Paul O. Hayne

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Research Interests

I am interested in the ways in which volatiles and thermal processes shape the geology, climate and habitability of planets and moons.

Education

Ph.D. in Geophysics & Space Physics, UCLA, 2010. Advisor: David A. Paige.

M.S. in Geophysics, Stanford University, 2005. Advisor: Norman H. Sleep.

B.S. in Geophysics, Stanford University, 2003.

Employment

Jet Propulsion Laboratory: Staff Scientist, 2012–present.

California Institute of Technology: Postdoctoral Scholar (with Prof. Oded Aharonson), 2010–2012.

Mission Involvement

NASA Europa Multiple Flyby Mission: Investigation Scientist and Co-Investigator, Europa Thermal Imaging System (E-THEMIS), 2015–present.

NASA Lunar Flashlight: JPL Science Lead, 2012–present.

NASA Lunar Reconnaissance Orbiter: Co-Investigator, Diviner Lunar Radiometer, 2011–present.

NASA Mars Reconnaissance Orbiter: Science team member, Mars Climate Sounder, 2007–present.

NASA/ESA Cassini-Huygens: Science team affiliate, Visual and Infrared Mapping Spectrometer (VIMS), 2006–present.

NASA Galileo: Science team affiliate, Near-Infrared Mapping Spectrometer (NIMS), 2009.

ESA Mars Express: Data analysis, High Resolution Stereo Camera (HRSC), 2006.

Publications

Peer-reviewed Journal Articles

1. Piqueux, S., Kleinböhl, A., **Hayne, P. O.**, Heavens, N. G., Kass, D. M., McCleese, D. J., ... & Shirley, J. H. (2016), Discovery of a widespread lowâĂŘlatitude diurnal CO_2 frost cycle on Mars, *J. Geophys. Res.*, in press.

2. Greenhagen, B. T., Neish, C. D., Williams, J. P., Cahill, J. T., Ghent, R. R., **Hayne, P. O.**, ... & Bandfield, J. L. (2016), Origin of the anomalously rocky appearance of Tsiolkovskiy crater, *Icarus, 273*, 237–247.

3. Bennett, K. A., Horgan, B. H., Gaddis, L. R., Greenhagen, B. T., Allen, C. C., **Hayne, P. O.**, ... & Paige, D. A. (2016), Complex explosive volcanic activity on the Moon within Oppenheimer crater, *Icarus, 273*, 296–314.

4. Bonnefoy, L. E., A. G. Hayes, **P. O. Hayne**, et al. (2015), Compositional and spatial variations in Titan dune and interdune regions from Cassini VIMS and RADAR, *Icarus, 270*, 222–237, doi:10.1016/j.icarus.2015.09.014.

5. **Hayne, P. O.**, and Oded Aharonson (2015), Thermal stability of ice on Ceres with rough topography, *J. Geophys. Res., 120*, 1567–1584, doi:10.1002/2015JE004887.

6. **Hayne, P. O.**, A. R. Hendrix, E. Sefton-Nash, P. G. Lucey, K. D. Retherford, J-P. Williams, M. A. Siegler, B. T. Greenhagen, & D. A. Paige (2015), Evidence for exposed water ice in the Moon's south polar regions from Lunar Reconnaissance Orbiter ultraviolet albedo and temperature measurements, *Icarus, 255*, 58–69, doi:10.1016/j.icarus.2015.03.032.

7. Glotch, T. D., Bandfield, J. L., Lucey, P. G., **Hayne, P. O.**, Greenhagen, B. T., Arnold, J. A., ... & Paige, D. A. (2015), Formation of lunar swirls by magnetic field standoff of the solar wind, *Nature Comm., 6.*

8. Piqueux, S., Kleinböhl, A., **Hayne, P. O.**, Kass, D. M., Schofield, J. T., & McCleese, D. J. (2015), Variability of the Martian seasonal CO2 cap extent over eight Mars Years, *Icarus*, doi: 10.1016/j.icarus.2014.10.045

9. Bandfield, J. L., **Hayne, P. O.**, Williams, J. P., Greenhagen, B. T., & Paige, D. A. (2015), Lunar surface roughness derived from LRO Diviner Radiometer observations, *Icarus, 248*, 357–372.

