CHAPTER 20

GEOLOGY

Doctoral Theses

01. KHAN (ABUL AMIR)
Study of Variability of Himalayan Cryosphere and Precipitation and Estimation of Glacial Melt Fraction in the Upper Ganga Basin.
Supervisor : Prof. N. C. Pant
Th 23151

Abstract
(Not Verified)

Hindu Kush-Karakoram-Himalaya (HKH) region represents one of the major non-polar cryosphere domains on the Earth. This region feeds three major rivers namely: the Indus, the Ganga and the Brahmaputra and supportsa huge population of ~1 billion people. The hydrological budget of the higher Himalayan rivers depends on the precipitation but the available estimateson snow cover and rainfall are highly variable and in few cases appear to be unacceptable. Reported precipitation variability for the Indus basin is morethan 250%, for the Ganga basin it is 100% and for the Brahmaputra basin it is more than 240%. This work investigates precipitation patterns for these three basins by using satellite based Tropical Rainfall Measuring Mission (TRMM-3B42) data and compares and validates it with APHRODITE and IMD interpolated gridded precipitation data. Derived from a ten-year data set, the average annual precipitation for the Indus, the Ganga and the Brahmaputra basins is estimated as 413 mm, 1081 mm and 1460 mm respectively. The estimate on glacial cover and its volume in the Himalayan-Karakoram regions shows variability of more than 130% and 250% respectively. The available estimates on the glacial melt fraction also shows high variability, for example for the Indus basin the variability is ~170%, for the Ganga basin it is ~300% and for the Brahmaputra basin the variability is more than 100%. The X-ray diffraction studies of the suspended sediment load (SSL) close to the snout of the Gangotri glacier shows that illite followed by chlorite, quartz, K feldspar and plagioclase constitute the main mineralogy of the SSL. Calculations of existing glacial melt fraction (~30% at Rishikesh) are not consistent with the reported glacial thinning rates. Careful selection of end members provides results (~11% glacial melt fraction at Devprayag) that are consistent with the expected thinning rates.

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02. GOGOI (Bibhuti)

Mafic-Felsic Magma Interactions From The Bathani Volcano Sedimentary Sequence of Chotanagpur Granita Gneiss Complex of Eastern India: Implications for Magma Mixing during arc Magmatism.

Supervisor: Dr. Ashima Saikia

Th 23070

Abstract
(verified)

The work focuses on magma mixing and mingling occurring at two domains of the Bathani volcano-sedimentary sequence (BVSS) of Chotanagpur Granite Gneiss Complex (CGGC), Eastern India. One unit is a granitic pluton that has been intruded by mafic dykes during the whole crystallization history of the magma chamber leading to magma mixing and mingling. The other unit is a rhyolite dome in which basaltic magma made its way through the already solidified portion of the rhyolitic magma chamber and floored on top of it to interact with the remaining melt forming andesitic rocks. Both these units preserve excellent structures and textures at outcrop/map scale whose origin can be explained in terms of magma mixing and mingling models. The occurrence of magma mixing in our study domains has been well documented by major-oxides mixing test. This work also uses two recently developed experimental mixing models that are based on physical properties of the interacting magmas. Physical properties like Temperature (T), Viscosity (η), Glass Transition Temperature (T_g) and Fragility (m) have been calculated for the magmas involved in the mixing process. These properties, in turn, have been used in the recently developed experimental mixing models. The models confirm that the intermediate rocks of GRD and NGP are indeed hybrid products formed by the interaction of mafic-felsic magmas. We have characterized the different magmas involved in the mixing process and has constrained their source characteristics. The accumulation of all these data have enabled us to build a geodynamic magma chamber modeling starting from the generation of different magma types to their emplacement, and finally leading to the formation of new hybrid rocks. These results have helped us corelate it to the Mahakoshal mobile belt of the Central india which marks suture line of the amalgmation of north and south Indian block during the Nuna supercontinent formation.

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03. LOUREMBAM (Ranjit Singh)

Late Cretaceous–Early Palaeocene Vertebrate Fauna of India: Diversity, Evolution and Palaeobiogeographical Implications.

