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Dept. Earth & Environmental Sciences
University of Rochester

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Academic Career:

2003-present Research Scientist, Paleomagnetic Research Group, University of Rochester
2003-present Lecturer, University of Rochester, Rochester, NY
2000-2003 Postdoctoral Fellow, Paleomagnetic Research Group, University of Rochester
2001 Shipboard Paleomagnetist, Ocean Drilling Program Leg 197 (co-propopent),
Motion of the Hawaiian Hotspot: A Paleomagnetic Test
2000-2003 Laboratory Instructor, University of Rochester, Rochester, NY
2000 Adjunct, University of Rochester, Rochester, NY
2000 Ph.D. (Geological Sciences) University of Rochester, Rochester, NY
1999 Adjunct, SUNY Geneseo, Geneseo, NY
1998 M.S. (Geological Sciences) University of Rochester, Rochester, NY
1994 B.A. (Geophysics) State University of New York at Geneseo, Geneseo, NY

Selected Field Experience:

2001 Shipboard paleomagnetist, Ocean Drilling Program Leg 197
2000 Field Assistant, Expedition to the High Canadian Arctic (Axel Heiberg
Island, Ellesmere Island), University of Rochester, Paleomagnetic
Research Group
1997 Expedition to Cretaceous Chalk deposits of the Gulf Coast
1996 Field Assistant, Expedition to the High Canadian Arctic (Axel Heiberg
Island), University of Rochester, Paleomagnetic Research Group
1994-present Select class related field trips around New York State; EES 101, EES 201

Research Interests:

Paleointensity, Cretaceous paleomagnetism, plate motion and tectonics, hotspot motion,
rock magnetism and environmental magnetism, experimental design for magnetic
measurements

Synergistic Activities:

- Referee for *Journal of Geophysical Research; Geochemistry, Geophysics, Geosystems; Earth and Planetary Science Letters; Earth, Planets and Space; Journal of Earth System Science, Proceedings of the National Academy of Science, National Science Foundation*
- Chapter/multi-media reviewer for Prentice Hall Publications, W. H. Freeman and Company, and Wiley Publications (historical geology and physical geology textbooks)

- Organizer/Instructor for local K-12 programs, including Science Olympiad, Odyssey of the Mind, Boy Scouts of America, Girl Scouts of America, and local charter schools and science museum exhibits (Rochester, NY)
- Mentor for high school students interested in summer internship opportunities in geology through local school districts (Rochester, NY)
- Staff advisor for undergraduate geology club (Undergraduate Student Geology Organization) and National Honor Society for Earth Scientists (Zeta Phi chapter of Sigma Gamma Epsilon)
- Local field trip leader for small interest groups through Mt Hope Cemetery (Glacial geology of Rochester, NY) and Rochester and Letchworth Gorges (Paleozoic geology of New York)
- Guest Expert for Discovery Kids Mystery Hunters
- Geologist tour guide for Friends of Mt. Hope Cemetery
- Hutchison Hall Sustainability Committee member

Professional Societies:

Geological Society of America, member since 1994

American Geophysical Union, member since 1995

Sigma Gamma Epsilon, member since 1995

Sigma Pi Sigma, member since 1993

Honors and Awards:

- Outstanding Student Paper Award, Geomagnetism/Paleomagnetism Section, American Geophysical Union Fall Meeting, 1998
- Magna Cum Laude, SUNY Geneseo, 1994
- Outstanding Student in Geological Sciences, SUNY Geneseo, 1994
- Barry M. Goldwater Scholarship Nominee for SUNY Geneseo, 1993

Session Chair: American Geophysical Union

Paleomagnetism from the America, R. Cottrell and others, Joint Assembly Meeting, Toronto, Canada, 2009.

Paleomagnetism Applied to Tectonics and the Geodynamo, R Cottrell, University of Rochester; A Smirnov, Yale University, Joint Assembly Meeting, 2006.

The Hawaiian-Emperor Seamounts: New Results and Implications for the Nature of Hot Spots II Posters, D Scholl, Stanford University; R Cottrell, University of Rochester, Fall Meeting, 2002.

Course work:

2003-present

EES 201 – Evolution of the Earth

This course is intended for students interested in the evolution of the Earth in terms of

tectonics, biology, and climate. Historical geology encompasses the 1) dynamic history of the physical Earth: the development of landforms, the rise and fall of ancient seas, movements of continents, and 2) the evolution of life on this planet in response to a changing Earth. In addition, this class focuses on a chronological survey of Earth and life history, emphasizing the evolution as seen in North America.

