Department of Earth Sciences (DES)

The Department of Earth Sciences (DES), IISER Kolkata is looking for bright and motivated students, who have completed their M.Sc./MS/M.Sc. Tech/M. Tech (with **minimum of 55% marks**) in: 1) Geology/Applied Geology/Geophysics /Earth Sciences/Marine geology/Environmental Sciences/Environmental Studies/Atmospheric Science/Environmental Engineering/Civil Engineering or any other branch of Geological sciences.

Or

2) Physics/Chemistry/Mathematics/Biological Sciences/Computational Seismology/interested to pursue research with the DES faculty member in the matching specialization.

Final year post-graduate students who are yet to obtain their degree may also apply; however, they must have completed their degree at the time of admission. Some of the important information about this program is provided below.

Eligibility for externally funded students: Candidates having valid **CSIR NET JRF / UGC-NET JRF / DST-INSPIRE / other equivalent fellowship** would be eligible to apply.

- Candidates must have **physics, chemistry and mathematics at 10+2 level**, and at least one of these subjects at their bachelor level.
- They can work with any faculty member in DES based on mutual research interest. The research areas in which department is looking for young and bright minds are listed below-

1. **Environmental Sciences**- Dr. Gopala Krishna Darbha is leading the environmental nanoscience and hydrogeochemistry group at the Department of Earth Sciences, IISER Kolkata. Their work is interdisciplinary, focusing on environment-geochemistry-colloid science. Their study involves understanding the factors responsible for the fate (stability and transport) of pollutants (such as plastics, pesticides, metals, persistent organic compounds) in the riverine and soil environments and further their sorption onto rock and mineral surfaces under the prevailing environmental conditions (pH, T, humic acid, carbonates and other suspended particulate matter such as clay).They are currently working on i) the impact of hydrogeochemistry on the transport of metal pollutants along the lower Ganga river basin ii) understanding the distribution and fate of micro- to nano- plastics along coastal zonesand rivers of India iii) the fate of nanopesticides in the environment iv)the transport of pollutants in porous (soil) media: column experiments&modelling v) application of eco-friendly materials derived from agricultural waste to remediate the potentially toxic metals such as chromium, lead, arsenic, zinc as well the organic contaminants such as dyes, perfluoroalkyl compounds. For more details on recent publications, achievements etc., please visit our website:https://gkdarbha.wixsite.com/gopaladarbha. The recent publications include:

   i)Impact of long-term storage of various redox-sensitive supported nanocomposites on their application in removal of dyes from wastewater: mechanisms delineation through spectroscopic investigations, Nitin Khandelwal, Ekta Tiwari, Nisha Singh, Remi Marsac, Thorsten Schäfer, Fazel AbdolahpurMonikh, Gopala Krishna Darbha, **Journal of Hazardous Materials, 2021, 401, 123375 (IF=9.038)**

   ii) Application of Zn/Al Layered Double Hydroxides for the removal of nano-scale plastic debris from aqueous systems, Ekta Tiwari, Nisha Singh, Nitin Khandelwal, Fazel AbdolahpurMonikh, Gopala Krishna Darbha, **Journal of Hazardous Materials, 397, 122769, 2020 (IF=9.038)**

iii) Effect of irrigation water type and other environmental parameters on CeO2 nanopesticide-clay colloid interactions, Ekta Tiwari, Mithu Mondal, Nisha Singh, Nitin Khandelwal, Fazel AbdolahpurMonikh, Gopala Krishna Darbha, **Environ. Sci.: Processes Impacts, 22, 1, 2020** ***(Selected as cover page article)*** **(IF=3.238)**

