Andrew Darling

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Education

Ph.D. Geological Sciences, *School of Earth and Space Science, Arizona State University*, Tempe, AZ 2016. *Chair: Kelin Whipple*.

M.S. Geological Sciences, *Department of Earth and Planetary Science, The University of New Mexico*, Albuquerque, NM 2010. *Chair: Karl Karlstrom*.

B.S. Environmental Geology, *Mesa State College (now Colorado Mesa University)*, Grand Junction, CO, Minors in Mathematics and Chemistry, Cum Laude, Honors, 2008.

Positions

2019 - present **Lecturer**, *University of Georgia*, Athens, GA.

2016 - 2019 **Research Scientist**, *Colorado State University*, Fort Collins, CO.

Grants and Fellowships

2015 NASA Space Grant Summer Fellowship: "A Lasting Earth Science Curriculum for use at Camp Tontozona." $7,000

2013 NASA Space Grant Fellowship: "Modeling Student Thinking about Erosion and Rivers." A teaching experiment conducted in the field and with virtual field-components to teach and explore student conceptions of canyon incision. $9,000

2011-2012 Science Foundation Arizona Fellowship, matching grant with RA funding; curriculum design and teaching of middle school students with hands-on stream table experiments and virtual field trips. $20,000

2009 PRIME Lab, Seed grant: "Tectonic Geomorphology from the upper Colorado River: Terrace Chronology from New Cosmogenic Burial Ages in Conjunction with Profile Analyses. $10,000

2005 NSF Research Experience for Undergraduates at Mesa State College (now Colorado Mesa University), Grand Junction, CO. Landscape evolution research. $3,000

Research Interests

Tectonic geomorphology and landscape evolution, recently focused on Colorado Plateau and Colorado River system. Research is framed in theoretical developments based on stream power incision model, numerical landscape evolution models and testing hypotheses of landscape evolution with empirical rates of change (incision rates, erosion rates, denudation rates), in the geologic context of the region studied. Specialization in cosmogenic isotope measurement (10Be, 26Al).

Cognitive domain research such as students' conceptions of landscape change and links between quantitative reasoning (mathematics education) and spatial and temporal reasoning (geoscience education). Current project using interviews to model students' units coordination schemes (after Steffe) and reasoning with magnitude and measurement (after Thompson) to understanding students' construction of scientific quantities.

Invited Talks

2017 University of Colorado

2015 Colorado Mesa University

2015 University of Northern Colorado

White Papers

2018 Pyle, E., **Darling, A.,** Kreager, Z., and Conrad, H. 2018, Research on Students' Conceptual Understanding of Geology/Solid Earth Science Content, In St. John, K. (Ed.) 2018, A Community Framework for Geoscience Education Research, *National Association of Geoscience Teachers*

2018 Pyle, E. J., Semken, S., **Darling, A.,** Bhattacharyya, J., Duggan-Haas, D., Pallant, A., Wiggen, J., and St. John, K., 2018, Closing the Loop: Communication for Transformation of Geoscience Teaching Practice: in St. John, K (Ed.) (2018). Community Framework for Geoscience Education Research. *National Association of Geoscience Teachers*

Refereed Conference Proceedings

Note: *mathematics education proceedings are double-blind, peer-reviewed multi-page publications*

in review Boyce, S., Byerley, C., **Darling, A.**, Grabhorn, J., and Tyburski, B., Relationships between calculus students' structures for static and dynamic reasoning. In S. Otten, Z. de Araujo, A. Candela, and C. Munter (Eds.), Proceedings of the 41st Annual Meeting of the North American Chapter of the International Group of the Psychology of Mathematics Education (PME-NA), St. Louis, MO.

Refereed Journal Articles and Reports

in revision **Darling, A.,** Whipple, K., Bierman, P., Clarke, B., Heimsath, A., Amplification of Erosion Rates in Resistant Rock Layers: Earth Surface Processes and Landforms.

2018 Luo, W., Smith, T., Whalley, K., **Darling, A.,** Ormand, C., Wei-Chen, H., Jui-Ling, C., Pelletier, J., Duffin, K., 2018, Earth surface modeling for education: How effective is it? - Four semesters of classroom tests with WILSIM-GC: *British Journal of Educational Technology*, DOI 10.1111/bjet.12653

2015 **Darling, A**., and Whipple K., 2015, Geomorphic constraints on the age of the western Grand Canyon: *Geosphere*, v. 11, no 4, p. 958-976.

