Inside...

The IRM Quarterly

WINTER 1995-6, VOL. 5, NO. 4 INSTITUTE FOR ROCK MAGNETISM

photo by M. Jackson

The new Vibrating Sample Magnetometer (VSM) from Princeton Measurements Corporation enables measurement of magnetization as a funtion of applied field (to 1.8 T), temperature (to 750 C) and orientation.

Micro-VSM Maximizes Magnetic Measurements

Peat Solheid
Rick Oches
IRM

Marvin Makes Minor Modifications

The most recent major equipment acquisition completes the planned assembly of state-of-the-art instrumentation at the IRM. At least for now.

A NEW MEMBER OF THE IRM FAMILY

Along with the new year (and a mighty cold winter), January brought the newest addition to the IRM family of instruments. Our long-awaited Princeton Vibrating Sample Magnetometer (VSM) arrived and was accompanied shortly after by Harry and Tony of Princeton Measurements Corporation, who assisted with the setup and demonstrated its ability to "kick butt" (*i.e., to perform superbly - ed.*). With sensitivity an order of magnitude better than our old, and recently cranky, house-built VSM and the ability to accommodate a much wider range of sample sizes than its MicroMag cousin, it is a welcome and popular addition to our rock-mag tool kit. Other major benefits include an impressive furnace (20 to 750 °C in under 9.8 seconds) that can be installed to measure both hysteresis loops and dipole moment versus temperature, greatly reduced measurement time (equal to that of the MicroMag), and the ability to measure both hysteresis loops and dipole moment versus orientation and/or temperature for anisotropy studies.

TEMPERATURE CONTROL

A vast improvement over our original VSM is the simplicity and speed of the new high temperature oven operation. With the furnace attached the maximum achievable field is 1.8 Tesla, and the temperature range is from ambient to 750 °C. In high temperature operation, a continuous jet of helium passes through the furnace and heats the sample. Precise temperature control is achieved by a thermocouple mounted precariously close to the sample, and oven temperature

VSM *continued on page 6...*

Visiting Fellows' Reports

The hardy and adventurous Visiting Fellows that made their way to the IRM over the winter were rewarded with some of the most brutally cold weather in recent memory. Koji Fukuma managed to stay warm in front of the new high-temperature VSM, while gathering hysteresis data for a set of ocean-floor samples. Chorng-Shern Horng puzzled over the properties of greigite-bearing sediments with perverse patterns of polarity. Jonathan Glen and Stuart Gilder boldly went where no one has gone before, in their attempt to image domains in a high-pressure iron phase in a diamond-anvil cell.

Koji Fukuma

University of Toronto - Erindale

High-temperature hysteresis properties of oceanic crustal rocks

My objective was to examine the effect of hydrothermal alteration on the magnetic mineralogy of oceanic crust. I used the newly-installed vibrating sample magnetometer (VSM) to obtain hysteresis parameters as a function of temperature, and also conducted low-temperature SIRM demagnetization experiments on the MPMS. About twenty representative samples, covering basalts through sheeted dikes from DSDP/ODP Hole 504B, were selected on the basis of published data and my own Curie temperature (T_c) and hysteresis data.

The new VSM works quite well. It is quick and easy to operate. Just one minute is necessary to take a hysteresis loop, and another minute to heat up a sample by flowing hot helium gas. These procedures are fully computer-controlled, with operating software of the same design as the AGFM (MicroMag) program. One has only to set measurement parameters, hit the return key and walk around. The only drawback is that it consumes a lot of helium gas. A full helium cylinder was gone every two days.

Temperature dependence of saturation magnetization, after subtracting paramagnetic contributions, showed a sharper change near T_c than that of strong-field magnetization obtained by a Curie balance. That could give a more precise estimate of T_c, especially when magnetic minerals are chemically unstable below their T_c. T_c can be also inferred from peaks of the temperature variation of high-field susceptibility. Some samples showed distinctive peaks which coincided with T_c estimated from the temperature dependence of saturation magnetization. However, other samples, especially typical titanomaghemite-bearing samples from the upper basalts, showed broad highs around the T_c. Saturation remanence and coercivity were also recorded as a function of temperature. Those curves inflected near 300 C, which was not seen on the saturation magnetization curves, for many samples.

I found that the Verwey and 30-34K transitions vary in a systematic way with the vertical position and the degree of alteration of samples. While no Verwey transition was observed in the basalt samples, samples from the sheeted dikes and from the highly altered transition zone exhibited clear and non-smeared Verwey transitions. The 30-34K transitions were observed for most samples except for least altered basalts and highly altered samples from the transition zone.

