EVOLUTION OF GRANULITE BLOCKS OF SOUTHERN INDIA*

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EXTENDED ABSTRACT

The author is grateful to the Geological Society of India for inviting him to deliver the Professor T.N. Muthuswami Endowment lecture for this year. This honour is of great importance to the author as Prof. Muthuswami was the first to describe sapphirine from Ganguvarpatti, Madurai in 1949, in Proceedings of Indian Academy of Sciences (vol.3) and the importance of the assemblages in 1957. In recent years, sapphirine bearing assemblages have been reported from a number of localities in Tamil Nadu, Eastern Ghat Belt, Southern Madagascar and East Antarctica. Sapphirine bearing assemblages (sapphirine+quartz and quartz absent assemblages) are considered synonymous with high temperature to ultra high temperature granulite grade metamorphism. These assemblages occur most commonly in terrains which have witnessed 550 Ma Pan-African tectono-thermal event world-wide. It is interesting to note that the term coined by Kennedy in 1957 now has assumed significance globally and is associated with rapid decompression or exhumation events. Delamination of the Thermal Boundary Layer (TBL) at 550 Ma or rift type environments are associated with this event.

As originally pointed out by Radhakrishna and Naqvi (1986), the existence of Early Proterozoic, Mid Proterozoic (Eastern Ghat Belt) and Late Proterozoic (550 Ma) mobile belts of granulite grade metamorphism is now accepted. We now use the term blocks and the topic of interest is not so much on how they have formed but how they have been brought together or accreted based on the concept of terrain assembly.

It is now generally accepted that the Early Proterozoic granulite belt of 2510 Ma comprising of Coorg-BR Hills-Nilgiris-Shevaroys-Madras formed during fluid present conditions on the involvement of hyper-saline fluids emanating from underplated basalts of alternative affinity. The CO_2 part of these fluids was left behind, as they have no great wetting abilities with quartz, in the lower continental crust, converted the lower crustal rocks to granulite (charnockites) and the NaCl, KCl bearing fluids surged upwards resulting in the formation of granitoids.

550 Ma old Southern Granulite Terrain

The granulite blocks, well south of the broad Palghat-Cauvery shear zone, bounded by the lineament extending from north of Anaimalai-Kodaikanal-Kodavur and onto Karur towards the northeast are dealt with in detail. The entire terrain south of Anaimalai-Kodaikanal, which includes the Madurai block, Cardomum hill ranges and the Kerala Khondalite Belts have witnessed the dominant 500 Ma old granulite event. The lithologies are also similar comprising charnockites, basic granulite bodies and meta-sedimentary swathes of quartzites, pelites and calc-silicate assemblages. This sedimentary association dominated by pelites (often Mg-rich) is distinct from that of the Dharwar supracrustals with almost total absence of BIF. These supracrustal units of the SGT have affinities with continental marginal basin sediments. This factor distinguishes the 550 Ma old SGT from Dharwars and lithologies north of broad Palghat-Cauvery Shear Zone.

Sapphirine Bearing Assemblages

After the first discovery of sapphirine by Muthuswami in Ganguvarpatti, numerous occurrences have been reported from Kiranur, Panrimalai, Perumal Malai, Kambam and Rajapalaiyam localities. Most of them cluster around the deep seated Kambam lineament, which hosts carbonatite-alkaline gabbro-syenite and alkali granites. Pelites of the 550 Ma old southern granulites range from: (a) Garnet-sillimanite-K-feldspar-biotite-plagioclase-quartz gneisses; (b) Garnet-cordierite-orthopyroxene-sillimanite-perthitic K-feldspar-plagioclase-quartz-graphite; (c) Garnet-sapphirine-cordierite-orthopyroxene-sillimanite-perthitic K-feldspar-plagioclase±prismatine; (d) Sapphirine-plagioclase intergrowths as specks in garnet bearing bodies close to pelitic enclaves.