2014 Crow, R., Karlstrom, K., **Darling, A.,** Crossey, L., Polyak, V., Granger, D., Asmerom, Y., and Schmandt, B., 2014, Steady incision of Grand Canyon at the million year timeframe: a case for mantle-driven differential uplift: *Earth and Planetary Science Letters*, v. 397, p. 159-173.

2013 Donahue, M. S., Karlstrom, K., Aslan, A., **Darling, A**., Granger, D., Wan, E., Dickinson, R., and Kirby, E., 2013, Incision history of the Black Canyon of Gunnison, Colorado, over the past 1 Ma inferred from dating of fluvial gravel deposits: *Geosphere*, v. 9, no. 4, p. 815-826.

2012 **Darling, A.L.,** Karlstrom, K.E., Granger, D.E., Aslan, A., Kirby, E., Ouimet, W.B., Lazear, G.D., Coblentz, D.D., Cole, R.D., 2012, New incision rates along the Colorado River system based on cosmogenic burial dating of terraces: implications for regional controls on Quaternary incision: *Geosphere*, v. 8, no. 5, p. 1020-1041.

2012 Karlstrom, K.E., Coblentz, D., Ouimet, W., Kirby, E., Van Wijk, J., Schmandt, B., Kelley, S., Lazear, G.,Crossey, L. J., Crow, R., Aslan, A., **Darling, A**., Dueker, K., Aster, R., MacCarthy, J., Hansen, S.M., Stachnik, J., Stockley, D., Donahue, M.S., and the CREST working group, 2012, Mantle-driven dynamic uplift of the Rocky Mountains and Colorado Plateau and its surface response: toward a unified hypothesis: *Lithosphere*, v. 4, p. 3-22.

2011 Karlstrom, K., Coblentz, D., Ouimet, W., Kirby, E., van Wijk, J., Schmandt, B., Crossey, L., Crow, R., Kelley, S., Aslan, A., **Darling, A**., Dueker, K., Aster, R., MacCarthy, J., Lazear, G., 2011, Evidence from the Colorado River system for surface uplift of the Colorado Rockies and western Colorado Plateau in the last 10 Ma driven by mantle flow and buoyancy. CRevolution 2; origin and evolution of the Colorado River system, workshop abstracts: Open-File Report - U. S. Geological Survey, 153-159.

2011 **Darling, A**., Karlstrom, K., Aslan, A., Granger, D., 2011, Differential incision rates in the upper Colorado River system; implications for knickpoint transience. CRevolution 2; origin and evolution of the Colorado River system, workshop abstracts: Open-File Report - U. S. Geological Survey, 74-79.

2011 Sandoval, M, Karlstrom, K., **Darling, A**., Aslan, A., Granger, D., Wan, E., Noe, D., Dickinson, W., 2011, Quaternary history of the Black Canyon of the Gunnison, Colorado. CRevolution 2; origin and evolution of the Colorado River system, workshop abstracts: Open-File Report - U. S. Geological Survey, 245-249

2011 Aslan, A., Karlstrom, K., Kirby, E., **Darling, A**., Kelley, S., 2011, Origin of the ancestral Colorado and Gunnison Rivers and post-10 Ma river incision rates in western Colorado. CRevolution 2; origin and evolution of the Colorado River system, workshop abstracts: Open-File Report - U. S. Geological Survey, 22-27.

2009 **Darling, A**., Aslan, A., Cole, R., Karlstrom, K., Betton, C., Wan, E., 2009, Late Quaternary incision rates and drainage evolution of the Uncompahgre and Gunnison Rivers, western Colorado, as calibrated by Lava Creek B ash: *Rocky Mountain Geology*, v. 44, p. 71-83.

2008 Aslan, A., Karlstrom, K., Hood, W., Cole, R.D., Oesleby, T., Betton, C., Sandoval, M., **Darling, A.**, Kelley, S., Hudson, A., Kaproth, B., Schoepfer, Benage, M., and Landman, R., 2008, River incision histories of the Black Canyon of the Gunnison and Unaweep Canyon: Interplay between late Cenozoic tectonism, climate change, and drainage integration in the western Rocky Mountains, in Raynolds, R.G., ed., Roaming the Rocky Mountains and Environs: Geological Field Trips: *Geological Society of America Field Guide* 10, p. 175-202.

Media Coverage

2015 At least 13 news outlets published articles about my research on the age of the Grand Canyon (Geosphere, 2015) including www.smithsonianmag.com and an interview for an Arizona National Public Radio affiliate.

