

## SUJOY MUKHOPADHYAY

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### Education

California Institute of Technology, Pasadena, CA, USA  
Indian Institute of Technology, Kharagpur, India  
Presidency College, University of Calcutta, India

Ph.D. Geochemistry, 2002  
M.Sc. Applied Geology, 1995  
B.Sc. Geology with Honors, 1992

### Professional Appointments

Professor, Geochemistry, U. California Davis	2014-present
Associate Professor, Geochemistry, Harvard University	2009-2014
Assistant Professor, Geochemistry, Harvard University	2003-2009
Postdoctoral Fellow, Carnegie Institution of Washington	2001-2003

### Selected Honors

2013 Gast Lectureship, jointly awarded by the EAG and the Geochemical Society  
2001 Carnegie Postdoctoral Fellowship  
2001 Everhart Distinguished Graduate Student Lecture at Caltech

### Research Interests

Sources and volatile budget of Earth, early volatile history of Earth, chemical evolution of the mantle-crust-atmosphere system, application of surface exposure dating to understanding land surface evolution, novel techniques for reconstructing mineral dust emission from continents and climatic effects of mineral dust, record of cosmic dust flux from sediments, technique development in Noble gas geochemistry.

### Synergistic Activities

*Departmental Service, U. California Davis*

Graduate admissions committee, 2014-present  
Space committee, 2014-present

*Departmental Service, Harvard University*

Co-Director, Graduate Studies Committee, 2008-2013.  
Graduate Studies Committee, 2004- present.  
Undergraduate Studies Committee, 2004-2006.  
Organizer of Departmental Colloquia, 2004-2006.  
Organized and led 37 undergraduates to a field trip to Hawaii, September 2008.  
Organized and led 36 undergraduates to a field trip to Hawaii, September 2005.

*Service to Earth Science community*

- Executive committee member of CIDER (Co-operative Institute for Dynamic Earth Research) (2011-present).

- Organizer of session on “New Tracers in Mantle Geochemistry” at the 23<sup>rd</sup> Goldschmidt Conference, Florence, Italy 2013.
- Organizer of the 2012 CIDER (Co-operative Institute for Dynamic Earth Research) summer program on “Deep Time: How did early Earth become our modern world?”
- Instructor for the 2012 CIDER summer program on “Deep Time: How did early Earth become our modern world?” at the Kavli Institute of Theoretical Physics, UCSB.
- Organizer of the 2011 Post-AGU CIDER Workshop
- Instructor and participant at the CIDER (Co-operative Institute for Deep Earth Research) 2010 summer school on “Water and volatiles in the Earth’s mantle and core” at the Kavli Institute of Theoretical Physics, UCSB.
- Organizer of session on “Quantifying Surface Processes Using Noble Gases” at the Fall 2008 Annual American Geophysical Union Meeting.
- Instructor and participant at the CIDER (Co-operative Institute for Deep Earth Research) 2008 summer school on “Boundary Layers in the Earth: a multidisciplinary view” at the Kavli Institute of Theoretical Physics, UCSB.
- International Program Committee member responsible for organizing the 17<sup>th</sup> Goldschmidt Conference, Cologne, Germany 2007.
- Organizer of session on “Timescales and Rates of Climate Change” at the 17<sup>th</sup> V.M. Goldschmidt Conference, Cologne, Germany, 2007.
- Organizer of the geochemistry program for the CIDER (Co-operative Institute for Deep Earth Research) 2006 summer school on “The nature and dynamics of the earth's transition zone: a multidisciplinary approach” at the Kavli Institute of Theoretical Physics, UCSB.
- Instructor and participant at the CIDER (Co-operative Institute for Deep Earth Research) 2006 summer school on “The nature and dynamics of the earth's transition zone: a multidisciplinary approach” at the Kavli Institute of Theoretical Physics, UCSB.
- Keynote lecturer and mantle geochemistry group leader at the MYRES meeting (Meeting of Young Researchers in Earth Sciences) on Heat, Helium, Hotspots, and Whole Mantle Convection, La Jolla, California, 2004.

