Jeffrey C. Andrews-Hanna

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EMPLOYMENT

University of Arizona, Lunar and Planetary Laboratory (Tucson, AZ)
Associate Professor — January 2017 – present
Southwest Research Institute (Boulder, CO)
Visiting scientist (during sabbatical) — January 2015 – January 2016
Staff scientist — January 2016 – January 2017
Colorado School of Mines, Department of Geophysics (Golden, CO)
Assistant Professor — August 2008 – April 2014
Associate Professor with tenure — April 2014 – December 2015
Massachusetts Institute of Technology (Cambridge, MA)
Postdoctoral Research Associate, Advisor: Prof. Maria Zuber — June 2006 – August 2008

EDUCATION

Washington University (St Louis, MO) — Fall 2001 – Spring 2006
Dept. of Earth and Planetary Sciences
Doctor of Philosophy, 2006; Advisor: Prof. Roger Phillips; Thesis title: *"The hydrology of Mars: An integrated climatic, tectonic, magmatic, and geodynamic approach."*
University of Colorado at Boulder (Boulder, CO) — Fall 2000 – Spring 2001
Cornell University (Ithaca, NY) — Fall 1995 – Spring 2000
Bachelor of Arts Degree in Astronomy, 2000

RESEARCH INTERESTS

My research focuses on the evolution of the solid planets and moons in the Solar System. I take an interdisciplinary approach to my research, focusing on the interactions between a broad suite of processes acting on the surfaces and interiors of the planets. To this end, I combine various numerical modeling techniques with analysis of gravity, topography, spectral data, and geomorphology. My primary research emphases are in the areas of planetary geodynamics, tectonics, volcanism, impacts, hydrology, and climate evolution. My lunar research focuses on the analysis of gravity and topography data to investigate the early history of the Moon, the structure of impact basins, and the large-scale structure of the planet. Areas of Mars research include the early climatic and hydrologic evolution, the origin of the martian dichotomy, the formation of Valles Marineris, and volcanic and tectonic processes. Research on Saturn's moon Titan is focused on hydrologic and climatic factors controlling lake stability.

FUNDING

Total budget of funded grants to date: $3.5M since 2009

- NASA Mars Data Analysis Program — 2009-2014
  The Sedimentary Record of Arabia Terra: Remote Sensing and Hydrologic-Climatic Modeling
  P.I. Jeff Andrews-Hanna, Co-I's Ray Arvidson and Sandra Wiseman (Washington University), and Mark Richardson (Ashima Research)
- NASA Mars Fundamental Research Program — 2010-2014

Mars tectonics: Valles Marineris and the South Tharsis Ridge Belt
P.I. Jeff Andrews-Hanna

- NASA Lunar Advanced Science and Exploration Research Program 2011-2014
  Crustal structure and formation mechanism of lunar multi-ring basins
  P.I. Jeff Andrews-Hanna, Co-I Richard Krahenbuhl (CSM) and Yaoguo Li (CSM)
- NASA Outer Planets Research Program 2011-2014
  The hydrology of Titan: An integrated topographic, geomorphic, and modeling approach
  P.I. Jeff Andrews-Hanna, Co-I's Karl Mitchell and Bryan Stiles (JPL), Claire Newman (Ashima)
- NASA Gravity Recovery and Interior Laboratory Guest Scientist Program 2012-2016
  A GRAIL gravity investigation of multi-ring basins and mascons: Forward and inverse modeling, and gravity gradiometry
  P.I. Jeff Andrews-Hanna
- NASA Planetary Geology and Geophysics Program 2014-2017
  Compressional tectonics and global strain on Mars, the Moon, and Mercury
  P.I. Jeff Andrews-Hanna
- NASA Mars Data Analysis Program 2014-2017
  Recent explosive volcanism on Mars
  P.I. Jeff Andrews-Hanna
- NASA Solar System Workings Program 2015-2018
  Climatic control of explosive volcanism on Mars
  P.I. Jeff Andrews-Hanna, Co-I Alejandro Soto (SwRI) and Mark Richardson (Ashima)
- NASA Solar System Workings Program 2015-2018
  Hydrology, climate, and sedimentary deposits of Meridiani Planum and Gale Crater
  P.I. Jeff Andrews-Hanna, Co-I Alejandro Soto (SwRI) and Reed Maxwell (CSM)
- NASA Lunar Data Analysis Program 2015-2018
  A GRAIL gravity investigation of density anomalies in the lunar subsurface as records of early geodynamics and tectonics
  P.I. Jeff Andrews-Hanna