Chorng-Shern Horng

Academica Sinica, Taipei

Greigite Alteration and Remanence

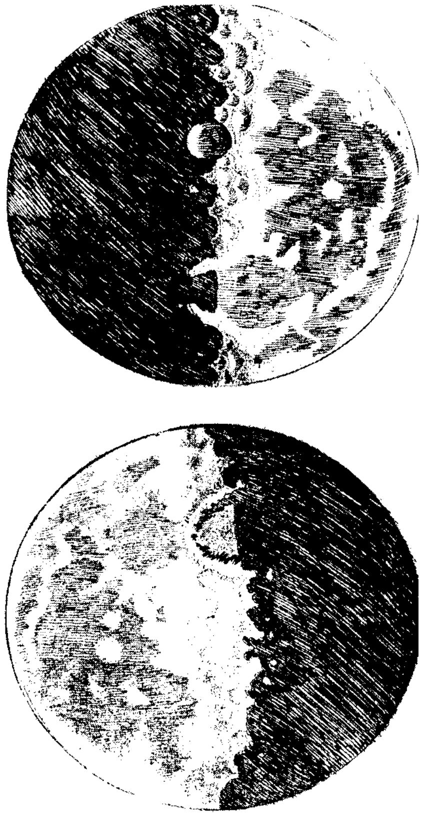
Paleomagnetic study of Plio-Pleistocene marine mudstones and siltstones from Taiwan has shown a number of zones of anomalous NRM polarity, i.e., polarity opposite to that expected on the basis of excellent nannofossil age control. The "wrong" polarities occur in different samples from the same site, or even in different specimens sliced from the same bedding-parallel core sample. X-ray diffraction has shown that magnetite, pyrrhotite and greigite are present in varying degrees throughout the section; the oxide is probably detrital and the sulfides are probably diagenetic.

The question I wished to address is the origin of the anomalous-polarity NRMs. In view of the variability of the anomalous remanence over small spatial scales, two hypotheses seemed possible. First, geochemical and diagenetic alteration of the magnetic minerals may have occurred in a "mottled" fashion, i.e., varying strongly over small length scales. If this were the case, one might expect to observe changes in magnetic mineralogy between specimens from the same core, and perhaps some correlation between magnetic mineralogy and anomalous polarity. However, preliminary tests on a MicroMag AGFM and XRD data did not support this hypothesis, which led to a second hypothesis: that diagenetic greigite in some cases carries a "self-reversed" CRM, perhaps due to coupling with magnetite.

Testing the latter hypothesis is more difficult, because it is not clear exactly what predictions follow from it, that can be tested by rock-magnetic experiments. If greigite grew as an overgrowth on magnetite, or interacting with it magnetically in some other manner, one might test for interacting magnetic behavior and for coexisting magnetite and greigite. However, if the process continued far enough, the magnetite may have been completely removed, leaving no tell-tale rock magnetic behavior to indicate its former presence.

I used the MPMS to look for the characteristic low-temperature transitions of magnetite and pyrrhotite (greigite has none) by giving samples a saturation remanence at 20 K and monitoring its decay on warming in zero field. Several specimens showed single-mineral transitions; no specimens showed evidence of both; and many specimens showed no transitions at all. Thermomagnetic analysis using the high-temperature Kappabridge also

VF Reports *continued on page 5…*



Galileo's drawings of the moon, from his Sidereus Nuncius, *1610 (from the 1989 translation by A. Van Helden, University of Chicago Press).*

Current Abstracts

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 culled 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 editing and condensation 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 2700 references, is available free of charge. Your contributions both to the list and to the Abstracts section of the* IRM Quarterly *are always welcome.*

Archeomagnetism

Shaw, J., D. Walton, S. Yang, T. C. Rolph, and J. A. Share
Microwave archaeointensities from Peruvian ceramics, *Geophys. J. Int., 124*, 241-244, 1996.
By using direct microwave excitation of magnetic grains, the authors have been able to produce a TRM without significantly heating the bulk sample, thus avoiding thermal mineralogical alteration. Thellier paleointensity determinations using the microwave heating technique have dramatically reduced scatter, and have clearly defined how field strength has varied in Peru over the past 2000 years.

Climate Change

Eyre, J. K., and D. P. E. Dickson
Mossbauer spectroscopy analysis of iron-containing minerals in the Chinese loess, *J. Geophys. Res., 100*, 17,925-17,930, 1995.
Mossbauer spectroscopy of bulk samples of Chinese loess shows two significant differences between strongly and weakly weathered layers. The former have a much higher content of SP hematite and higher ratios of paramagnetic Fe^{3+}/Fe^{2+}, suggesting that Fe liberated from silicates by weathering forms fine-grained hematite. Atomic absorbtion measurements show higher total Fe in the strongly weathered loess, indicating that mineralogy of dust input to the loess plateau varies with climate. Thus the mechanisms linking climate and mineralogy in the Chinese loess may be more complex than previously thought.

