CHAPTER 21

GEOLOGY

Doctoral Theses

200. BAWA (Nupur)
Fluvial Geomorphology as a Tool for Sustainable Stream Management, An Analysis from the Yamuna River Basin, India.
Supervisors : Dr. Vikrant Jain and Dr. Shashank Shekhar
Th 22566

Contents

1. Introduction. 2. Geomophological characterization of the Yamuna River. 3. Hydrological analysis and connectivity structure of the Yamuna River. 4. Stream power distribution pattern and its controls on geomorphic variability. 5. Geomorphology as a tool for environmental flow assessment : A case study from Delhi. 6. Discussions and conclusions. Annexures and references.

201. BHATTACHARJEE (Dipanjan)
Tectonics of Gavilgarh Fault Zone, Central India : A Multi-Disciplinary Approach.
Supervisor : Prof. Anupam Chattopadhyay
Th 22563

Abstract

Central Indian Tectonic Zone (CITZ), along which the northern and southern Indian cratonic blocks were sutured in Meso-Neoproterozoic, comprises a number of tectonic lineaments, e.g. Son-Narmada North Fault (SNNF), Son-Narmada South Fault (SNSF) and Gavilgarh-Tan Shear/Fault Zone (GTSZ/GFZ) which constitute the Son-Narmada-Tapti (SONATA) fault system. SNSF and Gavilgarh Fault Zone (GFZ) bound the mighty Satpura Mountain ranges, flanked by Narmada and Tapti-Purna river basins in the north and south respectively. This was interpreted by earlier workers as a 'Horst-and-Graben' structure formed by an extensional fault system. However, structural criteria used for this interpretation was unclear. On the contrary, seismological analysis of 1997 Jabbalpur earthquake indicates reverse/reverse-oblique fault movements on SNSF, which is not commensurate with extensional faulting in the recent time. To address this issue, the present doctoral research work was focused on the tectonics of the Gavilgarh Fault Zone, and partly on SNSF. Geological field mapping, structural analysis, geomorphological studies, luminescence dating and experimental modeling were carried out to understand the kinematics and fault reactivation history of the SONATA system. From the above study it is proposed that the Satpura Mountain range is a 'pop-up' structure, bound by two reverse faults viz. north-dipping GFZ and south-dipping SNSF. Presence of Gondwana sediments in the uplifted Satpura terrain indicates that the structural 'pop-up' was produced possibly by

structural inversion of a Paleo- to Mesozoic fault-bounded rift basin (Satpura basin), due to N-S crustal shortening related to the Indo-Tibetan plate collision since Tertiary. This also discards the idea of 'Horst-and-Graben' structure of the SONATA zone. Luminescence dating of river terrace sediments indicates that GFZ is an active fault and repeated tectonic uplift has occurred along the GFZ at ca. 50 ka, 30-40 ka and 14 ka.

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202. DEVRANI (Rahul)
Investigation of Valley-Fill Deposits in the Alaknanda Valley, NW Himalaya - It's Implication on River Response Studies.
Supervisor : Dr. Vimal Singh
Th 22319

Abstract

The valley-fill deposits in mountainous terrain are considered to store records of river response to past climatic shifts. The Alaknanda River basin – headwater tributary of the Ganga River – in NW Himalaya stores enormous amount of such valley-fill deposits that have been studied in the past by several workers. Some recent studies suggested valley-fill aggradation and incision on the basis of investigation of these valley-fill deposits. It is well-known that a river varies in its geological and geomorphological characteristics along its length; therefore, its response should also vary along its length. So this study is taken up to understand the evolution of the valley-fill deposits and controls of various geomorphic processes in specific reaches of the Alaknanda valley. Three windows viz., Pipalkoti valley, Srinagar valley and Kedarnath valley are chosen for this study. The Pipalkoti valley and the Srinagar valley are studied for old valley-fill deposits, whereas 2013 Kedarnath event is investigated to understand the response of a river to high-magnitude event. Comparison of geomorphic parameters like valley width, channel width, shear stress, chi slope value, river gradient along the length of the river, tributary junction and geological parameters such as structures, with the locations of valley-fill deposits shows that the occurrence of valley-fill deposits corresponds with the locations where valley width and channel width are high, chi slope is low, tributary junction and a structure is present. The study finally concludes that a river shows variable response along its length to any climatic event as the geomorphic processes vary in different reaches. It is suggested that individual reach of a river should be first investigated in isolation for geomorphic processes and then different reaches should be correlated. A model to study individual reach has also been proposed.

