

# Adrien P. M. Broquet

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<https://ab-ares.github.io/website/>

## EMPLOYMENT

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- 2026 – 2032 **DFG Emmy Noether Junior group leader** – German Aerospace Center (DLR), Berlin, Germany.
- 2024 – 2026 **Postdoctoral Research Associate – Humboldt Fellowship** – German Aerospace Center (DLR), Berlin, Germany.
- 2020 – 2024 **Postdoctoral Research Associate (with Jeffrey Andrews-Hanna)** – Lunar and Planetary Laboratory, University of Arizona, Tucson, USA.
- 2017 – 2019 **Teaching assistant** – Department of Earth, Environment & Space, Université de Nice Côte d'Azur, Nice, France.

## EDUCATION

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- 2020 **P.h.D** – Planetary Geophysics, Observatoire de la Côte d'Azur, Nice, France  
Grant: Doctoral School SFA, Nice.  
Advisor: Mark Wieczorek, Title: *The lithosphere of Mars*
- 2017 **Master 2** – Solid-Earth Geophysics, Institut de Physique du Globe de Paris, France  
With honors
- 2016 **Master 1** – Geosciences, Université Pierre et Marie Curie, Paris, France  
With honors
- 2015 **BSc** – Earth Sciences, Université Pierre et Marie Curie, Paris, France  
Best student honors

## RESEARCH INTEREST

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My scientific interest encompasses various aspects of planetary geophysics and is fueled by data collected from space missions. More specifically, I enjoy studying and modeling large-scale physical processes with geologic implications, from lithospheric compensation mechanisms, tectonics, thermal evolution models, to the spatio-temporal variation of the magnetic field.

## PHD THESIS PROJECT

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Links: [Manuscript](#) – [Defense slides](#)

My thesis characterizes the strong and cold outermost portion of Mars, conventionally referred to as the lithosphere. As a first project, I conducted an analysis ([Broquet & Wieczorek, 2019](#)) of the gravitational signature of kilometer-sized Martian volcanoes. In this study, we model the deformation of the lithosphere under volcanic loads and compare the resulting theoretical gravitation signal to observations. The bulk density of the volcanic structures is found to have a

mean value of  $3200 \pm 200 \text{ kg m}^{-3}$ , which is representative of iron-rich basalts as sampled by the Martian basaltic meteorites. The elastic part of the lithosphere, which maintains loads over geologic timescale, is constrained to have been weak when the oldest volcanoes ( $>3.2 \text{ Ga}$ ) formed, which implies that the lithosphere was hot and thin ( $<20 \text{ km}$ ) early in geologic history. Conversely, we obtain that younger volcanoes ( $<3 \text{ Ga}$ ) were emplaced on colder and stronger elastic lithospheres ( $30\text{--}100 \text{ km}$ ). This chronology of formation is consistent with a geodynamic history in which the lithosphere strengthens with time as the planet cools and controls the surface expression of magmatism.

In a second project, I investigated the composition and geodynamic state of the lithosphere beneath the Martian polar caps ([Broquet et al., 2020, 2021](#)). In these studies, we make use of radar and gravity data coupled with a lithospheric loading model to self-consistently estimate the composition of the polar cap, and the elastic thickness of the lithosphere underneath. We show that the lithosphere below the north polar cap is currently extremely rigid and cold ( $>330 \text{ km}$ ). In the south polar region, the present-day lithosphere is potentially thinner ( $>150 \text{ km}$ ), which helps satisfy global thermal evolution simulations that predict hemispheric differences in surface heat flow. Our inferred compositions suggest that for reasonable dust content, a minimum of 10%  $\text{CO}_2$  are buried in the north polar deposits. This is the first time a large quantity of dry ice is found within the north polar regions of Mars. Like on Earth, where the composition of buried ices gives hints on the climatic evolution of our planet, having  $\text{CO}_2$  at the north pole of Mars will help improve scenarios for the climate evolution of the planet.

## MISSION INVOLVEMENT

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**NASA Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight)**, Collaborator (2018 – ).