Thompson, R., and B. A. Maher
Age models, sediment fluxes and paleoclimatic reconstructions for the Chinese loess and paleosol sequences, *Geophys. J. Int., 123*, 611-622, 1995.
The authors analyze magnetic data from six sites across the Loess Plateau and reinterpret ^{10}Be data as largely reflecting primary dust loading rather than as a paleorainfall indicator. They explain the susceptibility of Chinese loess in terms of in-situ pedogenic ferrimagnetic enhancement, such that magnetic susceptibility is a direct indicator of paleorainfall. New reconstructions show paleorainfall variations between -12% and +28% for the central Loess Plateau, rather than the 50-100% variations suggested by previous ^{10}Be and magnetic susceptibility studies.

Hysteresis

Muttoni, G.
"Wasp-waisted" hysteresis loops from a pyrrhotite and magnetite-bearing remagnetized Triassic limestone, *Geophys. Res. Lett, 22*, 3167-3170, 1995.
Remagnetized samples of the Triassic Prezzo limestone from northern Italy contain a mixture of pyrrhotite and magnetite. Hysteresis loops are commonly "wasp-waisted" and remanent coercivity curves contain a break in slope, due to the coercivity contrast of the two minerals. The degree of "wasp-waistedness" is controlled by the relative proportions of the high and low coercivity fractions. Maximum B_{cr}/B_c ratios, and thus maximum degrees of "wasp-waistedness", are attained when the low remanent coercivity fraction contributes 15-35% to the bulk remanent coercivity curves.

Roberts, A. P., Y. Cui, and K. L. Verosub
Wasp-waisted hysteresis loops: mineral magnetic characteristics and discrimination of components in mixed mineral systems, *J. Geophys. Res., 100*, 17,909-17,924, 1995.
The authors outline a method for determining the magnetic components that can give rise to wasp-waisted hysteresis loops. In order to contribute significantly to wasp-waisted hysteresis behavior, a mineral component must account for a substantial portion of the total magnetization. As a result, weakly magnetic minerals such as hematite must occur in large concentrations to produce wasp-waisted loops in materials that also contain ferrimagnetic minerals.

Tauxe, L., T. A. T. Mullender, and T. Pick
Potbellies, wasp-waists and superparamagnetism in magnetic hysteresis, *J. Geophys. Res., 101*, 571-583, 1996.
Numerical simulations of hysteresis for SP/SD systems show that: (1) both wasp-waisted and potbellied loops can be produced by SP/SD assemblages; (2) wasp waists result when the SP fraction saturates quickly, whereas potbellies require a low initial slope for the SP fraction; (3) model potbellies require a SP/SD threshold diameter below 30 nm; for wasp-waists the model threshold diameter must exceed 8 nm; the occurrence of both wasp-waists and potbellies in natural samples thus indicates an actual room-temperature threshold of approximately 15 nm; (4) hysteresis in submarine basaltic glass resembles that modeled for an SP/SD with a threshold of 15-20 nm.

Mineral Extraction

Hounslow, M. W., and B. A. Maher
Quantitative extraction and analysis of carriers of magnetization in sediments, *Geophys. J. Int., 124*, 57-74, 1996.
Experiments using an integrated procedure for quantitative magnetic mineral extraction and a range of sediment types have provided estimates of the efficiency and representative nature of the extraction process. Magnetic measurements show that the modified extraction method extracts large proportions of the magnetization carriers (over 75% efficiency for magnetite-dominated sediments). The efficiency depends on mineralogy, on mode of occurrence of magnetic grains (discrete particles or inclusions in other grains), and to a certain extent on the density of sediment suspension during extraction.

Ocean Crust

Hall, J. M., and J.-S. Yang
Constructional features of Troodos type oceanic crust: Relationships between dike density, alteration, magnetization, and ore body distribution and their implications for in situ oceanic crust, *J. Geophys. Res., 100*, 19,973-19,989, 1995.
Quantitative relationships exist between dike density and hydrothermal alteration, magnetization, massive sulfide ore bodies, and other properties in a segment of the Troodos Ophiolite extrusive series. Low-T alteration extends from the top of the extrusives to the 25% dike density surface, and greenstone alteration is closely associated with the 50% dike density surface. An upper magnetic zone, characterized by high stable remanence, terminates just below the 25% dike density surface. A deeper magnetic zone, characterized by high induced magnetization, straddles the top of the sheeted complex. As a result of these relationships, an alternative is proposed to the lithologic profile for ODP Hole 504B.

Paleointensity

Thival, J., J.-P. Pozzi, V. Barthes, and G. Dubuisson
Continuous record of geomagnetic field intensity between 4.7 and 2.7 Ma from downhole measurements, *Earth Planet Sci. Lett., 136*, 541-550, 1995.
A continuous record of paleofield intensity, together with a precise magnetostratigraphy, has been obtained from downhole magnetic measurements at Site 884 of ODP Leg 145 in the North Pacific. The record confirms the sawtooth pattern of geomagnetic field intensity proposed by Valet and Meynadier. Reversals are characterized by a steep intensity decrease followed by a quick regeneration. Over each polarity interval, rapid variations are superimposed over a progressive decrease in mean intensity. We find that the duration of each polarity interval is inversely proportional to the mean rate of decrease in field intensity.