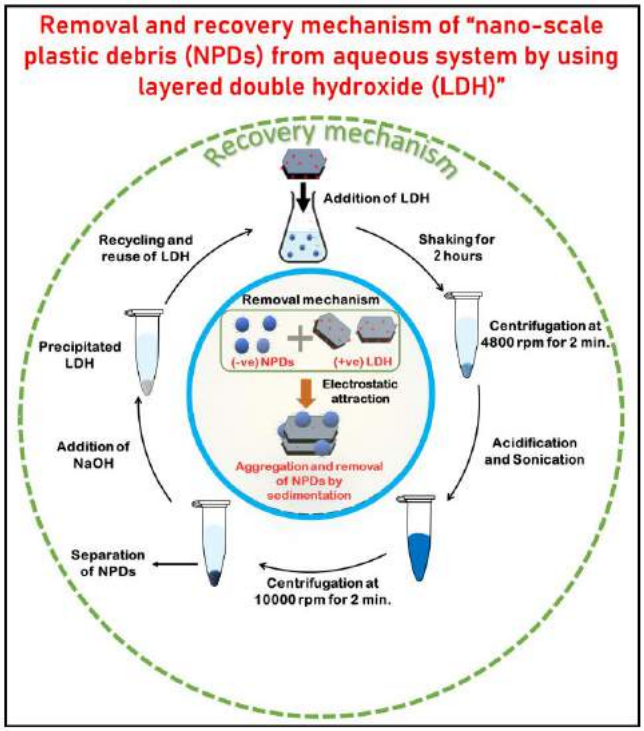
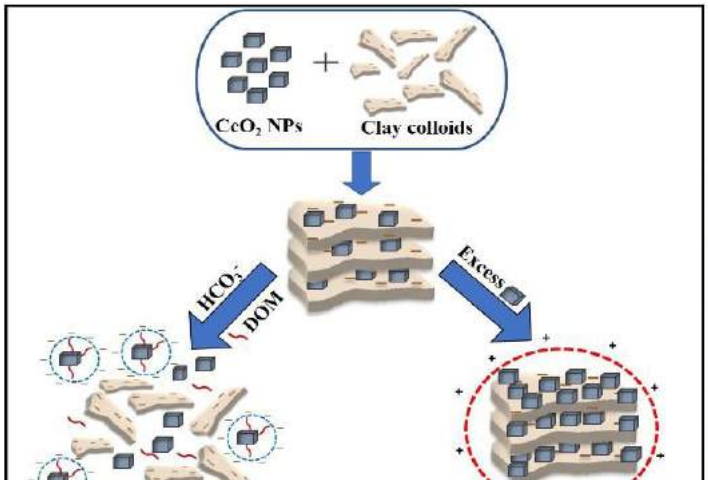


Figure 1: Mechanism to show the removal and recovery of nanoplastic debris from aqueous systems. J. Hazard. Mater., 2020, 397, 122769



2. **Computational Mineral Physics Group-** The Earth's interior is inaccessible to mankind. However, the evolution of the Earth and the other planets, as well as their present structure and dynamics, depends on processes that take place in their deep interiors. There are several ways in which the Earth's interior can be probed indirectly. First principles quantum mechanical based studies being one of them. In the last two decades it has progressively grown into an indispensable tool which is employed in conjugation with results flowing out of seismology, cosmochemistry, geochemistry, meteoritics, and high pressure and temperature laboratory

experiments to extract useful information that help us to thermodynamically model the Earth's interior.

The Mineral Physics group here at IISER Kolkata performs first principles density functional theory (DFT) based studies to investigate the dynamical stability and thermoelastic properties of probable phases inside the Earth at pressure and temperature conditions up to the Earth's inner core. Thermoelastic properties of minerals and melts are the crucial link that permit the seismic tomographic images of the Earth's interior to be translated into information of geophysical significance: mineralogy, composition, and temperature. State-of-the-art high-pressure experimental techniques and quantum mechanical first-principles atomistic simulations complement each other and help us obtain robust estimates of various physical and chemical parameters needed for seismic and geodynamical study of Earth interiors. For a brief overview of the scope of first principles based studies in Geo-sciences one may refer to the following review article: J. Brodholt and L Vočadlo, MRS Bulletin, Vol 31, September 2006. Dr. Gaurav Shukla and Dr. Swastika Chatterjee are currently leading this group.

3. **Geophysics-** Prof. Supriyo Mitra is looking for highly motivated PhD candidate to work in Seismology. The candidate is suppose to work in a project entitled "Seismic attenuation tomography of the Himalayas".
4. **Structural Geology-** Dr. Kathakali Bhattacharyya is looking for highly motivated PhD candidate to work on problems addressing structural and kinematic evolution of deformed rocks by deciphering structures at multiple scales. The requirements are a strong background in fundamentals of Structural Geology with experience in related fieldwork.
5. **Paleobiology** - A distinctive characteristic of life's evolutionary history is the increase in taxonomical and ecological diversity during the Phanerozoic (Bambach et al., 2007; Alroy et al., 2008). For marine invertebrates, numerous studies have analysed these diversification patterns and identified several potential causal mechanisms 'driving' these changes. However, a few issues require additional attention, and a candidate will have the opportunity to work on any of this general research themes: (1) analyzing the pattern of morphologic diversity evolution of marine invertebrates through time and its causal relationship with taxonomical and ecological diversities; (2) analyzing the biogeographic patterns of taxonomical and ecological diversifications of marine invertebrates through space and time. Basic knowledge in the 'R' Programming language is required. Dr. Subhronil Mondal is leading this group.

