

New IRM Visitor Programs

Julie Bowles
IRM

As a national multiuser facility funded in part by the National Science Foundation's Earth Science Program, the IRM is committed to serving the geoscience research and education communities. Few labs in the world have such a wide variety of rock and paleomagnetic equipment concentrated in a single facility, and part of our mission is to make this equipment available to the rock and paleomagnetic community, as well as to researchers in other fields who may benefit from magnetic studies.

To better accommodate a wider variety of visitors, the IRM, in consultation with our Review and Advisory Committee (RAC), has recently made some modifications to our Visitor programs. Since its inception in 1991, our Visiting Fellows program has allowed hundreds of users from across the U.S. and around the world access to IRM instruments and expertise. This program has been re-dubbed the **Visiting Research Fellow** program and will remain essentially unchanged. Starting in 2009, we have added two new visitor categories in order to provide access to more users, as well as new opportunities and services. The **U.S. Student Visiting Fellow** program is designed to give advanced undergraduate and graduate students specialized training in rock magnetic techniques and theories. The **U-Channel Visitor Program** provides users with access to our new automated, pass-through magnetometer system (see *IRM Quarterly*, v. 18, no. 3). As always, we also welcome informal **Guest Visitors** for short stays throughout the year.

Additional information, application materials, and instructions can be found below and online at www.irm.umn.edu/Visitor/.

U.S. Student Visiting Fellow Program

This program aims to provide financial (\$500) and instrumental support for advanced undergraduates and graduate students from U.S. institutions who seek to acquire state-of-the-art rock magnetic and/or paleomagnetic data for an individual research project. Special consideration will be given to students requiring data for the completion of a senior thesis or preliminary data for a proposal to support continued graduate research. More



Visiting Research Fellow Sarah Brownlee (U.C. Berkeley) measures the magnetic properties of single crystal hemo-ilmenites on the Magnetic Properties Measurement System (MPMS).

advanced students are also welcome to apply for regular **Visiting Research Fellowships** (below), which would allow access to a wider range of instrumentation.

Visiting Students may spend up to five days at the IRM and will work with IRM staff to:

- 1) Design an experiment or set of experiments that will further their research interests
- 2) Learn how to operate rock and/or paleomagnetic instrumentation
- 3) Process and interpret the generated data
- 4) Identify specific, attainable research goals that can be achieved with future magnetic measurements

An individualized learning component will be an integral part of the Visiting Student Program. The format will be flexible and will involve a mini-seminar or group discussion activity with IRM staff and faculty. This will take place shortly after arriving at the IRM and will be focused on a particular aspect of magnetism most suitable to the student's project and educational background. For example, in consultation with the student's advisor or sponsor, the learning activity could involve providing students with several papers to read prior to coming to the IRM, and then participating in a group discussion of the papers in preparation for their experiments.

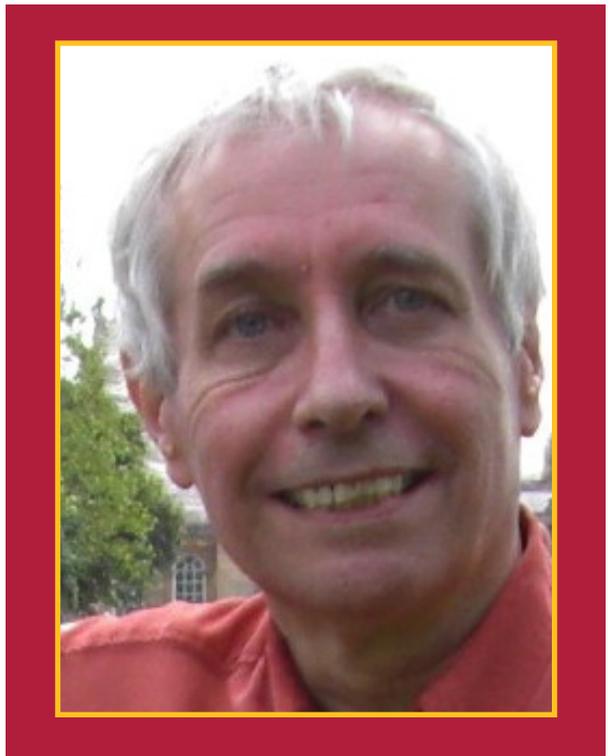
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G.W. (Geoff) Bartington: a pioneer in magnetic instrumentation