Physics

Honig, J. M.
Analysis of the Verwey transition in magnetite, *Journal of Alloys and Compounds, 229*, 24-39, 1995.
A review of thermodynamic and electrical transport phenomena in magnetite emphasizes the need for careful compositional control of single crystal growth. With increasing deviations from the ideal Fe_3O_4 composition, the Verwey transition suddenly shifts from the first order to a higher order regime. This hitherto unrecognized feature is documented by a variety of experimental techniques and is rationalized in terms of a mean-field theoretical approach.

Lehlooh, A. F., and S. H. Mahmood
Mossbauer spectroscopy of Fe_3O_4 ultrafine particles, *Journal of Magnetism and Magnetic Materials, 151*, 163-166, 1995.
Mossbauer spectroscopy is used to study a system of Fe_3O_4 ultra-fine particles at temperatures down to 5 K. The effective magnetic anisotropy constant K for the system is calculated using a method based on superparamagnetic relaxation, and one based on a collective magnetic excitation model. The resulting values, $2.6x10^5$ and $2.0x10^5$ J/m^3 respectively, are larger than those obtained for systems with larger mean diameters, implying a significant size dependence of K.

Reversals

Camps, P., M. Prevot, and R. Coe
Revisiting the initial sites of geomagnetic field impulses during the Steens Mountain polarity reversal, *Geophys. J. Int., 123.*, 484-506, 1995.
A paleomagnetic re-investigation of the Steens Mountain volcanics was designed to obtain detailed and complete vertical sampling of lava flows, at the same sites where impulsive transitional field behavior was identified previously. At site B (first impulse) the vertical change in NRM direction is best explained by thermochemical effects of the overlying B51 flow (although 25 m away the NRMs do appear to indicate impulsive field behavior). At site A, the second impulse does not appear to be an artifact of thermochemical overprinting.

Clement, B. M., P. Rodda, E. Smith, and L. Sierra
Recurring transitional geomagnetic field geometries: Evidence from sediments and lavas, *Geophys. Res. Lett., 22*, 3171-3174, 1995.
Records of the geomagnetic polarity transitions bounding the Nunival Subchron have been obtained from the Suva Marl, Fiji (18.2 degrees S, 178 E). The transitional VGP positions cluster near southern South America and are remarkably similar to the VGP paths for the same reversals obtained from Sicily. The similarities in these records from both lava and sediment records suggests that an inclined near-dipolar state of the transitional field recurred in these back-to-back reversals.

Quidelleur, X., and J.-P. Valet
Geomagnetic changes across the last reversal recorded in lava flows from La Palma (Canary Islands), *J. Geophys. Res., in press*, 1996.
Samples were collected from two adjacent sequences of flows spanning the M-B reversal. The intermediate VGP positions do not cluster within any preferred geographic areas. Paleointensity experiments on 60 samples by the modified Thellier method yielded 24 independent estimates of the paleofield, ranging from 3.9 to 46.0 micro-T. The flows preceding the polarity switch show significantly lower paleointensities than the post-reversal flows, consistent with the asymmetric saw-tooth pattern recently observed in sedimentary records.

Torsvik, T. H., A. Trench, K. C. Lohmann, and S. Dunn
Lower Ordovician reversal asymmetry: An artifact of remagnetization or nondipole field disturbance?, *J. Geophys. Res., 100*, 17,885-17,898, 1995.
Five stratigraphic polarity intervals are recognized within the lower Ordovician Gullhogen limestone of Sweden. Primary magnetite of detrital or biogenic origin is considered to be the principal remanence carrier. A conspicuous reversal asymmetry has been identified, in which the lowermost two normal polarity zones have NRM directions that deviate significantly from otherwise nearly antiparallel and typical lower Ordovician directions. The authors suggest nonzonal nondipole field disturbances lasting some 1-1.5 Myr as an explanation of the asymmetry.

Secular Variation

Holt, J. W., J. L. Kirschvink, and F. Garnier
Geomagnetic field inclinations for the past 400 kyr from the 1 km core of the Hawaii Scientific Drilling Project, *J. Geophys. Res., in press*, 1995.
A volcanic record of geomagnetic field

inclination has been obtained from 941 m of core. Analysis of 195 flows shows six instances of near-zero inclination and two instances of negative inclination (reverse polarity) within an otherwise normal-polarity core. Near-horizontal or negative inclinations at depths of 178, 260, and 320 m may be associated respectively with the Laschamp, Blake, and Jamaica/Biwa I/Pringle Falls events. Shallow inclinations below 400 m are attributed to long-term secular variation (10 to 50 Kyr periodicity). Inclinations average 30.9 degrees, significantly shallower than the geocentric axial dipole value of 36 degrees.