Teaching Interests

Field Methods, Geomorphology, Fluvial Geomorphology, Tectonic Geomorphology, Surficial Geochronology, Geochemistry, Mathematics in Geology, Teaching Methods for Earth Science, Geographic Information Systems

Teaching Experience

2016-current **Colorado State University** Instructor of record

- Environmental Geology (upper division)
- Fluvial Geomorphology (Graduate)
- Tectonic Geomorphology and Surficial Geochronology (Graduate Seminar, multiple semesters)
- Alliance/WCNR Summer STEM Institute (high school students)

2012-2016 **Arizona State University** Teaching Assistant
- Geomorphology (Graduate)
- Fundamentals of Planetary Geology (Graduate)
- Earth's Critical Zone (upper division)
- Introductory Geology
- Historical Geology Lab

2011-2015 **Camp Tontozona**-Educational Field Instructor
- Designed and implemented geological field lessons for diverse groups of middle school students. Around 1000 students and dozens of parents attended.

2011-2012 **Science Foundation Arizona Fellow**
- Designed and implemented curricula for an after-school program for middle school. Hands-on experiments and virtual field trips to explore fluvial processes and erosion.

2008-2010 **University of New Mexico** Teaching Assistant
- Advanced Field Geology (graduate)
- New Mexico Field Geology
- Structural Geology (upper division)

2006-2008 **Mesa State College**-Student Assistant
- Field-based Introductory Geology
- Introduction to Field Methods
- Structural Geology

Skills in Technical Programs and Languages for Data Analysis and Data Visualization

Expert ArcGIS, Adobe Illustrator, Microsoft Powerpoint, Google Earth, GPS Navigation, and Excel.

Intermediate Matlab, Python, DaVinci (image analysis), Adobe Photoshop, Remote Sensing, Microsoft Image Composite Editor.

National Service

2017- Secretary/Treasurer Geoscience Education Division of Geological Society of America

2017 NSF Panelist

2017- Reviewer for Journal Geophysical Research - Earth Surface

Departmental Service

2016- Started and running CSU Geosciences Department Social Seminar: biweekly 30 minute, informal department talks to build collaboration and community between students, research staff and faculty across different fields and to provide students practice space for engaging talks.

2011-2016 Cosmogenic isotopes laboratory: training junior students in lab methods, safety training (including HF) and managing lab operations such as maintaining acid and chemical inventory and ordering supplies as needed.

2004-2008 Docent, Western Colorado Math and Science Center: Thousands of hours explaining science in an informal education setting to school groups and the public, as well as designing new, and repairing old science displays. Display subjects: physics, electronics, geology, aeronautical engineering, ecology, biology, chemistry.

Awards and Achievements

2013/2014 Passed two qualifying exams required of Mathematics Education Ph.D. students

2008 Outstanding Student Award, Rocky Mountain Association of Geologists (RMAG)

Research Lab Experience

2014 Processed 25 clean quartz samples to targets at University of Vermont cosmogenic isotopes lab

2012-2015 Processed 50 cosmogenic nuclide samples to clean quartz at ASU cosmogenic isotope lab

2009 Processed 48 cosmogenic nuclide samples to AMS targets at PRIME lab (Purdue)

2007 Chemical Technician, Enviro-Chem Analytical, Inc., Grand Junction, CO. Sample processing, making standards in gravimetry, colorimetry and pH analyses.

Technical Field Research Experience

2006-current Traditional rock climbing: advanced skills in lead climbing, anchor building and assessment, safety consciousness in groups and as leader of groups. Skills used for sample collection in the field.

2007-current Whitewater rafting: advanced skills in reading water, avoiding obstacles in motorized, paddle and rowed craft of various size, maintaining safety in groups on whitewater. Certified in swift-water rescue. Used skills on seven Grand Canyon research trips and three Desolation Canyon research trips (>100 days combined) and recreational trips in Alaska, Utah, Arizona, Colorado and Mexico.

2010-current Canyoneering: advanced skills in rappelling and natural anchors, extensive group planning experience, first descents of remote canyons in Grand Canyon. Skills used for field surveys of catchments for scientific study.

2014-current Packrafting: Use of light-weight inflatable crafts for exploring truly remote wilderness accessible only by rivers, foot travel and/or bush aircraft.

Professional Memberships

Geological Society of America

American Geophysical Union

National Association of Geoscience Teachers

Professional Workshops Attended

2019

2017 Grand Challenges in Geoscience Education Research: Earth Educators Rendezvous

2016 Teaching Computation in the Sciences using MATLAB, Science Education Research Center, Carleton College

Abstracts for Professional Meetings

accepted for 2019 **Darling, A.,**Byerley, C., Tyburski, B., Boyce, S., Grabhorn, J., Connecting Constructs: Coordination of Units and Covariation, Poster Proposal, Special Interest Group of the Mathematical Association of America on Research in Undergraduate Mathematics Education (RUME).

accepted for 2019 Tyburski, B., **Darling, A.,** Byerley, C., Boyce, S., Grabhorn, J., The Role of Improper Fraction Schemes in STEM Students' conception of Measurement, Abstract, Joint Mathematics Meetings.