### **Invited Presentations**

- Probing the Hadean World with Noble Gases, *Gast Lecture*, Goldschmidt 2013.
- Xenon and the early volatile history of the Earth. *Studies of the Earth’s Deep Interior*, Leeds, UK, 2012.
- Evidence from Xenon isotopes for limited mixing between MORB and Plume sources. *Advances in Seismology and Implications for Interdisciplinary Research: Adam M. Dziewonski Symposium*, 2011.
- Evidence from Xenon isotopes for limited mixing between MORB sources and plume sources since 4.45 Ga. *Fall Meeting of the American Geophysical Union*, 2011.
- Insight into Earth’s accretion and structure from Neon and Xenon in Icelandic Basalt. *Fall Meeting of the American Geophysical Union*, 2010.
- Mantle mixing and the preservation of geochemical heterogeneities. *Interior of the Earth*, Gordon Research Conference, 2009.
- Mantle mixing and mantle flow from an isotopic perspective *Fall Meeting of the American Geophysical Union*, 2009.

- Mass flux across the 670 km discontinuity as constrained by the Earth's Argon-40 budget. *Fall Meeting of the American Geophysical Union, 2008.*
- Preserving high He-3/He-4 ratios in a convective mantle: *Keynote lecture at the 18<sup>th</sup> V. M. Goldschmidt, 2008.*
- Ar, Kr, and Xe composition of the Earth's mantle: Implications for the formation of the atmosphere. *17<sup>th</sup> V. M. Goldschmidt Conference, Cologne, Germany, 2007.*
- <sup>3</sup>He evidence for a short duration of the Cretaceous/Tertiary boundary event. *Fall Meeting of the American Geophysical Union, 2000.*

### **Professional Affiliations**

American Geophysical Society  
 Geochemical Society  
 Geological Society of America

### **Doctoral and Post-Doctoral Advisors**

Kenneth A. Farley, Larry Nittler

### **Collaborators**

Mike Oskin, Helge Gonnermann, Brendan Meade, Stein Jacobsen, John Lassiter, Alessandro Montanari, Natalie Mahowald, Amato Evan, David Pollard, Richard Norris

### **Postdoctoral Fellows**

- *Curtis Williams* (2014-present)
- *Robert Ackert* (Research associate, Harvard)
- *Eric Gayer* (Lecturer, Institut de Physique du Globe de Paris)
- *Helge Gonnermann* (Professor, Rice University)

### **Graduate Students**

- *Atreyee Bhattacharya* (Application of the Helium isotopic system to accretion of terrestrial and extraterrestrial dust through the Cenozoic. PhD 2012)
- *Maria Pető* (Application of noble gas isotopic systems to identify mantle heterogeneities. PhD 2014)
- *Rita Parai* (Volatiles in the Earth and Moon: Constraints on planetary formation and evolution, PhD. 2014)
- *Jonathan Tucker* (2010-)
- *Jennifer Middleton* (2011-)

### **Undergraduate Thesis Research**

- Philip Kreycik: Documenting Sahel dust generation: Corals as High-Resolution Archives; 2006; Winner of the Hoopes Thesis Prize.
- Rita Parai: New constraints on the HIMU mantle source from Helium and Neon isotopic measurements in Cook-Austral basalts; 2007 (Currently a postdoc at Carnegie Inst. Wash.).
- Allen Pope: Exposure dating with <sup>21</sup>Ne and its application to Antarctic Ice Sheet History; 2008 (Currently a graduate student at the University of Cambridge).

- Laura Lea Larsen-Strecker: Bedrock Erosion in the Waimea Canyon, Kauai, Hawaii: Modeling the Spatial distribution of Erosion rates from Cosmogenic  $^3\text{He}$ ; 2008; Co-Advised with Brendan Meade.
- Jennifer Middleton: Complex exposure histories in the Antarctic Dry Valleys; 2010 (Currently a graduate student at Harvard).

### Submitted Manuscripts

1. Šrámek, O., L. Stevens, W. F. McDonough, S. Mukhopadhyay, and J. Peterson, Subterranean production of neutrons,  $^{39}\text{Ar}$  and  $^{21}\text{Ne}$ : Rates and uncertainties, *Geochim. Cosmochim. Acta* ([arXiv:1509.07436](https://arxiv.org/abs/1509.07436)), in review.

