Japan Geoscience Union Meeting 2015
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SMP09-01 Room:201A Time:May 27 09:00-09:30

Extreme metamorphism, geodynamic regimes and supercontinent cycles

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This work is part of a larger project to use the geological record of magmatism and metamorphism to develop hypotheses about geodynamics that may be tested using numerical models. Apparent thermal gradients of metamorphism, as recorded by close-to-peak mineral assemblages, retrieved from rocks equilibrated at high P, P–T or T, for which the timing is obtained from various chronometers, may be used be interrogate the rock record to assess secular change in the apparent thermal gradients of metamorphism. One-sided subduction creates asymmetry in the thermal structure of convergent plate margins, with lower dT/dP in the subduction zone and higher dT/dP in the orogenic hinterland. During collisional orogenesis these distinct thermal environments are imprinted in the rock record as contrasting types of metamorphism. Proterozoic orogens record eclogite–HP granulite (E-HPG) metamorphism, with gradients of 350–750C/GPa, and granulite–UHT metamorphism, with gradients of 750–1500C/GPa. By contrast, Phanerozoic orogens register UHP metamorphism with strikingly lower gradients of 150–350C/GPa, and UHP metamorphism is the defining feature of Phanerozoic collisional orogenesis in Eurasia. What is the change in geodynamics recorded by these data?

For contemporary conditions, geodynamic modeling of collisional orogenesis shows that slab breakoff occurs at depths >300 km; strong lower crust results in coupled collision with UHP metamorphism, whereas weak lower crust results in decoupled collision with only E-HPG metamorphism. Increasing the ambient mantle temperature by 80–100C leads to shallow slab breakoff (<200 km) and unconventional modes of collision, viz a truncated hot collision regime (strong lower crust) and a two-sided hot collision regime (weak lower crust). Inverting these data, as ambient mantle temperature declined to <100C warmer than the present day the change to deeper slab breakoff generated a colder environment and enabled stronger crust?mantle coupling that allowed subduction of continental rocks to mantle depths. Thus, the appearance of UHP metamorphism is inferred to be a consequence of secular decrease in ambient mantle temperature. By contrast, granulite facies and UHT metamorphism in central East Gondwana likely represents deep crust metamorphosed under a large, moderately thick orogenic plateau that formed as a result of Ediacaran collision and hinterland thickening, with radiogenic heating generating peak metamorphic temperatures in the Cambrian. It may be no coincidence that Gondwana could have been located over the African LLSVP at the dawn of the Phanerozoic or that the first UHP belts had a subduction polarity broadly towards the core of East Gondwana.

The Ediacaran–Cambrian witnessed a change in the style of continental breakup and aggregation. In a Hoffman breakup, continental lithosphere fragments, disperses and reassembles by elimination of the complementary superocean (e.g. the process by which the Gondwanan elements of Rodinia were transformed into Gondwana). By contrast, in a Wilson cycle sensu stricto, continental lithosphere simply fragments and reassembles along the same (internal) contacts, closing an internally generated ocean basin (e.g. the transformation from Pannotia to Pangea). Internally generated ocean basins were opened and closed asymmetrically by rifting of ribbon terranes from the northern margin of Gondwana and their accretion to Laurentia, Baltica and Siberia forming the Caledonides, Variscides and Altaides, as reflected in the Cambrian to Triassic record of metamorphism. The change was also registered by multiple geochemical indices, such as epsilon Hf(t) and 87Sr/86Sr, with complex temporal records characterized by short wavelength variations that reflect the overlapping opening and closure of several major oceans (Iapetus, Rheic, Paleotethys and Neotethys). This pattern is superimposed on a simpler long wavelength variation that is temporally related to the supercontinent cycle.

