NASS
NAN YANG ACADEMY OF SCIENCES

Earth and Planetary Science
https://journals.nasspublishing.com/index.php/eps

EDITORIAL

Exciting Planetary Exploration, Planetary Science but also Earth Sciences

Albert Galy

Centre de Recherches Pétrographiques et Géochimiques, CNRS, Université de Lorraine, Vandoeuvre les Nancy, 54500, France

With more than 5000 exoplanets only discovered in the last 20 years [1], we can say that planetary science is in its infancy. Maybe a journal devoted to research on those exoplanets only is premature, but we can pave the way to grab information about those planets well before we can study their layers and the intricate interactions and feedback mechanisms that characterize complex planetary systems. How? Well, the most important revolution is in our mind and we have expanded the boundary conditions by starting to explore chemical and physical systems well beyond the conditions on Earth. This is also strongly supported by technological advances in our laboratories.

So, yes, we are at an exciting bend in planetary exploration and planetary science. More and more data are gathered by space missions, and I want to highlight the InSight mission (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) that landed on Mars in 2018, showing how a single robotic lander can change our understanding of the interior of a planet and how planets are different. For instance, the Martian mantle has only one rocky layer rather than two for the Earth and the core of Mars is large, with a much lower density than the Earth's core, suggesting the significant occurrence of light elements dissolved in the Martian iron-nickel core [2]. So, we know now that we should explore, experimentally, far more chemical and physical conditions than Earth-like situations. What is the limit? Our imagination, but also the support of this kind of research. However, this is needed if we want to make progress in our understanding of planets and their formations.

Some new processes have been even suggested directly from space exploration. In addition to thermal self-disruption or planet collisions, photoevaporation could remove a substantial part of the external envelopes of some observed exoplanets which could lead to false interpretations of different scenarios of gas accretion, and late planet formation [3]. The constraints on planets' formation and structure can also have conse-

*Corresponding Author:
Albert Galy,
Centre de Recherches Pétrographiques et Géochimiques, CNRS, Université de Lorraine, Vandoeuvre les Nancy, 54500, France;
Email: albert.galy@univ-lorraine.fr

Received: 23 April 2023; **Accepted:** 28 April 2024; **Published:** 30 April 2024

Citation: Galy, A., 2024. Exciting Planetary Exploration, Planetary Science but also Earth Sciences. *Earth and Planetary Science*. 3(1): 68–70. DOI: https://doi.org/10.36956/eps.v3i1.1095

DOI: https://doi.org/10.36956/eps.v3i1.1095

quences on the evolution of the surface of the planets with implications for the evolution of habitable planetary surfaces. For instance, the direct evidence for Mars of a crust capable of stabilizing hydrous minerals [4], which can effectively sequester volatiles into planetary interiors and the low seismic velocity of the upper ~10 km implying that the Martian cryosphere does not bear significant deep aquifers [5] let the detailed experimental study of the metastability of liquid water.

So, in a sense, planetary science has also grown up enough to benefit from the inevitable discussion from observations and models. Direct observations can lead to the definition of laboratory-based experiments, but also models that can be tested by observations or can suggest new observations or interpretations.

But this goes even further with some new look at the Earth started by planetary exploration. For example, the NASA Phoenix Lander on Mars reported that perchlorate was a dominant soluble anion in Martian soils [6]. At that time, on Earth, the most likely origin of perchlorates in the soil was that it was a residue of explosives. And if natural perchlorate on Earth were known, very little was about its origin. This led to a detailed investigation of the formation of perchlorate by experiments but also by direct observations in the Atacama Desert [7]. This location, on Earth, gained a substantial geological interest because of Martian exploration.