Susceptibility

Dearing, J. A., R. J. L. Dann, K. Hay, J. A. Lees, P. J. Loveland, B. A. Maher, and K. O'Grady
Frequency-dependent susceptibility measurements of environmental materials, *Geophys. J. Int.*, *124*, 228-240, 1996.
A new model explains χ_{fd} in terms of the behavior of all SP grains with diameters less than 30 nm. The model predicts maximum χ_{fd} of 14-17% for spherical SP ferrimagnetic grains between 10 and 25 nm. Synthetic and experimental data support the model predictions. Lower values of χ_{fd} percentage in soils are caused by the presence of narrow distributions of ultrafine SP grains, and frequency-independent stable SD and MD ferrimagnetic grains; some soils with low susceptibilities may have low χ_{fd} percentages due to the frequency-independent contributions of paramagnetic and canted antiferromagnetic minerals. .

Tectonics

Kodama, K. P., and J. M. Davi
A compaction correction for the paleomagnetism of the Cretaceous Pigeon Point Formation of California, *Tectonics*, *14*, 1153-1164, 1995.
Shallow paleomagnetic inclinations in the Pigeon Point Formation have previously been interpreted in terms of large-scale tectonic displacements. New paleomagnetic results confirm the shallow inclinations. Experimental redeposition and compaction produces a remanence with anomalously shallow inclination. ARM anisotropy in the redeposited samples varies systematically with degree of compaction and with inclination shallowing. This experimentally-calibrated relationship permits the natural remanence to be corrected for compaction shallowing, based on ARM anisotropy. The compaction-corrected NRM indicates 13 to 16 degrees of latitudinal displacement, rather than the 25 degrees indicated by the uncorrected NRM.

Tarduno, J. A. and J. Gee
Large-scale motion between Pacific and Atlantic hotspots, *Nature*, *378*, 477-480, 1995.
Paleolatitudes derived from Pacific guyots suggest only minor latitudinal shifts of Pacific hotspots during the Cretaceous, contrary to predictions from true-polar-wander (TPW) models. Instead of TPW, the data require relative motion between the Atlantic and Pacific hotspot groups, at a velocity of approximately 30 mm/yr, more than 50% larger than previously proposed.

Theory

Jun Ye and R. T. Merrill
Use of renormalization group theory to explain the large variation of domain states observed in titanomagnetites and implications for paleomagnetism, *J. Geophys. Res.*, *100*, 17,899-17,907, 1995.
Renormalization group theory shows that small thermal fluctuations close to the magnetic ordering temperature produce "predomain" structures that vary significantly from one experiment to the next, even under the same conditions. On cooling, these predomain structures are primarily responsible for determining the final domain states. The theory suggests that domain observations might be very useful to discriminate between primary TRM and many forms of secondary magnetization.

Xu, S., and D. Dunlop
Toward a better understanding of the Lowrie-Fuller test, *J. Geophys. Res.*, *100*, 22,533-22,542, 1995.
A new theory of acquisition and AF demagnetization of ARM and of SIRM in MD grains provides better understanding of the Lowrie-Fuller test. Relative stabilities are determined by the distribution of microcoercivity f(Hc), which is determined primarily by grain size and dislocation density. When f(Hc) is relatively constant, ARM is more stable than SIRM; when f(Hc) is Gaussian or exponential, the reverse is true. Both types of behavior occur in the MD size range. The Lowrie-Fuller test thus does not distinguish domain structure, but it does depend indirectly on grain size.

Timescales

G. A. Mead
Correlation of Cenozoic - Late Cretaceous geomagnetic polarity timescales: An Internet archive, *J. Geophys. Res.*, *in press*, 1996.
This compilation correlates 12 different polarity timescales published from 1968 to 1995, graphically and in tabular form, in order to enable geoscientists to compare studies dated on the basis of different timescales. The table and supporting documents are stored electronically on-line at the World Data Center-A for Paleoclimatology (National Oceanographic and Atmospheric Administration / National Geophysical Data Center). ■

...VF Reports *continued from page 2*

failed to show evidence of coexisting magnetic phases in the anomalous samples, in part due to alteration during heating.

The enigma of the mixed-polarity samples remains unresolved, in part due to the difficulty in distinguishing the different ferrimagnetic minerals involved by magnetic measurements, but perhaps equally due to the lack of a clear connection between hypothesis and observables.

Attempted High-Pressure Domain Imaging in Iron

Jonathan Glen and Stuart Gilder
Institut de Physique du Globe de Paris

We are carrying out research designed to experimentally determine the magnetic properties of iron, especially at high (> 20 GPa) pressures. Our latest attempt employed the MOKE (Magneto-Optic Kerr Effect) system at the IRM (see IRM Quarterly v. 2, 1992), where we hoped to image magnetic domains of the high pressure phase (hexagonal closed packed - hcp) of iron in a diamond anvil cell (DAC). Toting two DACs, one at 2.6 GPa and the other at 30.6 GPa, our aim was to compare the low pressure phase (body centered cubic- bcc) with that of hcp iron. Unfortunately, domains were not observed in either cell. This null result could be due to any of a variety of problems including depolarization by the diamonds, surface roughness or high coercivity. Despite the problems encountered during our short visit, further exploration with the MOKE and other techniques are forthcoming.

response is nearly instantaneous. The sample does not respond as rapidly, but we have found that for a 5 degree step, the sample will equilibrate in about 20 to 30 seconds, depending on its volume. A dipole moment measurement takes about 0.2 seconds, and a hysteresis loop takes between 1 and 5 minutes, depending on the sensitivity desired. We will leave you to do the math to determine how long a run will take.