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203. KAUSHI K (Tushar)

Late Neogene-Quaternary Planktic Foraminiferal Biostratigraphy and Paleoceanography of ODP Hole 807A, Ontong Java Plateau, Western Equatorial Pacific Ocean.

Supervisors : Prof. Devesh K Sinha and Dr. Ashutosh K Singh

Th 22321

Abstract

This work presents a biochronological and paleoceanographic study of planktic foraminifera recovered from the late Neogene-Quaternary section of Ocean Drilling Programme (ODP) Hole 807A, located on the Ontong Java Plateau, western equatorial Pacific Ocean (WEPO). In the present study, 50 planktic foraminiferal events were identified, enabling the identification of eight late Neogene-Quaternary biozones, from Globorotalia plesiotumida Interval Zone to the Globorotalia truncatulinoides Interval Zone. A major faunal turnover (17 events) from late Pliocene identified between 70 and 55 meters below sea floor, and spanning 0.67 million years. This significant faunal turnover is may be the result of the shift in ecological conditions pertaining to the closure of Indo-Pacific Seaway associated with Northern Hemisphere glaciation. The chronological framework for ODP Hole 807A has been refined from shipboard studies by applying Shaw's (1964) graphic correlation method. Based on integrating age model with biostratigraphy, numerical ages for 50 late Neogene and Quaternary planktic foraminiferal events have been determined. The shifting of the Pleistocene base to 2.6 Ma (Gradstein et al., 2012) require approximation with the faunal event for delineating new Pliocene-Pleistocene boundary in marine sections. In the present study, we propose that the last occurrence (LO) of Dentoglobigerina altispira altispira may be used as boundary marker as it occurs close to the Pliocene-Pleistocene boundary. Paleoceanographic studies employing census population and stable isotopic analysis have revealed the existence of proto-warm pool since late Miocene. Planktic foraminifera quantitative and qualitative analysis helped in documenting the timing of the closure of Indonesian Seaway and establishment of WPWP during late Pliocene. High amplitude fluctuation in δ18O values and strength of mixed layer dwellers during late Pleistocene can be associated with the dominating eccentricity (~100Ka) component of Milankovitch cycles resulting in sea level changes in WEP which ultimately influencing the strength of WPWP in western equatorial Pacific Ocean.

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204. MALLICK (Kirtiranjan)

Late Neogene-Quaternary Planktic Foraminiferal Biotratigraphy and Paleoceanography of ODP Hole 846B, Eastern Equatorial Pacific.