**ESA BepiColombo Laser Altimeter (BELA)**, Collaborator (2024 – ).

## PROFESSIONAL ACTIVITIES

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- **Reviewer and panelist** for the *NASA Solar System Workings, Lunar Data Analysis, and Mars Data Analysis* programs (2020 – ).
- **Reviewer** for *UK Space Agency Exploration Science program* (2024 – ).
- **20+ reviews** for the *Journal of Geophysical Research, Geophysical Research Letters, Icarus, Physics of the Earth and Planetary Interiors, Planetary and Space Science, Nature Geoscience, Nature Communications, Advances in Space Research, Geophysical Journal International, Survey of Geophysics*

## TEACHING

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- **200+ hours – Geophysics /Geology / Planetary Science / Field Work** – Department of Earth, Environment & Space, Université de Nice Côte d'Azur, Nice, France (2017–2019).
- **15+ hours – Planetology in middle schools** with [EduCosmos](#) & MEDITES (2018).
- **Coordinator & Teacher**, *Physics and Fundamentals of Planetary Exploration Summer School* at Technische Universität Berlin (2 weeks, 2025):  
Key topics – Fundamental physics of planetary science, gravity, orbital dynamics, methods of planetary exploration from imaging and spectrometry to seismology. Evolution of planetary

surfaces, with a focus on tectonic, volcanic and cratering processes. Past, present, and future of planetary exploration, from Apollo and Artemis to Psyche and Europa Clipper.

## SUPERVISION

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- **Interns:** Felix Rolser & Sabatino Santangelo (2024, DLR). Faris Beg (2025, DLR). Allie North & Theresa Büttner (2025–2026, DLR)
- **Master thesis:** Sabatino Santangelo (2024, DLR)
- **PhD:** Aymeric Fleury & Claudia Szczech (2023–2025, DLR). Sabatino Santangelo (2025–, DLR)

## OUTREACH

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- 2024      Invited speaker – Centre International de Valbonne à Sophia-Antipolis  
*Lunar Odyssey: Tracing the Journey from Initial Sketches to Pioneering Steps*
- 2022      Press coverage for [Broquet & Andrews-Hanna \(2022\)](#).  
[University of Arizona press release](#). Interviews for journals including [New Scientist](#),  
[Le Monde](#), [EL PAÍS](#). More info [@Altimetric](#)
- 2021      Invited speaker — Société d’Astronomie de Cannes, Cannes, France – *Exploration of the terrestrial planets* ([video link](#), in French)
- 2020      [Namazu Contest](#) Scientific tutor — French International School (Ireland) IES Nueve Valles (Spain), Middle School Roy d’Espagne (France).
- 2020      Invited speaker — Externat St Joseph la Cordeille, Toulon, France – *Our solar system*
- 2020      Invited speaker — Insight@School, Sophia Antipolis, France – *The lithosphere of Mars*
- 2019      Invited speaker — Club Vêga, Ollioules, France  
*The worlds around us: history and future of space exploration*
- 2019      Interview [La science en chemin, avec Adrien Broquet](#) (Ciel & Espace, David Fossé)
- 2017-18   Science Festival, Nice, France

## GRANTS – AWARDS

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- 2025      **Emmy Noether Junior Group leader** (1.4M, 2026–2032)
- 2023      [Best reviewer award](#), *Icarus*
- **Alexander von Humboldt Foundation Fellowship, 2 years**
- **Co-I Mercury’s tectonics** (PI: Jeff Andrews-Hanna – NASA SSW, 1 year)
- 2022      **Co-I Faulting on Pluto** (PI: Moruzzi – NASA FINESST, 2 years)
- [Best reviewer award](#), *Icarus*
- 2019      My thesis in 180 seconds, Final in Nice, 3rd place ([video link](#), in French)
- 2018      **Scholarship** Workshop in Geology and Geophysics of the Solar System, Serbia
- 2017      P.h.D. Doctoral grant from ED SFA, Nice
- 2016      **Scholarship** 29<sup>th</sup> International School of Space Science, Italy

## PEER-REVIEWED PUBLICATIONS

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Students supervised/co-supervised by A.B.