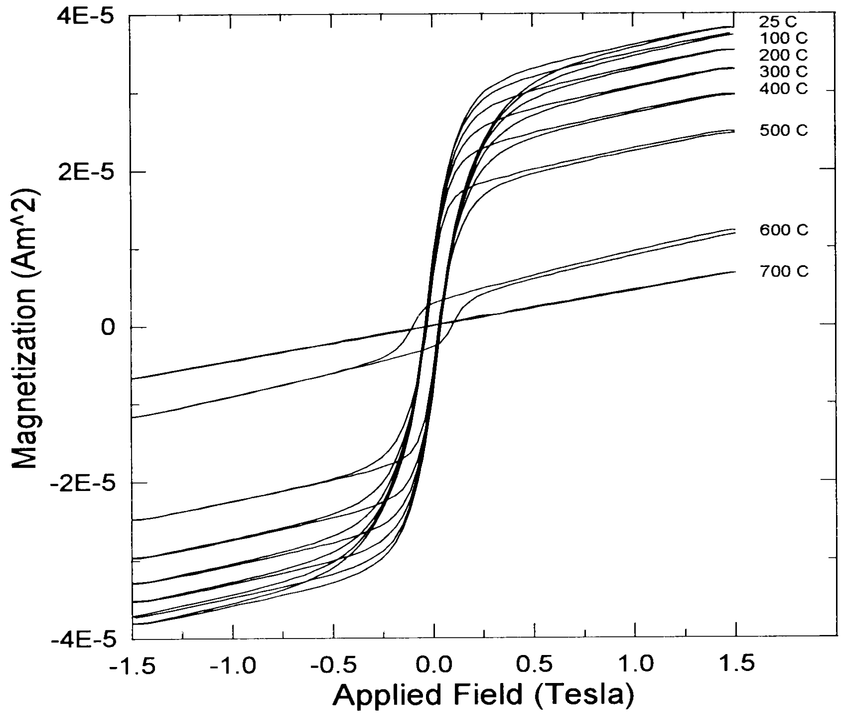
Sample Preparation

Samples can be in either chip or powder form. With the furnace in place, powder samples currently are limited to about 10 mg, which restricts samples to more strongly magnetic materials. We are developing new sample holders and hope to increase this capacity soon to allow high temperature measurement of weaker natural samples. Powders are sealed in quartz ampules and cemented onto ceramic holders. Solid samples can have maximum dimensions of 0.5 cm (length) x 0.5 cm (diameter) and are cemented directly onto the ceramic sample holders.

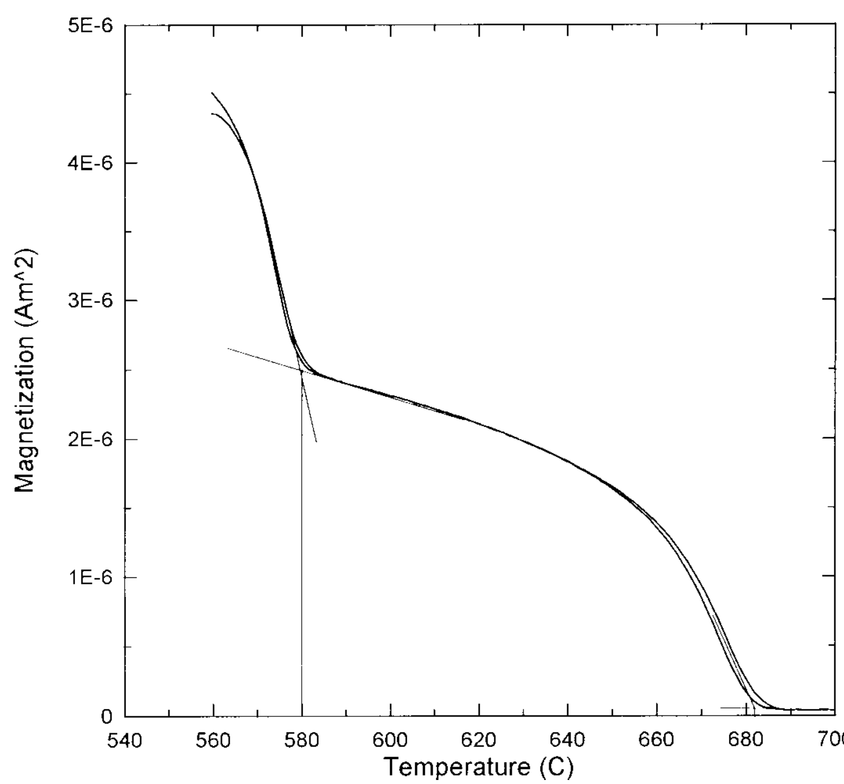
With the furnace removed (a half-day operation for disassembly and recalibration) the pole pieces of the magnet can be moved apart to accommodate larger samples. When this is done the maximum field is reduced to about 1.2 Tesla. In this configuration we can accommodate a variety of sample shapes and sizes. The optimal form is a 1 cc cube. Powdered samples can be packed into 1 cc cubes (that we make from spectroscopy cuvettes), and solid samples can be trimmed to this size. Other possibilities are our standard P1 boxes (5.28 cc) and ODP p-mag sample boxes (6 cc). For orientation-specific measurements, the samples can have a maximum diameter of 1.6 cm, and our 1 cc cubes work great for this.

