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Structural Setting of the Neoarchean Terrains in the Commonwealth Bay Area (143–145°E), Terre Adélie Craton, East Antarctica

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Abstract

Geological maps of East Commonwealth Bay Unit (ECB), (Terre Adélie and Georges V Land, Antarctica) are presented with a summary of the main structural and metamorphic data for the region. The ECB unit was developed during Neoarchean–Paleoproterozoic event (at 2.5–2.42 Ga), with (i) granulite metamorphism at 9±1.5 kbar and 800±50°C in the lower crust section and amphibolite metamorphism (P=5 kbar, T=750°C) at the upper crustal levels; (ii) the lower crustal granulites were uplifted, and suffered local partial melting and retrogression to the amphibolite facies at 550±50°C–5 kbar. Granulites were extruded in the core of a crustal-scale anticlinal fold, but retrogressed only on the rims of the anticline. Crustal-scale folding, along with other structural features resulted from intense NE-SW shortening that prevailed during the Neoarchean orogenic cycle. Strike-slip and extensional motions were only minor components in that process; (iii) top-to-the-East thrusting and nappe piling had (at least locally) occurred under lower amphibolite to greenschist facies conditions. Finally, it seems that (iv) the Paleoproterozoic 1.7 Ga structural imprint may have only affected the rims of the Archean units. The tectonic context observed in the 1.7 Ga Cape Hunter phyllites features mainly an E-W shortening component and vertical extrusion. The eastern (Mertz) and western (Port Martin) parts of the Archean block were reactivated by localized dextral shearing.

Key words: East Antarctica, Neoarchean, Paleoproterozoic, granulites, tectonics.

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Baurusuchus salgadoensis, a New Crocodylomorpha from the Bauru Basin (Cretaceous), Brazil

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Abstract

Baurusuchus salgadoensis is a new baurusuchid crocodylomorph from Bauru Basin (Cretaceous), Brazil, partially preserved through a complete skull. The fossil comes from a fine sandstone sequence of Adamantina Formation, General Salgado County, São Paulo State. The sedimentary sequence where it was found, located in Fazenda Buriti, is considered Turonian-Santonian in age. The described species – *Baurusuchus salgadoensis* sp. nov. – is a baurusuchid with an antorbital fenestra, double external nares with a bony septum, two well-fused supraorbitals, the supratemporal fenestrae larger than the orbits and a quadrangular-shaped laterotemporal fenestra. The position of the external nares, located on anterior and terminal portion of the rostrum together with the theropod-like lateral compression of the snout and teeth are indicators that *Baurusuchus salgadoensis* was a terrestrial crocodyliform. This was a carnivorous species and the lateral compression of the rostrum could be interpreted as a mechanism to increase the skull resistance forces during biting. The pointed, conical teeth, some with crenulated borders, could be used to perforate and to carve the prey. The geological context of *Baurusuchus salgadoensis* indicates that it probably lived in a hot and arid climate.

Key words: Crocodylomorpha, *Baurusuchus salgadoensis*, Baurusuchidae, Cretaceous, Brazil.

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Late Neoproterozoic-Cambrian Felsic Magmatism Along Transcrustal Shear Zones in Southern India: U-Pb Electron Microprobe Ages and Implications for the Amalgamation of the Gondwana Supercontinent

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Abstract

We report U-Pb electron microprobe ages for zircon and monazite from two granitic plutons from southern India, the Vattamalai granite within the Palghat-Cauvery Shear Zone system and the Pathanapuram granite within the Achankovil Shear Zone. A zircon grain from the Vattamalai granite has a core age of 693±132 Ma and is surrounded by a thick overgrowth with an age of 504±104 Ma. Monazites from the Vattamalai granite show a small range of ages between 500–520 Ma. PbO vs. ThO_2* plots of the monazites define a precise isochron age of 517±6.7 Ma (MSWD = 0.25). The oldest zircons in the Pathanapuram pluton are in the range 961–1149 Ma, with younger overgrowths at ~540–560 Ma. Monazite cores from the granite lie in the range of 526–574 Ma, whereas rims and bright overgrowths range from 506-539 Ma. These monazites define two linear arrays in PbO vs. ThO_2* plots with cores yielding an isochron age of 550±25 Ma (MSWD = 0.58) and the rims defining an age of 515±15 Ma (MSWD = 0.68).