Keywords: ultrahigh-temperature metamorphism, eclogite–high-pressure granulite metamorphism, ultrahigh-pressure metamorphism, geodynamic regimes, supercontinent cycles, Hoffman breakups and Wilson cycles

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SMP09-02 Room:201A Time:May 27 09:30-09:45

Tectono-metamorphic evolution during Asian continental growth

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In E- and SE-Asia, there are at least six micro-continental blocks of North China, South China, Indochina, Shanthai, Sibumasu and West Burma from NE to SW. Geological Research program to realize the tectono-metamorphic processes in continental collision zones of E- and SE-Asia has been done for the last decade. During the processes, the following new evidences were identified especially in Vietnam and related areas; 1) findings of UHT (˜1000 C) pelitic granulites, UHP (˜40 kbar) Dia-bearing eclogitic rocks and HP/MT gneisses from the Kontum Massif, 2) LT eclogite and HP granulite from the Song Ma suture zone, and 3) UHT/extremely-HP aluminous metamorphic rocks from the Red River zone. Estimated P-T conditions and reaction textures from these rocks delineate a characteristic clockwise P-T-t path for each other, which generally represent a collision zone metamorphism (Osanai et al., 2004; Nakano et al., 2008, 2009, 2013).

A simultaneous collision metamorphism throughout Vietnam should have taken place during the continental collision between Indochina and South China blocks, which led to the formation of the Trans Vietnam Orogenic Belt (TVOB: Osanai et al., 2008). Northern extension of the TVOB reaches up to Cangshan Mountains in Yunnan Province, near Dali, through the Ailaoshan terrane in China and tapers off caused by the final Indian sub-continent collision and large crustal deformation during Eocene time. Permo-Triassic metamorphic and granitic rocks in SW Borneo are considered as the southern extension of the TVOB, which would be separated by the South China Sea opening during Cenozoic. Pre-collisional low-grade metamorphic and plutonic rocks of Devonian age (400˜Ma) also distribute in the TVOB as large blocks surrounded by shear zones.

The metamorphic rocks from the Nujiang-Kachin area in Yunnan Province and Myanmar, and the Inthanon-Hua Hin area in Thailand indicate low-pressure metamorphic field gradients with low-pressure clockwise P-T evolution processes, which show a different evolution process to the TVOB (Yonemura et al., 2013). They situate in the continental collision boundary between the Shanthai and Sibumasu blocks. Newly determined LA-ICP-MS dating indicates a middle Triassic (220-200 Ma) collision metamorphism for the Nujiang-Kachin and Inthanon-Hua Hin areas. The LTHP (blueschist) and amphibolite-facies metamorphic rocks from the collision zone between Indochina and Shanthai blocks, which are Cangshan-Simao area in Yunnan Province and Rayong area in Thailand, also show a Permo-Triassic metamorphic age and a clockwise P-T evolution.

The metamorphic rocks from the Mongolian Altai Mountains in the Central Asian Orogenic Belt (CAOB: Sengor et al., 1993) show Devonian to Early Permian (ca. 350 Ma and ca. 260 Ma) collision metamorphic event. On the other hand the rocks from the Lake Zone in west-central Mongolia indicate Cambrian (ca. 500 Ma) metamorphism. Therefore the multiple collision zone metamorphism and related orogen to form the Asian Continent would have taken place from N (southern margin of Siberian Craton) to S and SW, and the collided blocks in SE-Asia were finally deformed and converged in the Sanjiang region by the Indian sub-continent collision at Eocene.

Keywords: Asian continent, micro-continent collision, collision metamorphism, extreme metamorphism, zircon U-Pb age

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SMP09-03 Room:201A Time:May 27 09:45-10:00

Metamorphosed bauxites from the Red River Shear zone, northern Vietnam: inferences and geological significance

