I R M
Institute for Rock Magnetism

University of Minnesota *Minneapolis, Minnesota*

Fall, 1991 Newsletter *Volume 1, Number 2*

Workshop a Success (if we do say so ourselves!)

The Environmental Magnetism Workshop held in Minneapolis last June, sponsored jointly by the ***IRM*** and the University of Minnesota's Paleorecords Research Training Group, was well-received by the participants and the instructors alike. Seventeen graduate students from all over the country, plus one from Germany, attended the four-day program of lectures, laboratory exercises, a poster session, and informal gatherings. The participants were eager to adapt rock magnetic techniques for use in their projects. Judging from our experience, the emerging interdisciplinary research area of environmental magnetism need only be announced to attract enthusiastic and capable young scientists.

Various topics were covered by guest faculty members. Dr. **John King** (University of Rhode Island) talked about the use of magnetic methods for deciphering the hydrological cycle, paleoclimatic reconstructions from magnetic studies of marine sediments, and the survival of magnetite in the sedimentary record. Dr. **Dennis Bazylinski** (Virginia Polytechnic Institute) lectured on magnetotactic bacteria, the origin of biogenic magnetite and greigite in sediments, and electron microscopy of small grains. Although Dr. **Richard Frankel** (California Polytechnic State University) was unable to attend, he did send some useful notes on the principles of Mössbauer spectroscopy. As a past user of the technique, Dr. **Mike Sharrock** (3M Corporation, ***IRM*** *Review and Advisory Committee [RAC]*) was called in at the last minute to outline the principles of Mössbauer spectroscopy. Dr. **Kerry Kelts** (University of Minnesota Limnological Research Center) also gave an impromtu talk on the complex regional response to global changes.

IRM staff provided the rest of the instruction for the workshop. Prof. **Subir Banerjee** reviewed magnetic granulometry, the magnetic study of loess, and the applications of the Mössbauer effect to environmental magnetism. Dr. **Bruce Moskowitz** gave the introductory

Workshop...*cont. on page 8*

Reports from the Visiting Fellows

Each issue of the *IRM Newsletter* will contain short summaries of the work done by Visiting Fellows at the ***IRM***. Four Visiting Fellows have already been here: Drs. **David Dunlop** and **Özden Özdemir** from the University of Toronto put our newest machines through their paces in a mid-June measurement extgravaganza. Dr. **Dave Douglass** from Pasadena City College had an opportunity in early August to get back into a lab after several years devoted exclusively to teaching. Finally, Ms. **Gina Frost** from the University of California–Santa Cruz accumulated piles upon piles of thesis material in late August. Each

VF's...*cont. on page 2*

In this issue...

VF's...*cont. from page 1*

Visiting Fellow has contributed the following summary of his or her work done here:

Magnetite Inclusions in Biotites; Magnetic Properties of Single Crystals of Magnetite

David Dunlop/Özden Özdemir
University of Toronto

The week that we spent at the ***IRM*** in late June as Visiting Fellows was the most intensive and productive period of research either of us has experienced for many years in any laboratory, including our own.

With the MPMS1 superconducting susceptometer, we measured low-temperature remanence and memory from 5K to 300K for several representative micas, all of which showed clear low-temperature transitions. We also measured $J_S(T)$ and remanence curves for three of our magnetite crystals and two magnetite powders. On the MicroMag magnetometer, we ran about two dozen mica samples, mainly single crystals. All yielded ferromagnetic hysteresis that was readily separated from the paramagnetism of the micas hosting the magnetites. Mica crystals as small as 0.1 mg, containing typically only 0.1% by weight of magnetite, were measurable, much to our surprise. At the other end of the dynamic range, some of the smaller magnetite crystals and also six sized magnetite powders, were also measurable. The heaviest (and most strongly magnetic) of the single crystals were run on the vibrating sample magnetometer (VSM). Since its automation, the VSM is almost as quick and convenient to use as the MicroMag.

Our most ambitious experiment was a rousing success. Using the small water-cooled furnace that we brought with us from Toronto, readily measurable and consistent TRMs were induced in our largest magnetite crystal, which approaches millimeter size. The thermal and AF demagnetization curves measured for these TRMs are vital for testing our latest theories of TRM in large multidomain grains. We were also able to measure AF demagnetization for ARM in the same crystal, and both thermal and AF demagnetization for saturation IRM. The stability and reliability of the superconducting rock magnetometer made the measurements quick and easy.