MISSION INVOLVEMENT

- NASA Gravity Recovery and Interior Laboratory (GRAIL) Guest Scientist 2012-2016

RESEARCH TOOLS

- Numerical modeling:
  - Finite difference modeling of groundwater flow and heat transfer
  - Boundary element modeling of tectonics
  - Finite element modeling of viscoelastic deformation
  - Spherical harmonic analysis of gravity and topography data, applied to problems of planetary loading, crustal structure, and tectonism
  - Programming in FORTRAN and MATLAB
- Data analysis
  - Analysis of gravity and topography using custom software in FORTRAN and MATLAB
  - Analysis of image, topography, and spectral data using ENVI and image editors

TEACHING

- PTYS 206 Our Golden Age of Planetary Exploration (*coming in Fall 2018*)
- GPGN 320 Continuum Mechanics (solid earth geophysics) (Spring 2014)

- GPGN 470/570 Applications of Satellite Remote Sensing (Spring 2009-2014)
- GPGN 475/575 Planetary Geophysics (Fall 2009-2014)
- GPGN 576 Special Topics in Planetary Science (Fall 2010-Fall 2014)
- GPGN 438 Senior Design (advised multiple student projects 2009-2014)
- CSM Geophysics Department Field Camp (1 week each in summers 2010-2013)
- Planetary Geophysics Lab Summer Field Trip (Summer 2012)
- EPSC 171 The Solar System (Summer, 2004-2005, co-Instructor at Washington University)

STUDENT AND POST-DOC RESEARCH MENTORING

• Alex Evans (post-doc)	Mars and Moon geodynamics	2015-present
• Alejandro Soto (post-doc)	Mars climate and hydrology	2012
• Johanna Jansen (PhD student)	Gravity of the Moon	2012-present
• David Horvath (PhD student)	Methane hydrology of Titan	2011-present
• Tyler Meng (PhD student)	Martian volcanology	2015-2016
• Stevie Francies (PhD student)	Martian volcanism	2013-2013
• Yaser Kattoum (MS student)	Lunar impact basins	2010-2012
• Ezgi Karasozen (MS student)	South Tharsis Ridge Belt, Mars	2010-2012
• Brian Davis (MS student)	Valles Marineris, Mars	2010-2013
• Kelsey Zabrusky (MS student)	Martian sedimentary deposits	2009-2011
• Hank Cole (undergraduate)	Martian tectonics	2013-present
• Matthew Emmett (undergraduate)	Impact craters	2012
• Lauren Jozwiak (undergraduate)	Olympus Mons, Mars	2010
• Ryan Isherwood (undergraduate)	Olympus Mons, Mars	2010-2012
• Joyce Hoopes (undergraduate)	Titan topography and lakes	2008-2010
• Alex Evans (PhD student, MIT)	Martian geodynamics	2007-2008
• Junlun Li (PhD student, MIT)	Martian polar caps	2007-2008