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Aluminous metamorphic rocks from the Red River Shear zone in northern Vietnam were investigated in this study. The shear zone has abundant pelitic rocks that have been formed under sillimanite-grade metamorphic condition at the Paleogene period. The aluminous rocks are mainly divided into high-grade (garnet-sillimanite-corundum, garnet-sillimanite-spinel, garnet-corundum-spinel rocks) and low-grade (kyanite-corundum-hematite-phengite rock) rocks and both types show similar whole rock chemical composition with basaltic to andesitic bauxites. Detailed petrographical observations, the high-grade metamorphosed bauxites have experienced prograde stage more than 2.0 GPa at 800 C (based on the assemblage of staurolite + kyanite + rutile + siderite in garnet). The low-grade bauxite preserves the peak condition at 500 C and pressure more than 1.2 GPa (based on the assemblage of hematite + corundum + rutile + phengite + allanite + chloritoid + kyanite in the matrix). Because bauxite commonly formed at the surface on the continent, such high-pressure metamorphic conditions from the metamorphosed bauxites suggest continent-continent collision and its subduction.

Zircon grains in garnet-sillimanite-corundum rock show several U-Pb ages from 265 Ma to 36 Ma may due to the loss of Pb during shearing and/or thermal event at the Paleogene time. However, dark luminescent zircon cores show concordia age of 257 +/- 8 Ma. The zircon cores contain CO2 rich fluid inclusions and the density is similar to other CO2 rich fluid inclusions trapped in garnet, corundum, and staurolite. Therefore, we conclude that the high-pressure metamorphism has occurred at the Late Permian that should have strong relation to continental collision between the Indochina and South China cratons.

Keywords: metamorphosed bauxite, continental collision, Red River Shear zone, Vietnam

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SMP09-04 Room:201A Time:May 27 10:00-10:15

Duration of low-P/T type metamorphism and zircon/garnet REE partitioning in migmatites, Ryoke metamorphic belt, Japan

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Duration of low-pressure/high-temperature type, upper amphibolite to granulite facies Ryoke metamorphism is estimated by SHRIMP zircon U-Pb dating. Zircon in migmatites (up to ca. 800^{o}C, ca. 0.5 GPa) has inherited core and metamorphic rim, and between them is a dark-cathodoluminescence (dark-CL) annulus with melt (glass) inclusions (Kawakami et al., 2013). The rim shows variation in age from ca. 95.5 Ma to 88.7 Ma, suggesting the duration of hypersolidus high-temperature condition for ca. 7 Myr. Zircon rims with old ages tend to show steeply positive HREE patterns whereas the young zircon rims tend to show less steeply positive HREE patterns. Ti content in zircon rims are low, ranging from 1.23 to 2.25 ppm. This small variation in Ti content may imply narrow temperature range of zircon rim formation.

Garnet in the same sample has zoning in trace elements, and REE and Y contents are high in the core and lower towards the rim, suggesting prograde growth of this garnet. Garnet shows steeply positive HREE patterns at the core whereas it becomes less steep at the rim. Zircon grains with dark-CL annulus with um-sized inclusions are also included in the garnet, and judging from the mixed analysis of thin zircon rim and core, these inclusion zircon also has rims with steeply positive HREE patterns. This suggests that the inclusion zircons also have the rim that grew during the prograde, melt-present stage of the Ryoke metamorphism, but has the steeply positive HREE patterns even though they likely grew simultaneously with garnet in the presence of melt.

Systematic change of REE patterns in garnet and in zircon rim described above suggests that availability of HREE decreased as zircon grew, because of the simultaneous growth of garnet. In spite of this, D_{REE}(garnet/zircon) does not show flat pattern nor approach unity for HREE (e.g., Rubatto, 2002), showing different trend from the cases in the UHT rocks. Possible controlling factors of D_{REE}(garnet/zircon) include (i) difference in pressure and temperature conditions, (ii) difference in garnet composition, especially in grossular content (Taylor et al., 2014), (iii) effect of self-diffusion of garnet trace element compositional profiles under UHT conditions (Buick et al. 2006), and (iv) different timing of zircon and garnet growth (Buick et al. 2006). Among the possible controlling factors of the difference of D_{REE}(zircon/garnet) from UHT examples discussed above, (ii) can be neglected because garnet in this study has low grossular content (0.02-0.03) but showing the steep HREE pattern. Factor (iii) is not likely because our garnet preserves zoning in trace elements and even the high-Y annulus is preserved. Factor (iv) is also not likely from the above-mentioned observations that support simultaneous growth of zircon and garnet. Therefore, the temperature condition could be the most likely factor to control D_{REE}(garnet/zircon), although an example of Whitehouse and Platt (2003) who reported the flat D_{REE}(garnet/zircon) pattern near unity does not fit this interpretation. Our example suggests that it can be misleading to judge timing of 'normal' granulite facies metamorphism solely from the D_{REE}(garnet/zircon) pattern on the assumption that D_{REE}(garnet/zircon) becomes unity when garnet and zircon coexisted.