10. **Hayne, P. O.**, McCord, T. B., & Sotin, C. (2014), Titan's surface composition and atmospheric transmission with solar occultation measurements by Cassini VIMS, *Icarus, 243*, 158–172.

11. **Hayne, P. O.**, D. A. Paige, N. G. Heavens (2014), The role of snowfall in forming the seasonal ice caps of Mars: Models and constraints from the Mars Climate Sounder, *Icarus 231*, 122–130.

12. Ghent, R. R., **Hayne, P. O.**, Bandfield, J. L., Campbell, B. A., Allen, C. C., Carter, L. M., & Paige, D. A. (2014), Constraints on the recent rate of lunar ejecta breakdown and implications for crater ages, *Geology, 42*(12), 1059–1062.

13. Bandfield, J. L., E. Song, **P. O. Hayne**, B. D. Brand, R. R. Ghent, A. R. Vasavada, D. A. Paige (2014), Lunar cold spots: Granular flow features and extensive insulating materials surrounding young craters, *Icarus 231*, 221–231.

14. Ingersoll, R. V., Pratt, M. J., Davis, P. M., Caracciolo, L., Day, P. P., **Hayne, P. O.**, ... & Hendrix, E. D. (2014), Paleotectonics of a complex Miocene half graben formed above a detachment fault: The Diligencia basin, Orocopia Mountains, southern California, *Lithosphere, 6*(3), 157–176.

15. Barnes, J. W., B. J. Buratti, E. P. Turtle, J. Bow, P. A. Dalba, J. Perry, R. H. Brown, S. Rodriguez, S. Le Mouelic, K. H. Baines, C. Sotin, R. D. Lorenz, M. J. Malaska, T. B. McCord, R. N. Clark, R. Jaumann, **P. O. Hayne**, et al. (2013), Precipitation-Induced Surface Brightenings Seen on Titan by Cassini VIMS and ISS, *Planetary Science, 2*, p. 1.

16. **Hayne, P. O.**, D. A. Paige, J. T. Schofield, D. M. Kass, A. Kleinböhl, N. G. Heavens, and D. J. McCleese (2012), Carbon dioxide snow clouds on Mars: South polar winter observations by the Mars Climate Sounder, *J. Geophys. Res., 117*, E08014, doi:10.1029/2011JE004040.

17. Vasavada, A. R., J. L. Bandfield, B. T. Greenhagen, **P. O. Hayne**, et al. (2012), Lunar Equatorial Surface Temperatures and Regolith Properties from the Diviner Lunar Radiometer Experiment, *J. Geophys. Res. 117*, E00H18.

18. **Hayne, P. O.**, B. T. Greenhagen, M. C. Foote, M. A. Siegler, A. R. Vasavada, and D. A. Paige (2010), Diviner Lunar Radiometer Observations of the LCROSS Impact, *Science, 330*, 477.

19. Paige, D. A., M. A. Siegler, J. A. Zhang, **P. O. Hayne**, et al. (2010), Diviner Observations of Cold Traps in the Lunar South Polar Region: Spatial Distribution and Temperature, *Science 330*, 479.

20. Greenhagen, B. T., P. G. Lucey, M. B. Wyatt, T. D. Glotch, C. C. Allen, J. A. Arnold, J. L. Bandfield, N. E. Bowles, K. L. Hanna, **P. O. Hayne**, E. Song, I. R. Thomas, and D. A. Paige (2010) Global Silicate Mineralogy of the Moon from the Diviner Lunar Radiometer, *Science 329*, 1507.