We will be discussing the science in more detail at future AGU meetings, but we wanted you and your colleagues to know right away how exciting it was for us to be able to generate so much important data in an all too brief visit. It wouldn't have been possible without the superb facilities and the cheerful cooperation of everyone at the ***IRM***.

Thermo-chemical Magnetic Overprinting in a Simple "Real Rock" System

Dave Douglass
Pasadena City College

The effects of thermo-viscous and chemical remagnetization on the NRM of sedimentary rocks are complex and not fully understood. The focus of this study is to examine a simple "real rock" system consisting of nearly vertical basalt dikes intruding nearly horizontal shallow marine sediments (Jurassic Carmel formation, central Utah) of varying lithologies. The remagnetization effects of a dike on a single stratum, at varying distances from the dike, are being investigated. The paleomagnetic results will then be coupled with concurrent work being done on the clay mineralogy and geochemistry of these same strata (by M. Hluchy, Alfred University). The results should lead to the development of a well-constrained model for 1) the thermal structure around the dikes, 2) the mineralogical and geochemical changes around the dikes, and 3) the remagnetization effects of the dike. The goal of the paleomagnetic part of the study is directed towards a better understanding of thermo-viscous and geochemical remagnetization processes in sedimentary rocks.

Work at the ***IRM*** was done primarily with the AF and thermal demagnetizers and the superconducting rock magnetometer. Preliminary results show a clear magnetic overprinting of the sediments attributable to the dikes. There is also a systematic variation in the severity of overprinting, blocking temperature, and coercivities within a given stratum at varying distance from the dikes. However, these magnetic properties vary among different strata. There appears to be no significant primary magnetic component identifiable in the sediments, even at considerable distance from the dikes.

Rock Magnetic Studies on Carbonates and Redbeds from China

Gina Marie Frost
University of California–Santa Cruz

Rock magnetic studies at the ***IRM*** included a coercivity spectrum analysis on samples of Cretaceous redbeds from China, for which three components of magnetization had been isolated from prior work done elsewhere. It is hoped that analysis of these spectra will provide information linking observed magnetic phases (coarse- and fine-particle authigenic and/or diagenetic hematite and detrital iron-oxide grains) with particular magnetic components. The technique involved determining the incremental IRM in 1kOe ΔH-intervals from the J *vs.* H curve at room temperature on unheated samples and after

VF's...*cont. on page 8*

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 Newsletter*. Articles published in familiar geological journals will be included, but special emphasis is given to current articles from physics, chemistry, and materials science journals. In addition, 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 1200 references, is available free of charge. As always, your contributions both to the Abstracts section of the *IRM Newsletter* and to the reference list are welcome.

Data Manipulation

Bazhenov, M.L., and S. V. Shipunov
Fold test in paleomagnetism: New approaches and reappraisal of data, *Earth Planet. Sci. Lett., 104*, 16-24, 1991.

An assessment of the fold test and two modified fold tests is made. All three tests are compared with the aid of simulated and real collections, and it is shown that the latter two are more sensitive than the first one.

Calderone, G. J., and R. F. Butler
The effects of noise due to random undetected tilts and paleosecular variation on regional paleomagnetic directions, *J. Geophys. Res., 96B*, 3973-3977, 1991.

A Monte Carlo simulation of Fisher distributions and perturbed distributions is used to estimate (1) the probabilities of drawing shallow versus steep directions from single samples from both distributions and (2) the amount and sense of bias of the estimate in the mean direction from a perturbed distribution.

Constable, C., and R. Parker
Deconvolution of long-core palaeomagnetic measurements—spline therapy for the linear problem, *Geophys. J. Int., 104*, 453-468, 1991.

A magnetization model for long sediment cores satisfying the measured pass-through magnetometer data to within the observational error is proposed. The approach is tested on a marine core that was subsequently measured in centimeter-sized individual specimens, with highly satisfactory results.

Fisher, N. I., and P. Hall
A general statistical test for the effect of folding, *Geophys. J. Int., 105*, 419-427, 1991.

A general statistical test is described which determine whether or not the means of magnetization vectors measured on each of two or more fold limbs are more tightly grouped after applying the fold correction than before. This bootstrap computer technique appears to provide the only feasible approach in such a general setting.