Keywords: high temperature metamorphism, partial melting, zircon, garnet, rare earth elements

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East Antarctica and supercontinent configuration: the Dronning Maud Land perspective

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The geology of East Antarctica and its correlation in major supercontinents is highly speculative, since only a very small part of it is exposed. Therefore a better connection between geology and geophysics is needed in order to correlate exposed regions with ice-covered, geophysically-defined, blocks. In Dronning Maud Land (DML), two distinct late Mesoproterozoic/early Neoproterozoic tectono-metamorphic provinces appear, separated by the major, NE-trending Forster Magnetic Anomaly and South Orvin Shear Zone. To the west of this lineament, the Maud Belt has clear affinities with Grenville-age continent-continent mobile belts. East of the Forster Magnetic Anomaly, juvenile rocks with early Neoproterozoic age (Rayner-age) and an accretionary character crop out. The international GEA-II expedition (2012) targeted a white spot on the geological map immediately to the E of the Forster Magnetic Anomaly. This area allows the characterization and ground-truthing of a large and mostly ice-covered region, the SE DML Province that had previously been interpreted as an older cratonic block. However, new SHRIMP/SIMS zircon analyses and their geochemistry indicates that the exposed basement consists of a ca. 1000-900 Ma juvenile terrane that is very similar to rocks in Sor Rondane. It lacks significant metamorphic overprint at the end of crust formation, but it shows medium to high-grade overprinting between ca. 630-520 Ma, associated with significant felsic melt production, including A-type granitoid magmatism. Therefore, the aeromagnetically distinct SE DML province does neither represent the foreland of a Late Neoproterozoic/EarlyPaleozoic mobile belt, nor a craton, as has previously been speculated. It more likely represents the more juvenile, westward continuation of Rayner-age crust (1000-900 Ma). To the west it abuts along the NE-trending Forster Magnetic Anomaly. The latter is interpreted as a suture, which separates typical Grenville-age crust of the Maud Belt (ca. 1200-1030 Ma) to the W from Rayner-age crust to the E. Therefore the larger eastern part of DML has clearly Indian affinities. Its juvenile character with a lack of metamorphic overprint at the end of crust formation points to an accretionary history along this part of the Indian segment of Rodinia, immediately following final Rodinia assembly.

Keywords: Dronning Maud Land, Forster Magnetic Anomaly, supercontinents, juvenile crust, early Neoproterozoic, suture zone

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SMP09-06 Room:201A Time:May 27 11:30-11:45

Insights from zircon chronology and chemistry constraints into Neoproterozoic orogens at Sor Rondane, East Antarctica

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Zircon chronology combined with its mineral chemistry is key tools for evaluating the temporal evolution of metamorphic processes. Assembly of Gondwana supercontinent has been argued in numerous studies. Generally the reported ages of Gondwana collision zones are in the range of 750-500 Ma (e.g., Meert, 2003; Jacobs et al., 2003; Grantham et al., 2003). From East Antarctica, a number of Neoproterozoic to Cambrian high-grade metamorphic terranes are distributed, and pervasive 550-500 Ma metamorphic ages have been reported from most of these terranes (e.g., Fitzsimons, 2000; Harley, 2003; Shiraishi et al., 2003) with minor >600-550 Ma ages (Shiraishi et al., 2008; Dunkley et al., 2014; Hokada and Motoyoshi, 2006).

