CHAPTER 22

GEOLOGY

Doctoral Theses

01. AADHISESHAN (K. R.)
Crustal Evolution in the Central Part of the Chitradurga Greenstone Belt and Surrounding Basment, Dharwar Craton, Southern India.
Supervisors : Prof. M. Jayanada and Prof. G. V. R. Prasad
Th 23905

Abstract
(Not Verified)

The present study from Dharwar craton is focused mainly on the basement gneisses and greenstone belts across Chitradurga boundary shear zone with the specific emphasis to understand the crustal evolution processes including the time frame of crust formation, petrogenetic processes, geodynamic context and micro block amalgamation. In order to address these issues, a detailed field, petrography, whole rock geochemistry and Nd isotope study of greenstone belts (Sargur Group-J. C. Pura, Bababudan Group-Kibbanahalli arm, Chitradurga and Javagondanahalli sequences) and U-Pb zircongeochronology of surrounding TTG basement in the west and east of Chitradurga boundary shearzone have been carried out. Western basement is dominated by old classical TTG (3313-3167 Ma) comprising dark grey banded tonalitic facies and a grey banded granodioritic facies with whitishtrondhjemite found along the foliation and/or some places cut-across tonalite and granodiorite. On the other hand, the eastern basement is mixture of old (3231-3176 Ma) and young basement (2600-2560Ma) rocks which comprising of the migmatitic gneisses belong to TTG series wherein they contain dark grey tonalite, grey granodiorite and whitish grey trondhjemite. The flat gneiss consists of most abundant dark grey coarse grained tonalite to quartz monzonite and minor granodiorite. Among greenstones Sargur Group-J.C. Pura dominated by komatiites (3385 Ma), Kibbanahalli arm (3000Ma), Chitradurga (2747 Ma) and Javagondanahalli (2740 Ma) are basalt and amphibolite incomposition. With detailed whole rock geochemistry and Nd isotopes reveals that western basement and old ereastern basement were generated at melting of a heterogeneous thickened oceanic island arc crust at shallow depth whilst melting of the base of such an arc crust or an oceanic plateau crust. The komatiite magma generation attributed to hotspot environment with raising mantle plume whereas the Kibbanahalli arm, Chitradurga basalts and Javagondanahalliamphibolites are attributed to arc, backarcand continental arc respectively.

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02. ANANYA DIVYADARSHINI
Morphotectonic Evolution of the ChitwanIntermontane Valley and its bordering Mountain Fronts, Central Himalaya, Nepal.
Supervisor : Dr. Vimal Singh
Th 23907

Abstract
(Verified)

Several intermontane valleys (locally also called as 'dun') are present along the frontal part of the Himalaya, e.g., Pinjaur and Dehra duns in the northwest and the Dang and Chitwan duns in the Central Himalaya. They have distinct landforms developed during the Late Quaternary under the combined influence of climate and tectonics. In contrast to the northwest Himalaya, the central Himalayan duns are not well studied. Hence, in the present study, we have investigated the Chitwan dun area. The primary objective of this study is to assess the influence of structures and Late Quaternary climatic fluctuations on land form development in the Chitwan dun. The morphotectonic evolution of the Frontal Siwalik (Churia) ranges is also investigated. The methodology used in this study includes detailed geomorphic and structural mapping, the study of geomorphic indices, topographic profiles, longitudinal river profiles, and drainage anomalies, combined with sedimentary characterization and OSL dating of the dun land forms. We identify several active structures in the Chitwan dun, associated with the Inner and Frontal Siwalik Ranges. They have shown intermittent tectonic activity during the Late Quaternary-Holocene; this has resulted in the development of several landforms and drainage reorganization in the study area. Climate plays an essential role in the geomorphic development of the Chitwandun towards the end of Pleistocene. We infer that the frontal ranges represent folds developed along six MFT segments initiated at different times. They either merge linearly or get relayed and truncated on opposite sides of a preexisting tear fault that controls the stress partitioning in the region. We conclude that faults identified in the study area have a potential for surface rupturing during future earth quakes, necessitating detailed investigation for future seismic threat.

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03. MEENAKSHI

Physil Compostional, Cell Parameteric and Organomolecular Records of the Chronolgically Constrained Loess-Palaeosols from Dilpur Formation, Kashmir : Palaeoclimatic Reconstruction.