PROFESSIONAL ACTIVITIES AND SERVICE

- Guest scientist – NASA Gravity Recovery and Interior Laboratory (GRAIL) mission (2012-present)
- NASA Planetary Data System-Geosciences Node Advisory Panel, member (2008 – present)
- Planning committee for the Lunar and Planetary Science Conference (LPSC), group lead for the Dynamics and Tectonics category (Clear Lake, TX, 1/17/12-1/20/12)
- Served on 9 NASA review panels (3 as group chief)
- External reviewer on numerous proposals for NASA MFRP, MDAP, PGG, and other programs
- Reviewer: numerous papers for *Nature, Science, Nature Geoscience, Geophysical Research Letters, Earth and Planetary Science Letters, J. Geophysical Research, Physics of Earth and Planetary Interiors, Icarus, Geology, Geological Society of America Bulletin, Geomorphology*
- Frequent interviews provided to popular science media (BBC, NPR, National Geographic, Science News, Nature News, and others) on planetary topics
- Judge, Stephen E. Dwornik Award at the *37th - 39th LPSC* (2006-8)

SELECT AWARDS AND RECOGNITION

- CSM teaching excellence award (2014, 2015)
- Dwornik award to undergraduate student Hank Cole for best undergraduate poster presentation at the Lunar and Planetary Science Conference (2015)

- Order of Omega Outstanding Faculty Member award (2013)
- NASA group achievement award for contributions to the MRO Gravity Science Team (2011)
- Dwornik award to graduate student Kelsey Zabrusky for best oral presentation at the Lunar and Planetary Science Conference (2011)
- First prize overall award to graduate student Brian Davis in the CSM Graduate Student Research Fair poster competition (2011)
- Editor's Citation for Excellence in Refereeing for Geophysical Research Letters (2010) and Icarus (2015)
- Stephen E. Dwornik Planetary Geoscience Student Paper Award for Best Oral Presentation at the *36th Lunar and Planetary Science Conference* (2005)

PEER-REVIEWED PUBLICATIONS

** Student/post-doc mentored by J.C.A.-H.*

1) Bottke, W. F., and **J. C. Andrews-Hanna** (2017), A post-accretionary lull in large impacts on early Mars, *Nat. Geosci., 10*, 344–348, doi:10.1038/NGEO2937.
2) *Cole, H. M., and **J. C. Andrews-Hanna** (2017), The anatomy of a wrinkle ridge revealed in the wall of Melas Chasma, Mars, *J. Geophys. Res. Planets, 122*, 889–900, doi:10.1002/2017JE005274.
3) *Jansen, J. C., **J. C. Andrews-Hanna**, Y. Li, P. G. Lucey, G. J. Taylor, S. Goossens, F. G. Lemoine, E. Mazarico, J. W. Head, C. Milbury, W. S. Kiefer, J. M. Soderblom, and M. T. Zuber (2017), Small-scale density variations in the lunar crust revealed by GRAIL, *Icarus, 291*, 107–123, doi:10.1016/j.icarus.2017.03.017.
4) *Evans, A. J., J. M. Soderblom, **J. C. Andrews-Hanna**, S. C. Solomon, and M. T. Zuber (2016), Identification of buried lunar impact craters from GRAIL data and implications for the nearside maria, *Geophys. Res. Lett., 43*, 2445–2455, doi:10.1002/2015GL067394.
5) *Horvath, D. G., **J. C. Andrews-Hanna**, C. E. Newman, K. L. Mitchell, and B. W. Stiles (2016), The influence of subsurface flow on lake formation and north polar lake distribution on Titan, *Icarus, 277*, 103–124, doi:10.1016/j.icarus.2016.04.042.
6) *Karasözen, E., **J. C. Andrews-Hanna**, J. M. Dohm, and R. C. Anderson (2016), The formation of the South Tharsis Ridge Belt: Basin and Range-style extension on early Mars? *J. Geophys. Res. Planets, 121*, doi:10.1002/2015JE004936.
7) Johnson, B. C., D. M. Blair, G. S. Collins, H. J. Melosh, A. M. Freed, G. J. Taylor, J. W. Head, M. A. Wieczorek, J. C. Andrews-hanna, F. Nimmo, J. T. Keane, K. Miljkovi, J. M. Soderblom, and M. T. Zuber (2016), Formation of the Orientale lunar multiring basin, *Science, 354*, 441–444.
8) Zuber, M. T., D. E. Smith, G. A. Neumann, S. J. Goossens, J. C. Andrews-Hanna, J. W. Head, W. S. Kiefer, S. W. Asmar, A. S. Konopliv, F. G. Lemoine, I. Matsuyama, H. J. Melosh, P. J. Mcgovern, F. Nimmo, R. J. Phillips, S. C. Solomon, G. J. Taylor, M. M. Watkins, M. A. Wieczorek, J. G. Williams, J. C. Jansen, B. C. Johnson, J. T. Keane, E. Mazarico, K. Miljković, R. S. Park, J. M. Soderblom, and D.-N. Yuan (2016), Gravity field of the Orientale basin from the Gravity Recovery and Interior Laboratory (GRAIL) mission, *Science, 354*, 438–441.
9) Soderblom, J. M., A. J. Evans, B. C. Johnson, H. J. Melosh, K. Miljković, R. J. Phillips, **J. C. Andrews-Hanna**, C. J. Bierson, J. W. Head III, C. Milbury, G. A. Neumann, F. Nimmo, D. E. Smith, S. C. Solomon, M. M. Sori, M. A. Wieczorek, and M. T. Zuber (2015), The fractured Moon: Production and saturation of porosity in the lunar highlands from impact cratering, *Geophys. Res. Lett., 42,* 6939–6944, doi:10.1002/2015GL065022.
10) **Andrews-Hanna, J. C.**, J. Besserer, J. W. Head, C. J. A. Howett, W. S. Kiefer, P. J. Lucey, P. J. McGovern, H. J. Melosh, G. A. Neumann, R. J. Phillips, R. J. Phillips, P. M. Schenk, D. E.

