Harsh Thakur

B.S./M.S. (Research), Majoring in Earth Science, Minor in Physics
Indian Institute of Science, Bangalore

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Research Interests: Planetary Sciences, Cosmochemistry, Origin of the Solar System

Education

Degree	Institute/Board	CGPA/Percentage	Year
Master of Science + Bachelor of Science (Research)	Indian Institute of Science	8.1 (as of Nov 2023)	2019-2024
Senior Secondary (Science & Math)	Central Board of Secondary Education	92%	2017-2019
Secondary	Central Board of Secondary Education	10/10	2017

Research Projects

- **Cratering Experiments (MEMIN-related) and Laser Ablation driven shock experiments on samples from Lonar Crater** *November 2023 – Present*

Prof. Ramananda Chakrabarti Centre for Earth Sciences (IISc, Bangalore)
Prof. Gopalan Jagadeesh Aerospace Engineering (IISc, Bangalore)
Prof. Steven Goderis Vrije Universiteit Brussel (Belgium)

– Plan to perform cratering experiments on samples from the Lonar crater, India, to study the compositional differences between source rock and ejecta after impact based on the MEMIN (Multidisciplinary Experimental and Modeling Impact Crater Research Network) experiments.
– To constrain shock-induced thermodynamic changes and rim formation through laser-ablation driver shock experiments.

- **Investigating HED Petrogenesis and Magmatic Evolution Through In-Situ Trace Element Abundances, and Sm-Nd, Ca, and Oxygen Isotopic Compositions** *August 2023 – Present*

Master of Science (Research) Thesis Advisors:
Prof. Ramananda Chakrabarti Indian Institute of Science (IISc, Bangalore)
Dr. Dwijesh Ray Physical Research Laboratory (PRL, Ahmedabad)
Prof. Mahesh Anand The Open University (Milton Keynes)

– Will be building upon the work done during my Bachelor's by measuring bulk isotopic data to dive deep into HED petrogenesis and the magmatic evolution of Vesta.
– Will investigate the in-situ REE (Rare-Earth Elements) patterns using LA-ICP-MS to analyse the Ce anomalies to understand whether it is a product of terrestrial weathering or an impact-related process
– LA-ICP-MS will also help in looking into HSE (Highly Siderophile Elements) abundances in individual grains of pyroxenes and plagioclase to comment upon the pristinity of these samples.
– This work will also include determining the Sm-Nd and Ca isotopic compositions using TIMS, which would tell a story about Vestan differentiation and its crustal evolution, respectively.
– The dating of zircon grains found in Lakangaon will lead to precise determination of the age of highly ferroan basaltic eucrites (like Lakangaon and Nuevo-Laredo).

- **Modeling The Sources of Lunar Mare Basalts Mapped by Chandrayaan-2** *May 2023 – June 2023*

Summer Intern Project Advisor: Dr. Shyama Narendranath Indian Space Research Organisation (ISRO)

– Modeled the crystallization pathway of the Lunar Magma Ocean (LMO) using the FXMOTR program starting from specific P-T conditions to form cumulate layers of distinct mineral modes and compositions at different depths.
– Gradient descent optimisation algorithm was used to retrieve the contribution from shallow and deep cumulate mantle layers after linear mixing.
– Results of the model are compared with elemental abundances from CLASS data (from Chandrayaan-2) over the mare.
– Manuscript under preparation. Abstract presented in-person at LEAG 2023. **Link**

- **Petrogenesis and Geochemistry of Fall HED Meteorites**

Bachelor of Science (Research) Thesis Advisors: *July 2022 – May 2023*
Prof. Ramananda Chakrabarti Indian Institute of Science (IISc, Bangalore)
Dr. Dwijesh Ray Physical Research Laboratory (PRL, Ahmedabad)

– Petrography of four HED fall (Lakangaon, Piplia Kalan, Lohawat, Vissannapeta) samples under EPMA.
– Acquired the ICP-MS data of these four samples to look at the bulk-rock trends, REE patterns, and MSE (Moderately Siderophile Elements) concentrations.
– In this study, an attempt has been made to model the formation of basaltic eucrites using a two-stage model (and a single-stage model for cumulate eucrites) based on the rare-earth element compositions assuming a chondritic (CI) precursor.
– Explored the possibility of impact contamination in eucrites and howardites through MSE concentrations and mixing models of pristine eucritic material with carbonaceous chondrites (CM/CR) material.
– Manuscript under preparation. (**Link** will be updated by Jan 2024) Thesis **Link.** Abstract presented in-person at MetSoc 2023. **Link**

- **The Lakangaon eucrite: a unique, non-cumulate piece of rock from the Vesta** *May 2022 - July 2022*

Summer Research Project Advisor: Dr. Dwijesh Ray Physical Research Laboratory (PRL), Ahmedabad

– Petrography and Petrogenesis of Lakangaon, an Indian Basaltic Eucrite derived from the HED Parent Body.
– Studied mineral chemistry, accessory phases, whole-rock chemistry, and Rare-Earth Element (REE) patterns to understand the formation of this unusually Fe-rich basaltic eucrite on the surface of 4Vesta, using EPMA and ICP-MS.
– Manuscript submitted in Geochemistry - **Link**. Abstract presented in-person at MetMESS – 2022. **Link**

- **Gas-Solid Reactions Relevant to Planetary Processes** *May 2021 - July 2021*

Summer Research Project Advisor: Prof. Penelope King Research School of Earth Sciences
Australian National University
– Declined offer due to COVID-19 travel restrictions

- **Aqueous alteration in the CM parent bodies in the early Solar System** *May 2021 - July 2021*

Summer Research Project Advisor: Prof. Ramananda Chakrabarti Indian Institute of Science (IISc, Bangalore)

– Analyzed the existing data of CM1 and CM2 chondrites, their trace element concentration patterns (including Rare-Earth Elements) and Ca isotopic composition.
– Compared mass spectrometric techniques and reference standards corresponding to the papers on calcium isotopes.
– Future work will include measuring Ca stable isotopes in CM chondrites using a double-spike TIMS technique.