Frank Oldfield
University of Liverpool

Readers of this Newsletter and all who have been involved in magnetic measurements over the last 3 decades will be saddened by the untimely death of Geoff Bartington on December 13, 2008. In response to the needs of environmental magnetists for a versatile, sensitive and stable range of susceptibility sensors for field and laboratory use, linked to a single meter, he developed the MS2 system that has become standard equipment in many laboratories worldwide. He began work on a prototype in 1978, in his home, with minimal financial support and little prospect of any significant future payoff. I was privileged to share in the development of the system with Geoff having met him at his workbench in Littlemore Scientific where I had gone to test and then purchase a classic susceptibility 'bridge' that he had made. After some excited discussions about needs and applications, he offered to carry the susceptibility meter to my car – an apparently unnecessary favour as it was small and light. Despite my protests, he insisted. Once we were outside, his motivation in accompanying me to the car became clear. He had envisioned the type of equipment I was keen to have and he was very keen to build a prototype. The problems were twofold. His boss, Prof. Teddy Hall, was against the idea as a waste of time and effort; moreover, Geoff did not have the money to buy the essential materials for the project as he was raising a family on a small salary with nothing to spare. I had just been given a grant of less than \$400 by the Institute of Hydrology for tracing stream gravel and decided there and then to hand the lot over to Geoff. We liaised over the next week about the broad requirements and performance specifications, after which I waited. In due course, the prototype meter (housed in a varnished marine ply box made by Geoff's twin brother) plus sensors arrived. There followed a good deal of collaborative work. Thanks to Geoff's creative genius and good humour, it felt like a cheerful conspiracy. The subsequent realization that there were interesting lessons to be learned from trying to characterize as economically as possible the frequency dependent component of the low field susceptibility led to the development of the dual frequency sensor. That in itself was a stroke of genius on Geoff's part and came to fruition only after many trials.

By now, the MS2 system is one of many pieces of scientific equipment manufactured by Bartington Instruments, established in 1985. The range also includes gradiometers for use in archaeological prospecting. A single example may serve to illustrate the key role his equipment has played in the development of environmental magnetism. By the mid-1980's, Liu Tungsheng and col-



Geoff Bartington

leagues had demonstrated the close correlation between the sequence of loess and palaeosol layers in the classic Luochuan section and the marine isotope stratigraphy that recorded orbital forcing of the Earth's climate during the Quaternary. The clearest demonstration of the correlation came from magnetic susceptibility measurements that showed higher values in the interglacial palaeosols than in the intervening loess layers. Early attempts to explain this, by George Kukla and colleagues, postulated that the alternations were the result of a broadly constant flux of atmospherically deposited magnetic particles that became diluted during glacial periods by the enhanced deposition of less magnetic dusts from the continental interior. Not until measurements of frequency dependent susceptibility were made was it possible to show that the orbitally tuned signature in the loess was largely the result of soil formation during interglacials, leading to the secondary enhancement of fine grained magnetic minerals. This opened up the way for a suite of highly significant papers using the magnetic susceptibility records from loess profiles as a basis for reconstructing the palaeoclimate of successive interglacial stages.

The range of applications extends well beyond this to include marine and lake sediment stratigraphy, soil survey, sediment source ascription and pollution studies. Geoff Bartington's capacity for innovative design was key to developments in all these fields of application. It is rare for a key innovation to be linked exclusively to the inventive genius of a single person and even rarer for his key contribution to be explicitly acknowledged. By writing this brief note I want to record and honour the work of Geoff Bartington and the role it played in the development of environmental magnetism.