Sor Rondane Mountains is one such area where older c.640-600 Ma high-grade metamorphic rocks along with pervasive 550-500 Ma age events have been reported (e.g., Shiraishi et al., 2008; Osanai et al., 2013; Adachi et al., 2013; Hokada et al., 2013). Hokada et al. (2013) discussed based on the zircon and monazite U-Th-Pb and REE analyses by using ion microprobe and electron microprobe applying to garnet-biotite-sillimanite gneiss and associated multiple generations of leucocratic veins in the central part of Sor Rondane Mountains, and suggested multiple (at least three stages of) metamorphic and fluid (intrusion of leucocratic vein) events at >700 Ma, 640-630 Ma and 550-520 Ma with main granulite-facies event at c.637+/-6 Ma. Combined with the other available and newly obtained age data, temporal processes of possible geologic events recorded in Sor Rondane Mountains and their implications for supercontinent evolution of Gondwana during c.700-550 Ma will be discussed.

Keywords: Gondwana supercontinent, zircon U-Pb age, rare earth elements, high-grade metamorphism, East Antarctica, Sor Rondane Mountains

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SMP09-07 Room:201A Time:May 27 11:45-12:00

Sr and Nd isotopes in metacarbonate rocks as proxies for paleo-tectonic reconstruction prior to supercontinent assembly

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Chemically precipitated carbonate sediments directly record seawater composition that helps us to decode the Earths paleo-environment, existence of paleo-oceans and provide valuable clues on paleo-tectonic position of continents in the Earths history. In addition, the geochemical and isotopic composition of carbonate rocks also have a strong dependence on the depositional tectonic setting and surrounding source rock composition especially in the Precambrian era, during which biological activity were less prominent and vegetation was virtually absent. Here we present evidence for the existence of an Oceanic Island arc system and peripheral Oceans before the formation of Gondwana supercontinent in the Neoproterozoic. Applying a multi-element isotope geochemical approach on chemostratigraphically well-constrained metacarbonate rocks collected from several supracrustal terrains in Gondwana, including the remote Sor Rondane Mountains in East Antarctica, we model carbonate deposition surrounding an island arc system, mid-ocean volcanic islands and shallow marine continental shelf of a yet unidentified interior Antarctic continent, all of which accreted and amalgamated in the late Neoproterozoic to early Paleozoic to form the Gondwana supercontinent.

We also compare the metacarbonate data with basement rocks from various neighboring Gondwana continents, wherein some regional affinities could be established. Nd model ages of cratonic basements from East Africa (Kalahari) and India (Dharwar) is obviously different from Balchen carbonate rocks from Sor Rondane in East Antarctica, and the possible existence of a cratonic nucleus within the East Antractic continent is speculated, surrounding which the carbonate rocks of the Balchen region might have deposited. Thus, the Sr and Nd isotopic compositions provide important information about depositional setting of sedimentary rocks and relationship with surrounding basement and continents. Geochemical proxies, such as Nd and Sr isotopes of metacarbonate rocks, can yield key information not only of paleo-oceans but also about the surrounding rocks of oceanic crust (basement) and continental crust during the time of deposition, which can lead us to a better understanding of paleo-tectonic setting of crustal fragments that assemble to form supercontinents.

Keywords: Metacarbonate rocks, Gondwana, Sr isotopes, Nd isotopes, tectonic setting

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SMP09-08 Room:201A Time:May 27 12:00-12:15

Comparison of Sr-Nd isotope data from N. Mozambique and Dronning Maud Land and Sor Rondane, Antarctica.