2008 - present, Fall, Even Years

EES 256 – Paleomagnetism and Global Plate Tectonics

The purpose of this class is to introduce the student to the concepts of paleomagnetism and its application in the study of global plate tectonics. The study of paleomagnetism revolutionized how scientists theorized how lithospheric plates moved – from the simplistic approach of continental drift to the actual mechanism of sea floor spreading and using paleomagnetic poles to demonstrate how lithospheric plates have moved in the past.

2009 - present, Fall, Odd Years

EES 205 – Solid Earth Geophysics

This course is intended for motivated juniors and seniors in the Earth & Environmental Sciences curriculum. Topics covered included composition of the earth; radioactivity and age of the earth; gravity field and rotation; earthquakes and propagation of seismic waves; magnetic field; paleomagnetism; heat generation and heat flow; plate tectonics and convection in the earth.

2009 – 2019, Fall (Co-Instructor, formally and informally)

EES 255/455 – Planetary Science: Geologic Evolution

This course will focus on geologic and geophysical studies of planets (interiors and surfaces), and the conditions that led to the origin of life. We will start with initial conditions, defined here as the formation of Earth and the Moon-forming event, and trace development of the planet from cooling of the magma ocean onwards. We next consider how our planetary neighbors (Venus and Mars) evolved, as well as key satellites in the solar system that may harbor life, or provide insight into early conditions on Earth.

2000-2006

EES 101 – Introduction to Physical Geology (Informally lecture; Laboratory)

This introductory geology class provides a broad overview of the Earth Sciences, from planetary evolution to the interplay of geology and climate. The course is a prerequisite for all undergraduate majors who are considering careers in the Earth and Environmental Sciences, while also satisfying science requirements for other undergraduate majors. A basic introduction to geological processes is supplemented with an emphasis on marine geology and plate tectonics. The course also aims to provide students with a geological background with which they can better evaluate current environmental issues, including

potential global warming. The lecture material is supplemented with laboratory exercises that enhance the students' understanding of Earth processes, including mineral and rock identification, river, glacial, desert and coastal landscapes, earthquakes, lunar geology, geologic time, deformation of the Earth's crust and climate change through geologic history.

1999

GSci 101 - Geologic History of Life (SUNY Geneseo)

An introduction to the evolution and development of life on Earth. Topics include the origin of life, development of multicellular organisms, evolution of land plants and animals, dinosaurs, mammals, and the use of paleontology in the interpretation of earth history. (Directed at non-science majors or those desiring a general background in Earth history. Credit may not be applied toward either the Geological Sciences major or the B.S. in Natural Science with PreK-6 provisional certification.)

GSci 100 – Our Geologic Environment (SUNY Geneseo)

This course is intended for non-science majors who have an interest in their physical environment. The course is designed to develop an understanding of the interaction of Earth processes, the environment, and the human population. Topics include Earth materials, natural resources, geologic hazards, environmental change, and global environmental issues.

Publications:

- Tarduno, J. A. & Cottrell, R. D. Paleomagnetic evidence for motion of the Hawaiian hotspot during formation of the Emperor seamounts. *Earth Planet. Sci. Lett.* **153**, 171–180 (1997).
- Tarduno, J. A., Cottrell, R. D. & Wilkison, S. L. Magnetostratigraphy of the Late Cretaceous to Eocene Sverdrup Basin: Implications for heterochroneity, deformation, and rotations in the Canadian Arctic archipelago. *J. Geophys. Res.-Solid Earth* **102**, 723–746 (1997).
- Tarduno, J. A. *et al.* Evidence for extreme climatic warmth from Late Cretaceous Arctic vertebrates. *Science* **282**, 2241–2244 (1998).
- Cottrell, R. D. & Tarduno, J. A. Geomagnetic paleointensity derived from single plagioclase crystals. *Earth Planet. Sci. Lett.* **169**, 1–5 (1999).
- Cottrell, R. D. & Tarduno, J. A. In search of high-fidelity geomagnetic paleointensities: A comparison of single plagioclase crystal and whole rock Thellier-Thellier analyses. *J. Geophys. Res.-Solid Earth* **105**, 23579–23594 (2000).
- Tarduno, J. A., Cottrell, R. D. & Smirnov, A. V. High geomagnetic intensity during the mid-Cretaceous from Thellier analyses of single plagioclase crystals. *Science* **291**, 1779–1783 (2001).
- Tarduno, J. A., Cottrell, R. D. & Smirnov, A. V. High geomagnetic intensity during the Mid-Cretaceous from Thellier analyses of single plagioclase crystals (vol 291, pg 1779, 2001). *Science* **293**, 607–607 (2001).
- Tarduno, J. A., Cottrell, R. D. & Smirnov, A. V. The Cretaceous superchron geodynamo: Observations near the tangent cylinder. *Proc. Natl. Acad. Sci. U. S. A.* **99**, 14020–14025 (2002).

