



Gneiss News

Earth Club — Department of Earth Sciences

Date: August 2026 — **Editors:** Team Earth Club

A very warm welcome!

Welcome to the first edition of Gneiss News! We are excited to relaunch the Earth Club with a fresh focus on building a vibrant community of Earth Science enthusiasts and sparking discussions about Earth science, while maintaining the scientific rigour of a journal club. In this newsletter, we will share the latest research findings, departmental updates, and upcoming events. We have divided it into the following sections:

- Solid Earth and Planetary Sciences
- Paleontology and Stratigraphy
- Department Updates
- Travelling to the core: Think!!!
- Upcoming Events / Schedule
- Petrology and Geochemistry
- Climate, Ocean and Environmental Sciences
- Field Photo Spotlight
- Cracking Rocks and Laughs

Explore the different sections and stay updated with the latest developments in Earth science. We hope that you find this newsletter informative and engaging, and we welcome your feedback and suggestions for future editions.

SOLID EARTH and PLANETARY SCIENCES

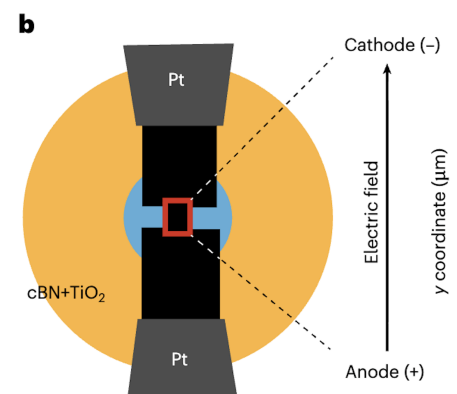
1. “SUPERIONIC” STATE UNDER EARTH’S CORE CONDITIONS.

In a breakthrough experiment mimicking the crushing pressures deep inside Earth, researchers have uncovered compelling evidence for an elusive “superionic” state in iron hydride.

To test long-standing theoretical predictions, the team synthesized a nearly stoichiometric face-centred cubic iron hydride compound (fcc FeH_x , $x \approx 1$). Using a laser-heated diamond anvil cell, they subjected the material to extreme pressures reaching up to 140 GPa—approaching the conditions similar to those in Earth’s inner core—while conducting in situ, time-resolved measurements.

Because ultra-light hydrogen atoms are notoriously difficult to observe directly under extreme pressure, researchers used the surrounding iron crystal lattice as a structural proxy. The investigation relied on two distinct experimental protocols: first, monitoring the continuous change in iron lattice volume during ramp heating from room temperature up to high temperatures ($\sim 2,000$ K); and second, applying a constant voltage bias during laser heating while mapping shifts in the diffraction signal to detect potential hydrogen redistribution.

The experiments revealed two interconnected lines of evidence pointing directly to a superionic phase transition, wherein hydrogen ions flow like a liquid through a rigid, solid iron framework.



Reference: Nagaya, Y., Okazaki, Y., Dekura, H. et al. Experimental indications of superionic behaviour in iron hydride under Earth’s core conditions. *Nat. Geosci.* 19, 855–860 (2026). <https://doi.org/10.1038/s41561-026-02001-5>

2. IISER KOLKATA RESEARCHERS INVESTIGATE JAROSITE AS A “GEOTHERMOMETER” FOR ANCIENT MARS.

Debdatta Banerjee and Swastika Chatterjee from the Department of Earth Sciences (DES) and the Centre for High Pressure Studies at IISER Kolkata investigated the thermodynamic stability of jarosite, $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$, and its potential use as a “geothermometer” for ancient Mars.

Using first-principles density functional theory (DFT), the researchers investigated the relative thermodynamic stability of jarosite in the presence of the relevant dopants, Na^+ and Al^{3+} . They found that Na^+ substitution at the K sites generally reduces the thermodynamic stability of jarosite. However, when the Na-rich component, also known as natrojarosite, is phase-segregated rather than forming a solid solution, its stability relative to K-end-member jarosite depends strongly on its crystal symmetry. The low-temperature monoclinic form of natrojarosite is found to be more stable, whereas the high-temperature trigonal form is less stable than pristine jarosite.

Thermodynamic calculations on Al-doped jarosite, $\text{KAl}_3(\text{SO}_4)_2(\text{OH})_6$, suggest that it is more stable than the undoped counterpart, irrespective of the alkali metal (Na or K) across the temperatures relevant to the Martian surface.

