Tectonic episodes in the basement of KG Basin

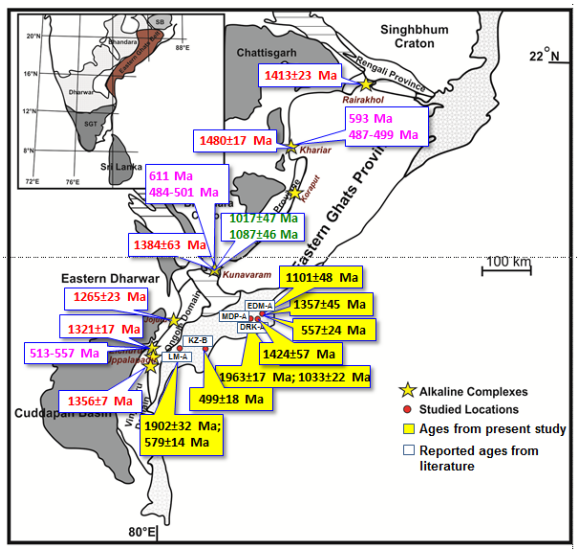

Fig. 3: Summary of obtained ages from the present study compared with reported ages

In the present study, charnockite samples were encountered in the basement of drilled well Lamellapadu-A, located towards the east in the Ongole Domain. (Fig. 3) The Sm-Nd whole-rock isochron age of these charnockite samples are determined to be 1902±32 Ma, indicating it to be the oldest charnockite body reported from the Ongole domain. The new age (~1.9 Ga) would constrain the upper limit of charnockite magmatism in the Southern EGB to be ~1.9 Ga, previously established as 1.7-1.6 Ga (Kovach et al., 2001; Dobmeier et al., 2006; Bhattacharya et al., 2014).

On similar lines, Upadhyay et al. (2006) reported khondalites in the EGB from Late Archaean/early Proterozoic–Mesoproterozoic provenances. Bhattacharya et al. (2013) reported several U-Pb and Pb-Pb ages of zircons from khondalites and other metapelites from north and central part of EGB, in which older detrital components define age peaks of 2499 Ma, 2470 Ma and 2340 Ma, with metamorphic overprinting during the Mesoproterozoic.

The present study reports a mid-Palaeoproterozoic protolith age for the khondalitic basement in the Eastern Ghats province through the Sm-Nd whole-rock isochron age of 1963±17 Ma encountered in garnet-sillimanite-gneissic core samples of well Mandapeta-A (Fig. 3).

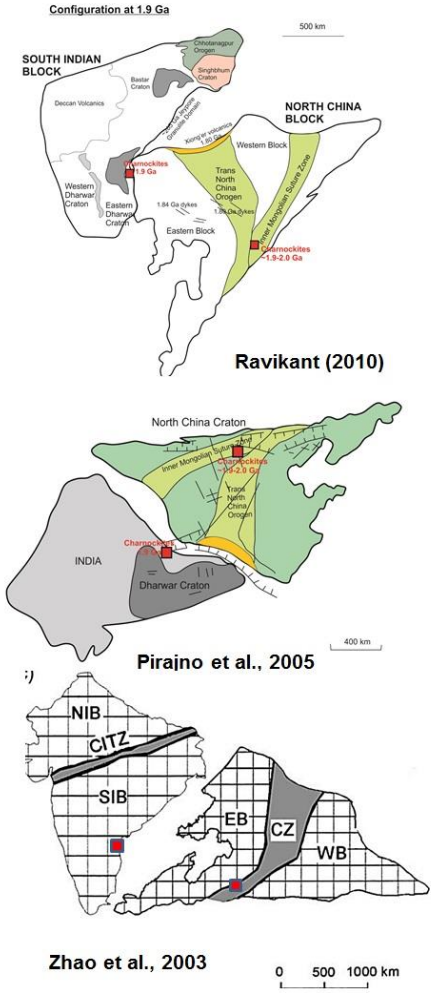

Fig. 4: Possible configurations of EGB-NCC prior to 1.9 Ga based on obtained ages of Charnockites and Khondalites in EGB