- Cottrell, R. D. & Tarduno, J. A. A Late Cretaceous pole for the Pacific plate: implications for apparent and true polar wander and the drift of hotspots. *Tectonophysics* **362**, 321–333 (2003).
- Tarduno, J. A. *et al.* The Emperor Seamounts: Southward motion of the Hawaiian hotspot plume in earth's mantle. *Science* **301**, 1064–1069 (2003).
- Tarduno, J. A. & Cottrell, R. D. Dipole strength and variation of the time-averaged reversing and nonreversing geodynamo based on Thellier analyses of single plagioclase crystals. *J. Geophys. Res.-Solid Earth* **110**, B11101 (2005).
- Tarduno, J. A., Cottrell, R. D. & Smirnov, A. V. The paleomagnetism of single silicate crystals: Recording geomagnetic field strength during mixed polarity intervals, superchrons, and inner core growth. *Rev. Geophys.* **44**, RG1002 (2006).
- Tarduno, J. A., Cottrell, R. D., Watkeys, M. K. & Bauch, D. Geomagnetic field strength 3.2 billion years ago recorded by single silicate crystals. *Nature* **446**, 657–660 (2007).
- Cottrell, R. D., Tarduno, J. A. & Roberts, J. The Kiaman Reversed Polarity Superchron at Kiama: Toward a field strength estimate based on single silicate crystals. *Phys. Earth Planet. Inter.* **169**, 49–58 (2008).
- Usui, Y., Tarduno, J. A., Watkeys, M., Hofmann, A. & Cottrell, R. D. Evidence for a 3.45-billion-year-old magnetic remanence: Hints of an ancient geodynamo from conglomerates of South Africa. *Geochem. Geophys. Geosyst.* **10**, Q09Z07 (2009).
- Vandermark, D., Tarduno, J. A., Brinkman, D. B., Cottrell, R. D. & Mason, S. New Late Cretaceous macrobaenid turtle with Asian affinities from the High Canadian Arctic: Dispersal via ice-free polar routes. *Geology* **37**, 183–186 (2009).
- Tarduno, J. A. *et al.* Geodynamo, Solar Wind, and Magnetopause 3.4 to 3.45 Billion Years Ago. *Science* **327**, 1238–1240 (2010).
- Neukirch, L. P. *et al.* An archeomagnetic analysis of burnt grain bin floors from ca. 1200 to 1250 AD Iron-Age South Africa. *Phys. Earth Planet. Inter.* **190**, 71–79 (2012).
- Tarduno, J. A. *et al.* Evidence for a Dynamo in the Main Group Pallasite Parent Body. *Science* **338**, 939–942 (2012).
- Tarduno, J. A. & Cottrell, R. D. Signals from the ancient geodynamo: A paleomagnetic field test on the Jack Hills metaconglomerate. *Earth Planet. Sci. Lett.* **367**, 123–132 (2013).
- Tarduno, J. A., Bono, R. K., Cottrell, R. D., Ferriere, L. & Scott, E. R. D. Paleomagnetism of the Eagle Station Pallasite. *Meteorit. Planet. Sci.* **49**, A391–A391 (2014).
- Tarduno, J. A., Cottrell, R. D., Davis, W. J., Nimmo, F. & Bono, R. K. A Hadean to Paleoproterozoic geodynamo recorded by single zircon crystals. *Science* **349**, 521–524 (2015).
- Tarduno, J. A. *et al.* Antiquity of the South Atlantic Anomaly and evidence for top-down control on the geodynamo. *Nat Commun* **6**, 7865 (2015).
- Bono, R. K., Tarduno, J. A. & Cottrell, R. D. Comment on: Pervasive remagnetization of detrital zircon host rocks in the Jack Hills, Western Australia and implications for records of the early dynamo, by Weiss *et al.* (2015). *Earth Planet. Sci. Lett.* **450**, 406–408 (2016).
- Cottrell, R. D., Tarduno, J. A., Bono, R. K., Dare, M. S. & Mitra, G. The inverse microconglomerate test: Further evidence for the preservation of Hadean magnetizations in metasediments of the Jack Hills, Western Australia. *Geophys. Res. Lett.* **43**, 4215–4220 (2016).