Supervisor : Prof. Devesh K. Sinha

Th 22565

Abstract

Finding teleconnections amongst various Oceanographic and climatic phenomena occurring at various parts of the world has been an important component for understanding the ocean-climate system. The Trans tropical Pacific is one such region which is well connected both at the ocean and atmospheric level. Equatorial under current, Cromwell current, south and north equatorial current connects western and eastern equatorial pacific while the Walker circulation connects these two regions via atmosphere. The whole process has profound effect not only on the Trans tropical Pacific but also the climatic pattern across the globe. The episodic strengthening and weakening of Walker circulation has caused La Niña and El Niño events at eastern equatorial pacific. Present study aims at reconstructing paleoceanographic condition of the strategically located ODP hole 846B at 3˚S latitude at Eastern equatorial Pacific. High resolution planktic foraminiferal biostratigraphic work has also been carried out with a sampling interval of 30 cm which roughly represent 9ky for last 6 million years. 46 Planktic foraminifera species have been identified and detailed taxonomic work have been carried out. During late Holocene Globorotalia inflata species show a increase in relative abundance up to 20 percent indicating an expansion of Antarctic Ice Sheet (AIS) which resulted in strengthening of Humboldt Current. Also this study reveals eight episodes during which Mixed layer dwelling planktic foraminiferal species (MLD) show a drastic increase. The faunal variations show peaks abundance of Upwelling indicator species group during late Pleistocene at ~ 300 Kya, 250 Kya, 190 Kya, 71 Kya and 25 Kya , suggesting increased upwelling at the region of site 846B. A correlation with the planktic stable isotopic record of SPECMAP (Imbrie 1984) shows that the above events are coveal with even marine isotopic stages (MIS10, MIS8, MIS6 MIS4 and MIS2).

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205. PATHAK (Vamdev)
Paleomagnetic, AMS and rock Magnetic Magnetic Studles on Lava Flows from Mandla Lobe of the Eastern Deccan Volcanic Province, India.
Supervisors : Prof. J P Shrivastava and Prof. Shiva Kumar Patil
Th 22320

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206. POSHTKOOHI (Monireh)
Geochemical Characterization and Tectonic Setting of Magmatism in the Proterozoic Cratons of Central Iran and Western India.
Supervisor : Prof. Talat Ahmad

Th 22564

Abstract

Biabank–Bafq district is one of the discrete terranes of Gondwanaland in east central Iran. The granitic gneisses exhibit subalkaline to midalkaline, calcalkaline, mostly alkalicalcic, medium to high K, ferrous affinities and are of two different genetic types: I–type and S–type. These samples have chemical features of syncollisional and volcanic arc tectonic environments. Hence, they were emplaced in an orogenic belt. The low –Ti mafic basement and cover rocks distinctly depict tholeiitic and high Ti cover mafic rocks with alkaline affinity and Fe rich in nature. Geochemically, mafic basement and cover rocks from Biabanak–Bafq district and Aravalli Craton in NW India have been derived from arc tholeiite and subcontinental lithosphere mantle source. The similarity between basement and cover rocks of Aravalli Craton and Central Iran have been assigned by negative Nb, Sr, P and Ti, and enrichment of LILE and Fe tholeiitic nature. These features are common in many arc and continental flood basalt suites and Proterozoic dykes, suggesting similar process activated during the evolution of these magma at the Proterozoic Era. On the REE diagram the BE–1 and BE–2 from Aravalli Craton and cover rocks are distinguished by enrichment in LREE relative to heavy REE for the rocks from Biabanak–Bafq district. Based on eNd (1.5 Ga) versus f (Sm/Nd) plot, the Banded Gneiss Complex crust from NW Indian shield and supracrustal rocks of Aravalli block indicate more similarities with the basement and cover rocks from Biabanak–Bafq district. The protoliths of these basement and cover rocks indicate a very long residence time in the crust before the melting event (TDM: 1.2–2.03 Ga and 1.06–1.66; 1.19 –1.91 and 1.28 –1.69). It can be inferred that both Cratons of Central Iran and Western India may have been linked together in the Proterozoic time.

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207. SANTOSH KUMAR

Metamorphic Evolution of the North Delhi Fold Belt (NDFB) and Its Implication on Sulfide Mineralization.

Supervisor : Dr. N. C. Pant

Th 22562

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208. SEKHAMO (Kowete-U)

Late Archaean Magmatism and Tectonic Processes in the Eastern Dharwar Craton, Southern India : Constraints from Zircon Geochronology, Whole Rock Geochemistry and Nd Isotopes.