Visiting Fellows' Reports

Atmospheric particulate matter revealed by magnetic analysis

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The main objective of my visit to the IRM was to investigate the magnetic properties of minerals that combine to form the particulate air pollution. Magnetic minerals are a common component of atmospheric particulates, mostly arising from anthropogenic activities. The goal of my project is to estimate the concentration of fine and ultrafine particulates and to distinguish anthropogenic and natural sources

Samples were taken from filters collecting particulate matter with diameter $< 10 \mu\text{m}$ (PM10) in different city areas. The particulate mass on the filter was also measured. Preliminary analyses of **isothermal remanent magnetization** at low and room temperature and hysteresis loops suggested a rather uniform mixture of low-coercivity, magnetite-like particles and variable grain-size populations with a substantial amount of ultrafine particles. **The results point to a general correlation between magnetization and concentration of particulates in the air, hence a greater presence of magnetic particles, in particular ultrafine particles, in high-traffic areas.**

Further measurements have been made at the IRM in order to better characterize grain size and mineralogical variations. **Low-temperature magnetic properties** were measured on a MPMS. Remanence vs temperature curves have been measured during subsequent cooling and warming of SIRM induced at room temperature with a 2.5T field (RT SIRM cooling), and during warming of SIRM induced at 15K with a 2.5T field (LT SIRM) after cooling in zero field (ZFC); finally a field cooling (FC) experiment was performed using a 2.5T field. Susceptibility measurements as a function of frequency, applied field and temperature were performed in selected samples. Hysteresis loops and IRM curves were determined at 15, 77, 268 and 300 K using the VSM; the coercivity of remanence was also measured during this experiment. Curie point (T_c) determinations were carried out using the VSM and KappaBridge.

Figure 1 shows low-temperature remanence curves of samples from a high traffic site (g12) and a city park site (d9). The general decrease of IRM between 15 and 300 K in both stations reflects a strong superparamagnetic (SP) component. **The Verwey transition marked by a decrease in remanence around 120 K in cooling curves points to the occurrence of magnetite.**

Susceptibility (χ) does not vary as a function of applied field, whereas it shows a frequency-dependent behavior. The increase of χ with temperature together with the

frequency-dependence suggest a contribution from superparamagnetic particles with a diversified size distribution, whose mineralogical composition is however difficult to identify. The measurements have noted a **higher intensity linked to the increased amount of particulate due to urban pollution and a major contribution of finer fraction.** The data collected at the IRM will be very useful to identify the particle size distribution and identify some magnetic differences between sites with different environmental conditions. **The low magnetic signal of the samples and the occurrence of thermally-induced mineralogical changes prevented a reliable determination of the Curie temperature.**

We plan to integrate these data acquired at the IRM with further analysis under the transmission electron microscope in order to determine the grain size distribution and substantiate the correlation between magnetic parameters and particulate concentration.

My time at the IRM was a great experience, and I would like to thank the IRM staff for the generous help and the opportunity to visit the lab.

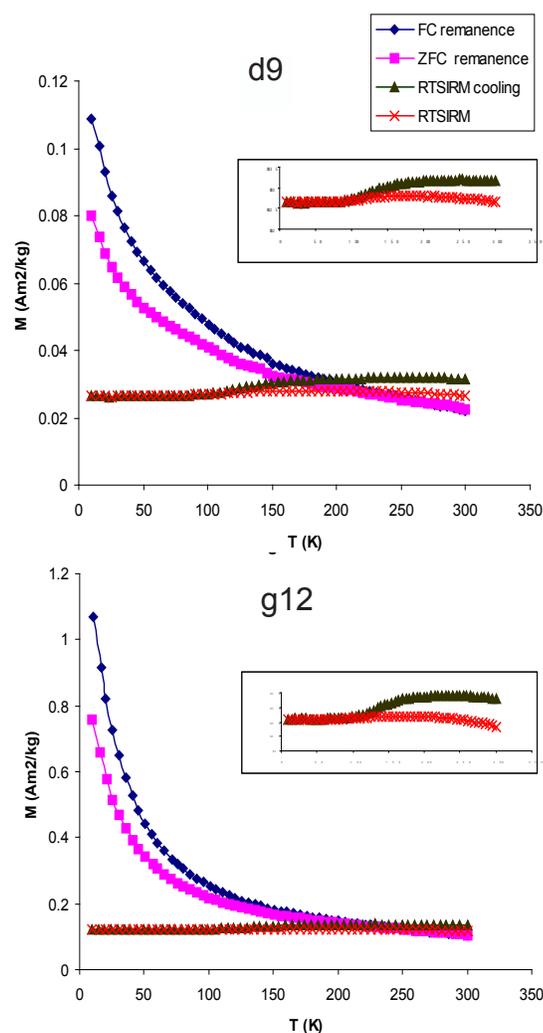


Figure 1: Low-temperature remanence curves for a green park (d9) and heavy traffic sample (g12) measured during subsequent cooling and warming of SIRM given at room temperature at 2.5T field (RT SIRM cooling), and measured during warming of SIRM given at 15K at 2.5T field (LT SIRM) after cooling in zero field (ZFC) and in presence of 2.5T field (FC). In the box is shown the expansion of the cooling curve and subsequent heating

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 list and to the Abstracts section of the IRM Quarterly are always welcome.