Smith, S. C. Solomon, and M. T. Zuber (2014), Structure and evolution of the lunar Procellarum region as revealed by GRAIL gravity data, *Nature, 514*, 68-71.

11) Besserer, J., F. Nimmo, M. A. Wieczorek, R. C. Weber, W. S. Kiefer, P. J. McGovern, **J. C. Andrews-Hanna**, D. E. Smith, and M. T. Zuber (2014), Grail gravity constraints on the vertical density structure of the lunar crust, *Geophys. Res. Lett., 41,* 5771–5777, doi: 10.1002/2014GL060240.

12) Williams, J. G., A. S. Konopliv, D. H. Boggs, R. S. Park, D.-N. Yuan, F. G. Lemoine, S. Goossens, E. Mazarico, F. Nimmo, R. C. Weber, S. W. Asmar, H. J. Melosh, G. A. Neumann, R. J. Phillips, D. E. Smith, S. C. Solomon, M. W. Watkins, M. A. Wieczorek, **J. C. Andrews-Hanna**, J. W. Head III, W. S. Kiefer, I. Matsuyama, P. J. McGovern, G. J. Taylor, and M. T. Zuber (2014), Lunar interior properties from the GRAIL mission, *J. Geophys. Res. 119*, 1546-1578.

13) **Andrews-Hanna, J. C.**, S. W. Asmar, J. W. Head III, W. S. Kiefer, A. S. Konopliv, F. G. Lemoine, I. Matsuyama, E. Mazarico, P. J. McGovern, H. J. Melosh, G. A. Neumann, F. Nimmo, R. J. Phillips, D. E. Smith, S. C. Solomon, G. J. Taylor, M. A. Wieczorek, J. G. Williams, and M. T. Zuber (2013), Ancient igneous intrusions and early expansion of the Moon revealed by GRAIL gravity gradiometry, *Science*, *339*, 675-678.

14) Wieczorek, M. A., G. A. Neumann, F. Nimmo, W. S. Kiefer, G. J. Taylor, H. J. Melosh, R. J. Phillips, S. C. Solomon, **J. C. Andrews-Hanna**, S. W. Asmar, A. S. Konopliv, F. G. Lemoine, D. E. Smith, M. M. Watkins, J. G. Williams, and M. T. Zuber (2013), The crust of the Moon as seen by GRAIL, *Science*, *339*, 671-675.

