

RORY D COTTRELL

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Academic Career

2008 – present	Scientist, Paleomagnetic Research Group, University of Rochester
2003 – 2008	Research Associate, Paleomagnetic Research Group, University of Rochester
2003 – present	Adjunct Instructor, University of Rochester
2000 – 2003	Postdoctoral Fellow, Paleomagnetic Research Group, University of Rochester
2001	Shipboard Paleomagnetist, Ocean Drilling Program Leg 197 (co-proponent)
2000 – 2003	Laboratory Instructor, University of Rochester
2000	Adjunct Instructor, University of Rochester
2000	Ph.D. (Geological Sciences) University of Rochester, May 2000
1999	Adjunct Instructor, State University of New York at Geneseo, Geneseo, NY
1998	M.S. (Geological Sciences) University of Rochester
1994	B.A. (Geophysics) State University of New York at Geneseo, Geneseo, NY

Selected Field Experience

2001	Shipboard Paleomagnetist, Ocean Drilling Program Leg 197, Motion of the Hawaiian Hotspot
2000	Field Assistant, Expedition to the High Canadian Arctic (Axel Heiberg Island, Ellesmere Island) UR Paleomagnetic Research Group
1997	Gulf Coast Cretaceous Chalk sample collection
1996	Field Assistant, Expedition to the High Canadian Arctic (Axel Heiberg Island) UR Paleomagnetic Research Group
1994 – present	Class-related field trips around New York State

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; Journal of Asian Earth Sciences*, National Science Foundation, NASA Research and Education Support Service, The Dutch Research Council
- Chapter/multi-media reviewer for Prentice Hall Publications, W. H. Freeman and Company, and Wiley Publications, Cambridge University Press (historical, physical geology and geophysics textbooks)

- Organizer/Instructor for local K-12 programs, including Science Olympiad, Odyssey of the Mind, Science Exploration Days at St. John Fisher, Festival of Ideas (Brighton School District), Boy Scouts of America, Girl Scouts of America, Rochester Museum and Science Center
- Consultant, Center for Professional Development and Education Reform, Warner School, University of Rochester, for a series of seminars related to Next Generation Science Standards, including expanding knowledge of disciplinary core ideas, the practices of science, and the nature of science, with a focus on Earth's magnetic field and planetary differentiation
- Mentor for high school students interested in summer internship opportunities in geology through local school districts (Rochester, NY)
Mentor for high school students interested in paleomagnetism and data science in the New York area (Regeneron Science Talent Search, placed in top 40, Spring 2023)
- Staff advisor for undergraduate geology club (Society of Earth and Environmental Science Students) 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), 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

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

Course Work:

2003 – present, Spring Semester, taught 22 times

EES(C) 201 – Evolution of the Earth (Cross-listed with SUSC 201), Primary Instructor

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 – 2019, Fall Semester, taught 12 times

EES(C) 255/455 – Planetary Science: Geologic Evolution and Planetary Habitability, Secondary Instructor

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.

Responsible for creating and teaching in class laboratory assignments related to planetary geology, student presentations,

2008 – present, Fall Semester, Even Years, taught 7 times

EES(C) 256/456 – Paleomagnetism and Global Plate Tectonics, Primary Instructor

The basic paleomagnetic methods used to determine absolute plate motions are reviewed. Applications include the potential cause and effect relationship between changes in absolute plate motions, mantle plume volcanism, orogeny, and climate change.

2009 – present, Fall Semester, Odd Years, taught 6 times

EES(C) 205 – Solid Earth Geophysics, Primary Instructor

This course is intended for motivated students that are interested in an introduction to geophysics. Material covered will focus on deep Earth processes: an introduction to potential fields, gravity, heat flow, magnetic fields, propagation of seismic waves, and a bottom-up approach to core processes, mantle flow and plate tectonics.

2000 – 2006, taught 7 times

EES 101 – Introduction to Physical Geology (Laboratory Instructor)

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.

2000, Spring Semester

EES 205 – Solid Earth Geophysics (Sabbatical Position)

1999, Spring Semester

GSci 101 – Geologic History of Life (State University of New York at Geneseo; Sabbatical Position)

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.)

1999, Summer Semester

GSci 100 – Our Geologic Environment (State University of New York at Geneseo; Primary Instructor)

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

J.A. Tarduno, **R.D. Cottrell** and S.L. Wilkison, Magnetostratigraphy of the Late Cretaceous to Eocene Sverdrup Basin: Implications for heterochroneity, deformation and rotations in the Canadian Arctic Archipelago, *Journal of Geophysical Research*, 102, 723-746, 1997.

J. A. Tarduno and **R. D. Cottrell**, Paleomagnetic evidence for motion of the Hawaiian hotspot during formation of the Emperor seamounts, *Earth and Planetary Science Letters*, 153, 171-180, 1997.

