CV — Mohit Melwani Daswani, Ph.D.

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Associate Professor developing coupled thermodynamic and geochemical models of ocean-world habitability. My computational and experimental work integrates thermodynamic modeling with laboratory measurement to predict how planetary interiors evolve chemically over geological time — and whether that evolution can sustain life. JWST confirmed a 2021 prediction from this framework: that metamorphic outgassing should enrich Europa's ocean in CO_2.

Employment

2026–Present: Associate Professor, Earth-Life Science Institute, Institute of Future Science, Institute of Science Tokyo
2020–2026: Research Scientist, Jet Propulsion Laboratory, California Institute of Technology

Coupled evolution modeling for ocean-world habitability assessment.
Sample-return mission formulation and landing-site characterization.
International collaboration leadership: JAXA, ELSI/Science Tokyo, Nantes University, the Open University (UK), Australian Nuclear Science and Technology Organisation.

2018–2020: Postdoctoral Scholar & Europa Clipper Project Science Affiliate, JPL — ocean-world geochemistry and mission science, with Dr. Steven Vance
2015–2017: Postdoctoral Scholar, University of Chicago — Mars geochemistry and paleoclimate modeling, with Prof. Edwin Kite

Education

2011–2015: Ph.D., Planetary Science / Geochemistry, The Open University
2009–2011: M.Sc., Geo-information Science & Earth Observation (Erasmus Mundus), Southampton / Lund / Warsaw / Twente
2003–2009: Geology, Autonomous University of Barcelona, with an Erasmus year at the University of Bern

Research

My work applies thermodynamic and reactive-transport modeling to planetary interiors, testing predictions against observation rather than leaving them as speculation. During my Ph.D. I built reactive transport models that quantified fluid-rock interactions in martian meteorites, establishing methods for coupling geochemistry to planetary evolution. At Chicago I extended these to Mars's global water cycle, constraining how the planet processed water and carbon before, and for some time after, its climate collapsed.
Since 2018 I have applied coupled evolution modeling to ocean worlds. My 2021 thermodynamic prediction of Europa's ocean composition was confirmed by JWST CO_2 detections in 2023 — direct validation of the approach. I have extended the same framework to Ceres, Titan, and exoplanet interiors, with a current focus on rock metamorphism as a source of chemical energy that can sustain habitability long after a body's initial ocean forms.

I lead three open-source computational tools used across the community: DEWPython, a Python implementation of the Deep Earth Water model for thermodynamics at extreme pressure and temperature; AccretR, which models stochastic planetesimal accretion to constrain initial bulk compositions; and PlanetProfile (with Dr. Styczinski and Dr. Vance), for self-consistent interior structure modeling of ocean worlds and rocky dwarf planets. My experimental work, including low-temperature calorimetry with students, has identified deviations from theoretical predictions that materially affect thermal evolution models. Current experiments examine high-pressure water-rock-organic interactions relevant to ocean-world interiors.

Research expertise

Coupled evolution modeling: Thermodynamic-geological coupling, interior-atmosphere evolution, habitability prediction over geological timescales.
Computational frameworks: PHREEQC, PFLOTRAN, Perple_X, custom thermodynamic databases, reactive transport modeling; lead developer of DEWPython and AccretR.
Sample-return and mission science: Apollo sample mineralogy, meteorite classification, planetary surface mineralogy characterization.
Experimental capabilities: High-pressure and -temperature thermodynamics, water-rock interactions, mineral-fluid equilibria, differential scanning calorimetry.
Cross-cutting applications: Planetary defense, exoplanet characterization, Mars paleoclimate, small-body physical and geochemical properties.

Funding & impact

As Principal Investigator, I have secured $1.16M in competitive funding, including the NASA Planetary Science Early Career Award (2020, ECTOPlaSM). As Co-Investigator, I contribute to projects totaling over $2M in additional funding. My 32 peer-reviewed papers appear in journals including *Nature Astronomy*, *Nature Communications*, *Science Advances*, and *Geophysical Research Letters*, and my research has been covered by *The Atlantic*, *Forbes*, *Smithsonian Magazine*, *CBC News*, Reuters, and *The Times*.
I have mentored 18 researchers — 4 Ph.D. students, 8 postdocs, 6 undergraduates — now placed at UCLA, Arizona State University, JPL, and other institutions, several as first authors in *Science Advances*, *Nature Astronomy*, and *Icarus*. Active international collaborations include JAXA's Extraterrestrial Sample Curation Center (Prof. Tomohiro Usui), the Earth-Life Science Institute (Dr. Shintaro Kadoya, Prof. Hidenori Genda), Nantes University (Prof. Gabriel Tobie, Prof. Christophe Sotin), and the Australian Nuclear Science and Technology Organisation.