### Publications

38. Rizo, H., Walker, R. J., Carlson, R. W., Horan, M. F., Mukhopadhyay, S., Manthos, V., Francis, D., Jackson M. G., [Preservation of Earth-forming events in the tungsten isotopic composition of modern flood basalts](#), *Science*, in press, doi:10.1126/science.aad8563, 2016.
37. Middleton, J. L., Langmuir, C. H., Mukhopadhyay, S., McManus, J. F., and Mitrovica, J. X., [Hydrothermal iron flux variability following rapid sea level changes](#). *Geophysical Research Letters* 43, doi:10.1002/2016GL068408, 2016.
36. Xu, J., Calaprice, F., Galbiati, C., Goretti, A., Guray, G., Hohman, T., Holtz, D., Ianni, A., Laubenstein, M., Loer, B. and Love, C. [A study of the trace  \$^{39}\text{Ar}\$  content in argon from deep underground sources](#). *Astroparticle Physics* 66, 53-60, doi:10.1016/j.astropartphys.2015.01.002, 2015.
35. Parai, R. and Mukhopadhyay, S. [The evolution of MORB and plume mantle volatile budgets: Constraints from fission Xe isotopes in Southwest Indian Ridge basalts](#). *Geochemistry, Geophysics, Geosystems* 16, 719-735, doi:10.1002/2014GC005566, 2015.
34. Carlson, R.W., Garnero, E., Harrison, T.M., Li, J., Manga, M., McDonough, W.F., Mukhopadhyay, S., Romanowicz, B., Rubie, D., Williams, Q. and Zhong, S. [How did early Earth become our modern world?](#) *Annual Review of Earth and Planetary Sciences* 42, 51-178, doi:10.1146/annurev-earth-060313-055016, 2014.
33. Tucker, J. M. and Mukhopadhyay, S. [Evidence for multiple magma ocean outgassing and atmospheric loss episodes from mantle noble gases](#). *Earth and Planetary Science Letters* 393, 254-265, doi:10.1016/j.epsl.2014.02.050, 2014.
32. Ferrier, K. L., Perron, J. T., Mukhopadhyay, S., Rosener, M., Stock, J. D., Huppert, K. L. and Slosberg, M. [Covariation of climate and long-term erosion rates across a steep rainfall gradient on the Hawaiian island of Kaua'i](#). *GSA Bulletin* 125, 1146-1163, doi:10.1130/B30726.1, 2013.
31. Petó M., Mukhopadhyay, S. and Kelley, K. A. [Heterogeneities from the first 100 million years recorded in deep mantle noble gases from the Northern Lau Back-arc Basin](#). *Earth and Planetary Science Letters* 369, 13-23, doi:10.1016/j.epsl.2013.02.012, 2013.
30. Ackert Jr., R.P., Putnam, A.E., Mukhopadhyay, S., Pollard, D., DeConto, R.M., Kurz, M.D. and Borns, H.W. [Controls on interior West Antarctic Ice Sheet Elevations: inferences from geologic constraints and ice sheet modeling](#). *Quaternary Science Reviews* 65, 26-38, doi:10.1016/j.quascirev.2012.12.017, 2013.