15) Melosh, H. J., A. M. Freed, B. C. Johnson, D. M. Blair, **J. C. Andrews-Hanna**, G. A. Neumann, R. J. Phillips, D. E. Smith, S. C. Solomon, M. A. Wieczorek, and M. T. Zuber (2013), The origin of lunar mascon basins, *Science*, *340*, 1552-1555.

16) *Isherwood, R. J., *J. M. Jozwiak, *J. C. Jansen, and **J. C. Andrews-Hanna** (2013), The volcanic history of Olympus Mons from paleo-topography and flexural modeling, *Earth Plan. Sci. Lett.*, *363*, 88-96.

17) *Kattoum, Y. N., and **J. C. Andrews-Hanna** (2013), Evidence for ring-faults around the Orientale basin on the Moon from gravity, *Icarus*, *226*, 694-707.

18) **Andrews-Hanna, J. C.** (2013), The origin of the non-mare mascon gravity anomalies in lunar basins, *Icarus*, *222*, 159-168.

19) *Zabrusky, K. J., **J. C. Andrews-Hanna**, and S. M. Wiseman (2012), Reconstructing the distribution and depositional history of the sedimentary deposits of Arabia Terra, Mars, *Icarus*, *220*, 311-330.

20) *Li, J., **J. C. Andrews-Hanna**, Y. Sun, R. J. Phillips, J. J. Plaut, and M. T. Zuber (2012), Density variations within the south polar layered deposits of Mars, *J. Geophys. Res.*, *117*, E04006, doi:04010.01029/02011JE003937.

21) **Andrews-Hanna, J. C.** (2012), The formation of Valles Marineris: 1. Tectonic architecture and the relative roles of extension and subsidence, *J. Geophys. Res.*, *117*, E03006 doi:03010.01029/02011JE003953.

22) **Andrews-Hanna, J. C.** (2012), The formation of Valles Marineris: 2. Stress focusing along the buried dichotomy boundary, *J. Geophys. Res.*, *117*, E04009, doi:04010.01029/02011JE003954.

23) **Andrews-Hanna, J. C.** (2012), The formation of Valles Marineris: 3. Super-isostasy, sedimentation, and subsidence, *J. Geophys. Res.*, *117*, E06002, doi:06010.01029/02012JE004059.

24) **Andrews-Hanna, J. C.**, and K. W. Lewis (2011), Early Mars Hydrology: 2. Hydrologic evolution in the Noachian and Hesperian epochs, *J. Geophys. Res. 116*, E02007, doi:10.1029/ 2010JE003709.

25) **Andrews-Hanna, J. C.**, M. T. Zuber, R. E. Arvidson, and S. M. Wiseman (2010), Early Mars hydrology: Meridiani playa deposits and the sedimentary record of Arabia Terra, *J. Geophys. Res.*, *115*, E06002, doi:06010.01029/02009JE003485.

26) Wray, J. J., R. E. Milliken, C. M. Dundas, G. A. Swayze, **J. C. Andrews-Hanna**, A. M. Baldridge, M. Chojnacki, J. L. Bishop, B. L. Ehlmann, S. L. Murchie, R. N. Clark, F. P. Seelos, L. L. .. Tornabene, and S. W. Squyres (2011), Columbus crater and other possible groundwater-fed paleolakes of Terra Sirenum, Mars, *J. Geophys. Res., 116*, E01001, doi:01010.01029/02010JE003694.

27) Wiseman, S. M., R. E. Arvidson, R. V. Morris, F. Poulet, **J. C. Andrews-Hanna**, J. L. Bishop, S. L. Murchie, F. P. Seelos, D. Des Marais, and J. L. Griffes (2010), Spectral and stratigraphic mapping of hydrated sulfate and phyllosilicate-bearing deposits in northern Sinus Meridiani, Mars, *J. Geophys. Res.*, *115*, E00D18, doi:10.1029/2009JE003354.