Charnockites and Khondalites of similar ages have also been reported in the North China Craton (NCC), from the Inner Mongolia Suture Zone (IMSZ) and the Trans-North China Orogen (TNCO) (ChunYan et al., 2007; Santosh et al., 2013). Zircons in the charnockites from the southern margin of Khondalite Belt fringing the UHT granulites in the IMSZ have been dated to be of 1932±24 Ma, whereas those from the charnockites to the western periphery of the TNCO have been dated to be 1.95-1.86 Ga. These charnockites have been associated with the UHT

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metamorphism in the IMSZ, dated to be ~1.9 Ga and ~1.92 Ga. These reported ages in corollary to the age of charnockites and khondalites from EGB could also be an indicative of a crustal configuration in which the Dharwar Craton was continuous with the North China Craton, as suggested by workers like Zhao et al. (2003), Pirajno et al. (2005) and Ravikant (2010) (Fig. 4).

Mesoproterozoic rifting at the cratonic margin and subsequent crustal evolution in the basement of KG Basin in EGB may be correlated to plate tectonic processes linked to the assembly and fragmentation of supercontinents in the past:

Tectonic-Tectonothermal episodes in the basement of KG Basin and links to Paleo-supercontinents- Pre-Rodinian Assembly:

The idea of a pre-Rodinian supercontinent was first postulated by Hoffman (1989) who furnished evidences that such a continent could have assembled in the period 2.0-1.8 Ga, which was later named Columbia by Rogers and Santosh (2002).

Though the detailed reconstruction of Columbia still remains a challenge, there is unequivocal evidence that the Mesoproterozoic Geology in many parts of the world is characterized by widespread continental rifting (1.5-1.2 Ga) and anorogenic magmatism possibly related to the breakup of a supercontinent (Upadhyay, 2008 and references therein). The opening of a Mesoproterozoic (~1.5-1.3 Ga) NE-SW trending rift at craton margin in southeastern India and the development of the Godavari-Pranhita rift as its likely aulocogen is similar to the 1.5-1.2 Ga ages of continental rifts associated with the final breakup of Columbia.

The ages obtained in the present study from wells Endamuru-A and Draksharama-A (1357±45 Ma and 1424±57 Ma, respectively) are consistent with the timing of alkaline magmatism associated with the Mesoproterozoic rifting in the KG Basin/EGB (1.5-1.3 Ga) (Fig. 5) and are correlatable with earlier reported ages (Mezger and Cosca, 1999; Upadhyay et al., 2006) from Khariar, Kunavaram, Elchuru, Jojuru and Uppalapadu alkalne complexes spanning the entire length of the craton-EGB contact.

The EGP in Rodinia–Corollary of a Wilson Cycle: Zhao et al. (2004) suggested that the final breakup of Columbia at about 1.3-1.2 Ga was immediately

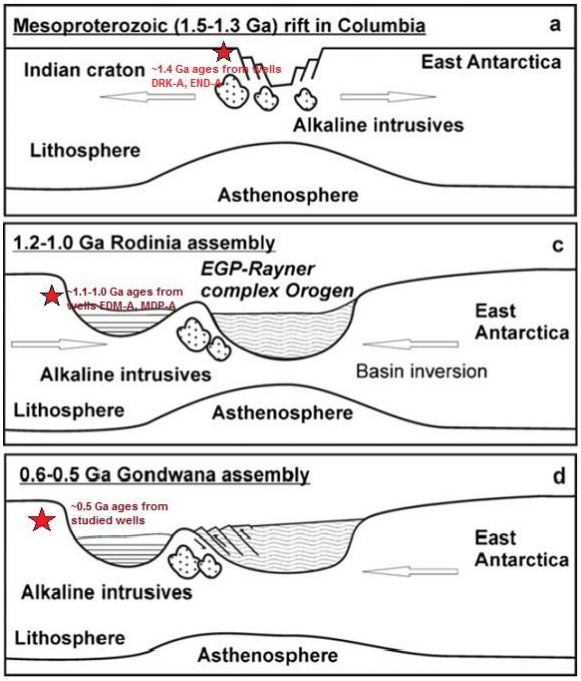

Fig. 5: Tectonic-tectonothermal events identified from the basement of KG Basin/EGB based on obtained ages

followed by the assembly of the supercontinent Rodinia along globally distributed Grenvillian orogens at ~1.0 Ga. The opening of the Mesoproterozoic rift between India and East Antarctica subsequent to the breakup of Columbia may have formed a large oceanic basin between the two where the sedimentary sequences of the EGP were deposited (Fig. 5).