Awards & fellowships

JST EXPERT-J Fellowship (2025) — competitive Cabinet Office J-RISE appointment as Tenure-Track Associate Professor, ELSI, selecting early-career researchers from G7 institutions.
NASA Planetary Science Early Career Award (2020) — Experimental and Computational Thermodynamics, Organics, and Planetary Structure Modeling (ECTOPlaSM).
Lunar and Planetary Institute Career Development Award (2014).
Mineralogical Society of Great Britain and Ireland Bursary (2014).
European Commission Erasmus Mundus Fellowship (2009–2011).

Teaching & mentoring

Lecturer, International Graduate Program, Science Tokyo. Guest lecturer at UCLA (2024), Louisiana State University (2023), and the University of Washington Astrobiology Colloquium (2021). Instructor, USC Bridge to the Geosciences program for underrepresented students at the Wrigley Marine Science Center; science career advisor for Grade 6–8 students at La Merced Academy, Montebello, California (2025). Supervised 18 students and postdocs to successful career outcomes since 2018.

Service & leadership

Reviewer for 10+ journals including *Nature Astronomy*, *Science Advances*, and *Geophysical Research Letters*; editor, *Frontiers in Astronomy and Space Science* special issue on planetary habitability. Panelist on 10+ NASA proposal review panels. Session convener at the Astrobiology Science Conference, Goldschmidt, AGU Fall Meeting, and the Water-Rock Interaction Meeting. Steering Committee member, Network for Ocean Worlds; organizing committee, LPI Brines Across the Solar System conference. Co-author on four Community Papers, and co-signee on three more, for the National Academies' Planetary Science and Astrobiology Decadal Survey 2023–2032.

Selected invited talks

Keynote — International Symposium on the Origin of Life, Keihanna, Kyoto (Sept. 2025).
Invited — ISAS/JAXA Planetary Exploration Workshop, Tokyo (Aug. 2023) — "The Metamorphic Brine–Ocean–Surface Deposit Connection at Ceres."
Invited — ELSI Seminar, Institute of Science Tokyo (Aug. 2023) — "Irreversible dehydration of rocky interiors leads to oceans on planetary bodies: Europa and Ceres as case studies."

Publications

Legend: 🌊 Ocean worlds 🌍 Paleoclimate & environmental chemistry 🪨 Meteorite geochemistry 🔬 Analytical methods 🧮 Computational tools 🌡️ Thermodynamics 🎓 Student or postdoc mentee/co-mentee

A. Peer-reviewed original papers

1. 🧮🌡️ Nisson, D., Melwani Daswani, M. et al. (2026). "Thermodynamic Constraints on H_2 Production and Habitability from Mg-rich Serpentinites as Mars Analogs." *J. Geophys. Res.: Planets.* doi:10.1029/2025JE009395.
2. 🧮🌡️🌍 Wang, C.-C.🎓, Usui, T. & Melwani Daswani, M. (2026). "A Thermochemical Modeling Perspective of Why Ca/Fe Carbonates Broadly Associate with Felsic Terrains on Mars." *J. Geophys. Res.: Planets.* doi:10.1029/2025JE009358.
3. 🌊🔬🧮🌡️ Mahboub, L. et al. incl. Melwani Daswani, M. (2026). "Electrical Properties of Icy World Oceans from Laboratory Measurements." *ACS Earth Space Chem.* doi:10.1021/acsearthspacechem.5c00333.
4. 🌊 Conor, N. et al. incl. Melwani Daswani, M. (2026). "Terrestrial Analogs to Titan for Geophysical Research." *Rev. Geophys.* 64, e2025RG000909. doi:10.1029/2025RG000909.
5. 🌊 Byrne, P. K. et al. incl. Melwani Daswani, M. (2026). "Little to no active faulting likely at Europa's seafloor today." *Nat. Commun.* 17:4. doi:10.1038/s41467-025-67151-3.
6. 🌍🧮🌡️ Kadoya, S. & Melwani Daswani, M. (2026). "Continued continental weathering during snowball Earth mitigated greenhouse gas buildup and prolonged global glaciation." *Earth Planet. Sci. Lett.* 679:119837. doi:10.1016/j.epsl.2026.119837.