The sapphirine bearing assemblages have been attracting the attention of petrologists, the world over, because of their associated assemblages like orthopyroxene-sillimanite-quartz-garnet-sapphirine and garnet-cordierite-ortho-pyroxene associations which generally form at high

Prof. T.N. Muthuswami Endowment lecture delivered at the Geological Society of India, Bangalore on 23 May 2002.

temperatures ranging between 850°C to 1050°C at pressures from 9 to 5 Kbars, indicating rapid decompression.

Correlation with Madagascar and East Antarctica

More than the metamorphic history, there is a tendency to correlate the different regions which host sapphirine bearing assemblages, with that of Madagascar and East Antarctica. Sapphirine bearing associations are quite common in several localities in Madagascar and in the Rayner and Lutz-Holm Bay complex of East Antarctica. Based on the assemblages and similar lithologies and grade of metamorphism not only correlations have been made but also a contiguity has been established. The established ones are the continuity of the 550 Ma old southern granulite terrain with that of southern Madagascar, south of the Ranotsara shear zone (Janardhan, 1999) and that of the Eastern Ghats with that of Rayner Complex and Lutz-Holm Bay (Mezger and Cosca, 1999).

Though there is a good fit between Southern Madagascar and 550 Ma old Southern Granulite Terrain, north of Madagascar the occurrence of Itremo sequence consisting of pelites and calc-silicate sequences of amphibolite grade intruded by 780 Ma old subduction zone related calc-alkaline granitoids make the correlation difficult. These sequences correlate well with that of Aravallis and Malani sequences of Rajasthan and recent publications by Ashwal and his group (Torsvi et al. 2001) have indeed established a connection between the Rajasthan lithologies via Seychelles. Recently, Janardhan and Srikarni (2002) have described pelitic assemblages, sapphirine bearing assemblages from Mt. Abu-Balaram area about 60 km south of Udaipur. This can be correlated with the sapphirine bearing occurrence in northern Madagascar. The age of these sequence is still to be established, with the only constraint being the age of Mt. Abu granite intrusion which has been dated to be around 830 Ma. This occurrence is also close to the Phulad lineament.

The India-Madagascar connection is important from the point of gold mineralisation and that of graphite deposits. In Madagascar, gold is mined only on a local scale along the major shear zones and we have a similar situation in India as well. Further, the role of Marion hotspot activity assumes great significance. Marion plume and its extrusives have been dated to be 88±2 Ma old. It is of significance that the St. Mary Island enclaves, just west of Mangalore have also been dated to be around 91 Ma old (Torsvik et al. 2000). Thus it can be confidently stated that Madagascar was lying close to the southern India and connection established via Seychelles to Kutch/Gujarat. Our finding of sapphirine bearing assemblages associated with charnockites in a way firms up the connection.

Importance of 550 Ma Old Granulite Massif/Belt and Placer Deposits

It is well known that the beaches of southern most India all along the southern Kerala, southern Tamil Nadu and along the beaches of Gopalpura are rich in placer deposits which host monazite, rutile, ilmenite, zircon and garnet. It is also known that India hosts 26% of the world placer deposits in these minerals, particularly in Ti-bearing minerals. However, it should be stated that only a small part of these deposits are being exploited. Monazite mining is under the Atomic Minerals Division which has its own plant. In recent years there has been a great deal of activity in garnet exploitation.

It is of great significance that at least in India these deposits are mostly associated with granulite grade charnockite/khondalite belts. This is true of southern India and Orissa beaches. This connection has to be established more firmly.

Uplift of the Southern Granulite Blocks

It is well established that the 2500 Ma old granulite blocks viz. the Nilgiris and the Shevaroys are bounded by lineament like that of Moyar, Bhavani and the Shevaroy/ Yercaud, whilst the granulite terrain of the 550 Ma are dissected by lineaments. Marion hotspot activity of 90 Ma must have played a key role in the uplift of these granulite blocks. Neotectonic activity has indeed played a role in the uplift.

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