$ (Ma)
Zircon	A	28.7	225.8	2730	0.133141 ± 71	1.29737 ± 79	0.070672 ± 19	948
	B	25.1	201.3	1081	0.124028 ± 66	1.26231 ± 72	0.073815 ± 15	1036
	C	39.3	245	265	0.131265 ± 67	1.48238 ± 102	0.081941 ± 38	1244
	D	35.3	256.9	1880	0.136477 ± 75	1.63236 ± 96	0.086745 ± 18	1355
	E	16.1	132.5	849	0.122159 ± 85	1.25556 ± 92	0.074544 ± 14	1056
Monazite	B	2637	2715	1885	0.145719 ± 67	1.3993 ± 65	0.069646 ± 48	918
	C	1633	1488	3530	0.133188 ± 65	1.24677 ± 63	0.067892 ± 101	865
	D	2103	2910	23900	0.157861 ± 73	1.65473 ± 76	0.076024 ± 38	1096
	F	1842	1914	1319	0.086651 ± 40	0.696368 ± 33	0.05831 ± 69	541

consistent with the long-lived UHT event in the EGP [24]. The Neoproterozoic population, however, could be further sub-divided into two age groups, namely, between 815 & 700 Ma and between 600 & 530 Ma respectively and this is consistent with 541 Ma monazite fraction, as recorded by TIMS analysis.

The whole rock Rb-Sr and Sm-Nd isotopic data for granulites and granites of this boundary region is presented in **Table 4**. It is interesting to note that some mafic granulites (4MG) are observed interbanded with the khondalites (4KH), away from the shear zone, similar to that recorded from Sunki area (cf. Figure 4(a) in [41]). Rb-Sr data in the Khondalite (4KH) indicated ~1.6 Ga Sr-model date. The Sr model date for khondalites in the EGP (including 4 KH) provide some constraints on the age of sedimentation [42]. Sm-Nd isotopic data for the interbanded mafic granulite (4MG), indicated mafic crust formation around 1.6 Ga.

As for the Paleoproterozoic provenance of the precursor khondalite sediments, the Nd-model date of the khondalite, 2.5 Ga and the dominantly granitic, but including some mafic rocks of the BC, as reported by [42], are also recorded from granite in this boundary region.

Secondary amphibole, aligned in the direction of extension (**Figure 2(c)**) provides 580 Ma cooling age (**Table 4**).

6. Discussion

The granitoids and mafic enclaves in the adjoining BC provide information on the Archaean cratonic evolutionary array between 3.0 Ga mafic magmatism and 2.5 Ga granitic batholiths, indicated here with Nd-model (crustal derivation) ages.

In this marginal segment of the EGP, magmatism and sedimentation at ~1.6 Ga indicated by Nd-model date and Sr-model date respectively, are indicative of

Table 3. U-Pb isotopic data for zircons by LAICPMS in Khondalite (4KH), Paikmal, Eastern Ghats Province, India.