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Environmental Magnetism and Paleoclimate Proxies

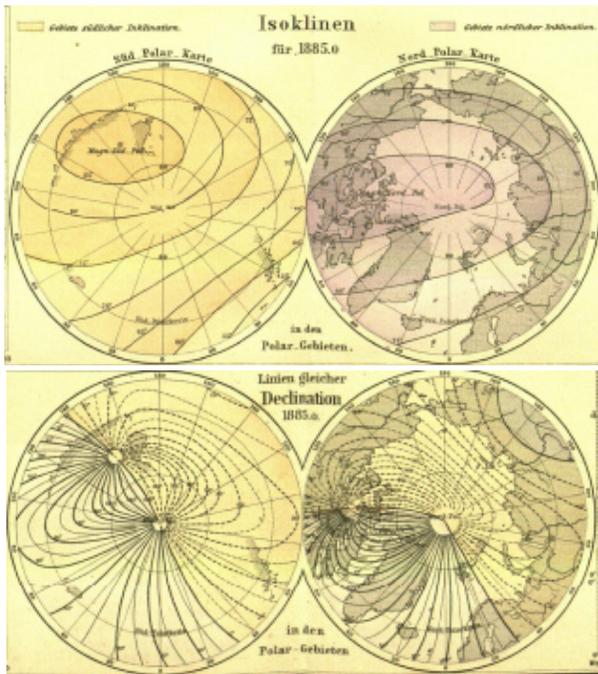
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Polar projections of geomagnetic inclination (top) and declination (bottom) from Atlas des Erdmagnetismus (1891) by Georg Neumayer. A German scientist and polar explorer, Neumayer proposed the first International Polar Year (1882-1883) and established the Flagstaff Observatory for Geophysics, Magnetism and Nautical Science in Australia.

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IRM Graduate France Lagroix receives 2008 Gilbert Award



Photo courtesy of Vincent Courtillot. From left to right: Gary Acton, Catherine Constable, Steve Constable, Ted Evans, France Lagroix, Bruce Moskowitz, Jean-Pierre Valet, Richard Blakeley.

France Lagroix, former IRM student (PhD, 2004) is the 2008 recipient of the William Gilbert Award presented by the Geomagnetism and Paleomagnetism section of the American Geophysical Union. She was cited for her excellence in rock magnetism and its applications to tectonics, paleoclimate, and fundamental studies. Currently she is a CNRS research scientist at the Institute de Physique du Globe de Paris, France. Congratulations, France!

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Other

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This program is meant to help cultivate young researchers with an interest in paleomagnetism and rock magnetism. We anticipate and encourage Visiting Students to apply for full-fledged Visiting Research Fellowships at any point after their Visiting Student Program is completed.

Applicants must be enrolled as full-time students at an accredited U.S. university or college. We strongly urge, but do not require, the student's home institution to commit to providing an equal, matching grant to the student to help defray travel expenses.

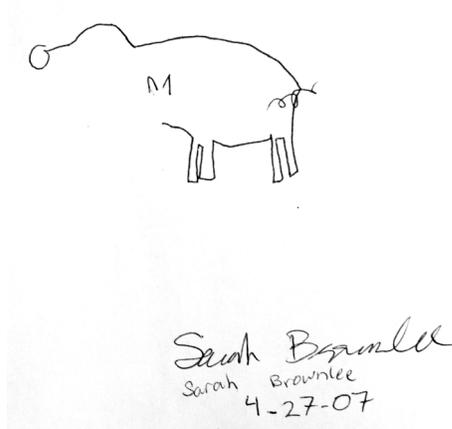
U-Channel Visitor Program

The IRM's new u-channel (long-core) magnetometer system is available for use by visitors with continuous cores (4.2 cm access diameter optimized for standard u-channels) or discrete samples for paleomagnetic and basic rock-magnetic or environmental-magnetic work. The system allows for automated measurement of samples and has in-line alternating field and ARM coils and off-line IRM capacity (see www.irm.umn.edu or *IRM Quarterly*, v. 18, no. 3). A relatively modest \$150 per day usage fee includes unlimited use of the u-channel system, training and assistance with the equipment, and (if desired) help with data interpretation and analysis. A *fee waiver* is available for users who can demonstrate that the fee would constitute a financial hardship, and nobody will be denied access based on ability to pay.