2018 Pyle, E., **Darling, A.,** Kraeger, B., Conrad, S., How Do We Learn How Students are Learn? GER Grand Challenges on Solid Earth Conceptual Understanding: Geological Society of America: Abstracts with Programs: v. 50, no. 6, p. xx.

2018 **Darling., A.,**, Whipple, K., Bierman, P., Heimsath, A., Long term Incision History of the Grand Canyon Inferred from the Pattern of Short-Term Erosion and Incision Rates: Geological Society of America: Abstract with Programs: V. 50, no. 6, p. xx.

2016 **Darling, A.**, Whipple, K.,Forte, A., Clarke, B., Bierman, P., 2016, Effects of stratigraphic variation in rock strength on erosion rate patterns in landscape evolution from numerical models and cosmogenic sampling in Grand Canyon and Grand Staircase: Geological Society of America: Abstract with Programs: v. 8, no. 7, p. xx

2015 **Darling, A.**. and Whipple, K., 2015, Tributary response to baselevel fall in Grand Canyon: incision timing and influences of coarse sediment supply on knickpoint form and channel steepness: Abstract EP53B-1021 presented at 2015 Fall Meeting, AGU, San Francisco, CA Dec-14th-19th.

2014 **Darling A.**, Whipple, K., Nichols, K., Bierman, P., 2014, High cosmogenic nuclide derived erosion rates on the Grand Staircase: strong lithologic control on erosion patterns or an artifact of non-uniform distribution of quartz and cliff-slope topography: Geological Society of America: Abstract with Programs: v. 46, no. 6, p.241.

2013 Crow, R., Karlstrom, K., **Darling, A**., Crossey, L., Polyak, V., Granger, D., Asmerom, Y., and Schmandt, B., 2013, Mantle Bouyancy-driven Differential Incision of the Grand Canyon: Geological Society of America: Abstract with Programs: v. 45, no. 7, p. 57.

2013 Whipple, K., **Darling, A**., 2013, A Geomorphic Perspective on the debate over the antiquity of Grand Canyon: Geological Society of America: Abstract with Programs: v. 45, no. 7, p. 482.

2013 **Darling, A.**., Whipple, K., Nichols, K., Bierman, P., 2013, Landscape Evolution in the Grand Canyon region: Insights from Erosion Rates and Tributary Stream Profiles: Geological Society of America: Abstract with Programs: v. 45, no. 7, p. 482.

2013 Robertson, J., Karlstrom, K., Huntoon, P., Warme, J., Crow R., **Darling, A**., Granger, D., 2013, Deep-seated Bedrock Landsliding in Grand Canyon: Implications for Grand Canyon Evolution: Geological Society of America: Abstract with Programs: v. 45, no. 7, p. 641.

2013 Aslan, A., Kirby E., Karlstrom, K.E., **Darling, A**., Rosenburg, R., Heizler, M., Boraas, M., 2013, New constraints on the timing of Green River Integration, Southwestern Wyoming and Northwestern Colorado: Geological Society of America Abstract with Programs: v. 45, no. 7, p. 635.

2012 **Darling, A**., Whipple, K., Nichols, K., Bierman, P., 2012, Exhumation and Landscape Evolution along the Colorado River: A Proposed means of differentiating the roles of baselevel fall and lithologic heterogeneity: Abstract EP51A-0967 presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.

2012 Crow, R., Karlstrom, K., Crossey, L., **Darling, A.**, Polyak, V., Granger, D., Asmerom, Y., 2012, Spatial Variation in Grand Canyon incision: New geochronology on river terraces and the Surprise Valley Landslide: Geological Society of America Abstract with Programs: v. 44, no. 6, p. 81.

2012 Robertson, J., Huntoon, P., **Darling, A**., Crow, R., Karlstrom, K., Warme, J., Savage, J., Crossey, L., Channer, M., 2012, Multi-stage evolution of Grand Canyon's Surprise Valley Landslides and their interaction with carving of Grand Canyon: Geological Society of America Abstracts with Programs, v. 44, no. 6, p. 18.

2012 **Darling, A.L**., Whipple, K., Nichols, K., Karlstrom, K., Granger, D., Bierman, P., 2012, Transient incision in layer-cake stratigraphy, cosmogenic rates and dates in the context of Glen Canyon: Geological Society of America Abstracts with Programs, v. 44, no. 6, p. 19.