Spot	Isotopic ratios and errors											Isotopic ages (Ga) and errors				Conc.
	Pb^{207}/U^{235}	1sigma	Pb^{206}/U^{238}	1 sigma	erro corr.	U^{238}/Pb^{206}	1 sigma	Pb^{207}/Pb^{206}	1 sigma	Pb^{208}/Pb^{206}	1 sigma	Pb^{206}/U^{238}	1 sigma	Pb^{207}/Pb^{206}	1 sigma	$\frac{Pb^{206}/U^{238}}{Pb^{207}/Pb^{206}}$
								(%)								
3.1	1.1276	0.0226	0.1225	0.0014	0.58	8.1640	0.0948	0.0662	0.0007	0.0963	0.0239	0.745	0.008	0.809	0.021	92
4.1	0.7404	0.0124	0.0907	0.0007	0.47	11.0209	0.0877	0.0600	0.0007	0.0439	0.0111	0.560	0.004	0.598	0.024	94
8.1	0.9936	0.0166	0.1136	0.0010	0.51	8.8023	0.0749	0.0639	0.0006	0.0606	0.0142	0.694	0.006	0.733	0.021	95
10.1	0.6757	0.0102	0.0842	0.0005	0.39	11.8774	0.0704	0.0580	0.0006	0.0583	0.0135	0.521	0.003	0.523	0.022	100
11.1	1.0847	0.0173	0.1224	0.0009	0.48	8.1692	0.0631	0.0647	0.0007	0.0366	0.0085	0.744	0.005	0.761	0.022	98
12.1	1.3229	0.0222	0.1377	0.0013	0.56	7.2614	0.0676	0.0684	0.0007	0.1300	0.0293	0.832	0.007	0.878	0.021	95
13.1	1.4326	0.0205	0.1496	0.0008	0.39	6.6861	0.0377	0.0700	0.0007	0.1339	0.0298	0.899	0.005	0.928	0.019	97
14.1	1.3530	0.0129	0.1424	0.0011	0.79	7.0206	0.0527	0.0697	0.0004	0.0487	0.0195	0.858	0.006	0.917	0.011	94
15.1	1.2761	0.0140	0.1353	0.0012	0.80	7.3925	0.0646	0.0686	0.0004	0.0462	0.0181	0.818	0.007	0.884	0.011	93
17.1	1.1721	0.0138	0.1294	0.0012	0.78	7.7308	0.0708	0.0655	0.0005	0.0939	0.0357	0.784	0.007	0.785	0.017	100
18.1	1.4086	0.0177	0.1487	0.0018	0.96	6.7262	0.0815	0.0695	0.0005	0.0349	0.0131	0.894	0.010	0.913	0.014	98
19.1	0.7966	0.0064	0.0968	0.0006	0.76	10.3324	0.0633	0.0602	0.0003	0.0566	0.0208	0.596	0.003	0.604	0.013	99
20.1	0.6891	0.0049	0.0864	0.0005	0.77	11.5755	0.0635	0.0577	0.0003	0.0104	0.0038	0.534	0.003	0.511	0.012	104
21.1	1.4750	0.0157	0.1540	0.0013	0.80	6.4950	0.0557	0.0700	0.0004	0.0467	0.0166	0.923	0.007	0.926	0.012	100
22.1	0.8105	0.0232	0.0977	0.0019	0.69	10.2337	0.2013	0.0604	0.0007	0.0353	0.0131	0.601	0.011	0.611	0.027	98
23.1	1.7660	0.0257	0.1738	0.0022	0.88	5.7541	0.0732	0.0749	0.0005	0.0690	0.0239	1.033	0.012	1.068	0.012	97
26.1	1.0940	0.0391	0.1277	0.0020	0.44	7.8307	0.1229	0.0655	0.0007	0.1020	0.0339	0.775	0.011	0.785	0.021	99

Table 4. Whole rock Rb-Sr, Sm-Nd and K-Ar isotopic data for granulites and granite-basalt of Bastar Craton around Paikmal, western boundary of Eastern Ghats Province, India.

Sample	Rock	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86} (X)	Error	Sr^{87}/Sr^{86} (Y)	Error	T(Ma) 1.42	Error Ri = 0.705	
4KH	Khondalite	117.0	50.9	6.755	0.078	0.864593	0.000117	1644.4	27.7	
		Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd$	Error	$^{143}Nd/^{144}Nd$	Error	$f_{Sm/Nd}$	$T_{DePaolo}$ (Ga)	$\square_{(0)}$
4KH	Khondalite	3.665	19.703	0.1125	0.0007	0.511381	0.000008	−0.43	2.5	−24.52
4MG	Mafic granulite	3.137	9.770	0.1941	0.0011	0.512835	0.000013	−0.01	1.6	3.85
4BG	Granite	8.885	52.49	0.1024	0.0006	0.510863	0.000009	−0.48	3.0	−34.63
4BB	Mafic enclave	1.621	6.425	0.1525	0.0004	0.512052	0.000012	−0.22	2.5	−11.42
		Material	K %	Error K%	Ar^{40}rad (10^{-6} cm^3 STP/g)		Ar^{40} Atm (%)		Age and error (Ma)	
PK 3/2B/05	Mafic Granulite	Amphibole	0.7778	1.3477	20.68		7.05		580.5 ± 15	

