Evidence of high pressure metamorphism along the Mahanadi Shear Zone in the Eastern Ghats Province, eastern India: Implications on tectonics and continental assembly involving India and East Antarctica

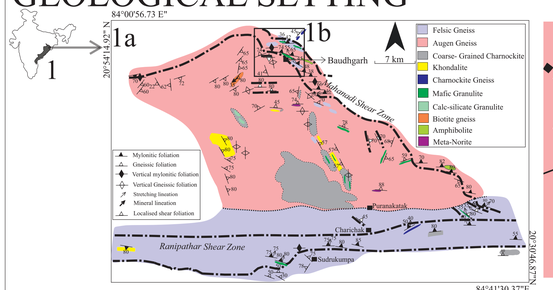
Shuvankar Karmakar[1], Sankar Bose[1], Gautam Ghosh[1], Nilanjana Sorcar[2], Sneha Mukherjee[2], Kaushik Das[3]

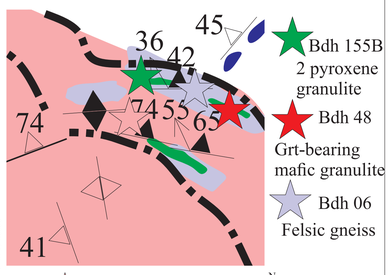
[1]Department of Geology, Presidency University, Kolkata-700073; [2]National Centre for Earth Science Studies, Thiruvananthapuram, India, 695011; [3] Department of Earth and Planetary Systems Science, Hiroshima University, Japan - 7398526

THE PROBLEM

- Eastern Ghats Province (EGP) is a crucial link between India and East Antarctica for Proterozoic reconstruction of Rodinia. The metamorphic events occured at ~ 1000-900 Ma.
- EGP is argued to be constituted of several crustal domains with suspected boundaries marked by shear zones. However, there is no difference in metamorphic history among the reported domains. So, the question is whether the shear zones are terrane boundaries or intra crustal in nature.
- The present work focuses on Mahanadi Shear Zone (MSZ) which seperates two crustal domains, Angul and Phulbani of EGP. It is to be tested whether MSZ played an important role of a terrane boundary.

GEOLOGICAL SETTING





The study area lies around Boudh town, Odisha, India. The WNW - ESE trending Mahanadi Shear Zone seperates Phulbani domain from Angul domain, EGP. The dominant rock types is augen gneiss with enclaves of felsic gneiss and different types of mafic granulites.

Average mylonitic foliation is 278/37N (n=66) and stretching lineation is plunging 29° towards 330° (n=52) (Fig. 1c).