Supervisor : Prof. M Jayananda

Th 22318

Abstract

The doctoral research presented in the thesis address Paleo- to Neo-archean crust accretion, reworking and evolving geodynamic processes through integrated approach involving field, petrography, U-Pb zircon geochronology, whole rock geochemistry, Nd and Hf isotopic work on the granitoids along the NW-SE crustal corridor of the Dharwar Craton, Southern India. Detailed field work reveals mix of older migmatitic gneisses and younger tonalitic banded gneisses whilst granitoids comprise dominant juvenile (sanukitoids) and minor anatecticcomponents both of which together often define mingling and mixing.Petrographic studies show significant changes in mineralogy from older migmatitic TTG to younger banded tonalities (Na-rich to Ca-rich plagioclase) granitoid facies (hornblende and Cpx in sanukitoids to biotite in anatectic granites).U-Pb zircon ages reveal three major crust forming events (3.3-3.2 Ga, 2.7 Ga and 2.6-2.54 Ga) that contributed to the continental growth in the eastern part of the Dharwar craton. Elemental and Nd-Hf isotope results suggest derivation of basement gneisses through two stage melting of oceanic arc crust at different depths within or beneath the plagioclase stability field while sanukitoids from mantle (hotspot environments) and the anatectic facies as derived from reworking of the pre-existing continental crust. Elemental and isotope data of the TTG-granitoids as well as contemporaneous greenstone volcanism have been attributed to evolving geodynamic processes from dominant arc crust melting during 3.3-2.7 Ga to hotspot magmatism associated with rising plumes during 2.6-2.54 Ga. The present study show episodic accretion of juvenile continental crust during 3.3-3.2 Ga, 2.7 Ga and 2.6-2.54 Ga which culminated with a major episode of reworking and cratonization close to 2.5 Ga.

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209. SHRIVASTAVA (Ankush)
Late Neogene-Quaternary Planktic Foraminiferal Biostratigraphy and Paleoceanography of ODP Site 1085A, Southeast Atlantic..
Supervisor : Prof. Devesh K. Sinha
Th 22561

Abstract

With the growing realization of the role of oceans in controlling the global climate it has become important to understand the past climatic variations and the tolerance of the oceans to such changes. In the present study a sediment core from southeast Atlantic ODP site 1085A was selected to study the variability in upwelling intensity and Interoceanic exchange of surface water between Indian and Atlantic Ocean during

last 6 million years. Broad changes in surface ocean conditions were demonstrated with the help of proxies, in this case planktic foraminifera. This study also tries to contribute towards planktic foraminiferal biostratigraphy with very high resolution sampling (~30cm) of 400m long core (1H-43X) for the last six million years. We documented and illustrate all the late Neogene-Quaternary planktic foraminiferal species from ODP site 1085A, cape basin, Southeast Atlantic Ocean and study the major evolutionary lineages. The planktic foraminiferal documentation from this part of the world ocean is seriously lacking as compared to the other parts of the Atlantic Ocean. Detailed planktic foraminiferal biochronology work has been carried out by estimating the absolute ages of all the late Neogene-Quaternary planktic foraminiferal events; and comparing the dates from Southeast Atlantic Ocean from the other parts of world (Berggren et al 1995a, 1995b). Shaw's graphic correlation method were used for correlating DSDP site 588, 590 (southwest pacific) and ODP site 1085A (Southeast Atlantic ocean examined in the present study) and developing standard composite reference section and age model for precise scaling of the paleoceanographic events that occurred in this region. Also we reconstructed Plio-Pleistocene ocean circulation history in the region based on planktic foraminiferal census data and stable isotope (Oxygen and carbon) record.