- Dare, M. S. *et al.* Detrital magnetite and chromite in Jack Hills quartzite cobbles: Further evidence for the preservation of primary magnetizations and new insights into sediment provenance. *Earth Planet. Sci. Lett.* **451**, 298–314 (2016).
- Bono, R. K., Tarduno, J. A., Dare, M. S., Mitra, G. & Cottrell, R. D. Cluster analysis on a sphere: Application to magnetizations from metasediments of the Jack Hills, Western Australia. *Earth Planet. Sci. Lett.* **484**, 67–80 (2018).
- Hare, V. J. *et al.* New Archeomagnetic Directional Records From Iron Age Southern Africa (ca. 425-1550 CE) and Implications for the South Atlantic Anomaly. *Geophys. Res. Lett.* **45**, 1361–1369 (2018).
- Bono, R. K., Tarduno, J. A. & Cottrell, R. D. Primary pseudo-single and single-domain magnetite inclusions in quartzite cobbles of the Jack Hills (Western Australia): implications for the Hadean geodynamo. *Geophys. J. Int.* **216**, 598–608 (2019).
- Bono, R. K., Tarduno, J. A., Nimmo, F. & Cottrell, R. D. Young inner core inferred from Ediacaran ultra-low geomagnetic field intensity. *Nat. Geosci.* **12**, 143–+ (2019).
- Tarduno, J. A. Cottrell, R.D., *et al.* Paleomagnetism indicates that primary magnetite in zircon records a strong Hadean geodynamo. *PNAS* **117**, 2309–2318 (2020).

Select Presentations:

- Cottrell, RD, Lawrence, K, Bono, RK, Johnson, CL, Tarduno, JA. (2019) Evidence for a Late Lunar Dynamo Revisited. Abstract No. GP43B-0794, presented at The American Geophysical Fall Meeting, San Francisco, CA, 9-13 December.
- Cottrell, RD, Tarduno JA, Bono, RK, Oda, H (2018) Microconglomerate tests establish magnetic fidelity of Hadean zircons, Abstract GP11A-08 presented at 2018 Fall Meeting, Washington D.C. 10-14 December.
- Cottrell, RD, Tarduno, JA, Bono, RK, Oda, H. (2019) Paleomagnetic remanence tests: the essentials for investigations of the ancient geodynamo held by single crystals, Abstract No. EGU2019-8703, presented at The European Geophysical Union Meeting, Vienna, Austria, 7-12 April.
- Cottrell, RD, Lawrence, K, Bono, RK, Johnson, CL, Tarduno, JA. (2019) Evidence for a late Lunar dynamo revisited. Abstract Contribution No. 2132, presented at the Lunar and Planetary Science Conference, The Woodlands, Texas, 18-22 March.
- Cottrell, RD, Tarduno, JA, Bono, RK, Thern, ER, Chhibber, SK (2016) The Hadean to Paleoproterozoic geodynamo: microconglomerate tests from siliciclastic metasedimentary rocks from the Southern Cross Terrane of Western Australia, Abstract DI13A-2344 presented at 2016 Fall Meeting, AGU, San Francisco, Calif. 12-16 December.
- Cottrell, RD, Tarduno, JA, Bono, RK, Dare, MS (2016) The inverse microconglomerate test: Definition and application to the preservation of Paleoproterozoic to Hadean magnetizations in metasediments of the Jack Hills, Western Australia, EGU2016-9203, Vienna, Austria, 17-22, April 2016.
- Cottrell, RD, Tarduno, JA, Bono, RK (2015), Micro-conglomerate tests and the Hadean to Paleoproterozoic geodynamo as recorded in zircons of the Jack Hills, Abstract GP23B-1302 presented at 2015 Fall Meeting, AGU, San Francisco, Calif., 14-18 December.