28) *Evans, A. J., **J. C. Andrews-Hanna**, and M. T. Zuber (2010), Geophysical limitations on the erosion history within Arabia Terra, *J. Geophys. Res.*, *115*, E05007, doi:05010.01029/02009JE003469.

29) **Andrews-Hanna, J.C.**, and Zuber, M.T. (2010), Elliptical craters and basins on the terrestrial planets, *in* Reimold, W.U., and Gibson, R.L., eds., Large Meteorite Impacts and Planetary Evolution IV: Geological Society of America Special Paper 465, p. 1–13, doi:10.1130/2010.2465.

30) Murchie, S. L., L. Roach, F. Seelos, R. E. Milliken, J. Mustard, R. Arvidson, S. M. Wiseman, K. A. Lichtenberg, **J. C. Andrews-Hanna**, J. Bishop, J.-P. Bibring, M. Parente, and R. V. Morris (2009), Evidence for the origin of layered deposits in Candor Chasma, Mars, from mineral composition and hydrologic modeling, *J. Geophys. Res.*, 114, E00D05, doi:10.1029/2009JE003343.

31) **Andrews-Hanna, J. C.** (2009), Planetary Science: A mega-landslide on Mars, *Nature Geoscience: News and Views*, 2, 248-249.

32) **Andrews-Hanna, J. C.**, M. T. Zuber, and S. A. Hauck (2008), Strike-slip faults on Mars: Observations and implications for global tectonics and geodynamics, *J. Geophys. Res., 113*, E08002, doi:10.1029/2007JE002980.

33) **Andrews-Hanna, J. C.**, M. T. Zuber, and W. B. Banerdt (2008), The Borealis Basin and the origin of the martian crustal dichotomy, *Nature*, *453*, 1212-1215.

34) Wiseman, S. M., R. E. Arvidson, **J. C. Andrews-Hanna**, R. N. Clark, N. Lanza, D. Des Marais, G. A. Marzo, R. V. Morris, S. L. Murchie, H. E. Newsom, E. Z. Noe Dobrea, A. M. Ollila, F. Poulet, T. L. Roush, F. P. Seelos, and G. A. Swayze (2008), Phyllosilicate and sulfate-hematite deposits within Miyamoto crater in southern Sinus Meridiani, *Geophys. Res. Lett.*, *35*, L19204, doi:19210/11029/12008GL035363.

35) Zuber, M. T., R. J. Phillips, **J. C. Andrews-Hanna**, S. W. Asmar, A. S. Konopliv, F. G. Lemoine, J. J. Plaut, D. E. Smith, and S. E. Smrekar (2007), Density of Mars' south polar layered deposits, *Science*, 317, 1718-1719.

36) **Andrews-Hanna, J. C.**, and R. J. Phillips (2007), Hydrological modeling of outflow channels and chaos regions, *J. Geophys. Res. 112*, E08001, doi:10,1029/2006JE002935.

37) **Andrews-Hanna, J. C.**, R. J. Phillips, and M. T. Zuber (2007), Meridiani Planum and the global hydrology of Mars, *Nature, 446,* 163-166.

38) Wang, C.-Y., M. Manga, and **J. C. Hanna** (2006), Can freezing cause floods on Mars, *Geophys. Res. Lett.*, *33*, L20202, doi:20210.21029/22006GL027471.

39) **Hanna, J. C.,** and R. J. Phillips (2006), Tectonic Pressurization of aquifers in the formation of Mangala and Athabasca Valles, Mars, *J. Geophys. Res. 111 (E3)*, E03003, doi:10.1029/2005JE002546.

40) **Hanna, J. C.**, and R. J. Phillips (2005), Hydrological modeling of the Martian crust with

application to the pressurization of aquifers, *J. Geophys. Res.*, *110*, E01004, doi:01010.01029/02004JE002330.