The age data from the granite plutons indicate multiple thermal imprints in southern India with the latest orogeny during the Late Neoproterozoic-Cambrian (Pan-African). The older zircon cores up to 1149 Ma from the Pathanapuram pluton suggest inherited components of late Mesoproterozoic age, caught up within the granite magma. However, the dominant 570–520 Ma ages obtained from both zircons and monazites closely compare with similar ages for magmatism and metamorphism from throughout the East African Orogen. Late Neoproterozoic-Cambrian felsic magmatism occurred along both the Palghat-Cauvery Shear System and the Achankovil Shear Zone, indicating that these shears were active at this time and may have served as pathways for the emplacement of magmas generated at depth. The magmatism represents part of the various collisional-extensional episodes that marked the final amalgamation of the Gondwana supercontinent.

Key words: Granite, zircon, monazite, EPMA U-Pb-Th dating, Gondwana.

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Evidence for Proterozoic Collision from Airborne Magnetic and Gravity Studies in Southern Granulite Terrain, India and Signatures of Recent Tectonic Activity in the Palghat Gap

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Abstract

The composite airborne total intensity map of the Southern Granulite Terrain (SGT) at an average elevation of 7000' (≈ 2100 m) shows bands of bipolar regional magnetic anomalies parallel to the structural trends suggesting the distribution of mafic/ultramafic rocks that are controlled by regional structures/shear zones and thrusts in this region. The spectrum and the apparent susceptibility map computed from the observed airborne magnetic anomalies provide bands of high susceptibility zones in the upper crust associated with known shear zones/thrusts such as Transition Zone, Moyar-Bhavani and Palghat-Cauvery Shear Zones (MBSZ and PCSZ). The quantitative modelling of magnetic anomalies across Transition Zone, MBSZ and PCSZ suggest the presence of mafic rocks of susceptibility (1.5–4.0 x 10^{-3} CGS units) in upper crust from 8–10 km extending up to about 21–22 km, which may represent the level of Curie point geotherm as indicated by high upper mantle heat flow in this section.

Two sets of paired gravity anomalies in SGT and their modelling with seismic constraints suggest gravity highs and lows to be caused by high density mafic rocks along Transition Zone and Cauvery Shear Zone (CSZ) in the upper crust at depth of 6–8 km and crustal thickening of 45–46 km south of them, respectively. High susceptibility and high density rocks (2.8 g/cm^3) along these shear zones supported by high velocity, high conductivity and tectonic settings suggest lower crustal mafic/ultramafic granulite rocks thrusted along them. These signatures with lower crustal rocks of metamorphic ages of 2.6–2.5 Ga north of PCSZ and Neoproterozoic period (0.6–0.5 Ga) south of it suggest that the SGT represents mosaic of accreted crust due to compression and thrusting. These observations along with N-verging thrusts and dipping reflectors from Dharwar Craton to SGT suggest two stages of N-S directed compression: (i) between Dharwar Craton and northern block of SGT during 2.6–2.5 Ga with Transition Zone and Moyar Shear towards the west as thrust, and (ii) between northern and southern blocks of SGT with CSZ as collision zone and PCSZ as thrust during Neoproterozoic period (0.6–0.5 Ga). The latter event may even represent just a compressive phase without any collision related to Pan-African event. The proposed sutures in both these cases separate gravity highs and lows of paired gravity anomalies towards north and south, respectively. The magnetic anomalies and causative sources related to Moyar Shear, MBSZ and PCSZ join with those due to Transition Zone, Mettur and Gangavalli Shears in their eastern parts, respectively to form an arcuate-shaped diffused collision zone during 2.6–2.5 Ga.

Most of the Proterozoic collision zones are highlands/plateaus but the CSZ also known as the Palghat Gap represents a low lying strip of 80–100 km width, which however, appears to be related to recent tectonic activities as indicated by high upper mantle heat flow and thin crust in this section. It is supported by low density, low velocity and high conductive layer under CSZ and seismic activity in this region as observed in case of passive rift valleys. They may be caused by asthenospheric upwarping along pre-existing faults/thrusts (MBSZ and PCSZ) due to plate tectonic forces after the collision of Indian and Eurasian plates since Miocene time.