- Cottrell, RD, Tarduno, JA and Bono, RK (2015), The geodynamo as recorded in Archean and Hadean zircons, Abstract GP22A-07 presented at 2015 Joint Assembly Meeting, Montreal, Quebec, Canada., 3-7 May.
- Cottrell, RD, Tarduno, JA and Bono, RK (2014), Paleomagnetic measurements of Archean and Hadean zircons, Abstract GP53A-3752 presented at 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- Cottrell, RD, Tarduno, JA, Davis, WJ and Mamajek, E (2013), Constraining the geodynamo and magnetopause during Earth's first billion years, Abstract V31E-07 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
- Cottrell, RD, Tarduno, JA, Bono, RK (2012) Probing the Oldest Geodynamo, EGU2012-12523, Vienna, Austria, 22-27 April 2012.
- Cottrell, RD, Evans, KM, Jacobs, RA, May, BB, Pelz, JB, Rosen, MR, Tarduno, JA and Voronov, J (2010), Eye-tracking novice and expert geologist groups in the field and laboratory, Abstract ED11C- 03 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Cottrell, RD, Tarduno, JA, Watkeys, MK, Huffman, TN (2008), Multispecimen and temper archeomagnetic studies: Application to Iron Age sites from southern Africa, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract GP43C-03
- Cottrell, RD, Wendt, AK, Tarduno, JA, Watkeys, MK, Huffman, TN (2008), Paleointensity of Iron Age pottery shards from southern Africa, Eos Trans. AGU, 89(23), Jt. Assem. Suppl., Abstract GP41B-06
- Cottrell, RD, Tarduno, JA, Watkeys, MK (2007) Examining the strength of Earth's early magnetic field (solicited) EGU2007-A-02030, Vienna, Austria, April 2007.
- Cottrell, RD, Tarduno, JA, Doubrovine, PV (2007), Motion of Pacific mantle plumes, Eos Trans. AGU, 88(52), Fall Meet. Suppl., Abstract U34A-05
- Cottrell, RD, Tarduno, JA, Watkeys, MK (2006), Stromberg Lava Directional and Paleointensity Data from Transitional Lava flows: Implications for the Mesozoic Dipole Low, Eos Trans. AGU, 87(36), Jt. Assem. Suppl., Abstract GP23A-04
- Cottrell, RD, Tarduno, JA (2006) Low temperature oxidation and long-term paleointensity (solicited) EGU06-A-08682, Vienna, Austria, 03-07 April 2006.
- Cottrell, RD, Tarduno, JA, Watkeys, MK (2005), Rock magnetic and paleointensity data from plagioclase crystals of the Stormberg (Karoo) Lavas of Lesotho, Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract GP13A-0033
- Cottrell, RD, Smirnov, AV, Tarduno, JA (2004), Rapid true polar wander: A quixotic search?, Eos Trans. AGU, 85(47), Fall Meet. Suppl., Abstract U33A-0024
- Cottrell, RD and Tarduno, JA (2002) LATE CRETACEOUS TO EARLY TERTIARY MOTION OF THE HAWAIIAN HOTSPOT AND ITS GEODYNAMIC IMPLICATIONS, GSA Cordilleran Section - 98th Annual Meeting (13-15 May 2002).
- Cottrell, R D and Tarduno, J A, Pacific Apparent Polar Wander: Evidence for Hotspot Drift and Plate Motion Rather Than Rapid True Polar Wander, Eos Trans. AGU, 82, Spring Meet. Suppl., Abstract T51A-06, 2001.
- Cottrell, R D, Tarduno, J A, and Smirnov, J.A. Evidence for High Geomagnetic Field Intensities During Times of Low Reversal Frequency, Eos Trans. AGU, 82, Spring Meet. Suppl., Abstract GP52A-05 - Invited, 2001.

- Cottrell, R D and Tarduno, J A, High geomagnetic intensities during the mid-Cretaceous: Tests using Thellier analyses of plagioclase crystals from basalts of the High Canadian Arctic, Eos Trans. AGU, 81, Fall Meet. Suppl., Abstract GP72B-07, 2000.
- Cottrell, R D and Tarduno, J A, Late Cretaceous True Polar Wander: Not So Fast, Eos Trans. AGU, 81, Spring Meet. Suppl., Abstract T51A-06, 2000.
- Cottrell, R D and Tarduno, J A, A Comparison of Whole Rock and Single Crystal Thellier-Thellier Paleointensity Results, Eos Trans. AGU, 79, Fall Meet. Suppl., Abstract GP31B-12, 1998.
- Cottrell, R D and Tarduno, J A, Single Crystal Paleointensity Studies, Eos Trans. AGU, 79, Spring Meet. Suppl., Abstract GP21A-08, 1998.
- Cottrell, R D and Tarduno, J A, Magnetic Hysteresis Properties of Single Crystals: Prelude to Paleointensity Studies, Eos Trans. AGU, 78, Fall Meet. Suppl., Abstract GP41A-05, 1997.
- Cottrell, R D and Tarduno, J A, Tectonic and paleoclimatic implications of a high latitude Late Cretaceous pole position for the Pacific plate, Eos Trans. AGU., 78, Spring Meet. Suppl., Abstract GP51A-14, 1997.
- Cottrell, R D and Tarduno, J A, Paleolatitude of the Detroit Seamount: Implications for the motion of the Pacific plate and Hawaiian hotspot, Eos Trans. AGU, 77, Fall Meet. Suppl., Abstract GP72-08, 1996.