Lienert, B. R.
Monte-Carlo simulation of errors in the anisotropy of magnetic susceptibility, a second-rank symmetric tensor, *J. Geophys. Res., in press*, 1991.

Monte-Carlo perturbations of synthetic tensors were used to evaluate the Hext/Jelínek elliptical confidence regions for AMS eigenvectors, with satisfactory results.

Schott, J. J., J. C. Turlot, and J. Thomann
The fit of polar wander curves by small circles using Marquardt's algorithm: Statistical properties, *Geophys. J. Int., 105*, 731-745, 1991.

The construction of smooth apparent polar wander paths, including the determination of ellipses of confidence around the calculated poles of the model is re-examined. Applications to the North America apparent polar wander path using previously published data sets are give as illustrations.

Tauxe, L., N. Kylstra, and C. Constable
Bootstrap statistics for paleomagnetic data, *J. Geophys. Res., 96B*, 11723-11740, 1991.

A bootstrap approach for the calculation of uncertainties for means or principle directions of paleomagnetic data based on data resampling techniques is described.

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Domains

Halgedahl, S. L.
Magnetic domain patterns observed on synthetic Ti-rich titanomagnetite as a function of temperature and in states of thermoremanent magnetization, *J. Geophys. Res., 96B*, 3943-3972, 1991.

Kittel-like and maze-like Bitter patterns on titanomagnetite are studied to investigate the relationship between the temperature dependence of magnetic domain structure and the nature of TRM.

Remember...

Current Abstracts

Moon, T. S.
Domain states in fine particle magnetite and titanomagnetite, *J. Geophys. Res., 96B*, 9909-9923, 1991.

Theoretical calculations based on a simple model of domain structure are made to determine the particle size, mineralogical, stress, and temperature dependence of the local energy minimum domain states available to fine particles of magnetite and titanomagnetite.

Ye, J., and R. T. Merrill
Differences between magnetic domain imaging observations and theory, *Geophys. Res. Lett., 18*, 593-596, 1991.

A quasi-two-dimensional model is developed to calculate domain structures in magnetite grains containing two to twenty domains. The 'domains' are not uniformly magnetized, but become more so with increasing number of domains, consistent with domain imaging results.

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Geology

Borradaile, G. J.
Remanent magnetism and ductile deformation in an experimentally deformed magnetite-bearing limestone, *Phys. Earth Planet. Inter., 67*, 362-373, 1991.

Limestones containing PSD magnetite with a saturation IRM were deformed triaxially. Changes in magnetic properties were consistent with reduction of effective grain size and change of shape of the magnetite.

Heller, F., *et al.*
Magnetic susceptibility of loess in China, *Earth Planet. Sci. Lett., 103*, 301-310, 1991.

A comparison of magnetic properties of a given paleolsol layer from different regions of the Chinese Loess Plateau suggests that the magnetic properties may aid in a detailed reconstruction of the continental paleoclimatic conditions for the last 2.5 Ma.

Jackson, M. J., and G. Borradaile
On the origin of the magnetic fabric in purple Cambrian slates of north Wales, *Tectonophys., 194*, 49-58, 1991.

The anisotropy of magnetic susceptibility in slate from Penrhynn was found to be weaker than expected in view of their large finite strain and hematite-dominated mineralogy. Several lines of evidence suggest that this is a result of the presence of two or more generations of hematite.

Kodama, K.P., and A. G. Goldstein
Experimental simple shear deformation of magnetic remanence, *Earth Planet. Sci. Lett., 104*, 80-88, 1991.

Shear box experiments were run on magnetic rock analogues to determine how the remanence vector behaves during simple shear strain. Results indicate that rotation of remanence-carrying grains can often account for the deformation of the remanence vector.

Mckernan, S., *et al.*
High-resolution electron microscopy of olivine-magnetite interfaces, *Mat. Res. Symp. Proc., 159*, 407-412, 1989.

High-resolution lattice images have been obtained from magnetite precipitates in naturally oxidized iron-rich olivines. The magnetite/olivine interface is shown to be extremely sharp with steps and misfit dislocations present at the interface.

Shashkanov, V. A., A. I. Novoselov, and A. V. Smirnov
The nature and magnetic anisotropy and inclination errors of orientational magnetization in sedimentary rocks, *Izv. Akad. Nauk SSSR Ser. Fiz. Zemli (Phys. Solid Earth), 25*, 46-54 (in Engl. transl.), 1989.