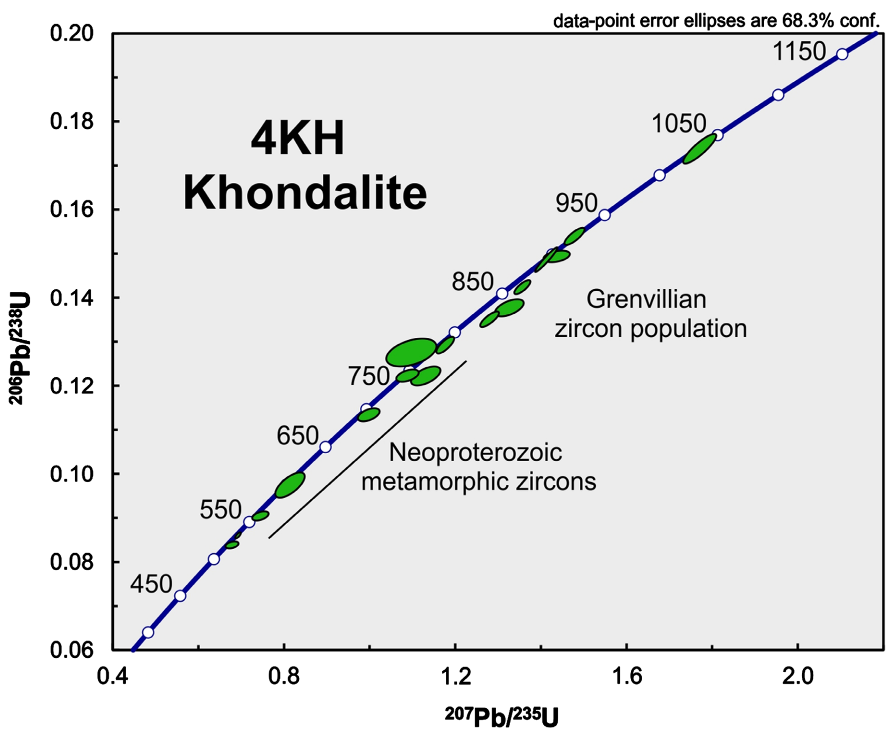


Figure 3. Zircon U-Pb Concordia plot for Khondalite sample 4KH.

the evolution of the volcano sedimentary basin, the most common record/feature of the Precambrian basins [43 and references therein].

The accretionary orogenesis between ~1100 and 918 Ma are represented by

U-Pb isotopic data for zircon and monazite in the khondalite of the EGB, recorded here is consistent with the long-lived thermal event reported from the Proterozoic EGP [24].

Monazite growth between 918 Ma and 865 Ma in the khondalite could represent the decompression, as recorded from the boundary shear zone rocks, khondalite and mafic granulite.

Between the end of the long-lived thermal event around 918 Ma and initiation of the Rodinia break-up around 865 Ma (zircon & monazite), a time gap of about 53 Ma was recorded in this boundary shear zone. Hence, the 15 km exhumation of the granulites in the shear zone, as revealed by petrological data in this report, could have occurred in 53 Ma. This, compared with 7 km exhumation in about 100 Ma in the core of the orogen, reported from Paderu [11], could signify relatively rapid exhumation and consistent with the model of extrusion tectonics [12].

The ~ 1600 Ma event as a significant world event involving sedimentation, magmatism, metamorphism and crustal anatexis, was reported from the SC in a review article [44]. From the EGB, ~ 1600 Ma sedimentation and magmatism in this boundary area, along with metamorphism and crustal anatexis reported from other areas [45] [46], demonstrate a similar nature of the event in the EGB, India.

7. Conclusions

1) Evolution of contrasting crustal pairs, BC segment and the marginal belt of the EGB indicated a shear zone development coeval with exhumation of deep crustal granulites.

2) Geochronological record reveals rapid exhumation consistent with extrusion tectonics.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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