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210. SINGH (Arvind Kumar)
Geology, Geochemistry and Evaluation of Hydrocarbon Source Rock Potential for the Argillaceous Intervals from the Proterozoic Vindhyan Basin.
Supervisor : Dr. Partha Pratim Chakraborty
Th 22323

Abstract

The present work attempts characterization of shales across ~ 4.5 km. thick Vindhyan succession, spanning over >500 million years of time period in Proterozoic history. Process-based facies and paleo-environmental analysis of shale units revealed their deposition in marine shelf domain, varying in bathymetry between inner shelf and distal shelf, often beyond storm wave base. From appreciation of facies pattern and paleocurrent, a rift-related half-graben model is proposed for Arangi and Koldaha Shale and low-gradient stable shelf model, with well-defined proximal-distal energy gradient, is proposed for shale units from Rampur Shale onward. Appreciating roles of weathering in the provenance (CIA values), hydrological sorting and mineralogical constitution of shale units, a differentiated felsic source is inferred for the Vindhyan sediments. Factor and XRD analysis suggest some mixing of mafic sediments during Sirbu deposition. Taking into consideration the overwhelming north-westward paleocurrent, south-southeastward provenance is predicted; Chhottanagpur Gneissic Complex (CGC) and Mahakoshals are probable source terrains. From low concentration of molybdenum (Mo) and Mo/TOC ratios in Vindhyan shales, it is

inferred that the Vindhyan sea was a stratified sea with Sulphidic, reduced deep water and oxygenated surface water in most parts of its depositional history and the basin eventually became uniformly circulated during the Sirbu time including oxygenation of its deep water which is evident from ~3‰ enrichment in $^{13}\delta C_{org.}$ value within organic matter from the Sirbu Shale. The formations- specific Total Organic Carbon (TOC) analyses revealed high (>2 % up to 8 %) values within Arangi and Bijaygarh Shales. Further, C-H-S analysis and Rock-Eval pyrolysis suggested Vindhyan organic matters as Type-III (humic) in character with high carbon (C) and negligible hydrogen (H) contents and thus, gas-prone but most are under- or over-matured, except Arangi and Bijaygarh Shales. Hence, these two shales show some potential for hydrocarbon production.

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211. SINGH (Vikram Pratap)
Quaternary Paleoceanography of ODP Sites from the Sulu Sea and Equatorial Indian Ocean : Planktic Foraminiferal Evidences
Supervisors : Prof. Devesh K Sinha and Dr. Ashutosh K Singh
Th 22317

Abstract

This work aims at studying the effects of variation in Western Pacific Warm Pool on the climatic conditions over Indian Ocean during the Quaternary Period, with the help of planktic foraminifera recovered from two tropical ODP sites in Sulu Sea and equatorial Indian Ocean. The Sulu Sea is connected to South China Sea, Pacific Ocean and Celebes Sea and forms an integral part of the ITF. The Indian Ocean is affected by the migration of the ITCZ, which controls the Indian monsoon and equatorial upwelling. The analysis of planktic foraminifera from Sulu Sea reverals reduction in WPWP several times during Quaternary, identified on the basis of seven Pulleniatina Minimum Events. The PMEs show a striking coincidence with positive excursion in $\delta^{18}O$ records of foraminiferal tests and indicate towards declining SST due to reduction in the WPWP. This reduction could be due to glacial- and ENSO- events. The glacial events were identified by occurrence of temperate species along with abundance of eutrophic species suggesting intensification of the cold Oyashio Current, while ENSO events are marked by the abundance of eutrophic species and absence of temperate fauna. The Indian Ocean records reveal six events of northward ITCZ migration, named as Quaternary ITCZ Migration Events (QIM events), identified on the basis of an abundance of upwelling indicator species. The high abundance of upwelling indicator species indicates towards the northward migration of ITCZ that cause convergence of strong trade winds, thereby intensifying the equatorial upwelling. The comparison of data from both the sites has revealed that the PMEs are

coincident with QIM and suggest that due to reduction in WPWP, the SST in the Indian Ocean would have severely diminished and led to the development of strong pressure-temperature gradient. As a result the SW winds would have intensified causing the northward migration of ITCZ.

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212. SRIVASTAVA (Surabhi)
Compositional Studies on Organic Matter Associated with Clays of the Jhilmili and other Intra-volcanic Bole Beds from the Eastern Deccan Volcanic Province : Palaeoenvironmental Implications and K/Pg Boundary Transition.
Supervisor : Prof. J P Srivastava
Th 22322

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