Supervisors : Prof. J. P. Shrivastava and Prof. Rakesh Chandra

Th 24281

Abstract
(Not Verified)

Uncontaminated, continuous Dilpur Formation sequence, Karewa Group archives glacial-interglacial episodes of Pleistocene age. Lithostratigraphic sections were studied to reconstruct palaeoclimatic history. On the basis of 14C AMS ages, Last Glacial Maxima (18-22 ka) and Penultimate Glacial Maxima (127-130 ka) were recognized along with a stadial period of 65-67 ka. Clay minerals revealed effect of pedogenesis which led to smectitization of illite under pre and post-glaciations. Climate sensitive clay minerals yielded a cold period of 30 ka (covering pre and post glaciation) and warm (inter-stadial) period of 10 ka. Further, cell parametric and inter-atomic distances of the clay minerals show lattice distortions in illite as well as chlorite structures associated with the palaeosol layers deposited just prior and

subsequent to the glaciations. The cell parameters revealed three glacial incidences of ~5 ka each and two inter glaciations ~ 55 ka each. Organo-molecular studies revealed climate linked changes in the vegetation patterns during inter-stadial and transitional periods marked by abundance of grass-type of vegetation at the time of deposition of palaeosol layers just prior and subsequent to the loess layers. However, higher plants and trees marked their dominance during the deposition of other palaeosol layers pedogenised during interstadial periods. Clay mineralogical, 14C ages and organo-molecular results and durations of glaciations correlate well with the Chinese Loess Plateau and Marine Isotope Stages (MIS) of Lisiecki and Ramyo (2011) from North Atlantic, respectively. Finally, palaeocliamtic set-up in conjunction with the published work resolved three stadials of 127 - 94, 78 - 58 and 42 - 10 ka intervened by three inter-stadials of 94 - 78, 58 - 42 and 10 - 0 ka.

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04. SARKAR (Arindam)
Mesoscopic, Microscopic and Geochemical Study of Pseudotachylytes: Understanding the Frictional Melting Process in Seismic Fault Zones.
Supervisor : Prof. Anupam Chattopadhyay
Th 23906

Abstract
(Verified)

Genesis of fault-related pseudotachylyte is fraught with many controversies, some of which have been addressed in the present study. Pseudotachylytes from Sarwar-Junia Fault Zone (SJFZ) in Rajasthan and Gavilgarh-Tan Shear Zone (GTSZ) in Central India were studied in the present doctoral research project. Outcrop study of the SJFZ pseudotachylytes show a variety of melt-rich veins (M-Pt) with complex network, produced by multiple episodes of brittle shearing within a fault zone cutting across garnet-kyanite-biotite gneiss intruded by dolerite dykes. In contrast, the GTSZ pseudotachylytes show fault vein-injection vein network within my loniticgranitoids over a large area, possibly produced by aingle major earthquake. Microstructural (optical and SEM) study of M-Pt shows spectacular melt-origin microstructures like spherulites, microlites, coronastructures and glassy patches in the matrix, pointing undoubtedly to a melt-origin. C-Pt shows dominantcataclasis of host rock mineral grains with limited melting along the grain margins. XRD study shows indirect evidence of glass phase in M-Pt. Relict clast size versus frequency distribution of M-Pt and C-Pt shows powerlaw (fractal) relationship with deviation at the finest and the coarsest size ranges which suggests preferential melting and removal of finest size clasts from the matrix. In contrast, a cataclasite (Ct) shows bi-fractal size frequency distribution indicating absence of melt. Roundness of clasts in M-Pt, C-Pt and Ct cannot show anun ambiguous relationship between melting and roundness. Geochemistry of M-Pt veins, their host rocks, microlites and matrix domains suggests that pseudotachylyte is produced by preferential melting of maficmineral phases of the host rock by disequilibrium melting. During cooling of the melt a variety of microlites, with chemical composition different from the parent rock minerals, crystallize from the melt and form the matrix.Rate of cooling varies within a single pseudotachylyte vein and/or between different veins, and produces avariety of microlitic and spherulitic microstructures.

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1.Introduction 2. Geogogical settings of the study areas 3. Field study of pseudotachylyte 4. Microstructure of pseudotachylyte veins 5. Grain size and roundness analysis of relict clasts in pseudotachylyte 6. Geochemical study of melt-dominated pseudotachylyte 7. Discussion 8. Summary and conclusions. Reference.

05. SHUBHENDU (Shekhar)
Depositional Modelling of the Post : Burdigalian Sandhan Formation, Western Kutch, India in 'Sequence' Stratigraphic Backdrop.
Supervisor : Dr. Pramod Kumar
Th 23904

Abstract
(Verified)