And that is because, even our planet, Earth, still holds many secrets. Of course, the time to go off and map a terra incognita is over. But some basic questions are still eluding us and are quite fundamental for our understanding of planets and their habitability. For instance, if the Earth's dynamo is generally well accepted as the source of its magnetic field, the geological records of the polar wander and the temporal changes in the intensity of the magnetic field are far less understood while numerical modelling is still struggling to reconstruct those terrestrial observations [8]. Once again, this is a topic requiring an open mind, and also maybe abandoning Lyell's actualism since other planets or moons can acquire or maintain their magnetic fields by other means (tidal frictions, elliptic orbits, ...) [8]. Also, how strong are the links between the evolution of the planet's interior and the external envelopes? In many cases, we can find big question marks regarding the evolution of our planet. What are the cycles of volatiles and life-supporting elements? Is the Wilson cycle the pacemaker of the Earth's climate and a leading process in the evolution of life, or life itself and its self-organisation and evolution is powerful enough that the Earth has already entered the era of the theory of Gaïa? [9,10] Are volcanism and earthquakes driven by climate (and the weight of the local hydrosphere) or the dynamic of the Earth's mantle is modulating the climate and the water cycle at the surface? We now know that our planet underwent through major and irreversible changes: the appearance of life, the initiation of plate tectonics, and the great oxidation event, to name a few. How did these happen? Are they linked? Can we apply Lyell's actualism to all geological eras? Can we transpose what we know about the Earth to other planets? Yes, by transcending traditional disciplinary boundaries, Earth and Planetary Science is a fundamental scientific topic that will see important breakthroughs soon. I hope this journal, Earth and Planetary Science, will contribute to the dissemination of cutting-edge scientific ideas supported by robust multidisciplinary observations.

Funding

This research received no external funding.

Conflict of Interest

The authors disclosed no conflict of interest.

References

[1] Catalogue of Exoplanets [Internet] [cited 2024 Apr 24]. Available from: https://exoplanet.eu/catalog/

[2] Stähler, S.C., Khan, A., Banerdt, W.B., et al., 2021. Seismic detection of the martian core. Science. 373, 443–448.
DOI: https://doi.org/10.1126/science.abi7730

[3] Armstrong, D.J., Lopez, T.A., Adibekyan, V., et al., 2020. A remnant planetary core in the hot-Neptune desert. Nature. 583, 39–42.
DOI: https://doi.org/10.1038/s41586-020-2421-7

[4] Wernicke, L.J., Jakosky, B.M., 2021. Martian hydrated minerals: A significant water sink. Journal of Geophysical Research: Planets. 126(3), e2019JE006351.
DOI: https://doi.org/10.1029/2019JE006351

[5] Manga, M., Wright, V., 2021. No cryosphere-confined aquifer below InSight on Mars. Geophysical Research Letters. 48(8), e2021GL093127.
DOI: https://doi.org/10.1029/2021GL093127

[6] Hecht, M.H., Kounaves, S.P., Quinn, R.C., et al., 2009. Detection of perchlorate and the soluble chemistry of martian soil at the Phoenix lander site. Science. 325, 64–67.

DOI: https://doi.org/10.1126/science.1172466
[7] Catling, D.C., Claire, M.W., Zahnle, K.J., et al., 2010. Atmospheric origins of perchlorate on Mars and in the Atacama. Journal of Geophysical Research: Planets. 115(E1). DOI: https://doi.org/10.1029/2009JE003425
[8] Christensen, U.R., 2019. Planetary magnetic fields and dynamos. Oxford Research Encyclopedia of Planetary Science. DOI: https://doi.org/10.1093/acrefore/9780190647926.013.31
[9] Rubin, S., Veloz, T., Maldonado, P., 2021. Beyond planetary-scale feedback self-regulation: Gaia as an autopoietic system. BioSystems. 199, 104314. DOI: https://doi.org/10.1016/j.biosystems.2020.104314
[10] Arènes, A., Latour, B., Gaillardet J., 2018. Giving depth to the surface: An exercise in the Gaia-graphy of critical zones. The Anthropocene Review. 5(2), 120–135. DOI: https://doi.org/10.1177/2053019618782257