Experimental data are reported on the magnetic anisotropy and inclination errors in synthetic magnetite-containing sedimentary rocks. Mechanisms for the formation of magnetic anisotropy in sediments, and a method for reconstructing the inclination of the magnetic field in the sedimentation area are discussed.

Zhorin, V. A., *et al.*
Magnetic properties and structure of iron oxides after plastic flow under pressure, *Izv. Akad. Nauk SSSR Ser. Neorg. Mater. (Inorg. Mater.), 26*, 843-848, 1990.

During plastic flow of the iron oxides γ-Fe_20_3 and Fe_30_4, most of the material undergoes a change of structure to the hexagonal form of α-Fe_20_3, and part of the material becomes X-ray amorphous but retains the magnetic structure characteristic of the original system.

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...send in your abstracts for the next issue...

Models

McFadden, P. L., *et al.*
Reversals of the Earth's magnetic field and temporal variations of the dynamo families, *J. Geophys. Res., 96B*, 3923-3933, 1991.

A model for polarity reversals is tested to show that the contribution to the field of the secondary (quadrupole) dynamo family is smaller when the reversal rate is low, and that contributions from the secondary family are inversely related to contributions from the primary (dipole) family.

Parker, R. L.
A theory of ideal bodies for seamount magnetism, *J. Geophys. Res., in press*, 1991.

A unidirectional model for the magnetization of seamounts is developed and tested against artificial magnetic anomalies and three seamount surveys, with satisfactory results.

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Paleomagnetism

Besse, J., and V. Courtillot
Revised and synthetic apparent polar wander paths of the African, Eurasian, North American, and Indian plates, and true polar wander since 200 Ma, *J. Geophys. Res., 96B*, 4029-4050, 1991.

Available paleomagnetic data is reanalyzed using more stringent selection criteria such as evidence for lack of remagnetization, accurate dating, and proper structural analysis. Relative motion models are used to transfer all data in a common reference frame.

Duncan, R. A., and M. A. Richards
Hotspots, mantle plumes, flood basalts, and true polar wander, *Rev. Geophys., 29*, 31-50, 1991.

A review of the mantle convection processes responsible for the hotspots and flood basalt phenomena are described, plus a discussion of true polar wander of plates relative to the fixed hotspot network is presented.

Papamarinopoulos, S., *et al.*
Palaeomagnetic and mineral magnetic studies of sediments from Ball's Cavern, Schoharie, USA, *Earth Planet. Sci. Lett., 102*, 198-212, 1991.

Paleomagnetic measurements on two sediment sequences from a cave near Schoharie, NY, are found to be similar to other North American records. A correlation is made with lake sediment records back to 13,000 yr BP and with a sediment record from between about 23,000 and 30,000 yr BP.

Tric, E., *et al.*
Paleointensity of the geomagnetic field during the last eight thousand years, *J. Geophys. Res., in press*, 1991.

High resolution records of the relative paleointensity of the geomagnetic field have been obtained which show large scale changes in the dipole field moment. The results demonstrate the potential of sediments for such studies and constitute a first step towards obtaining a global paleointensity record over a long period of time.

van Hoof, A. A. M., and C. G. Langereis
Reversal records in marine marls and delayed acquisition of remanent magnetization, *Nature, 351*, 223-225, 1991.

Reversed-to-normal transitional records from marine marls in which the magnetite-borne higher-temperature component of remanence shows a delayed remanence acquisition relative to a lower-temperature component. The high-temperature component does not reflect geomagnetic changes during the reversal in these samples.

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Physics

Arajs, S., N. Amin, and E. E. Anderson
Magnetic coercivity of Fe_30_4 particle systems, *J. Appl. Phys., 69*, 5122-5123, 1991.

The magnetic coercivity and squareness of various Fe_30_4 particle systems which exhibit considerable deviations from spherical symmetry are investigated as a function of particle size and packing density.

Avilova, T. E., V. I. Bagin, and T. S. Gendler
Magnetic properties of massive and fine-particle hematite, *Izv. Akad. Nauk SSSR Ser. Fiz. Zemli (Phys. Solid Earth), 25*, 146-154 (in Engl. transl.), 1989.