Field Training

- **Inter-University Exchange Program on Sustainable Earth** *8 – 23 July, 2023*
Niigata University, Japan

– Field training program as part of the Inter-University Exchange Project, Human Resource Development Program on Field Science Research in the Indo-Pacific Region supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology, Japan).
– Studied sedimentary outcrops to understand the type of flow, sedimentation, and collected fossils.
– Visited the Fossa Magna Museum (UNESCO Geopark) and the North-American plate - Eurasian plate fault line.
– Visited the labs that study natural hazards at Niigata University and INPEX company to see their operations on natural gas.

- **Field Trip to KGF (Kolar Gold Fields), Karnataka, India** *26 Feb, 2023*
Indian Institute of Science (IISc, Bangalore)

– Field training at Kolar Gold Fields, one of the oldest gold producing mines in the world, which lies on an archaen Dharwar Craton in Southern India.
– A thin band of banded iron formation runs almost N-S in the western part of the area. Texturally there were four distinct types of amphibolites classified as massive, schistose, granular and fibrous.

Presentations and Conference Experience

Presented Abstract at LEAG (Lunar Exploration and Analysis Group) – 2023, titled "Modeling the Sources of Lunar Mare Basalts Mapped by Chandrayaan-2" The travel was supported by an early-career researcher travel grant.	20-22 September, 2023
Presented Abstract at MetSoc – 2023, titled "Petrogenesis and Geochemistry of Fall HED Meteorites" The travel was supported by the Barringer Travel Award	13-18 August, 2023
Presented Abstract at MetMESS – 2022, titled "The Lakangaon eucrite, a unique, non-cumulate piece of rock from the Vesta"	24 - 25 November, 2022
Attended Platinum Planetary Seminar Series (PPP-SS), conducted by Physical Research Laboratory (PRL), Ahmedabad	Jan. 2022 - Nov. 2022
Attended online 'Cosmic Explorations Speaker Series' (CESS) by the Lunar and Planetary Institute (LPI)	March 2020 – March 2022
Attended a two-day symposium on 'Meteoroids, Meteors, and Meteorites: Messengers from Space' (MetMESS - 2021) by Physical Research Laboratory (PRL), Ahmedabad	29 - 30 November 2021
Attended two-day 'Lunar Science Workshop 2021' by the Indian Space Research Organisation (ISRO)	6 - 7 September 2021

Technical Skills

- **Programming Languages**: C, C++, Python (including Machine Learning libraries), HTML, Git, LATEX
- **Scientific Software and Packages used**: MATLAB, OriginPro, SPICE Suite, SciDavis, Python (inc. Numpy & Pandas)
- **Characterization & Wet Lab**: ICP-MS, TIMS (Radiogenic and Stable Sr; Ca using Double-Spike), EPMA

Key Courses Taken

- **Earth and Environmental Sciences**: Introduction to Earth System, Introduction to Basic Geology, Fundamentals of Climate Science, Experimental Methods in Environmental Chemistry, Design Principles in Environmental Engineering, Origin and Evolution of the Earth, Isotope Geochemistry, Introduction to Petrology, Introduction to Satellite Geodesy, Introduction to Chemical Oceanography, Geophysical Processes, Solid Earth Geophysics, Atmosphere Fluid Dynamics
- **CSE & Mathematics**: Algorithms & Programming, Analysis and Linear Algebra (I,II), Probability & Statistics
- **Physics & Engineering**: Introductory Physics- Mechanics, Oscillations and Waves; Electricity, Magnetism and Optics; Modern Physics, Introduction to Electrical And Electronic Engineering, Nanoscience and Device Fabrication, Intermediate Mechanics, Oscillations and Waves, Intermediate Electromagnetism and the Quantum Physics Of Radiation, Intermediate Thermal Physics and the Physics of Materials, Polymer Science and Engineering, Basics of Semiconductor Devices and Technology, Elements of Solid Mechanics, Mathematical Methods Of Physics
- **Others**: Introductory Biology (I,II, III), Basic Chemistry (Physical, Organic, Inorganic), Ways of Doing: Mapping Science - Society Relationships 1, Mapping India through the Folk Arts, Journalism for Scientists, Introduction to Governance

Positions of Responsibility

- **Tutorial Assistant (TA)** – Undergraduate Course titled 'Introduction to Earth and its Environment' *Jan. – April 2023*
- **Co-Founder,** Investments & Learning, a Club under EntIISc* *Nov. 2021 – Nov. 2022*
- **Coordinator,** Pravega** *Oct. 2020 – Sept. 2021*
- **Volunteer,** Notebook Drive*** *Nov. 2019 – Present*
- **Volunteer,** SFRI**** *July 2022 – Present*

Languages

- English, Hindi, & Marathi: Fluent
- Spanish, French, & Japanese: Beginner

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* *EntIISc is the Entrepreneurship and Innovation Cell of IISc.*

** *Pravega is the Annual Science, Tech. and Cultural Festival at IISc. Bangalore, organized by the Undergraduate students.*

*** *Non-profit organization in IISc, which is aimed at improving the quality of education in under-privileged schools in Bangalore.*

**** *SFRI (Science for Rural India) is a community within IISc, working to improve science education in rural India.*