Accepted U-Channel Visitors are also encouraged to select a small number of pilot samples for more detailed rock magnetic analyses on a limited number of other IRM instruments. This data may be used to explore potential future avenues of research or the feasibility of returning to the IRM as a **Visiting Research Fellow** with a targeted rock magnetic study.

Visiting Research Fellowships

Formerly known simply as the Visiting Fellowship program, this program remains unchanged. Fellowships provide access to the full set of IRM instrumentation for up to 10 days and partial reimbursement of actual travel costs (up to \$750). Topics for research are open to any field of study involving fine particle magnetism, but preference will be given to projects relating magnetism to geological or environmental studies, or to fundamental physical studies relevant to the magnetism of Earth materials. In general, projects that require only widely-available equipment (such as paleomagnetic or low-field susceptibility instruments) will be given lower priority than those that require a variety of more specialized rock-magnetic instruments (e.g. low-temperature, high-field susceptometers, domain imaging, Mossbauer spectroscopy).



A traditional Friday afternoon diversion at the IRM involves drawing a pig while blindfolded. Results of Visiting Fellow Sarah Brownlee's effort are shown above.

Guest Visitors

Many researchers may not have need for an extended stay at the IRM. If you require access to only two or three instruments, for periods up to 3 days, please contact us about scheduling an informal visit. We accommodate these visits throughout the year as scheduling permits.

Application Process and Deadlines

Informal **Guest Visitors** are welcome to contact us throughout the year to schedule a short visit at a mutually convenient time. E-mail us (irm@umn.edu) with a brief description of your research interests, equipment needs, and preferred dates.

For **all other visitor categories**, applications will be reviewed twice per year (**April 30** and **October 30**). We recognize that some projects are time sensitive because of the potential for rapid, post-coring, sediment diagenesis. Therefore, time-sensitive applications will be entertained year round and allowed as scheduling permits.

Application materials and instructions can be found online at www.irm.umn.edu/Visitor/. Application requirements differ slightly for each visitor category, but the basic process involves writing a short (1 - 3 page) proposal, describing your research goals and plans. Applications will be reviewed by IRM staff and members of our external Review and Advisory Committee (RAC).

If you have any questions about which category best fits your needs, or otherwise require assistance with your application, please feel free to contact us to discuss your research.

Help Us Spread the Word!

We love having visitors to our labs, as we always get to meet new people and learn interesting new things. With the enlargement of our visitor programs, we hope to extend our welcome to people we haven't seen before. Please encourage your friends, colleagues, and students to consider a trip to the IRM.

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The IRM Quarterly

The *Institute for Rock Magnetism* is dedicated to providing state-of-the-art facilities and technical expertise free of charge to any interested researcher who applies and is accepted as a Visiting Fellow. Short proposals are accepted semi-annually in spring and fall for work to be done in a 10-day period during the following half year. Shorter, less formal visits are arranged on an individual basis through the Facilities Manager.

The *IRM* staff consists of **Subir Banerjee**, Professor/Founding Director; **Bruce Moskowitz**, Professor/Director; **Joshua Feinberg**, Assistant Professor/Associate Director; **Jim Marvin**, Emeritus Scientist; **Mike Jackson**, **Peat Solheid**, and **Julie Bowles**, Staff Scientists.

Funding for the *IRM* is provided by the **National Science Foundation**, the **W. M. Keck Foundation**, and the **University of Minnesota**.

The *IRM Quarterly* is published four times a year by the staff of the *IRM*. If you or someone you know would like to be on our mailing list, if you have something you would like to contribute (*e.g.*, titles plus abstracts of papers in press), or if you have any suggestions to improve the newsletter, please notify the editor:

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IRM Visitor Program Application Deadline

April 30

Apply now for :

Visiting Research Fellowship
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U.S. Student Visiting Fellowship

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See inside for details!



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