Supervisor: Prof. G.V.R. Prasad

Th 23071

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04. PANDEY (Mayuri)
Provenance and Depositional Conditions of Miocene Oceanic Sediments off Coast of East Antarctica: Clues for Sub-ice Geology and Paleoclimate.
Supervisor : Prof. Naresh Chandra Pant
Th 22762

Abstract
(Not Verified)

The present study is an attempt to infer the the sub-ice geology of the provenance and climatic conditions prevalent during Pliocene to Late Miocene and from the detrital marine sediments from the site U1359, off the coast of Wilkes Land. The temporal variation of the clay mineralogical data shows a dominance of illite with chlorite, smectite and kaolinite in decreasing concentration. Factor analysis was carried out post heavy media separation to find out mineral associations and their variability pattern. Six factors were obtained out of which explains 89% of the variance. A compilation of published $\delta^{18}O$ with three factors and clay mineral variation with respect to the age of the sediments have been used to interpret six ice advance stages at 6.62-6.72 Ma, 7.43-7.60 Ma, 8.04-8.42 Ma, 10.83-10.96 Ma and 12.06- 12.21 Ma which might have hindered the supply from Ferrar Large Igenous Province present in the interior of the Wilkes Land resulting into decrease in supply of clinopyroxenes and smectite. Chemical analyses of the heavy fractions are inferred to be sourced from the igneous provenance represented by FLIP into the cratonic area of the Wilkes Land. Metamorphic minerals including orthopyroxene, high-Ca garnet and high-Ti biotite indicate a source in a high-grade metamorphic terrain. Presence of muscovite schist as rock fragment point towards a very low grade metamorphic terrain. The limiting conditions deduced from the geothermometry are around 869±24 °C and 587±17°C at 7kbar indicating presence of high grade as well as medium grade of metamorphism. The age obtained from the monazite represents a low grade deformation-metamorphic event during Neoproterozoic i.e. at 799±13 Ma. The Neoproterozoic age can be explained as a consequence of ca. 830–750 Ma magmatic activity resulting in the Gairdner-Amata dyke swarm and also formation of the Adelaide Rift Complex in formerly adjacent Australia

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05. PAUL (Pritam Paritosh)
Autogenic and Allogenic Controls on Late Paleoproterozoic Continental and Marine Sedimentation: Clues From Gwalior Rift Basin, Central India.
Supervisor : Prof. Partha Pratim Chakroborty
Th 22763

Abstract
(Not Verified)

The Paleoproterozoic Gwalior basin is riftogenic in origin and represented by ~1.8 km thick unmetamorphosed and undeformed lithopackage constituted of clastic (Par Formation) and chemical (Morar Formation) sediment successions. Process-based facies and paleo-environmental analyses of Par succession allowed delineation of products of continental (alluvial fan, braid plain), transitional (fluvio-tidal, tidal and wave dominated shoreface) and marine (shelf) depositional conditions. With NE-SW oriented shoreline, the basin had its depocentre in the northwest. The braided fluvial system flowing from southeast met the basin coastline. Paleohydraulic estimation from cross set thickness of Par fluvial deposit allowed postulation of dry climatic condition during Par deposition. The late Paleoproterozoic time frame for the basin is established from i) 1787±60 Ma Sm-Nd whole rock mineral Isochron age of a basaltic sill and ii) $^{87}Sr / ^{86}Sr$ (0.707403) of Morar carbonates. Mixed tidal system was operative in parts of Gwalior coastline with dominance of diurnal tide. Fast Fourier transform of tidalite data revealed cyclic variations in lamina thickness constituting cycles of 12-14 and 25-28 laminae; 12-14 cycles dominate

with 5 successive neap crossovers indicating influence of tidal declination. Bounded between a non-conformity at its base and Type II unconformity at its top, the Par succession represents a depositional "sequence" constituted of lowstand, transgressive and highstand 'Systems tracts'. Positive Eu anomalies in PAAS normalized REE pattern of Morar BIF and carbonates suggest operation of high temperature, reduced hydrothermal solution in shallow subtidal waters of the Gwalior Sea. The basin at its deeper level remained suboxic. From present study it is inferred that between pre 2.38 Ga anoxic ocean and post 1.8 Ga stratified oxic-sulfidic (canfield) ocean, deep ocean hydrosphere was suboxic (with dissolved pO_2 content less than 0.2 ml/lit) that denied Mn oxidation and Ce sequestration. Local oasis at Gwalior coastline was created through photosynthesis of algal communities.

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06. SAHA (Subhojit)
Tracking Evolution of Mesoproterozoic Singhora and Ampani Basins from the Bastar Craton, Central India using Multi – Proxy Analysis.
Supervisor : Prof. Partha Pratim Chakraborty and Dr. Kaushik Das
Th 22764

Abstract
(Not Verified)