Key words: Collision, Proterozoic, Southern Granulite Terrain, Palghat Gap, airborne magnetic and gravity anomalies.

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Arsenic Levels in Groundwater from Quaternary Alluvium in the Ganga Plain and the Bengal Basin, Indian Subcontinent: Insights into Influence of Stratigraphy

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Abstract

Late Quaternary stratigraphy and sedimentation in the Ganga Alluvial Plain and the Bengal Basin have influenced arsenic contamination of groundwater. Arsenic contaminated aquifers are pervasive within lowland organic rich, clayey deltaic sediments in the Bengal Basin and locally within similar facies in narrow, entrenched river valleys within the Ganga Alluvial Plain. These were mainly deposited during early-mid Holocene sea level rise. Arsenic was transported from disseminated sources as adsorbed on dispersed phases of hydrated-iron-oxide. These were preferentially entrapped as sediment coatings on organic-rich, fine-grained deltaic and floodplain sediments. Arsenic was released later to groundwater mainly by reductive dissolution of hydrated-iron-oxide and corresponding oxidation of sediment organic matter. Strong reducing nature of groundwater in the Bengal Basin and parts of affected middle Ganga floodplains is indicated by high concentration of dissolved iron (maximum 9–35 mg/l). Groundwater being virtually stagnant under these settings, released arsenic accumulates and contaminates groundwater. The upland terraces in the Bengal Basin and in the Central Ganga Alluvial Plain, made up of the Pleistocene sediments are free of arsenic contamination in groundwater. These sediments are weakly oxidised in nature and associated groundwater is mildly reducing in general with low concentration of iron (<1 mg/l), and thus incapable to release arsenic. These sediments are also flushed free of arsenic, released if any, by groundwater flow due to high hydraulic head, because of their initial low-stand setting and later upland terraced position.

Key words: Arsenic in groundwater, Bengal Basin, Ganga Alluvial Plain, Holocene sea-level rise, Quaternary stratigraphy.

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Petrogenetic Appraisal of Early Palaeozoic Granitoids of Kinnaur District, Higher Himachal Himalaya, India

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Abstract

The Early Palaeozoic felsic magmatism of Kinnaur district is represented by more-or-less equivalent Akpa granitoids (477±29 Ma) and Rakcham granitoids (453±9 Ma), which form an integral part of the Central Crystalline Zone in the southern portion of the Tethys Himalayan Tectogen. Both, Akpa granitoids (AG) and Rakcham granitoids (RG), intrude the rocks of the Vaikrita Group. Substantially low magnetic susceptibility values (χ = 0.016–0.187 × 10^{-3} SI) of these Early Palaeozoic granitoids suggest their nature similar to as ilmenite series (reduced-type) granitoids emplaced in a syn-collisional tectonic setting. The modal compositions of AG mainly correspond to two-mica (muscovite-biotite) monzogranite belonging to the granitoids generated by crustal fusion. Based on mineral assemblage (Ms+Bt+Tur+Ap), associated skarn-type tungsten mineralization, occurrence of metasedimentary enclaves, and whole-rock geochemistry (SiO_2 = 70.75–72.95 wt.%, TiO_2 = 0.02–0.17 wt.%, K_2O/Na_2O = 1.05–2.32, molar A/CNK = 0.93 to 1.33, CIPW corundum 0.17 to 3.82 wt.%, Av. Sr = 304ppm, initial $^{87}Sr/^{86}Sr$ = 0.7206±0.00235), the AG can be typically characterized as peraluminous (S-type) granite as similarly noted for RG. Higher Rb/Sr ratio and initial $^{87}Sr/^{86}Sr$ = 0.737±0.002 of RG compared to that of AG however indicate involvement of relatively more crustal component in generation of RG. The AG is enriched in Ba and light rare earth elements (LREE). The chondrite normalized REE patterns of AG appear weakly fractionated (La_N/Lu_N = 1.06–6.43) and show pronounced negative Eu-anomaly (Eu_N/Eu^* = 0.03). The AG and RG represent typical S-type granite suites that *largely* evolved due to differential degree of anatexis (partial fusion) of sedimentary protoliths, prior to Caledonian but after the Pan-Indian thermal orogenic event.