1. Santangelo, S., Plesa, A.-C., **Broquet, A.**, et al. Present-Day Thermal State and Surface Heat Flux of the Moon. *Journal of Geophysical Research: Planets* (2025). [10.1029/2025JE009458](https://doi.org/10.1029/2025JE009458)
2. Morruzzi, S., Andrews-Hanna, J.C., **Broquet, A.**, Schenk, P. Compensation state and geophysical evolution of Sputnik Basin on Pluto. *Journal of Geophysical Research: Planets* (2025). [10.1029/2025JE009125](https://doi.org/10.1029/2025JE009125)
3. Andrews-Hanna, J.C., Bottke, W.F., **Broquet, A.** et al. Southward impact excavated magma ocean at the lunar South Pole–Aitken basin. *Nature* (2025). [10.1038/s41586-025-09582-y](https://doi.org/10.1038/s41586-025-09582-y)
4. Bjornes, E., Brandon, C.J., **Broquet, A.** et al. Evidence for an early formation of Serenitatis basin at 4.25 Ga shifts lunar chronology. *Geophysical Research Letters* (2025). [10.1029/2025GL116654](https://doi.org/10.1029/2025GL116654).
5. **Broquet, A.**, Maia, J., & Wieczorek, M.A. On the Crustal Architecture of the Terrestrial Planets. *Journal of Geophysical Research: Planets* (2025). [10.1029/2025JE009139](https://doi.org/10.1029/2025JE009139)
6. Mittelholz, A., Moorkamp, M., **Broquet, A.**, & Ojha, L. Gravity and magnetic field signatures in hydrothermally affected regions on Mars. *Journal of Geophysical Research: Planets* (2025). [10.1029/2024JE008832](https://doi.org/10.1029/2024JE008832).
7. **Broquet, A.**, Plesa, A.-C., Klemann, V., et al., Glacial isostatic adjustment reveals Mars's interior viscosity structure. *Nature* (2025). [10.1038/s41586-024-08565-9](https://doi.org/10.1038/s41586-024-08565-9).
8. Szczec, C., **Broquet, A.**, et al.. Relaxation states of large impact basins on Mercury based on MESSENGER data. *Geophysical Research Letters* (2024). [10.1029/2024GL110748](https://doi.org/10.1029/2024GL110748).
9. **Broquet, A.\***, Rolser, F.\*, Plesa, A. C., Breuer, D., & Hussmann, H. (2024). Mercury's crustal porosity as constrained by the planet's bombardment history. *Geophysical Research Letters* (2024). [10.1029/2024GL110583](https://doi.org/10.1029/2024GL110583). (\*) both authors contributed equally to this work
10. Liang, W.\*, **Broquet, A.\*** et al., Vestiges of a lunar ilmenite layer revealed by GRAIL gravity data. *Nature Geoscience* (2024). [10.1038/s41561-024-01408-2](https://doi.org/10.1038/s41561-024-01408-2). (\*) both authors contributed equally to this work.
11. **Broquet, A.**, & Andrews-Hanna, J. C., A volcanic inventory of the moon. *Icarus* (2024). [10.1016/j.icarus.2024.115954](https://doi.org/10.1016/j.icarus.2024.115954).
12. **Broquet, A.**, & Andrews-Hanna, J. C., The moon before mare. *Icarus* (2024). [10.1016/j.icarus.2023.115846](https://doi.org/10.1016/j.icarus.2023.115846).
13. Xu, Z., **Broquet, A.**, et al., Investigation of Martian regional crustal structure near the dichotomy using S1222a surface-wave group velocities, *Geophysical Research Letters* (2023). [10.1029/2023GL103136](https://doi.org/10.1029/2023GL103136).
14. Andrews-Hanna, J. C., & **Broquet, A.**, The history of global strain and geodynamics on Mars. *Icarus* (2023). [10.1016/j.icarus.2023.115476](https://doi.org/10.1016/j.icarus.2023.115476).
15. **Broquet, A.** & Andrews-Hanna, J. C., Plume-induced flood basalts on Hesperian Mars: An investigation of Hesperia Planum, *Icarus* (2023). [10.1016/j.icarus.2022.115338](https://doi.org/10.1016/j.icarus.2022.115338).
16. **Broquet, A.** & Andrews-Hanna, J. C., Geophysical evidence for an active mantle plume underneath Elysium Planitia on Mars, *Nature Astronomy* (2022). [10.1038/s41550-022-01836-3](https://doi.org/10.1038/s41550-022-01836-3).

17. Wieczorek, M. A., **Broquet, A.**, et al., InSight constraints on the global character of the Martian crust, *Journal of Geophysical Research: Planets* (2022). [10.1029/2022JE007298](https://doi.org/10.1029/2022JE007298).
18. Khan, A., [...], **Broquet, A.**, et al., Upper mantle structure of Mars from InSight seismic data, *Science* (2021). [10.1126/science.abf2966](https://doi.org/10.1126/science.abf2966).
19. Knapmeyer-Endrun, B., [...], **Broquet, A.**, et al., Thickness and structure of the martian crust from InSight seismic data, *Science* (2021). [10.1126/science.abf8966](https://doi.org/10.1126/science.abf8966).
20. **Broquet, A.**, Wieczorek, M. A., & Fa W., The composition of the south polar cap of Mars derived from orbital data. *Journal of Geophysical Research: Planets* (2021). [10.1029/2020JE006730](https://doi.org/10.1029/2020JE006730).
21. **Broquet, A.**, Wieczorek, M. A., & Fa W., Flexure of the lithosphere beneath the north polar cap of Mars: Implications for ice composition and heat flow. *Geophysical Research Letters* (2020). [10.1029/2019GL086746](https://doi.org/10.1029/2019GL086746).
22. **Broquet, A.**, & Wieczorek, M. A., The Gravitational signature of Martian volcanoes. *Journal of Geophysical Research: Planets* (2019). [10.1029/2019JE005959](https://doi.org/10.1029/2019JE005959).