29. Huang, S., Jacobsen, S.B. and Mukhopadhyay, S. [147Sm-143Nd systematics of Earth are inconsistent with a superchondritic Sm/Nd ratio](#). *Proceedings of the National Academy of Sciences of the United States of America*, 4929-4934, doi:10.1073/pnas.1222521110, 2013.
28. McGee D. and Mukhopadhyay S. [Extraterrestrial He in sediments: From recorder of asteroid collisions to timekeeper of global environmental changes](#). In *The Noble Gases as Geochemical Tracers* (Ed. P. Burnard), Advances in Isotope Geochemistry Series, Springer Verlag, pp. 155-176, doi:10.1007/978-3-642-28836-4\_7, 2013.
27. Parai R., Mukhopadhyay S. and Standish J. [Heterogeneous upper mantle Ne, Ar and Xe isotopic compositions and a possible Dupal noble gas signature recorded in basalts from the Southwest Indian Ridge](#). *Earth and Planetary Science Letters* 359, 227-239, doi:10.1016/j.epsl.2012.10.017, 2012.
26. Tucker, J.M., Mukhopadhyay, S. and Schilling, J.G. [The heavy noble gas composition of the depleted MORB mantle \(DMM\) and its implications for the preservation of heterogeneities in the mantle](#). *Earth and Planetary Science Letters*, 355, pp.244-254, doi:10.1016/j.epsl.2012.08.025, 2012.
25. Mukhopadhyay, S., Ackert Jr., R.P., Pope, A.E., Pollard, D. and DeConto, R.M. [Miocene to recent ice elevation variations from the interior of the West Antarctic ice sheet: Constraints from geologic observations, cosmogenic nuclides and ice sheet modeling](#). *Earth and Planetary Science Letters* 337, 243-251, doi:10.1016/j.epsl.2012.05.015, 2012.
24. Mukhopadhyay, S. [Early differentiation and volatile accretion recorded in deep-mantle neon and xenon](#). *Nature* 486, 101-104, doi:10.1038/nature11141, 2012.
23. Parai R. and Mukhopadhyay S. [How large is the subducted water flux? New constraints on mantle regassing rates](#). *Earth and Planetary Science Letters* 317-318, 396-406, doi:10.1016/j.epsl.2011.11.024, 2012.
22. Middleton, J.L., Ackert Jr., R.P. and Mukhopadhyay, S. [Pothole and channel system formation in the McMurdo Dry Valleys of Antarctica: New insights from cosmogenic nuclides](#). *Earth and Planetary Science Letters* 355, 341-350, doi:10.1016/j.epsl.2012.08.017, 2012.
21. Ackert Jr., R. P., Mukhopadhyay S., Pollard D., DeConto R. M., Putnam A. E., and Borns H. W. [West Antarctic Ice Sheet elevations in the Ohio Range: Geologic constraints and ice sheet modeling prior to the last glacial maximum](#). *Earth and Planetary Science Letters* 307, 83-93, doi:10.1016/j.epsl.2011.04.015, 2011.
20. Evan A. T. and Mukhopadhyay S. [African dust over the northern tropical Atlantic: 1955-2008](#). *Journal of Applied Meteorology and Climate* 49, 2213-2229, doi:10.1175/2010JAMC2485.1, 2010.
19. Mahowald, N. M., Kloster S., Engelstaedter S., Moore J. K., Mukhopadhyay S., McConnell J. R., Albani S., Doney S. C., Bhattacharya A., Curran M. A. J., Flanner M. G., Hoffman F. M., Lawrence D. M., Lindsay K., Mayewski P. A., Neff J., Rothenberg D., Thomas E., Thornton P. E., and Zender C. S. [Observed 20<sup>th</sup> century desert dust variability: impact on climate and biogeochemistry](#). *Atmospheric Chemistry and Physics Discussions* 10, 12585-12628, doi:10.5194/apcd-10-12585-2010, 2010.
18. Gonnermann H. M. and Mukhopadhyay S. [Preserving high concentrations of noble gases in a convecting mantle](#). *Nature* 459, 560-563, doi:10.1038/nature08018, 2009.
17. Parai R., Mukhopadhyay S., and Lassiter J. C. [New constraints on the HIMU mantle source from Helium and Neon Isotopic composition of basalts from the Cook-Austral](#)