J. A. Tarduno, D. B. Brinkman, P. R. Renne, **R. D. Cottrell**, H. Scher, P. Castillo, Evidence for Extreme Climatic Warmth from Late Cretaceous Arctic Vertebrates, *Science*, 282, 2241-2244, 1998.

R. D. Cottrell and J. A. Tarduno, Geomagnetic paleointensity derived from single plagioclase crystals, *Earth and Planetary Science Letters*, 169, 1-5, 1999.

R. D. Cottrell and J. A. Tarduno, Late Cretaceous True Polar Wander: Not So Fast, *Science*, 288, 2283, 2000.

R. D. Cottrell and J. A. Tarduno, In search of high fidelity geomagnetic paleointensities: A comparison of single plagioclase crystal and whole rock Thellier-Thellier analyses, *Journal of Geophysical Research*, 105, 23,579-23,594, 2000.

J. A. Tarduno, **R. D. Cottrell**, and Alexei V. Smirnov, High Geomagnetic Field Intensity During the mid-Cretaceous from Thellier Analyses of Single Plagioclase Crystals, *Science*, 291, 1779-1783, 2001.

J. A. Tarduno, **R. D. Cottrell**, and A. V. Smirnov, The Cretaceous superchron geodynamo: Observations near the tangent cylinder, *Proceedings of the National Academy of Sciences of the United States of America*, 99, 14020-14025, 2002.

R. D. Cottrell and J. A. Tarduno, 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.

J. A. Tarduno, R. A. Duncan, D. W. Scholl, **R. D. Cottrell**, B. Steinberger, T. Thordarson, B. C. Kerr, C. R. Neal, F. A. Frey, M. Torii, and C. Carvallo, The Emperor Seamounts: Southward Motion of the Hawaiian Hotspot Plume in Earth's Mantle, *Science*, 301, 1064-1069, 2003.

J. A. Tarduno and **R. D. Cottrell**, Dipole strength and variation of the time-averaged reversing and nonreversing geodynamo based on Thellier analyses of single plagioclase crystals, *Journal of Geophysical Research*, 110, B11101, doi:10.1029/2005JB003970, 2005.

J. A. Tarduno, **R. D. Cottrell**, and A. V. Smirnov, The paleomagnetism of single silicate crystals: Recording geomagnetic field strength during mixed polarity intervals, superchrons, and inner core growth, *Reviews in Geophysics*, 44(1), RG1002, 10.1029/2005RG000189, 2006.

J. A. Tarduno, **R. D. Cottrell**, M. K. Watkeys, and D. Bauch, Geomagnetic field strength 3.2 billion years ago recorded by single silicate crystals, *Nature*, 446, 657-660, doi:10.1038/nature05667, 2007.

R. D. Cottrell, J. A. Tarduno, and J. Roberts, The Kiaman Reversed Polarity Superchron at Kiama: Toward a field strength estimate based on single silicate crystals, *Physics of the Earth and Planetary Interiors*, 169, 49-58, doi:10.1016/j.pepi.2008.07.041, 2008.

Y. Usui, J. A. Tarduno, M. Watkeys, A. Hofmann and **R. D. Cottrell**, Evidence for a 3.45 billion-year-old magnetic remanence from conglomerates of South Africa, *Geochem. Geophys. Geosystems (G-cubed)*, 10, Q09Z07, 2009.

J. A. Tarduno, **R. D. Cottrell**, M. K. Watkeys, A. Hofmann, P. V. Doubrovine, E. E. Mamajek, D. Liu, D. G. Sibeck, L. P. Neukirch and Y. Usui, Geodynamo, Solar wind, and magnetopause 3.4 to 3.45 billion years ago, *Science*, 327, 1238-1240, 2010.

J. A. Tarduno, **R. D. Cottrell**, F. Nimmo, J. Hopkins, J. Voronov, A. Erickson, E.G. Blackman, E.R.D. Scott, R. McKinley, Evidence for a Dynamo in the Main Group Pallasite Parent Body, *Science*, 338, 939-942, 2012.

J. A. Tarduno, **R. D. Cottrell**, Signals from the ancient geodynamo: A paleomagnetic field test on the Jack Hills metaconglomerate, *Earth and Planetary Science Letters*, 367, 123-132, 2013.

J. A. Tarduno, M. K. Watkeys, T. N. Huffman, **R. D. Cottrell**, E. G. Blackman, A. Wendt, C. A. Scribner, C. L. Wagner, Antiquity of the South Atlantic Anomaly and evidence for top-down control on the geodynamo, *Nature Communications*, 6, Article no. 7865, 2015.

J. A. Tarduno, **R. D. Cottrell**, W. J. Davis, F. Nimmo, R. K. Bono, A Hadean to Paleoproterozoic geodynamo recorded by single zircon crystals, *Science*, 349, 521-524, 2015.

R. D. Cottrell, J. A. Tarduno, R. K. Bono, M. S. Dare, G. Mitra, The inverse microconglomerate test: Further evidence for the preservation of Hadean magnetizations in metasediments of the Jack Hills, Western Australia, *Geophysical Research Letters*, 43, 4215-4220, 2016.

R. K. Bono, J. A. Tarduno, **R. D. Cottrell**, 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 and Planetary Science Letters*, 450, 406-408, 2016.

M. S. Dare, J. A. Tarduno, R. K. Bono, **R. D. Cottrell**, J. S. Berd, K. P. Kodama, Detrital magnetite and chromite in Jack Hills quartzite cobbles: Further evidence for the preservation of primary magnetizations and new insights into sediment provenance, *Earth and Planetary Science Letters*, 451, 298-314, 2016.

R. K. Bono, J. A. Tarduno, M. S. Dare, G. Mitra, **R. D. Cottrell**, Cluster analysis on a sphere: Application to magnetizations from metasediments of the Jack Hills, Western Australia, *Earth and Planetary Science Letters*, 484, 67-80, 2018.

V. J. Hare, J. A. Tarduno, T. N. Huffman, M. K. Watkeys, P. C. Thebe, M. Manyanga, R. K. Bono, **R. D. Cottrell**, New Archeomagnetic Directional Records From Iron Age Southern Africa (ca. 425-1550 CE) and Implications for the South Atlantic Anomaly, *Geophysical Research Letters*, 45, 1361-1369, 2018.

R. K. Bono, J. A. Tarduno, F. Nimmo, **R. D. Cottrell**, Young inner core inferred from Ediacaran ultra-low geomagnetic field intensity, *Nature Geosciences*, 12, 143-147, 2019.

J. A. Tarduno, **R. D. Cottrell**, R. K. Bono, H. Oda, W. J. Davis, M. Fayek, O. van 't Erve, F. Nimmo, W. Huang, E. R. Thern, S. Fearn, G. Mitra, A. V. Smirnov, E. G. Blackman, Paleomagnetism indicates that primary magnetite in zircon records a strong Hadean field, *Proceedings of the National Academy of Sciences of the United States of America*, 117, 2309-2318, 2020.

C.I.O Nichols, J.F.J. Bryson, **R. D. Cottrell**, R.R. Fu, R.J. Harrison, et al., A time-resolved paleomagnetic record of the Main Group Pallasites: Evidence for a large-cored, thin-mantled parent body, *Journal of Geophysical Research: Planets*, 126(7), 2021.

J. A. Tarduno, **R. D. Cottrell**, K. Lawrence, R. K. Bono, W. Huang, C. L. Johnson, et al., Absence of a long-lived lunar paleomagnetsphere, *Science Advances*, 7(32), eabi7647, 2021.

T. Zhou, J. A. Tarduno, F. Nimmo, **R. D. Cottrell**, R. K. Bono, M. Ibanez-Mejia, et al., Early Cambrian renewal of the geodynamo and the origin of inner core structure, *Nature Communications*, 13(1), 2022.

J. D. Bridges, J. A. Tarduno, **R. D. Cottrell**, T. D. Herbert, Rapid strengthening of the Westerlies accompanied intensification of North Hemisphere glaciation, *Nature Communications*, 14(1), 2023.

J. A. Tarduno, **R. D. Cottrell**, R. K. Bono, N. Rayner, W. J. Davis, T. Zhou, F. Nimmo, A. Hofmann, J. Jodder, M. Ibanez-Meija, M. K. Watkeys, H. Oda, G. Mitra, Hadean to Paleoproterozoic stagnant-lid tectonics revealed by zircon magnetism, *Nature*, 618, 531-536, 2023.

R. D. Cottrell, R. K. Bono, J. E.T. Channell, H-P Bunge, No Late Cretaceous true polar wander oscillation and implications for stability of Earth relative to the rotation axis, *Earth and Planetary Science Letters*, 620, 118338, 2023.

Select Presentations

Cottrell, RD, Tarduno, JA, Bono, RK. Late Cretaceous true polar wander oscillation artifact: further evidence for Earth's long-term rotational stability, Abstract No. EGU22-6011, presented at The European Geophysical Union Virtual Meeting, 23-27 May 2022.

Cottrell, RD, Lawrence, K, Bono, RK, Johnson, CL, Tarduno, JA. Evidence for a Late Lunar Dynamo Revisited. Abstract No. GP43B-0794, presented at The American Geophysical Fall Meeting, San Francisco, CA, 9-13 December 2019.

Cottrell, RD, Tarduno, JA, Bono, RK, Oda, H. 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 2019.

Cottrell, RD, Lawrence, K, Bono, RK, Johnson, CL, Tarduno, JA. 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 2019.

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, 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.