Understanding the thermal evolution of our planetary neighbour is crucial for unraveling the history and evolution of other rocky worlds.

Reference: Debdatta Banerjee, Swastika Chatterjee; Decoding episodes of past temperature spikes on the Martian surface using jarosite. *Phys. Chem. Chem. Phys.* 2026; 28 (16): 9955–9973. <https://doi.org/10.1039/d5cp04468e>

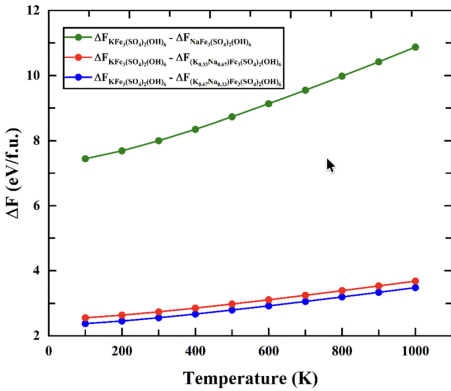


Figure 1: Relative change in Helmholtz energy (ΔF) for different jarosite concentrations with respect to K-end-member jarosite as a function of temperature.

Petrology and Geochemistry

3. GOLD MOBILITY IN SUBDUCTION ZONES.

There has long been a geological mystery: how does gold actually move around inside the Earth to form the massive deposits we eventually mine, or recover from sediments (pieces of rocks) transported along rivers?

Scientists have long suspected that when tectonic plates collide, the denser one is dragged beneath the other—a process called subduction—and that this is when gold becomes mobilized. A fascinating new study by geologists looked at ancient, deeply buried rocks from the Greek islands of Santorini, Ios, Naxos, and Syros to track gold’s journey.

As these rocks are subducted deeper into the Earth, they experience intense high-pressure and low-temperature conditions (in geological terms, this is called high-pressure, low-temperature metamorphism). The immense pressure drives fluids out of the rocks. The researchers discovered that gold is significantly mobilized, or released, with these fluids right at a critical pressure threshold, or boundary, known as the blueschist–eclogite facies transition. (Blueschist and eclogite facies are types of metamorphic rocks, simplistically speaking.)

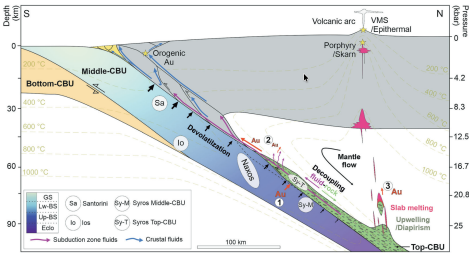


Figure 2: Model for the Au cycle in subduction zone.

Instead of just getting trapped in these immense pressure zones where the subducting slab meets the Earth’s mantle, the gold hitches a ride with these fluids as they escape. It either travels upwards along the plate boundary or eventually becomes part of volcanic magmas.

The most interesting part of this research is how it explains why certain volcanoes are rich in gold while others are barren. It turns out that which parts of the crust and sediments are dragged down by the subducting plate completely dictate the gold fertility of the resulting magma.

If the subducting plate pulls down altered oceanic crust or deep-sea pelagic sediments, the resulting magmas tend to be highly enriched in gold. On the flip side, if the plate primarily drags down terrestrial, continent-derived sediments, the resulting magmas end up being remarkably poor in gold.

This beautifully explains why certain ancient volcanic areas become massive mining hubs while others hold nothing, completely shifting how we understand the life cycle of gold.

Reference: Patten, C.G.C., Peillod, A., Hector, S. et al. Gold mobility in subduction zones, the slab perspective. *Commun Earth Environ* 7, 641 (2026). <https://doi.org/10.1038/s43247-026-03653-2>

Paleontology and Stratigraphy

4. Evolutionary Anomaly or Environmental Indicator? New Study Explores Irregular Shell Coiling in Paleozoic Ammonoids

S. E. Vdovichenko from Borissiak Paleontological Institute, Russian Academy of Science, Moscow, 117647 Russia, examines a long-standing paleontological puzzle: irregular shell coiling in Late Paleozoic monomorph ammonoids. While ammonoids are traditionally recognized by their uniform, circular spiral shells, certain lineages independently evolved non-planispiral shapes, including triangular, tetrangular, elliptical, and cordate whorls. The study tracks these non-canonical shell forms across three main Paleozoic orders—Clymeniida, Tornoceratida, and Goniatitida—ranging from the Late Devonian through the Permian. Notable groups such as Wocklumeria, Parawocklumeria, and Entogonites demonstrate how these structural deviations developed throughout ontogeny. Because these distinct shapes were brief yet widespread, several irregularly coiled species now serve as crucial index fossils for fine-scale stratigraphic dating across major Paleozoic boundaries. Vdovichenko evaluates both biotic factors (such as developmental plasticity and trade-offs in buoyancy or hydrodynamics) and abiotic triggers (including sea-level fluctuations and climate stress) as potential drivers for these evolutionary bursts. The synthesis offers key insights into how ancient marine invertebrates repeatedly accessed alternative developmental pathways during times of environmental transition.