   References: (i) Alroy, J, et al. 2008. Phanerozoic trends in the global diversity of marine invertebrates. Science 321.5885: 97-100. (ii) Bambach, R.K., et al. 2007. Autecology and the filling of ecospace: key metazoan radiations. Palaeontology 50:1–22.
6. **Tectonic Geomorphology**- The Earth Surface Dynamics group led by Dr. Sanjay Kumar Mandal is looking for highly motivated Ph.D. candidates interested in the broad areas of tectonics and geomorphology. The successful candidate will have the opportunity to design and conduct research in one or more of the following areas: (1) deciphering the geomorphic sensitivity of Himalaya to climate change and associated hazards on natural and human systems; (2) orogen-scale climate-erosion-tectonics coupling; (3) decoding tectonics from topography, geomorphic, and sedimentological archives with key emphasis on the foreland basin and terrace-fill sedimentary records of the Himalaya. The multidisciplinary research work will be based on a combination of fieldwork, isotopic analysis of natural samples (such as bedrock, soil, and sediments), and numerical models. The students are expected to conduct original research, present research findings in national or international conferences, and publish

in peer-reviewed scientific journals. The following figures show our present field areas in the northwestern Indian Himalaya.

Figure 1. Thick valley-fill straddling the Yamuna River in northwestern Indian Himalaya.

Figure 2. Fluvial landscape of the Yamuna basin in northwestern Indian Himalaya.

7. **Metamorphic Petrology:** Metamorphic Petrology Research Group: The members of this group are interested in understanding the processes involved in the formation and evolution of continental crust through geological time by studying the high-grade metamorphic rocks in orogenic belts. High-grade metamorphic rocks provide us a window into the lower crust. The information stored in these rocks helps to characterize tectonometamorphic processes and reconstruct the pressure-temperature (P-T) evolution path followed by the rocks. Dating metamorphic events is a major aspect for the understanding of orogenic processes. It brings temporal constraints on the pressure-temperature evolution (P-T path) of rocks during their burial (e.g. in subduction zones) and subsequent exhumation. Coupling metamorphic and geochronological data is therefore crucial for the understanding of the dynamics of orogenic belts and, consequently, for proposing any geodynamic reconstructions. The group is currently working on the different regions of the Southern Granulite Terrane and Eastern Ghats Belt. The goal of these studies is to combine state-of-the-art petrological, geochemical and geochronological analyses on the studied rocks to understand crustal evolution. The metamorphic petrology research group at the Department of Earth Sciences at IISER Kolkata is currently led by Dr.Tapabrato Sarkar.

8. **Archean crustal evolution in central India: A granitoid perspective**

The actual mechanism of Archaean crust formation remains a major research interest globally. Granitoids are the dominant rock type in Archaean cratons. They provide vital clues to the mechanism and geodynamic setting of continental crust formation. Archaean granitoids of diverse types are well exposed in central India. This Ph.D. project aims to study the field and age relationship, and geochemistry of these granitoids to understand their petrogenesis, role in crust formation and crust-mantle interaction, and to suggest geodynamic model for Archaean crustal evolution. The project will provide an opportunity to the candidate to get involved in field mapping and detailed sampling in exotic terrains followed by petro-mineralogical study, whole-rock geochemistry and zircon U-Pb dating and Hf isotopic study. The student is suppose

to work with Dr. Sukanta Dey.

References: (i) Ghosh, J.G., 2004. 3.56Ga tonalite in the central part of the Bastar Craton, India: oldest Indiandate. Journal of Asian Earth Sciences, 23, 359–364. (ii) Mondal, M.E.A., Hussain, M.F., Ahmad, T. 2019. Archaean granitoids of Bastar craton, Central India. In: S. Dey, J.-F. Moyen (Eds.), Archean Granitoids of India: Windows into Early Earth Tectonics Geological Society, London, Special Publications, 489,https://doi.org/10.1144/SP489-2019-311 (iii) Hariharan, R., Mukhopadhyay, J., Beukes, N.J., Gutzmer, J., Belyanin, G.A., Armstrong, R.A., 2009. Evidence for an early Archaean granite from Bastar craton, India. Journal of theGeological Society, 166, 193–196.

Please note *that fulfilling the minimum essential criteria does not ensure that a candidate will be called for the interview. Additional criteria for shortlisting might be set by the department based on academic records, experience and research interest of the candidates. Reservations of candidates will be as per government norms.The departmental faculty profiles can be found at the URL: http://www.iiserkol.ac.in*