7. 🌊🧮🌡️ Miller, K. E., Melwani Daswani, M., Sotin, C. et al. (2026). "Titan's refractory core evolution: Implications for organics in its subsurface ocean." *Icarus* 449:116961. doi:10.1016/j.icarus.2026.116961.
8. 🧮🌡️ Weber, J. M. et al. incl. Melwani Daswani, M. (2025). "Architectures and Instruments for Enceladus Exploration." *J. Geophys. Res.: Planets* 140, e2024JE008715. doi:10.1029/2024JE008715.
9. 🌊🧮 Bagheri, A. et al. incl. Melwani Daswani, M. (2025). "Exploring the Interior Structure and Mode of Tidal Heating in Enceladus." *Planet. Sci. J.* 6:10, 245. doi:10.3847/PSJ/ae0cab.
10. 🌊🧮🌡️ Courville, S. W.🎓, Castillo-Rogez, J. C., Melwani Daswani, M., Robare, J. & O'Rourke, J. G. (2025). "Core metamorphism controls dynamical habitability of mid-sized ocean worlds: The case of Ceres." *Sci. Adv.* 11, eadt3283. doi:10.1126/sciadv.adt3283.
11. 🌊🧮 Scully, J. E. et al. incl. Melwani Daswani, M. (2025). "Small in Number but Mighty in Significance: Impact Craters as Windows into Europa's Subsurface." *J. Geophys. Res.: Planets* 130:7, e2024JE008670. doi:10.1029/2024JE008670.
12. 🌊🌍🧮🌡️ Işık, S.🎓, Melwani Daswani, M. et al. (2025). "Thermodynamic constraints on the citric acid cycle and related reactions in ocean world interiors." *ACS Earth Space Chem.* doi:10.1021/acsearthspacechem.4c00371.
13. 🌊🔬 Martinez, E. et al. incl. Melwani Daswani, M. (2025). "Organic Adsorption onto Iron Hydroxide and Sulfide Minerals: Implications for Ceres Sample Return Analysis." *ACS Earth Space Chem.* doi:10.1021/acsearthspacechem.4c00372.
14. 🌊🧮 Petricca, F.🎓 et al. incl. Melwani Daswani, M. (2025). "Gravity and Radio Science Investigation at the Moons of Uranus to Reveal Subsurface Oceans and Characterize Interior Structures." *J. Geophys. Res.: Planets* 140, e2024JE008715. doi:10.1029/2024JE008715.
15. 🌊🌍🌡️ Affholder, A. et al. incl. Melwani Daswani, M. (2025). "The viability of glycine fermentation in Titan's subsurface ocean." *Planet. Sci. J.* 6, 86. doi:10.3847/PSJ/adbc66.
16. 🌊🧮🌡️ Lesage, E. et al. incl. Melwani Daswani, M. (2025). "Signatures of past and present cryovolcanism on Europa: Composition, geology, interior." *Nat. Commun.* 16, 1886. doi:10.1038/s41467-025-57070-8.
17. 🌊🧮🌡️ Petricca, F.🎓 et al. incl. Melwani Daswani, M. (2025). "Partial differentiation of Europa inferred from Galileo gravity data." *Nat. Astron.* doi:10.1038/s41550-024-02469-4.
18. 🌊🧮🌡️ Pou, L. et al. incl. Melwani Daswani, M. (2024). "Tidal seismicity in the Moon and implications for the rocky interior of Europa." *Planet. Sci. J.* 5, 142. doi:10.3847/PSJ/ad47bc.
19. 🌡️🔬 Chua, B. H.🎓 et al. incl. Melwani Daswani, M. (2023). "Low-temperature specific heat capacity of water–ammonia mixtures down to the eutectic." *ACS Earth Space Chem.* 7, 1971–1979. doi:10.1021/acsearthspacechem.3c00091.
20. 🌊🧮🌡️ Courville, S. W.🎓 et al. incl. Melwani Daswani, M. (2023). "Timing and abundance of clathrate formation control ocean evolution in outer solar system bodies: Challenges of maintaining a thick ocean within Pluto." *Planet. Sci. J.* 4, 179. doi:10.3847/PSJ/acf377.
21. 🌊🧮🌡️ Styczinski, M. J.🎓, Vance, S. D. & Melwani Daswani, M. (2023). "PlanetProfile: Self-consistent interior structure modeling for ocean worlds and rocky dwarf planets in Python." *Earth Space Sci.* 10, e2022EA002748. doi:10.1029/2022EA002748.
22. 🌊🌡️ Naseem, M. et al. incl. Melwani Daswani, M. (2023). "Salt distribution from freezing intrusions in ice shells on ocean worlds: Application to Europa." *Planet. Sci. J.* 4, 181. doi:10.3847/PSJ/ace5a2.
23. 🌊🌡️🧮 Castillo-Rogez, J. C. et al. incl. Melwani Daswani, M. (2023). "Compositions and interior structures of the large moons of Uranus and implications for future spacecraft observations." *J. Geophys. Res.: Planets* 128, e2022JE007432. doi:10.1029/2022JE007432.
24. 🌊🌡️🧮 Diab, J.🎓, Melwani Daswani, M. & Castillo-Rogez, J. (2023). "Bulk composition and thermal evolution constrain the formation of organics in Ceres' subsurface ocean via geochemical modeling." *Icarus* 391, 115339. doi:10.1016/j.icarus.2022.115339.