PETROLOGY

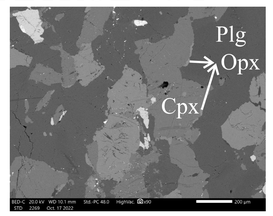


Fig.3A:Cpx is breaking down to Opx within 2-pyroxene granulite

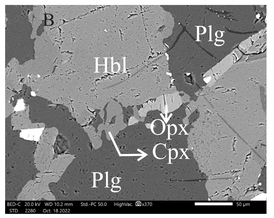


Fig.3B: Hbl is breaking down to Cpx and Opx within 2-pyroxene granulite

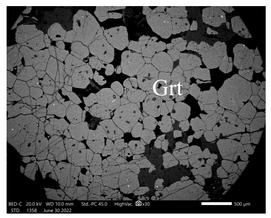


Fig.3C: Layer of Grt within Grt-bearing mafic granulite

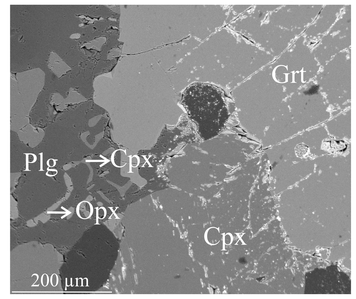


Fig 3D: Coarse Grt is breaking down to Cpx±Opx+Plg

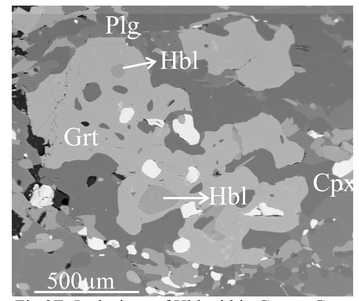


Fig 3E: Inclusions of Hbl within Coarse Grt

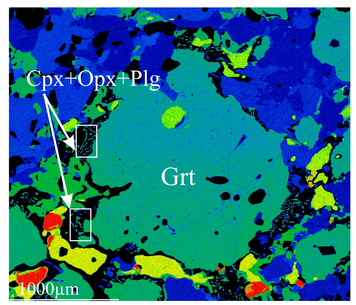


Fig. 3F: Fe map of Grt-bearing mafic granulite.

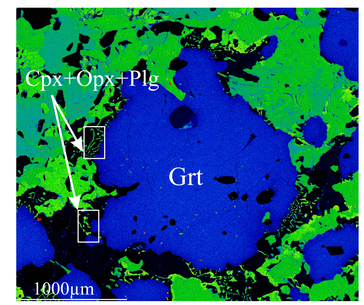
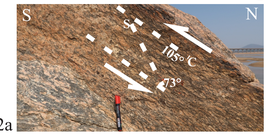


Fig. 3G: Mg map of Grt-bearing mafic granulite.

Sequence of Reactions:

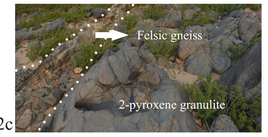
1. Hbl + Plg = Grt + Cpx + Melt (Fig.3E), Hbl dehydration melting form peak assemlage.
2. Grt + Qtz = Cpx ± Opx + Plg (Fig. 3D) Symplectite formed during exhumation
3. Cpx + Opx + Plg + melt = Hbl + Qtz (Fig. 3A, during cooling)
4. Hbl + Qtz = Cpx + Opx + Plg + melt (Fig. 3B, reheating)

FIELD RELATIONS

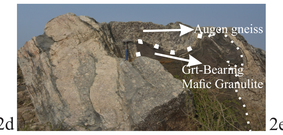


2a

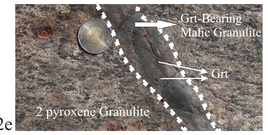
2b



2c



2d



2e

Augen gneiss: Qtz+Plg+Kfs+Grt+Ilm +Hbl+Bt
Felsic gneiss: Qtz+Kfs+Plg+Grt+Rt+ Ms+Ilm+Bt
2pyroxene granulite: Opx+Plg+Cpx+ Bt+Ilm±Qtz
Grt-bearing mafic granulite: Grt+Cpx +Plg+Qtz+Ilm+Hbl+Bt+Opx

The shear sense (S-C fabric; Fig. 2a) from the mylonitized augen gneiss indicates a top-to-the south movement in MSZ with steep to gently N-NW plunging stretching lineation. (Fig. 2b). Detail thermochronometric studies were done from four samples, details of which are given in earlier sections. 2-pyroxene granulite occur as lenses and small enclaves within mylonitized felsic gneiss (Fig. 2c). Grt-bearing mafic granulites occur as enclaves within mylonitized augen gneiss and 2-pyroxene granulite (Fig. 2d & 2e).

GEOTHEROBAROMETRIC CALCULATIONS & PHASE DIAGRAM MODELLING

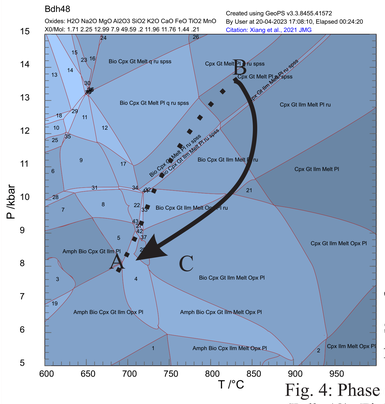


Fig. 4: Phase diagram of Grt-bearing mafic granulite (Bdh 48). Field for numerical values are not presented for clarity.