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A recently proposed mega-nappe model for the Neoproterozoic?Cambrian-age Kuunga Orogeny involves collision between N. and S. Gondwana. S.Gondwana is inferred to have comprised southern Africa (consisting of the Kalahari Craton and parts of adjacent metamorphic belts including the Barue and Nampula complexes of the Mozambique Belt), western Dronning Maud Land (WDML), Antarctica (consisting of the Grunehogna Craton and the Maud Belt) and Sri Lanka (consisting of the Vijayan Complex). N. Gondwana is inferred to have comprised parts of south central Africa, Sri Lanka, Madagascar and India (consisting of the Tanzanian Craton and parts of adjacent metamorphic belts including the Xixano Complex of Cabo Degado Complex, the Highlands and Wanni Complexes, the Central Dronning Maud Land and Sor Rondane areas and Lutzo Holm Bukta areas.

Differences in published geochronological data from the metamorphic belts of the various areas are fundamental to defining the various components of the mega-nappe model. Comparison of published and unpublished Sr and Nd radiogenic isotope data, calculated at 500Ma from the metamorphic belt basement gneisses of the mega-nappe component areas, show broad differences between the different areas from N and S Gondwana.

Neoproterozoic to Cambrian-age granitoids which intrude the various areas mostly mirror their host country rocks suggesting localised anatexis without significant juvenile input. Sr and Nd isotope data from some of these intrusions suggest that they were sourced in the footwall but intrude the hanging wall components of the mega-nappe. The Sr-Nd data from the N Gondwana correlated areas dominantly show marginally negative, less evolved ϵNd characteristics but similar, positive, wide ranged ϵSr characteristics compared to the S. Gondwana correlated areas.

Comparison of the Sr-Nd isotopic provinces show broad similarities with various geophysical domains defined by recently published aeromagnetic and gravity data sets from Antarctica.

The data are evaluated in terms of their implications for the meg-nappe model for the Kuunga Orogeny.

Keywords: N. and S. Gondwana, Sr and Nd isotopes, mega-nappe model, Kuunga Orogeny

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SMP09-09 Room:201A Time:May 27 12:15-12:30

Mesoproterozoic suture between India and Madagascar

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The understanding of position of southern India in various supercontinent assemblies, its amalgamation and rifting with various continental fragments have significant implication in understanding the tectonic processes through geological time-scale. The southern India is a mosaic of various crustal domains, which are divided by shear/suture zones, but several controversies exist regarding the tectonic framework, shear zones and crustal blocks of southern India. The detailed structural lineament mapping of southern India along with new and compiled of geological and geochronological datasets help in delineating new shear zones and redefining the Precambrian crustal blocks of southern India. Especially, in a Madagascar- India correlation point of view, recent studies have reconstructed plate margins of India and Madagascar based on flexural isostasy along the Western Continental Margin of India (WCMI) and the Eastern Continental Margin of Madagascar. In this context, the newly proposed Mesoproterozoic Kumta and Mercara suture zones (1400-1000 Ma) welding Archean crustal blocks in western India offer critical insights into Precambrian continental juxtapositions and the crustal evolution of Gondwana. The textural evidences, mineral chemistry and thermodynamic modeling of quartz-phengite schist, garnet-biotite schist from the Kumta suture suggest peak metamorphic P-T conditions of c. 18 kbar, 550^{o}C and c. 11 kbar, 790^{o}C respectively and garnet-biotite-kyanite-gedrite-cordierite gneiss from the Mercara suture suggests peak metamorphic P-T conditions of c. 12.5 kbar, 825^{o}C. The calc-silicate granulite and mafic granulite were re-equilibrated under high-pressure conditions of 15-20 kbar at a temperature of 800-900^o C. The Bondla-ultramafic complex in the northwest of Kumta suture contains shale, basalt, dolerite, gabbro, chromite bearing serpentinite, chromitite and peridotite. The chromite chemistry from ultramafics suggests the evolution in a supra-subduction zone arc setting. Towards the east of the Kumta suture, the Sirsi shelf contains weakly deformed sedimentary rocks (limestone, shale, banded iron formations, greywacke, sandstone and quartzite) unconformable on high-grade ca.2571 Ma gneisses of the Dharwar craton. The Karwar block to the west of the Kumta suture is mainly composed of weakly deformed tonalite-trondhjemite-granodiorite (TTG) with enclaves of amphibolite. Whole-rock major and trace element data suggest that the TTGs (Type I, low K2O, high Na2O, Sr) were derived from a volcanic arc, and that the TTGs (Type II, high K_2O, low Na_2O, Sr) have within-plate signatures. Amphibolites have a chemical composition comparable to basalts to basaltic andesites with MORB signatures. The Karwar block TTGs (Type I) are ca. 3200 Ma with ?Hf range of -0.7 to 4.4. The whole-rock ?Nd ranges from -2.4-2.1 representing juvenile crustal origin. The Coorg block, about 100 km south of Karwar block mainly consists of highly metamorphosed lower-crustal rocks yielding 3200 Ma age with positive to negative ?Hf spread (3.3. to -3.2) indicating their source as mixture of juvenile and recycled crustal materials. Metasedimentary rocks from the Kumta suture have ?Hf (t) values that range from -9.2-5.6, and TDM ages that range from 2747-3546 Ma; comparable values in metasedimentary rocks from the Mercara suture range are from -18.9-4.2 and from 3214-3647 Ma respectively. Synthesis of the above results suggests that the Kumta and Mercara suture zones incorporate sediments, which range in age from Paleoarchean to Mesoproterozoic, and were subjected to high-pressure metamorphism in the late Mesoproterozoic. The protolith sediments were mainly derived from juvenile crust that was mixed with products of recycled older continental crust. Integration of the results indicates the Mesoproterozoic Kumta-Mercara suture in western Peninsular India interpreted as eastern extension of the Betsimisaraka suture of Madagascar.