The present work involved multi-proxy analyses including i) field mapping, ii) process-based facies and facies association analyses, iii) sediment geochemistry and iv) detrital zircon geochronology from two aerially separate basins viz. the Singhora and Ampani basins from eastern margin of the Bastar craton. Two transgressive depositional cycles viz. Singhora Depositional Cycle (SDC) I (sourced from southeast) and II (sourced from the northwest), punctuated by a Type-I unconformity constitute the Singhora lithopackage. In contrast, the Ampani basin records a single transgressive cycle that received detritus from northwest. Monazite U–Th–total Pb EPMA chemical dating from interbedded tuffaceous units present within Ampani and Singhora lithopackages yielded ~1500 and ~1450 Ma ages and point towards contemporaneity of the basins and Mesoproterozoic time frame. Geochemically the tuffs imply operation of a volcanic arc system at the East Indian Craton margin at the time of initiation of these basins. Detrital zircon age spectra from the Singhora reveals addition of Paleoarchean (~3500 Ma) and Mesoproterozoic (~1650 Ma) sources from the middle stratigraphic level upward. Symptomatic change in detrital zircon age profile is also recorded from middle stratigraphic level of the Ampani basin as Archean ages fade away and Paleo- to Mesoproterozoic ages (~2050 and 1760 Ma) are added in upper part of its stratigraphy. In addition, both the basins register major contribution from 2500 Ma source throughout their stratigraphy. The idea also gets support from sediment geochemistry and whole rock ε_{Nd} values of sediments. From the youngest population of detrital zircon grains, the ages of sedimentation in the Singhora and Ampani basins are estimated as of <1627 Ma (1640±13) and <2035 Ma (2079±44), respectively. Structural analysis in both the basins reveal their pervasively deformed character with presence of plane-noncylindrical to non-plane- noncylindrical fold geometry in outcrop to basin scale.

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07. USHAM (ARNOLD LUWANG)
Source of Arsenic and Other Toxic Elements Contamination in Singrauli Industrial Region With Special References to GBPS Rihand Reservoir.
Supervisor : Prof. Chandra Shekhar Dubey
Th 22761

Abstract
(Not Verified)

The Singrauli industrial region is a fast developing energy hub of India providing around 10% of the total installed energy capacity. The region has six main coal based super thermal power plants which are located in the vicinity of Singrauli coal mining area. There is a large artificial reservoir known as GBPS Rihand reservoir that provides water supply to the power plants and to the surrounding habitat. These coal mining activities and operation of super thermal power plants released various toxic elements (Hg, As, F) in the study area as many related health hazards have been reported in the area. The present study deals with sources of contamination of toxic elements and their relative abundance in the area. Most of the water sample lies above the permissible limit under USSL classification unsuitable for irrigation purposes. The ICP-MS analysis of coal, ground water and reservoir water in the vicinity of Bina & Kakri mines depicted high Mercury, Arsenic and Fluoride contents. The analysis of trace elements near the six major thermal power plants revealed the presence of high toxic elements such as Arsenic, Mercury, Fluoride, etc. in the coal, soil, slurry water and reservoir areas. The soil near the super thermal power plants showed the presence of Arsenolite derived from oxidation of Arsenic bearing sulphides from coal combustion in the super thermal power plants and distributed due to the disposal of heavy amount of fly ash and slurry water in the area. Fluoride is observed in the ground water and reservoir in the vicinity of coal mining areas and it may be due to the presence of high fluorine observed by ICP-MS, SEM and XRD analysis in the coals of Kakri and Bina mining areas. High Fluoride content and its effects had been reported in the eastern part, Dudhi area.

08. VERMA (Neelam)
Geomorphic And Morphometric Investigation of the Ganga River.
Supervisor: Prof. Dr. Vimal Singh
Th 23072

Abstract
(Not Verified)

The Ganga River is one of the most widely studied rivers of India and the investigations delt with various geological aspects such as river response, basin evolution, sediment budgeting etc. Despite being the well studied river, there exists some gaps in knowlege that restrict our understanding of the late Quaternary evolution of the Ganga River. The present research work is an attempt to bridge some of the identified voids. One of the important findings of the present work is the identification of the axial stream of the basin to which has been designated as Himalayan Foreland River (HFR). The analysis of the length, discharge and the incision data pointed out the fact that Ganga River holds its identity upto Allahabad, after which it becomes a tributary to the master stream of the basin (HFR). The sedimentological, geochronological and the geomorphological studies in this stretch of the piedmont segment of the Ganga River highlighted the fact that the Ganga River gained its present position ~7 ka before present. The Ganga Rivers swinged along the western and eastern valley margin after 31ka. The control of the subsurface geology and the climate on the Ganga River in the alluvial plains in the medial reaches is manifested by the behavior of the river. The study suggest the tectonic and climatic control on the geomorphology of the area and the different behavior of the river. Variability in different geomorphic units in the Ganga and Yamuna river and the respective basins suggest the control of Yamuna River on the Ganga River. The present research work added knowledge to the the exiting literature to understand the geomorphic evolution of the Ganga River during late Quaternary. It is also helpful to recreate the sequence of events in the evolutionary history and Quaternary sedimentation of the Ganga River.

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