The reaction sequence has been traced on a phase diagram showing 3 anchor points. **Point A**: Prograde stage. **Point B**: Peak P & T calculated from Coasre Grt+Cpx+Plg+Qtz:**14-12 Kbar** & **760°-840°C.** **Point C**: Cooling stage form garnet corona and hbl. P &T from Coarse Grt rim along with Grt+Cpx+Plg & Symplectite Cpx+Plg±Opx:**8-9 Kbar** & **700°-750°C**.

The overall P-T path is **clockwise** which suggesting decompression (ΔP = 6 Kbar) result from exhumation of about 20km.

GEOCHRONOLOGY

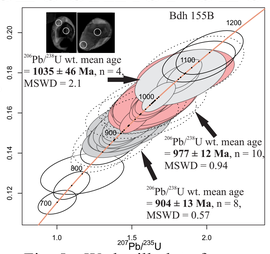


Fig. 5a: Wetherill plot of analyzed zircon from 2-pyroxene granulite

ca.1035 Ma- inherited age
ca. 977 Ma- crystallization age
ca. 904 Ma- cooling age

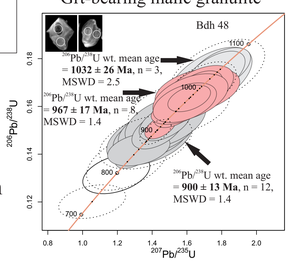


Fig. 5b: Wetherill plot of analyzed zircon from Grt-bearing mafic granulite

ca.1032 Ma- inherited age
ca. 967 Ma- crystallization age
ca. 900 Ma- cooling age

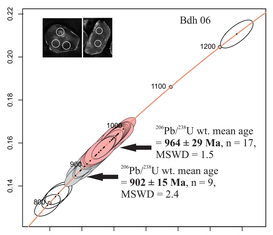


Fig. 5c: Wetherill plot of analyzed zircon from felsic gneiss

ca. 964 Ma- crystallization age
ca. 902 Ma- cooling age

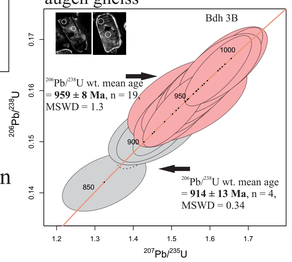


Fig. 5d: Wetherill plot of analyzed zircon from augen gneiss

ca. 959 Ma- crystallization age
ca. 914 Ma- cooling age

DISCUSSION AND CONCLUSION

- Evidence of high pressure (**14-12 Kbar & 760°-840°C)** metamorphisrm reported first time from MSZ which seperates the two domains of EGP.
- Structural data suggests that Angul domain is thrusted over Phulbani domain which caused lower part of Phulbani domain to go down to 14 kbar and exhume up to 8kbar. So, about 20 km tectonic exhumation was caused due to collision (Fig.6.).
- Whether the Angul domain was attached to a part of Prydz Bay, East Antarctica is debated, but Phulbani domain was an intergral part of EGP.
- Our results prove that MSZ acted as an important terrane boundary juxtaposing India (Phulbani domain) and East Antarctica (Angul domain) during ~ 950 - 900 Ma. The mafic rocks of the MSZ bear the evidence of fossilized suture zone of this terrane accretion and collision.

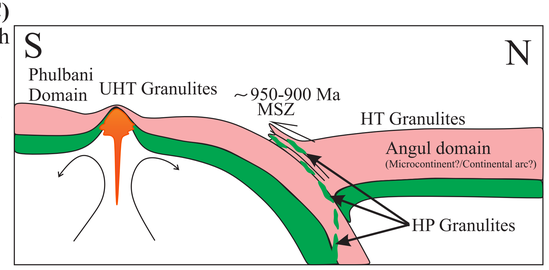


Fig.6: Schematic tectonic model diagram of the evoluiton of MSZ

Acknowledgement: Thanks to **CSIR-India** for providing the fund for research to SK.

QR Code: