The Eighth Santa Fe Conference on Rock Magnetism

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The Eighth Santa Fe Conference on Rock Magnetism was held from June 24-27 at St. John’s College in Santa Fe, New Mexico. Approximately 50 participants from 10 countries convened for a series of lively, in-depth discussions on current topics in rock magnetism and related disciplines. The meeting was made possible through funding from the National Science Foundation, Earth Science Division. Additional conference support was provided by ASC Scientific, Bartington Instruments, Princeton Measurements Corporation, and Quantum Design.

Prior to the meeting, John Geissman (University of New Mexico) led the first ever meeting field trip to Valles Caldera National Preserve. Thanks to John’s generosity and hard work in proposing, planning and leading the trip, we spent several pleasurable hours near Jaramillo Creek at the famous paleomagnetic site that gave the Jaramillo subchron its name [Doell and Dalrymple, 1966]. Although subsequent work has demonstrated that this site actually documents a later event [Singer and Brown, 2002], the Jaramillo creek locality helped lead to the widespread acceptance of the Vine-Matthews-Morley hypothesis of seafloor spreading.

The meeting officially kicked off later that evening, with the first of two keynote lectures, this one by Peter Olson (Johns Hopkins University). The keynote lectures are meant to provide transdisciplinary perspectives and are typically given by speakers outside the traditional rock- and paleo-magnetic community. Olson’s well-received talk achieved this goal by addressing recent developments and improvements in dynamo modeling, while pointing out the important synergies that can be achieved by careful intercomparison of paleomagnetic data and the geodynamo models. Conference participants were able to discuss the lecture and catch up with old friends at a wine reception following the talk.

Friday morning commenced with a session on “Successful Developments in Paleointensity,” convened by Joshua Feinberg (University of Minnesota) and Yohan Guyodo (IMPMC). Talks by Lisa Tauxe (Scripps Institution of Oceanography) and Andrew Roberts (Australian National University) invited participants to be hopeful about the future of paleointensity research, while recognizing the current challenges and limitations. In a talk explicitly titled “An optimist’s view of paleointensity,” Tauxe discussed the problems frequently encountered in paleointensity studies and how we can identify and overcome those problems. Roberts focused on sedimentary relative paleointensity, highlighting many important discoveries made through this technique; he also pointed out the challenges ahead in achieving better resolution, longer records, a better physical understanding of remanence acquisition processes, and being able to identify and disentangle the causes for differences among records. These talks were followed by Jeff Gee (Scripps Institution of Oceanography), who spoke on development of a method

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Deep continental drilling in the basin of Mexico (central Mexico)

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The Basin of Mexico is a high altitude tropical site (98° 59' W, 19° 15' N; 2,250 m asl), that had an extensive lake system sensitive to climatic fluctuations during the past times [1]. A set of four cores up to 120 m depth were collected in the lacustrine sediments of Chalco sub-basin. Radiocarbon dates available from previous works [2,3] on the upper 25 m of lake sediments (20 $^{14}$C dates), indicate that -- by linear extrapolation -- the 120 m record could cover the last ca. 200-220 kyr. This lacustrine record would provide unique information on Meso-America climate. The sedimentary sequence can give a perspective on long term and millennial scale climate change and its environmental impact in a tropical highland location, information on the variability of the main atmospheric circulation patterns during glacial and interglacial times, and volcanic activity of three of the major stratovolcanoes in central Mexico (Popocatepetl, Iztaccihuatl and Nevado de Toluca volcanoes), as well as from the Chichinautzin monogenetic volcanic field around Chalco basin. This record would also provide a regional long term view of the climatic variability, if correlation with sites such as Laguna Salada (Baja California) [4] and Peten Itza (Guatemala) [5] is possible.

Despite the intense volcanic activity recorded along central Mexico during the Cenozoic, tephra layers account for less than 1 % of the total sedimentary sequence thickness. Chronological controls for the upper sequence are certainly established by $^{14}$C dating and tephrochronology. However, the intermediate and basic composition of tephras makes it difficult to determine a reliable chronology by $^{40}$Ar/$^{39}$Ar dating, and paleomagnetic analyses seems to be a plausible method for dating the sedimentary sequence. Sediment deposition rates recorded in the upper sediments of Chalco basin are 0.5-2.0 mm/yr; the lowest rate gives an average of 52 cm/kyr, which is still high enough for recording paleomagnetic excursions or events [6].

Azimuthally unoriented cores were collected with Shelby barrels and piston Livingston systems in sections one meter long. Cores were split, and then imaging and scanning was performed at the Limnological Research Center (U of M). Sediments are composed of massive brown to gray silt, banded and laminated diatom ooze, and volcaniclastic sediments (Fig. 1). Low field magnetic susceptibility (MS) was measured along the core halves. U-channels were collected continuously in the sedimentary sequence, except for a section nearly 20 m long between 85 and 105 m depth. NRM of U-channels and AF demagnetization measurements were carried out in an automated 2G u-channel cryogenic magnetometer.

Figure 1. Simplified stratigraphy, NRM inclination and preliminary age model for a composite core section 125 m long of Chalco lacustrine sediments. The inclination of GAD value (34.5 °) is indicated in a gray line. Age model is based on $^{14}$C dating from upper sediments.
Low or negative NRM inclination suggests the presence of geomagnetic excursions (Fig. 1). According to the preliminary age model, these “excursions” might correspond to the Laschamp (ca. 41 kyr), Blake (ca. 120 kyr) and Pringle Falls (ca. 220 kyr) events [7].

Sections with anomalous (very low or negative) NRM inclinations were stepwise AF demagnetized in fields from 5 to 170 mT (Fig. 1). At present, only five ca. 1m-sections were AF demagnetized. Directions are mostly stable from 10 to 40 mT (Fig. 2), and the mean destructive field lies below 50 mT.

Several sources of errors may affect the inclination record, from mislabeling of core sections to bioturbation, variations due to diagenetic processes affecting the magnetization parameters, smoothing of geomagnetic inclination by compaction, etc. So, very careful analysis and confirmation with parallel core sequences and discrete sample measurements is required before interpreting the presence of geomagnetic excursions.

AF demagnetization of NRM between 0-40 mT in two continuous cores show low and negative inclination centered at 24.65 m depth (Fig. 3). According with our preliminary age-model, this could correspond to the Laschamp Event [8]. The Blake Event [7] might be also recorded, as two parallel cores show negative inclinations at ca. 73 m depth. However, it is still under analysis as discrepancies in stratigraphic correlation and magnetic measurements prevent the unequivocal confirmation of its recording in Chalco sediments. The last probable excursion recorded in Chalco sediments is the Pringle Falls Event [9]; however, no AF demagnetization of NRM has been carried out yet of this part of the record.

We plan to continue the paleomagnetic analysis in order to corroborate the record of these geomagnetic excursions, and further continue with the rock magnetic studies in order to investigate the variations of magnetic mineralogy and their relationship with environmental changes. I want to thank to the staff members of the IRM for their kind assistance and fruitful discussions during this and previous visits.

References

Current Articles

A list of current research articles dealing with various topics in the physics and chemistry of magnetism is a regular feature of the IRM Quarterly. Articles published in familiar geology and geophysics journals are included; special emphasis is given to current articles from physics, chemistry, and materials-science journals. Most abstracts are taken from INSPEC (© Institution of Electrical Engineers), Geophysical Abstracts in Press (© American Geophysical Union), and The Earth and Planetary Express (© Elsevier Science Publishers, B.V.), after which they are subjected to Procrustean culling for this newsletter. An extensive reference list of articles (primarily about rock magnetism, the physics and chemistry of magnetism, and some paleomagnetism) is continually updated at the IRM. This list, with more than 10,000 references, is available free of charge. Your contributions both to the Archeomagnetism section and to the Abstracts section of the IRM Quarterly are always welcome.

Archeomagnetism


Bio(geo)magnetism


Environmental Magnetism and Paleoclimate Proxies


Extraterrestrial Magnetism


Geomagnetism and Geodynamo Studies


Jackson, L.P., and J.E. Mound, Geomagnetic variation on decadal

Diagram of a pivoting compass needle in Peregrinus’s Epistola de Magnete (1269).


**Magnetic Field Records and Paleointensity Methods**


**Rock and Mineral Magnetism**

Bezaeava, N.S., J. Gattacceca, P. Rochette, R.A. Sadykov, and V.I. Trukhin, Demagnetization of terrestrial and extraterrestrial rocks under hydrostatic pressure up to 1.2 GPa, Phys. Earth Planet. Int., 179 (1-2), 7-20, 2010.


**Mineral Physics and Chemistry**


Other


Santa Fe Conference. Continued from pg. 1.

John Geissman (University of New Mexico) describes the outcrops near Jaramillo Creek. (Photo by Mike Jackson.)

for recovering relative paleointensity from samples with a multi-component thermal remanence.

Friday afternoon’s session – organized by Mike Fuller (University of Hawaii) and Kristin Lawrence (Stanford University) – was devoted to Extraterrestrial Magnetism. Richard Harrison (Cambridge University) discussed the potential for using chondrule-derived dusty olivines to recover information about geomagnetic fields in the early solar system. Ian Garrick-Bethel (University of California, Santa Cruz) presented data from a lunar troctolite and spoke about the resulting implications for lunar paleointensity and lunar dynamo existence and timing. Kristin Lawrence (Stanford University) gave an overview talk focusing on the paleointensity of extraterrestrial (predominantly lunar) materials.

Saturday morning started off with the second keynote lecture by Brandy Toner (University of Minnesota) on the biogeochemical signatures of iron oxyhydroxides in deep-sea deposits. By combining synchrotron radiation X-ray techniques with Mössbauer spectroscopy and magnetic measurements, Toner is trying to understand and distinguish the biotic and abiotic pathways that Fe follows in deep-ocean cycling. The keynote lecture was followed by a general session on Environmental Magnetism, convened by Christoph Geiss (Trinity College) and Richard Reynolds (US Geological Survey). Ted Evans (University of Alberta) gave a nice review talk on loess-paleosol magnetism, followed by Subir Banerjee (University of Minnesota) on the search for a model of loess alteration. Banerjee questioned under what conditions loess magnetism reflects paleoclimate and asked whether it is possible that ferrihydrite is the precursor to all other authigenic magnetic minerals in soils. An overview talk by Eduard Petrovsky (Institute of Geophysics, ASCR) on the current state of environmental magnetism focussed on the utility of easily-made susceptibility measurements.

Andrew Newell (North Carolina State University) and Aleksey Smirnov (Michigan Technological University) organized the Saturday afternoon session devoted to the “Quantitative Modeling of Mineral Magnetic Data.” Ramon Egli (Ludwig-Maximilians University) presented recent work on modeling single-domain contributions in sediment using a Preisach/FORC approach. This was followed by Richard Harrison (Cambridge University) who provided an overview of atomistic simulations: what are
they, how do they work, and how they can be used in rock and mineral magnetism. Andrew Newell (North Carolina State University) gave a talk on domain wall pinning.

The meeting closed on Sunday morning with a session devoted to discussion of an upcoming Summer School in Rock Magnetism to be held at the IRM in the summer of 2011. Bruce Moskowitz (University of Minnesota) and Laurie Brown (University of Massachusetts) led the discussion, which included debate over who should be targeted, and what the subject matter and format of the school should be.

The Sunday morning session was perhaps a fitting way to end the meeting: looking towards the future of the field and considering how to educate the next generation of rock magnetists. Based on the breadth and depth of topics discussed at the meeting, it promises to be a bright future.

References

Petrus Peregrinus
(or Pierre de Maricourt)
fl. 1269, France

Little is known about this 13th century French scholar, apart from his manuscript on magnetism, Epistola de magnete. When the work was composed in 1269, Peregrinus may have been a crusader in the army of Charles, duke of Anjou, during the siege of Lucera. The Epistola contains the first known description of a freely-pivoting (dry) magnet. He also provides the first extant European description of magnetic polarity, describes the properties and effects of magnets on each other, and tries to prove the possibility of perpetual motion with magnets. This text is also noted for his application of inductive reasoning and use of experimental methods to draw conclusions. In addition to his studies on magnetism, Peregrinus also wrote a manuscript describing a complicated universal astrolabe that was not widely adopted. In 2005, the European Geophysical Union established the Petrus Peregrinus Medal for outstanding contributions in the field of magnetism and paleomagnetism.

Visiting Fellows
June - December, 2010

Stacey Emmerton
Imperial College London
Understanding the formation process of magnetic minerals in oil sands

Yifan Hu
University of Florida
Demystifying the high-inclination, high-coercivity, NRM component in sediments from eastern equatorial Pacific (IODP Expedition 320/321)

Tomas Kohout
University of Helsinki
High temperature magnetic properties of kamacite-taenite-iron mixtures observed in meteorites

Dan McCuan*
California State University, Bakersfield
Late Pleistocene Paleomagnetic Field Record from the Sediments of Summer Lake, Oregon

Neil Ringerwole*
Grand Valley State University
Tobago, West Indies, incremental vertical axis rotation history

Peter Selkin
University of Washington, Tacoma
Magnetic Characterization of Emissions from the Tacoma Smelter

Rob Sternberg
Franklin & Marshall College
Low-temperature properties of central Mediterranean and Southwestern U.S. obsidians

Arlo Weil
Bryn Mawr College
Complementary Rock Magnetic data to support ongoing research into Orogenic Curvature

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October 31

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