Keywords: Gondwana Supercontinent, Continental Correlation, Crustal evolution, Mesoproterozoic suture

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A comprehensive study on India-Madagascar paleo-fit in the Gondwana Supercontinent

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This study addresses one of the most disputed problems in the history of the earth science, which is on the paleo-fit of India and Madagascar continents in the Gondwana Super Continent Assembly. The study contributes new constraints on, and definitions of, the reconstructed plate margins of India and Madagascar based on flexural isostasy along the western continental margin of India (WCMI) and the eastern continental margin of Madagascar (ECMM). We have estimated the nature of isostasy and crustal geometry along the two margins, and have examined their possible conjugate structure. Here we utilize elastic thickness (Te) and Moho depth data as the primary basis for the correlation of these passive margins. We employ the flexure inversion technique that operates in spatial domain in order to estimate the spatial variation of effective elastic thickness. Gravity inversion and flexure inversion techniques are used to estimate the configuration of the Moho/Crust-Mantle Interface that reveals regional correlations with the Te variations. These results correlate well with the continental and oceanic segments of the Indian and African plates. The present study has found a linear zone (˜1680 km) of anomalously low-Te (1-5 km) along the WCMI, which correlates well with the low-Te patterns obtained all along the ECMM. We suggest that the low-Te zones along the WCMI and ECMM represent paleo-welding zones of lithosphere thermally and mechanically weakened by the combined effects of the Marion hotspot and lithospheric extension due to rifting. Based on the present Te results, we have produced a precise India-Madagascar assembly during the time of their rifting (see Figure below), which is confirmed by the Moho geometry and the bathymetry of the conjugate shelf margins, and by the matching of tectonic lineaments, lithologies and geochronological belts between India and Madagascar.

Figure Caption: Elastic thickness structure of the western margin of India and eastern margin of Madagascar (left), correlation of similar Te zones of India-Madagascar conjugate margins (centre), and the paleo-fit of India and Madagascar deduced from the Te correlations justified by the fit of shear zones (Ratheesh Kumar et al., Gondwana Research, 2014).

Keywords: Gondwana, Paleo-fit, elastic thickness