Fine Tuning

As with all of our equipment, we are attempting to customize and optimize both hardware and software for sometimes peculiar rock-magnetic measurement demands. Jim is making some modifications to the control software, in cooperation with the Princeton people, customizing it to accommodate IRM users' unique needs. Peat keeps the folks in the Scientific Apparatus machine shop busy creating new and unusual precision sample holders. The rest of the IRM crew waits patiently for their turn with the new toy. ■



Hysteresis loops at various temperatures for a hematite-magnetite mixture. Loops are "wasp-waisted" from room temperature up to 500 C, with Hc determined primarily by the magnetite and Hcr by the hematite. At 600 C (above the magnetite Curie temperature), the hysteresis is due to hematite.



Thermomagnetic analysis of the same hematite-magnetite specimen.

IRM Web Site Upgraded

A workhorse instrument of the IRM: our state-of-the-art ADCM (automatic drip coffee maker).

The IRM presence on the World-Wide Web has become a bit more concrete with the latest efforts of Webmeister Bernie Housen. Researchers planning a visit to the IRM can now get on-line information about the instruments available, sample preparation, and even campus and city maps. Various files can be downloaded from the *IRM* Web site, including the bibliographic compilation of over 2700 references to papers on rock magnetism and paleomagnetism, as well as Visiting Fellowship application forms, and the *IRM Quarterly*. A guest page describes the activities of the current or most recent visitor. And students and staff are each highlighted on their own page, including Christoph Geiss's spectacularly gruesome self-portrait (don't miss it!)

Future enhancements in the works include browsable and/or searchable versions of the reference list and the *Quarterly*. In the techno-utopia of the near future, you may even be able to view real-time video of the ADCM!

Santa Fe III Conference on Rock Magnetism

We are pleased to announce that the Third Santa Fe Conference on Rock Magnetism will be held at St John's College in Santa Fe, June 27-30, 1996. The conference, sponsored by the Institute for Rock Magnetism (University of Minnesota), with support from NSF, will feature a format promoting in-depth discussions centered on two themes: (1) Constructing high-resolution geomagnetic paleointensity and paleodirectional databases as inputs for magnetohydrodynamic modeling, especially of geomagnetic field reversals, and secular variations; (2) Establishing cross-validated multiple rock magnetic proxy records of environmental and climate change for inputs and validation data for global and regional change models.

The open discussion format will require us to restrict the number of participants to approximately 40, including students and senior researchers. NSF funding will enable us to help pay travel costs for those who have no other source of funds (up to a maximum of $300). To indicate your interest in participating, and to apply for travel funds, contact Mike Jackson at the IRM by April 22, 1996.

"Magnetization of Ocean Crust" Conference

Paul Johnson
University of Washington

Dates: October 21 to 24, 1996
Location: Orcas Island, San Juan Islands, Washington State
Registration Deadline: 1 August 1996

Conveners:
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Marine magnetic anomalies have played a pivotal role in the theory of Plate Tectonics, and studies of the magnetization of oceanic crust continue to influence our view of the formation and evolution of the oceanic basins. In spite of the interdisciplinary implications of these studies, there has not been a conference related to the Magnetization of Oceanic Crust for almost 20 years. Research initiatives that focus on the formation of ocean crust (RIDGE/InterRIDGE), off-axis crustal evolution (Ocean Drilling Program) and large-scale behavior of the geomagnetic field (CSEDI) all rely heavily on the record of magnetization that is transcribed, with varying fidelity, within the ocean floor. New developments in the acquisition and analysis of magnetic survey data, and the recent availability of upper and lower crustal rock samples from the sea floor, have carried our understanding of ocean crustal magnetization beyond the simple block models that have served the community for decades. A number of research groups are developing these recently-acquired data sets into exciting new, and sometimes conflicting, models of the magnetization of the sea floor. In order to evaluate these new models, and to devise a common strategy for advancing our understanding of the magnetization of the sea floor, a conference on the Magnetization of Oceanic Crust will be held during October, 1996. Partial support for conference participants will be available through RIDGE and USSAC funds (with priority based on arrival-date of registration material), with additional funding being requested from NSF. Further information regarding the conference and registration process is available from any of the people listed above.