2011 Karlstrom, K.E., **Darling, A**., Crossey, L.J., Crow, R., Coblentz, D., Ouimet, W., Kirby, E., van Wijk, J., Kelley, S., Heizler, M.T., Aster, R., MacCarthy, J., Lazear, G., Dueker, K., Hansen, J., and Stachnik, J., 2011, Neogene and ongoing dynamic uplift of the Rocky Mountains due to mantle convection, and its surface manifestations New Mexico Geological Society spring meeting New Mexico Geology, May 2011, v. 33, p. 44.

2011 Aslan, A., Karlstrom, K., Kirby, E., Rosenberg, R., **Darling, A.L**., 2011, Late Cenozoic River Incision Rates from the Colorado Rockies and Implications for Neogene Uplift: Geological Society of America Abstracts with Programs, v. 43, p.272.

2010 **Darling, A.L**., Karlstrom, K.E., Granger, D.E., Aslan, A., Kirby, E., Ouimet, W.B., Coblentz, D.D., CREST working group, 2010, New incision rates along the Colorado River system based on cosmogenic burial dating of terraces: implications for regional controls on differential incision: Eos, Transactions, American Geophysical Union, v., 91

2010 Aslan, A., Karlstrom, K., Kirby, E., Lazear, G., Ouimet, W., Kelley, S., **Darling, A**., Heizler, M., 2010, Post-10 ma river incision rates in western Colorado: implications for Neogene uplift of the Colorado rockies Geological Society of America, 2010 annual meeting Abstracts with Programs - Geological Society of America, November 2010, v. 42, p. 77

2009 Karlstrom, K., Coblentz, D., Ouimet, W., Kirby, E., van Wijk, J., Schmandt, B., Crossey, L., Crow, R., Kelley, S., McKeon, R., Aslan, A., **Darling, A.**, Duekey, K., Aster, R., Lazear, G., Hilton, D., 2009, Dynamic uplift of the Colorado Rockies and western Colorado Plateau in the last 6 Ma driven by mantle flow and buoyancy: Evidence from the Colorado River region: Eos, Transactions, American Geophysical Union, v., 90, no 52.

2009 **Darling, A.L**., Karlstrom, K., Kirby, E., Ouimet, W., Aslan, A., Granger, D., 2009, Incision history of the Colorado River system over the last several Ma from cosmogenic burial dating of high terrace gravels: Eos, Transactions, v. 90, 52.

2009 **Darling, A.L**., Karlstrom, K., Kirby, E., and Ouimet, W., 2009, Comparison of the modern profiles and discharge of the Green and Colorado rivers and implications for epeirogenic uplift of the Colorado Plateau and Rocky Mountains: Abstracts with Programs - Geological Society of America, v.41 no. 7, p. 306.

2008 Aslan, A., Hood, W., Karlstrom, K.E., Kirby, E., Granger, D., Betton, C., **Darling, A**., Benage, M., and Schoepfer, S., 2008, Abandonment of Unaweep Canyon 1 Ma and the Effects of Transient Knickpoint Migration, Western Colorado: Geological Society of America Abstracts with Programs, v. 40, no. 6, p. 220.

2007 Karlstrom, K.E. and the **CREST project team**, 2007, Interconnections between the mantle and the near-surface system above the Aspen Anomaly, central Colorado, and implications for Cenozoic uplift of the Rocky Mountains: American Geophysical Union Fall meeting, Eos Transactions of the American Geophysical Union, v. 88, no. 52, T14C-02.

2007 Hayden, A., Morgan, P., Cobin, P., Hess, A., Pryor, A., Young, E., **Darling, A**., Houghton, J, Aslan, A., 2007, Late Holocene Climate variability and implications for the onset of arroyo incision along the Little Dolores River, western Colorado: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 306.

2007 **Darling, A**., Aslan, A., Betton, C., Cole, R., and Karlstrom, K.E., 2007, Late Quaternary incision rates and drainage evolution of the confluence of the Uncompahgre and Gunnison rivers based on terraces dated with lava creek B ash, western Colorado: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 306.

2007 **Darling, A**., Rider, K., Gloyd, J., Cole, R., 2007, Sedimentologic characteristics of Late Cenozoic gravel armored surfaces on the southwestern flank of Grand Mesa, western Colorado: Geological Society of America Abstracts with programs, v. 39, no. 6, p. 307

2006 Rider, K., **Darling, A.**, Gloyd, J., Cole, R., 2006, Relative Ages and Origins of Grand Mesa pediments, Colorado: Geological Society of America Abstracts with Programs, v. 38, no. 6, p. 34.