- [Islands](#). *Earth and Planetary Science Letters* 277, 253-261, doi:10.1016/j.epsl.2008.10.014, 2009.
16. Mukhopadhyay S. and Kreycik P. [Dust Generation and Drought Patterns in Africa from Helium-4 in a Modern Cape Verde Coral](#). *Geophysical Research Letters* 35, L20820, doi:10.1029/2008GL035722, 2008.
  15. Gayer E., Mukhopadhyay S., and Meade B. J. [Spatial variability of erosion rates inferred from the frequency distribution of cosmogenic  \$^3\text{He}\$  in olivines from Hawaiian river sediments](#). *Earth and Planetary Science Letters* 266, 303-315, doi:10.1016/j.epsl.2007.11.019, 2008.
  14. Acosta-Kane D., et al. [Discovery of underground argon with low level of radioactive Ar-39 and possible applications to WIMP dark matter detectors](#). *Nuclear Instruments and Methods in Physical Research A* 587, 46-51, doi:10.1016/j.nima.2007.12.032, 2008.
  13. Gonnermann H. M. and Mukhopadhyay S. [Non-equilibrium degassing and a primordial source for helium in ocean-island volcanism](#). *Nature* 449, 1037-1040, doi:10.1038/nature06240, 2007.
  12. Ackert Jr., R. P., Mukhopadhyay S., Parizek B. R., and Born H. [Ice elevation near the West Antarctic Ice Sheet divide during the Last Glaciation](#). *Geophysical Research Letters* 34, L21506, doi:10.1029/2007GL031412, 2007.
  11. Oskin M., Perg L., Blumentritt D., Mukhopadhyay S., and Alexander I. [Slip rate of the Calico fault: Implications for geologic versus geodetic rate discrepancy in the Eastern California Shear Zone](#). *Journal of Geophysical Research* 112, B03402, doi:10.1029/2006JB004451, 2007.
  10. Farley K. A., Libarkin J., Mukhopadhyay S., and Amidon W. [Cosmogenic and nucleogenic  \$^3\text{He}\$  in apatite, titanite, and zircon](#). *Earth and Planetary Science Letters* 248, 451-461, doi:10.1016/j.epsl.2006.06.008, 2006.
  9. Mukhopadhyay S. and Farley K. A. [New insights into the carrier phase\(s\) of extraterrestrial  \$^3\text{He}\$  in geologically old sediments](#). *Geochimica Cosmochimica Acta* 70, 5061-5073, doi:10.1016/j.gca.2006.06.1566, 2006.
  8. McKeegan K. D., et al., [Isotopic compositions of cometary matter returned by Stardust](#). *Science* 314, 1724-1728, doi:10.1126/science.1135992, 2006.
  7. Busemann H., Young A. F., Alexander C. M. O., Hoppe P., Mukhopadhyay S., and Nittler L. R. [Interstellar chemistry recorded in organic matter from primitive meteorites](#). *Science* 312, 727-730, doi:10.1126/science.1123878, 2006.
  6. Farley K. A., Ward P., Garrison G., and Mukhopadhyay S. [Absence of extraterrestrial He-3 in Permian-Triassic age sedimentary rocks](#). *Earth and Planetary Science Letters* 240, 265-275, doi:10.1016/j.epsl.2005.09.054, 2005.
  5. Mukhopadhyay S., Lassiter J. C., Farley K. A., and Bogue S.W. [Geochemistry of Kauai shield lavas: Implications for the chemical evolution of the Hawaiian plume](#). *Geochemistry, Geophysics, Geosystems* 4, 2002GC000342, doi:10.1029/2002GC000342, 2003.
  4. Messenger S., Stadermann F. J., Floss C., Nittler L. R., and Mukhopadhyay S. [Isotopic signatures of presolar material in Interplanetary Dust](#). *Space Science Reviews* 106, 155-172, doi:10.1023/A:1024637704533, 2003.
  3. Mukhopadhyay S., Farley K. A., and Montanari A. [A short duration of the Cretaceous-Tertiary boundary event: evidence from extraterrestrial helium-3](#). *Science* 291, 1952-1955, doi:10.1126/science.291.5510.1952, 2001.

2. Mukhopadhyay S., Farley K. A., and Montanari A. [A 35 Myr record of helium in pelagic limestones from Italy: implications for accretion of interplanetary dust from Maastrichtian to middle Eocene](#). *Geochimica Cosmochimica Acta* 65, 653-669, doi:10.1016/S0016-7037(00)00555-X, 2001.
1. Farley K. A. and Mukhopadhyay S. [An extraterrestrial impact at the Permian-Triassic Boundary?](#) *Science* 293, 2343, doi:10.1126/science.293.5539.2343a, 2001.