25. 🌊🌡️ Castillo-Rogez, J. C., Melwani Daswani, M. et al. (2022). "Contribution of non-water ices to salinity and electrical conductivity in ocean worlds." *Geophys. Res. Lett.* 49, e2021GL097256. doi:10.1029/2021GL097256.
26. 🌊🌡️🧮🌍 Melwani Daswani, M. & Castillo-Rogez, J. C. (2022). "Porosity-filling metamorphic brines explain Ceres' low mantle density." *Planet. Sci. J.* 3, 21. doi:10.3847/PSJ/ac4509.
27. 🌊🧮🌍 Castillo-Rogez, J. C. et al. incl. Melwani Daswani, M. (2022). "Science drivers for the future exploration of Ceres: From solar system evolution to ocean world science." *Planet. Sci. J.* 3, 64. doi:10.3847/PSJ/ac502b.
28. 🌊🧮 Marusiak, A. G. et al. incl. Melwani Daswani, M. (2021). "Exploration of icy ocean worlds using geophysical approaches." *Planet. Sci. J.* 2, 150. doi:10.3847/psj/ac1272.
29. 🌊🧮🌡️🌍 Melwani Daswani, M. et al. (2021). "A metamorphic origin for Europa's ocean." *Geophys. Res. Lett.* 48, e2021GL094143. doi:10.1029/2021GL094143.
30. 🌊🧮🌡️ Běhounková, M. et al. incl. Melwani Daswani, M. (2021). "Tidally-induced magmatic pulses on the oceanic floor of Jupiter's moon Europa." *Geophys. Res. Lett.* 48, e2020GL090077. doi:10.1029/2020GL090077.
31. 🌍 Perl, S. M. et al. incl. Melwani Daswani, M. (2021). "A proposed geobiology-driven nomenclature for astrobiological in situ observations and sample analyses." *Astrobiology* 21, 954–967. doi:10.1089/ast.2020.2318.
32. 🪨🧮🔬 Morlok, A. et al. incl. Melwani Daswani, M. (2020). "Mid-infrared reflectance spectroscopy of carbonaceous chondrites and calcium–aluminum-rich inclusions." *Planet. Space Sci.* 193, 105078. doi:10.1016/j.pss.2020.105078.
33. 🌍🌊🧮🪨 Vance, S. D. & Melwani Daswani, M. (2020). "Serpentinite and the search for life beyond Earth." *Phil. Trans. R. Soc. A* 378, 20180421. doi:10.1098/rsta.2018.0421.
34. 🌍🧮🌡️ Kite, E. S. & Melwani Daswani, M. (2019). "Geochemistry constrains global hydrology on Early Mars." *Earth Planet. Sci. Lett.* 524, 115718. doi:10.1016/j.epsl.2019.115718.
35. 🌍🧮🌡️ Melwani Daswani, M. & Kite, E. S. (2017). "Paleohydrology constrained by mass balance and mineralogy of pre-Amazonian sodium chloride lakes on Mars." *J. Geophys. Res.: Planets* 122, 1802–1823. doi:10.1002/2017JE005319.
36. 🌍🧮🌡️🪨 Melwani Daswani, M. et al. (2016). "Alteration minerals, fluids, and gases on early Mars: Predictions from 1-D flow geochemical modeling of mineral assemblages in meteorite ALH 84001." *Meteorit. Planet. Sci.* 51, 2154–2174. doi:10.1111/maps.12713.
37. 🪨🔬 Gross, J. et al. incl. Melwani Daswani, M. (2013). "Petrography, mineral chemistry, and crystallization history of olivine-phyric shergottite NWA 6234: A new melt composition." *Meteorit. Planet. Sci.* 48, 854–871. doi:10.1111/maps.12092.

B. Non-peer-reviewed original papers

1. 🧮🌡️ Chan, A.🎓, Melwani Daswani, M. & Vance, S. (2021). "DEWPython: A Python implementation of the Deep Earth Water model and application to ocean worlds." *arXiv preprint*, arXiv:2105.14096.

C. Books and other publications

1. 🌊🧮🌡️🌍 Vance, S. D., Crósta, A. P., Melwani Daswani, M. et al. (2025). "Chapter 13: Exchange processes between surface, atmosphere, and interior." In *Titan After Cassini-Huygens* (R. M. C. Lopes, Ed.), Elsevier, pp. 399–422. doi:10.1016/B978-0-323-99161-2.00009-7.
2. Co-author on four Community Papers for the National Academies of Sciences, Engineering, and Medicine's Planetary Science and Astrobiology Decadal Survey 2023–2032. (Co-signee on three additional papers.)