21. McCord, T. B., ..., and **P. O. Hayne** (2010), Hydrated minerals on Europa's surface: An improved look from the Galileo NIMS investigation, *Icarus 209*, 639–650.

22. Barnes, J. W., ..., **P. O. Hayne**, et al. (2009), VIMS Spectral Mapping Observations of Titan during the Cassini Prime Mission, *Planet. and Space Sci., 57*, 1950–1962.

23. McCord, T. B., **P. Hayne**, et al. (2008), Titan's surface: Search for spectral diversity and composition using the Cassini VIMS investigation, *Icarus, 194*, 212–242.

Book Chapters and Reports

Aharonson, O., A. Hayes, **P. O. Hayne**, R. Lopes, A. Lucas, J. T. Perron, (2012), Titan's Surface Geology, in: C. G. Mueller-Wodarg, T. Cravens and E. Lellouch (Ed.), *Titan: Surface, Atmosphere and Magnetosphere*, Cambridge University Press, Cambridge, UK.

Hayne, P. O., A. P. Ingersoll, D. A. Paige, & 32 co-authors (2014), "New approaches to lunar ice detection and mapping," *Keck Institute for Space Studies Report*. [PDF]

Honors & Awards

Visiting Scientist, The Helen Kimmel Center for Planetary Science, Weizmann Institute of Science, Israel (2016).

Study Leader, Keck Institute of Space Studies: "New Approaches to Lunar Ice Detection and Mapping" (2013–2014).

NASA Group Achievement Awards: Mars Climate Sounder Science Team (2010, 2011), Diviner Lunar Radiometer Science Team (2011, 2012, 2013, 2014) and Operations Team (2011).

Best Student Paper, NASA Lunar Science Forum (2010).

Simon Latimer Award for Service, Dept. of Earth Space Sciences, UCLA (2008).

Graduate Fellowship, Institute of Geophysics and Planetary Physics (IGPP) (2006–2008).

Chancellor's Prize, UCLA – Awarded to top incoming graduate students (2006).

Graduate Research and Teaching Fellowship, Stanford University (2003–2005).

Physics Department Undergraduate Fellowship, Stanford University (2001).

Teaching & Mentorship

2015–present	Research Advisor, Caltech Postdoctoral Scholars Program
2015–present	Research Advisor, NASA Postdoctoral Program
2013–2016	Mentor, JPL/Caltech summer undergraduate internship programs
2012, 2013	Mentor, LPI High School Lunar Research Program
2008	Teaching Assistant/Guest Lecturer, UCLA, Earth & Space Sciences 10: Exploring Mars
2004, 2005	Teaching Assistant, Stanford, Geophysics 50: Physics of the Earth
2002, 2003	Teaching Assistant, Stanford, Physics 50: Observational Astronomy

Recent Invited Talks

July, 2016	Lunar and Planetary Institute, Houston, TX
November, 2015	International Space Exploration Coordination Group
July, 2015	NASA Exploration Science Forum, Mountain View, CA
January, 2015	University of California, Santa Cruz, CA
May, 2014	SETI Institute, Mountain View, CA

Service & Leadership

2012–present	*Founder*, Young Scientists for Planetary Exploration
2012–present	*Review Panel Member*, NASA Science Mission Directorate
2009–2010	*Raconteur*, Planetary Science Decadal Survey, NRC Space Studies Board
2007–2008	*President*, Earth and Space Sciences Student Organization, UCLA
2005	*Project Facilitator*, FORGE, Mwange Refugee Camp, Zambia
2002–2004	*President*, Stanford Astronomical Society, Stanford University

Professional affiliations: American Geophysical Union, American Astronomical Society (Division of Planetary Sciences), Geological Society of America, American Institute of Physics, Sigma Xi

Computer languages and environments: C/C++, Matlab, IDL/ENVI, Python, UNIX Shell scripting, Fortran, ISIS, NAIF/SPICE, HTML/CSS, JavaScript