## SELECTED LIST OF TALKS

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- 2025      **EPSC-DPS Joint Meeting 2025, Helsinki, Finland**  
*Mercury's geodynamic and tectonic history*  
**EGU 2025, Vienna, Austria (invited)**  
*Lunar volcanism: a Geophysical perspective.*
- 2024      **EPSC 2024, Berlin, Germany**  
*Glacial isostatic adjustment reveals Mars interior viscosity structure*  
**ETH Zurich, Zürich, Switzerland (invited)**  
*Lunar volcanism: a Geophysical perspective.*  
**55<sup>th</sup> LPSC, Houston TX, USA**  
*A volcanic inventory of the Moon*  
**EGU 2024, Vienna, Austria (invited)**  
*Viscoelastic relaxation of the lithosphere beneath the Martian polar caps: Implications for the polar caps' formation history and planetary thermal evolution*
- 2023      **ETH Zurich, Zürich, Switzerland (invited)**  
*Geophysical evidence for an active mantle plume underneath Elysium Planitia.*  
**International Plate Tectonics Group (invited)**  
*Geophysical evidence for an active mantle plume underneath Elysium Planitia.*
- 2022      **IPGP, Planetary Science group, Paris, France (invited)**  
*Geophysical evidence for an active mantle plume underneath Elysium Planitia.*  
**53<sup>th</sup> LPSC, Houston TX, USA**  
*Is there an active mantle plume underneath Elysium Planitia?*
- 2021      **ETH Zurich, Zürich, Switzerland (invited)**  
*Loading the Martian lithosphere in space and time.*  
**52<sup>th</sup> LPSC, Houston TX, USA**

*Plume-induced flood basalts on Hesperian Mars: An investigation of Hesperia Planum.*

- 2020 **DLR Institute, Berlin, Germany (invited)**  
*The lithosphere of Mars.*
- 2019 **50<sup>th</sup> LPSC, Houston TX, USA**  
*Geodynamic state of the lithosphere beneath the northern polar cap of Mars.*
- 2018 **49<sup>th</sup> LPSC, Houston TX, USA**  
*The gravitational signature of Martian volcanoes.*  
**DLR Institute, Berlin, Germany (invited)**  
*Composition, elastic and thermo-mechanical properties of the Martian lithosphere.*
- 2017 **Geodesy & Rheology, Université Valrose, Nice, France**  
*The gravitational signature of Martian volcanoes.*

## OPEN SOURCE CODES AND CONTRIBUTIONS

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- DSP (*Displacement Strain Planet*) — **Creator**  
[https://github.com/AB-Ares/Displacement\\_strain\\_planet](https://github.com/AB-Ares/Displacement_strain_planet) — [documentation](#)  
*Displacement\_strain\_planet* provides several Python functions and example scripts for generating gravity, crustal thickness, displacement, lateral density variations, stress, and strain maps on a planet given a set of input constraints such as from observed gravity and topography data.
- TeHF (*Te Heat Flow*) — **Creator**  
[https://github.com/AB-Ares/Te\\_HF\\_Conversion](https://github.com/AB-Ares/Te_HF_Conversion) — [documentation](#)  
*Te\_HF\_Conversion* provides several Python functions that allow 1) converting the elastic thickness of the lithosphere to planetary heat flow (and a yield strength envelope) given several input parameters including crustal thickness, strain rate, or radiogenic heating; 2) retrieving the elastic thickness (or mechanical thickness, and a yield strength envelope) of the lithosphere based on a temperature profile.
- Py\_Admittance — **Creator**  
[https://github.com/AB-Ares/Py\\_Admittance](https://github.com/AB-Ares/Py_Admittance) – [documentation](#)  
*Py\_Admittance* is a code that allows computing the global observed and theoretical admittance functions and their spatio-spectrally localized versions.
- SHTOOLS (*Spherical Harmonic Tools*) — **Contributor**  
<https://github.com/SHTOOLS/SHTOOLS>  
*SHTOOLS/pyshtools* is a Fortran-95/Python library that can be used for spherical harmonic transforms, multitaper spectral analyses, expansions of gridded data into Slepian basis functions, standard operations on global gravitational and magnetic field data.