Magnetic properties of massive and fine-particle hematite specimens are investigated. Diagnostic features are established for isotropic and anisotropic hematites.

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Current Abstracts

Bandow, S., and K. Kimura
Disappearance of long range spin-order in ultrafine magnetite particles, *Z. Phys. D, 19*, 271-273, 1991.

Measurements of ultrafine magnetite particles show that a bulk-like ferromagnetic state cannot be formed in particles less than 3.4 nm in diameter.

Bottoni, G.
Influence of the magnetic interactions on the reversal mode of magnetic recording particles, *J. Appl. Phys., 69*, 4499-4501, 1991.

An experimental correlation is found between the presence and strength of magnetic interactions in an assembly of magnetic particles and the mode of magnetization reversal of the particles.

Yamada Conference XXV on Magnetic Phase Transitions—Osaka, Japan, 13-16 April 1990, *J. Magn. Magn. Mater., 90-91*, 67-68, 1990.

Papers concerning the oscillations caused by magnetoelastic interactions [Ozhogin and Preobrazhenskii], the acquisition of magnetization in single crystals [Kato, *et al.*], and other topics are presented.

Luo, H.-L., K. Sun, and X.-F. Nie
The anisotropy measurement of the ultrafine gamma-Fe_2O_3 powder, *Chin. Sci. Bull., 35*, 2040-2043, 1990.

A method is presented by which the anisotropy constant may be calculated by using the equations for describing the relaxation process of superparamagnetic particles.

Parker, F. T., *et al.*
Spin canting in gamma-Fe_2O_3 particles, *J. Appl. Phys., 69*, 4505, 1991.

Mössbauer spectroscopy of small acicular γ-Fe_20_3 particles shows that the spin canting is a bulk phenomenon and is not confined to a thin surface layer. Potential implications of these results for magnetization reversal in these particles is discussed.

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Remanences

El-Hilo, M., K. O'Grady, and J. Popplewell
The peak in the TRM in a fine particle system, *J. Appl. Phys., 69*, 5133-5135, 1991.

TRM for a system of magnetite particles was found to peak only after 15 s, and that the time variation of the TRM was found to fit the stretched exponential test over the whole range of time examined.

Gapeev, A. K., *et al.*
A direct comparison of the properties of CRM and VRM in the low-temperature oxidation of magnetites, *Geophys. J. Int., 105*, 407-418, 1991.

An examination of CRM acquired when nearly SD size magnetite undergoes low-temperature oxidation to maghemite and of VRM acquired by the daughter phase maghemite is made in which a chemico-viscous remanence (CVRM) is identified.

Hodych, J. P.
Low-temperature demagnetization of saturation remanence in rocks bearing multidomain magnetite, *Phys. Earth Planet. Inter., 66*, 144-152, 1991.

Loss of saturation remanence upon cooling is attributed at higher temperatures to a decrease in the magnetostriction constant which presumably unblocks domain walls pinned by internal stresses, and at lower temperatures to the Verwey transition.

Kelso, P. R., S. K. Banerjee, and H.-U. Worm
The effect of low-temperature hydrothermal alteration on the remanent magnetization of synthetic titanomagnetites: A case for acquisition of chemical remanent magnetization, *J. Geophys. Res., in press*, 1991.

In order to simulate oceanic crust conditions, synthetic titanomagnetite with a TRM was hydrothermally altered to titanomaghemite under various temperature, pressure, and *p*H conditions while in a magnetic field. The CRM produced was found to lie along the applied field direction, not the TRM direction. Implications for the marine magnetic anomalies are discussed.

Markovskii, V. S., and S. A. Taraschchan
The magnetization of zones deep within the Earth's crust, *Geofiz. Zh. (Geophys. J.), 9*, 905-913, 1991.

The feasibility of rock magnetization under the temperature conditions currently believed to exist in deep zones of the continental crust is experimentally substantiated.

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Pariso, J. E., and H. P. Johnson
Alteration processes at Ocean Drilling Program/Deep Sea Drilling Project hole 504B on Costa Rica rift: Implications for magnetization of oceanic crust, *J. Geophys. Res., in press*, 1991.

Magnetics properties and oxide petrography results are presented from the most recent penetration at Hole 504B during ODP Leg 111. Despite a magnetization which is lower than expected, it appears that the sheeted dike complex at Hole 504B is capable of making a substantial contribution to the overlying marine magnetic anomaly.