Sequence stratigraphy is a novel concept of sedimentary record that provides a predictive model of basin fill architecture bounded by time-correlative plane. The concept aims at relative sea-level fluctuation and tries to find out amplitude and rate of past change in sea-level, hence it is a process based stratigraphic analysis, descriptive discipline and predictive model of basin-fill architecture. The systems tract forms during the various stage of base-level curve thus include the entire range of depositional systems along the dip of the sedimentary basin, from fluvial to coastal, shallow-marine and deep-marine. Facies are deposited under particular depositional condition and reflect processes operated (flow-regime dynamics), thus product reflects the particular environment of deposition. The post-Burdigalian siliciclastic dominated Sandhan Formation deposited in passive-margin setting, controlled by relative sea-level vs. rate of siliciclastic supply without tectonic hindrance deposited inhigh energy open shoreline condition characterized by the shallow-marine bar-trough system, can be divided into the lower marine (138m) and upper braided fluvial deposits (150m) along the type-section, Kankawati River. The succession is comprised of 7 facies associations: 1-Foreshore (beach), 2-Uppershoreface, 3-Lower shore face, 4-Lagoon and barrier bar. 5-Channel and channel fill, 2-Sandy and gravel bar 3-Overbank fines and paleosol. The two-tier unconformity-bounded Sandhan Formation represents a strong asymmetric sequence, is divided into transgressive systems tract, high stand systems tract and falling stage systems tract are separated by sequence boundary, maximum flooding surface and basal surface of forced regression. The thick fluvial sediments at the upper part of the Sandhan Formation is identified as high energy braided system (Donjek-type) in the type section area, on the other side of the Median-High, fluvial is characterized by Platte-type braided system. The distribution of facies in the study area is controlled by pre-existing Mesozoic structures (Naira Riverfault and Median High), led to saucer-shape basin geometry.

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1.Introduction 2.Regional geology 3.Facies analysis 4.Architectural element analysis 5.Organic palynofacies 6.Sequence stratigraphy 7. Depositional model and paleogrographicsetting 8. Conclusions. References.

06. SUKUMAR PARIDA
Investigating Connectivity Structure of Dehra Dun, NW Himalaya.
Supervisors : Dr. Vimal Singh and Prof. Sampat Kumar Tandon
Th 24307

Abstract
(Verified)

A river acts as a 'conveyor belt' that connects various landscape units and moves matter, energy, and life. These landscape units are categorized as sources, buffers, and sinks. In the Ganga river system, the Himalaya and the Indian craton act as sources, the Ganga plains form the buffer zone, and the Ganga-Brahmaputra delta forms the sink. Efficiency of material transfer between these zones depends on the connectivity of various landscape units. The frontal Himalaya experience high uplift and are prone to erosion. However, a noticeable portion of sediment produced here gets trapped in buffer zones like intermontane valleys that store and evacuate sediments at different time scales. We investigated connectivity structure of one such intermontane valley - Dehra Dun present in the NW Himalaya. We have looked at (i) the channel width variations along the rivers of Dehra Dun, (ii) hydrological connectivity of three ungauged rivers by estimating bank full discharge, and (iii) the grain size evolution by analysing mid-channel bars of the same three rivers. The results of these analyses are compared to the connectivity index (IC) map of the study area. The results suggest that the northern Mussoorie Range is connected to the axial rivers by the Dun rivers. Further, the results show that the longitudinal connectivity of coarse sediments along the Dun rivers is poor. We conclude that within Dehra Dun, the landforms such as surfaces, and terraces also act as compartments and buffer the sediments derived from the Mussoorie range. These compartments get connected to the Ganga and the Yamuna rivers when the rivers in the Dun are incising; whereas, they get disconnected during the steady state and aggradation phase of the Dun rivers. These processes have huge potential to impact the sediment dynamics in the proximal Ganga Plains.

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07. VARAY (L. Sardine)
Geomorphic Analysis of Glacio-Fluvial Coupling in Two Neighbouring River Basins in the Northwest Himalayas India.
Supervisors : Dr. S. K. Singh and Dr. Vikrant Jain
Th 23908

Abstract
(Not Verified)

The impact of increased temperature on the Third Pole, as the Himalayas is referred to, and the likely cascading impacts on the general downstream hydrology have been widely noted. However, the impact on the fluvial geomorphology has not received specific attention. Change in The glacial domain in terms of melt increase and permafrost degeneration will change discharge and sediment flux into fluvial system, which will induce change in fluvial processes and forms. This process based glacio-fluvial coupling is studied in the two glaciated basins in the northwest Himalaya, viz., the Sutlej River basin and the Yamuna River basin. The two basins have seen a decrease in the clean glacier cover with a corresponding increase in the glacial lake area over the past fifteen years(2000-2015) with a greater magnitude of change in the Sutlej River basin. Stable oxygen isotope of water samples showed that melt contributes about 41.1% to 66.79% and 6.56% to 10.63% to the total river discharge in the Sutlej and the Tons River (glaciated tributary of the Yamuna River) basins respectively. For different scenarios of increase in melt, stream power increase in the Sutlej River basin will be significant as opposed to the Tons River. Further, topographic analyses through hypsometric integral, steepness index, chi (χ) plot and excess topography showed that the Sutlej River basin is more out of equilibrium compared to the Yamuna River basin. This finding along with greater and more enduring permafrost degeneration will translate into more vigorous sediment mobilization in the Sutlej River basin. Present analysis shows that even though the Sutlej and

the Yamuna river basins are neighbouring basins, the geomorphic response to enhanced glacial melting will be significantly different. The river reaches in the Sutlej River basin will be significantly more impacted in comparison to the Yamuna River system.

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