Key words: Ilmenite series, Peraluminous, Early Palaeozoic granitoids, Kinnaur, Higher Himachal Himalaya

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Hot-fluid Driven Metasomatism of Samalpatti Carbonatites, South India: Evidence from Petrology, Mineral Chemistry, Trace Elements and Stable Isotope Compositions

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Abstract

The magmatic heritage of carbonatites can be identified on the basis of a combination of geological criteria such as, their mode of occurrence, the nature of associated igneous rocks, the presence of minerals of igneous origin, fenitization, characteristic trace element contents and isotopic composition. Late Proterozoic Samalpatti carbonatites were studied in view of these criteria, and were found to contain metamorphic minerals that normally form under thermal metamorphic conditions and which have unusual chemical compositions. A combination of criteria points clearly to a magmatic origin for these carbonatites. Field relations indicate that the dominant modes of intrusion of carbonatite into the encompassing pyroxenites and syenites include small dykes, veins, or lenses. The igneous nature of these carbonatites has been described elsewhere and chemically they are classified as calico-carbonatites. Currently, very little is known about the metamorphic textures and mineralogy observed in the Samalpatti carbonatites. In this study, several metamorphic minerals are reported including diopside, grossularite, vesuvianite, K-feldspar and wollastonite, and a hornfelsic texture is described. These mineral phases and texture characterize thermal metamorphism under low pressure and high temperature (LP-HT) metamorphic conditions (650°–750°C) or metasomatism aided by hot-fluid advection. The metamorphic nature of minerals reported is also confirmed by electron microprobe study. The Samalpatti carbonatite samples show much lower values of characteristic trace elements (P, Sr, Ba, Zr, Nb, Th, Y and REEs) than average concentrations for magmatic carbonatite. Stable isotopic ($\delta^{13}C$ and $\delta^{18}O$) compositions of Samalpatti carbonatites do not fall in the primary igneous carbonatite (PIC) domain. The petrological and chemical signatures of these carbonatites suggest metasomatism in conjunction with fluid advection. Such a metasomatic process may drastically change the chemistry of the rocks in addition to enrichment of heavier stable isotopes. During this metasomatic process, characteristic elements would be dissolved in the high $\delta^{18}O$ fluid, and together with Rayleigh fractionation would contribute to enhanced concentrations of ^{13}C and ^{18}O in Samalpatti carbonatites.

Key words: Metasomatism, metamorphosed carbonatite, petrology, geochemistry, Samalpatti.

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Emplacement History of Pasupugallu Gabbro Pluton, Eastern Ghats Belt, India: a Structural Study

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Abstract

Structural mapping of the Pasupugallu pluton, an elliptical intrusive gabbro-anorthosite body, emplaced into the western contact zone between the Eastern Ghats Mobile Belt and the Archaean East Dharwar Craton, along the east coast of India, reveals concentric, helicoidal and inward dipping magmatic and/or tectonic foliations. We identify a <1 km-wide structural aureole characterized by pronounced deflection of regional structures into margin parallel direction, mylonitic foliations with S-C fabrics, sigmoidal clasts, moderately plunging stretching lineations, non-cylindrical intrafolial folds, and stretched elliptical mafic enclaves in the aureole rocks. Our results suggest that the pluton emplacement is syn-tectonic with respect to the regional ductile deformation associated with the terrane boundary shear zone at the western margin of the Eastern Ghats. We present a tectonic model for the emplacement of the pluton invoking shear-related ductile deformation, rotation and a minor component of lateral expansion of magma. The intrusive activity (1450–800 Ma) along the western margin of the Eastern Ghats can be correlated with the significant event of recurring mafic, alkaline and granitic magmatism throughout the global Grenvillian orogens associated with the continent-continent collision tectonics possibly related to the amalgamation and the breakup of the supercontinent Rodinia.

Keywords: Pluton emplacement, Eastern Ghats, shear zone, Pasupugallu pluton, syndeformational intrusion.