New Visiting Fellows Selected

Note: the next Visiting Fellow proposal deadline will be June 14, for visits during the period September 1996 to March 1997. Application forms are available from our Web site or by mail.

The December deadline produced a large number of excellent Visiting Fellow proposals, which our Review and Advisory Committee (RAC) was able (with some difficulty) to narrow to the following group of visitors for the spring and summer. The list below is arranged alphabetically and project titles have been ruthlessly shortened.

Students

Adrian Muxworthy, *Oxford*: Metastable remanence in MD magnetite

Scarlet Relle, *UC-Irvine*: Coagulation and settling of magnetic particles in water

Andrew Warnock, *Lehigh*: Simplifying multicomponent magnetizations

Tim Wawrzyniec, *New Mexico*: Magnetic properties of Elk Range rocks

Post-PhD

Peter Blum and Carl Richter, *ODP*: Ground-truthing Milankovitch and sub-Milankovitch susceptibility variations

Laurie Brown, *UMass*: Remanence carriers in the Teasure Mountain tuffs

John Geissman, *New Mexico*: Origin and subsequent chemical destruction of geologically stable magnetizations

Özden Özdemir and David Dunlop, *Toronto-Erindale*: Rock magnetic and paloeintensity experiments on single-crystal magnetite and goethite

Roy Roshko, *Manitoba*: Hysteresis in particulate and continuous magnetic media ▬

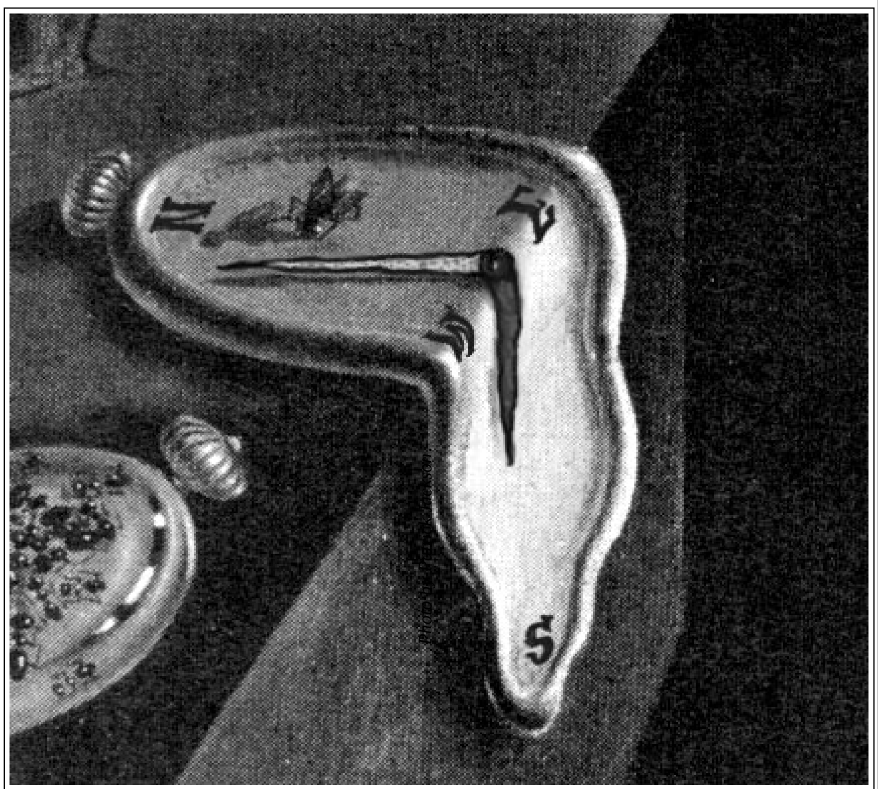
Erratum

In the last issue of the Quarterly (Fall 1995), our new high-temperature VSM was described as "enabling measurements up to x C." Several alert readers noticed that this description does not actually contain enough information to solve for x. For the complete solution please see the cover story of this issue. ▬

IRM Student Wins AGU Award

For the second consecutive issue, the *IRM* congratulates graduate student Stefanie Brachfeld, who received an Outstanding Paper Award for her fall AGU poster entitled "Holocene paleoclimate records from Antarctic glacial-marine sediments: Rock magnetic and biologic indicators of paleoproductivity." Coauthors were Amy Leventer and Eugene Domack. ▬

Reductio Ad Absurdum



Detail from "The Persistence of (Magnetic) Memory" by Salvador Dali and Taras Pokhil

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/Director; Bruce Moskowitz, Assistant Professor/Associate Director; Jim Marvin, Senior Scientist; and Mike Jackson, Senior Scientist/Facilities Manager.

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