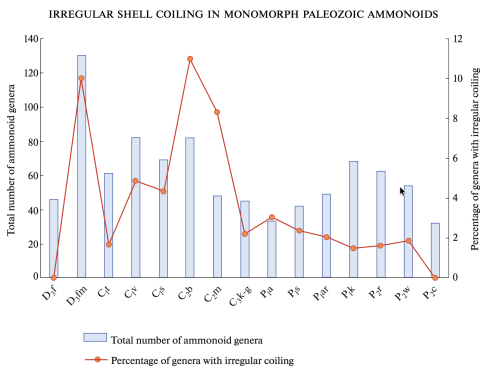


Figure 3: Diversity dynamics of ammonoids with irregular coiling in the Late Paleozoic.

Reference: Vdovichenko, S.E. Irregular Shell Coiling in Monomorph Paleozoic Ammonoids. *Paleontol. J.* 60, 144–156 (2026). <https://doi.org/10.1134/S0031030126600782>

Climate, Ocean and Environmental sciences

5. Unraveling the Ancient Monsoon

The South Asian monsoon is one of the most powerful and intricate climate systems on our planet, dictating the livelihoods of billions. But what happens when we try to read its deep history? Unraveling the ancient monsoon has long frustrated paleoclimate specialists because the violent past summer downpours and the dry winter winds

usually blend into a single, confusing isotopic signal in the geological record. However, a recent breakthrough in paleoclimatology has finally cracked the code, allowing us to mathematically separate these ancient seasons.

This new study was conducted in the northeastern Arabian Sea, which offers a perfect setting for isotopic study. The South Asian monsoon system comprises a wet summer monsoon and a dry winter monsoon, which are traditionally difficult to untangle in geological records because most proxies mix the seasonal signals together. To resolve this, researchers analyzed a sediment core from the northeastern Arabian Sea, off the coast of Pakistan, where the two seasons affect the ocean in distinct ways. They discovered that while summer monsoon winds are tightly linked to high-northern-latitude climates, the winter monsoon progressively weakened as global temperatures rose during the last Deglaciation (as recorded in ice cores from glaciers).

To reconstruct these distinct seasonal drivers, they used high-resolution mass spectrometry imaging (MSI) on marine sediments.

Sea surface temperatures (SST), which in this region are primarily driven by evaporative cooling from winter monsoon winds, were reconstructed using the alkenone unsaturation index ($U_{37}^{K'}$). Conversely, the summer monsoon strength was tracked using the GDGT-based C_{Ca}T index, which reflects changes in water-column oxygenation and the oxygen minimum zone caused by summer upwelling. The researchers also extracted plant-wax biomarkers, specifically targeting long-chain alkanes like C_{13} . By performing carbon-isotope ($\delta^{13}C$) analysis on these alkanes, they could track shifts between C_3 (wet climate) and C_4 (dry climate) vegetation to estimate precipitation seasonality, while hydrogen-isotope (δD) analysis allowed them to track changes in the moisture source.

These findings challenge traditional interpretations of established Asian monsoon proxy records, particularly speleothem $\delta^{18}O$ time series. Historically, a progressive decrease in speleothem $\delta^{18}O$ during Greenland Interstadial 1 was interpreted as an intensification of the summer monsoon. However, this study also showed that this isotopic depletion actually reflects a seasonal bias caused by an influx of winter precipitation driven by subtropical westerly jets. Because moisture transported from distant sources like the Mediterranean undergoes progressive upstream rainout, it carries a highly depleted isotopic signature. This disproportionately lowers the annual-mean $\delta^{18}O$ and δD values, masking the fact that the winter monsoon winds were actually weakening.

Ultimately, the data indicate that while summer monsoons respond directly to Northern Hemisphere high-latitude climate, winter monsoon winds and regional precipitation are strongly controlled by precession in Earth's orbit and the steepening of upper-tropospheric temperature gradients caused by global temperature rise.