This was followed by the inversion of the rift basin as a result of the collision between proto India and East Antarctica during the assembly of Rodinia. The collision formed the Grenvillian EGP-Rayner complex orogen where the EGP sediments and the rocks of the Rayner complex were deformed, metamorphosed and migmatized at granulite-facies condition (Upadhyay, 2008) (Fig. 5). The Mesoproterozoic rifting and the Grenvillian basin closure may thus represent a Wilson cycle (i.e. the

opening and closure of an ocean) related to the breakup of Columbia and the assembly of Rodinia.

The present study reports similar ages of metamorphism from the EGP, viz, 1100±31 Ma from well Endamuru-A and 1033±22 Ma from well Mandapeta-A, which are consistent with the age of high-grade granulite facies metamorphism during the Grenvillian event in Southeastern India and East Antarctica (Fig. 5).

Pan-African deformation and metamorphism of alkaline complexes: Gondwana Assembly: As a result of Pan-African tectonic movements during the assembly of Gondwana, the Grenvillian granulites of EGP were thrust westward over the Indian craton. The alkaline complexes and the other craton margin rocks were deformed and metamorphosed to amphibolite-facies condition during this event (Fig. 5).

New age data have suggested that high-grade metamorphism in some areas of East Antarctica and elsewhere in Gondwanaland is of late Neoproterozoic to Cambrian in age (Upadhyay, 2008). Since the EGB was juxtaposed against east Antarctica during Gondwana assembly, it must have been affected by Neoproterozoic-Cambrian events. Pan-African ages in the EGB rocks have been reported by different workers (Kovach et al., 1997; Mezger and Cosca, 1999; Simmat and Raith, 1998; Upadhyay, 2008 and references therein). Present study also reports several Pan-African ages in the studied core samples from wells Endamuru-A (557±24 Ma), Lamellapadu-A (579±14 Ma) and Kaza-B (499±18 Ma), indicating that the Pan-African thermal imprint has affected the basement of KG Basin as well, concealed under the phanerozoic cover, yet played an important part in the basement configuration during westward thrusting and deformation of EGP rocks during the Gondwana assembly.

Conclusions

In the present study, Precambrian basement from five wells of KG Onshore was attempted for Geochronological studies through Rb-Sr and Sm-Nd dating, which provided following important geochronological constraints in the area covered by alluvium, in terms of tectonic and tectonothermal episodes in the basement of KG Basin and by analogy, the Eastern Ghats Belt:

1. The 1902±32 Ma age of the charnockitic basement from well Lamellapadu-A and 1963±17 Ma age of the khondalitic basement from well Mandapeta-A, can be correlated with contemporaneous charnockite and khondalite emplacements in the Inner Mongolian Suture Zone (IMSZ) and the Trans-North China Orogen (TNCO), in the North China craton, which has been proposed to be the part of a supercontinent along with south Indian Cratons prior to 1.9 Ga.
2. Mesoproterozoic emplacement ages, 1424±57 Ma and 1357±45 Ma obtained from the basements of wells Draksharama-A and Endamuru-A, respectively, represent the timing of alkaline magmatism during 1.5–1.2 Ga in the EGB/KG basement, subsequent to the rifting of Southern India–Antarctica during the Mesoproterozoic.
3. Later stage metamorphic imprint ages determined from the basement of KG Basin, around ~1100 Ma from wells Endamuru-A and Mandapeta-A, and of around ~500 Ma from wells Lamellapadu-A, Endamuru-A and Kaza-B, represents closing of the oceanic basin during amalgamation of south India–Antarctica due to Rodinia assembly (Grenvillian tectonothermal event, ~1.1–1.0 Ga), and Gondwana assembly during Pan-African event (~0.6–0.5 Ga), respectively.

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