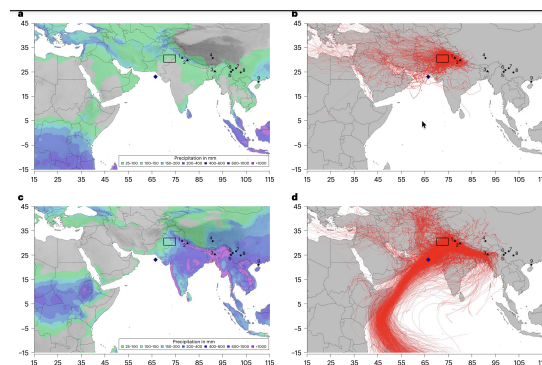


Figure 4: Core locations and precipitation regimes during the summer and winter monsoon seasons.

Obreht, I., Lückge, A., Mohtadi, M. et al. Contrasting drivers of South Asian summer and winter monsoon evolution during the last deglaciation. *Nat. Geosci.* 19, 959–965 (2026). <https://doi.org/10.1038/s41561-026-02023-z>

Department Updates

1. Prof. Gopala Krishna Darbha Has a New Buddy!

The **Optical Photothermal Infrared Spectroscopy coupled with Raman spectroscopy (O-PTIR)** was inaugurated on **6 June 2026**, opening new possibilities for the detection and characterization of extremely small particles, including **submicron-sized microplastics**.

The O-PTIR system combines infrared and Raman spectroscopy, allowing the **same particle to be characterized simultaneously using both techniques**. According to the facility information, particles as small as approximately $1\mu m$ can be detected, addressing an important limitation in the analysis of very small particulate matter.

A key feature of the system is its **automated particle-size analysis module**, which enables precise identification and selection of particles for subsequent IR and Raman analysis. This capability is particularly relevant to environmental studies, where the identification of increasingly small plastic particles is becoming important.

The facility was inaugurated by **Dr. Satheesh Reddy**, Member of the National Security Advisory Board and former Chairman of the Defence Research and Development Organisation (DRDO).



With the ability to combine chemical identification with high-resolution particle analysis, the new O-PTIR facility could provide researchers with a powerful tool for studying microplastics, particulate materials, and other micron- to submicron-scale samples.

Field Photo Spotlight



Photographer: Atri Majumdar – 22MS

Location: Gujarat coast near Porbandar.

The beach here is a fossilized coral reef. Everything you see is fossilized.

Travelling to the core: Think!!!

While surface rocks fracture easily under stress, mountains sustain immense weight for millions of years. Why doesn't a mountain's weight cause the rocks beneath it to fail and the structure to collapse?

Look for the answer in our next issue.

Cracking Rocks and Laughs

1. Earth's history: Someone asked an Earth scientist:

“How do you know what happened millions of years ago?”

The Earth scientist pointed at the landscape.

“Evidence.”

“But that's just a mountain.”

The scientist smiled.

“Exactly. It doesn't delete its browser history.”

2.

Why are garnets the most rational during chaotic situations?*Because they are stable under pressure.***Why can't kyanite handle a lot of homework?***Because it is under high pressure.***Why did the metamorphic rock lose a poker game?***Because it folded.*

Upcoming Journal Club Sessions

Aug 25: Kicking Off Our Summer Internship Talks: “Core Conversations”!

Aug 25 — 7:30 PM — Geochemical Signatures in a Sediment Core along the Southwest Indian Ridge

Venue: G02. Speaker: Sinchita Manna, DES.

Aug 26 — 7:30 PM — Paleoclimate Reconstruction using Microbial Lipids

Venue: G02. Speaker: Mainak Bhattacharya, DES.

September — Drainage Divide Morphology and Landscape Evolution Across an Active Anticline hetauda-Chaura-Marin Dun Region, Nepal

Venue: TBA. Speaker: Kingshuk Mondal, DES.

September — Speaker: Asmit Gupta, DES, Topic: TBA

Aug 29 (Saturday): A movie night in collaboration with The Movie Club.

Movie: 2012. Dear Freshers, this is your chance to have some fun.

Want to submit a field photo, contribute to the newsletter, or write a blog post?
Reach out to us. Email us at earth.club@iiserkol.ac.in.

The Plates keep moving. So do we:
Parshwa Pavankumar Boke, Ananya Das and Neetesh Singh Narwariya

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