Pick, T., and L. Tauxe
Chemical remanent magnetization in synthetic Fe_3O_4, *J. Geophys. Res., 96B*, 9925-9936, 1991.

A study of CRM in synthetic magnetite shows that the average CRM direction parallels the applied field, and the CRM intensity increases with applied field; but the CRM/ARM ratio is not independent of the applied field, and the easy axis aligns with the CRM field. A revised model which incorporates these observations is proposed.

Walderhaug, H. J., T. H. Torsvik, and R. Løvlie
Experimental CRM production in a basaltic rock; evidence for stable, intermediate palaeomagnetic directions, *Geophys. J. Int., 105*, 747-756, 1991.

The direction of the CRM acquired when hematite is grown by oxidation from a magnetic parent mineral is controlled both by the remagnetizing field and the primary remanence (NRM), giving rise to stable high-blocking remanence components with intermediate directions, and precluding identification of the primary NRM component.

Meetings Update

Twentieth General Assembly of the IUGG

Vienna, 11-24 August, 1991
Ken Hoffman
California Polytechnic State Univ.

Rock magnetic (RM) research played a principal role in the two explicitly RM sessions and also spilled into virtually all sessions involving paleomagnetic research. For example, the session "Magnetic Characteristics of Well-Defined Samples" first saw a wide range of approaches and findings, from a video presentation of a 3-D micromagnetic simulation of hysteresis properties for PSD magnetite, to the experimental comparison of bitter patterns and alternating force magnetometer measurements during hysteresis in hematite, to high-temperature domain observations using the magnetooptic Kerr-effect. Both in this session and in the session entitled "Rock Magnetism of Sediments," RM properties and characterization studies were presented involving a number of natural and synthetic particles, from commonly researched materials such as iron, hematite, magnetite, and titanomagnetite, to more poorly-understood minerals such as goethite, pyrrhotite, and greigite, and to more complex remanence problems involving metastable systems such as lepidocrocite-maghemite-hematite. The sediment session also touched on a number of RM problems relevant to paleomagnetic investigation including inclination error, magnetization of loess, mineral control of magnetic fabric, and the identification of magnetic mineralogies in sedimentary environments. Other paleomagnetism sessions saw a variety of RM contributions including a blocking temperature spectra-based test to distinguish between TRM and CRM in igneous rocks, and further RM input into the problem of the separation of multicomponent magnetizations.

The next meeting of IAGA will be held in August 1993 in Cordova, Argentina. Currently proposed are a total of five sessions: a full-day session entitled "Phase Changes and Domain States in Magnetic Minerals" [W. Williams and V. Shcherbakov], a half-day session "Rock-magnetic Tests for Reliability of Paleomagnetic Data" [P. Schmidt and S. Cisowski], a full-day session "Paleomagnetism, Rock Magnetism and Climate Change" [J. King and B. Maher], a half-day session "Magnetic Properties of deformed rocks," [A. Hirt and F. Hrouda], and a full-day session "Diagenetic Processes and Their Importance in Paleomagnetism" [P. Turner and S. Lund].

Fifth Joint MMM/ Intermag Conference

Pittsburgh, 18-21 June, 1991
Mike Sharrock
3M Corporation

In general, the conference reaffirmed the continuing viability of magnetic technology for information storage, even if one restricts attention to systems using the conventional inductive head for reading. The use of the newer magnetoresistive head technology for reading opens up still greater potential.

The session devoted to particulate recording media showed, as in recent conferences, the continued vitality and diversity of this important area of technology. Hexagonal ferrites (substituted barium ferrites), especially, are attracting strong interest and accounted for six of the fifteen papers. Metallic particles, the other type of material attracting attention for potential advanced uses, were the subject of five papers.

For the person who has everything...

Handbook now available!

The "Handbook from the Environmental Magnetism Workshop," consisting of the combined lecture and laboratory notes (partially-edited) from the workshop, is available for a cost of $10.00 (to offset copying costs–the ***IRM*** is no profiteering institution!). To get a copy, send your order along with a check, payable to University of Minnesota Geology Department Service Fund #28, to the address given at the end of this newsletter.

Workshop...*cont. from page 1*

lecture on the basics of magnetism and the magnetic properties of geologically-interesting materials. In the lab, **Chris Hunt** demonstrated remanence and susceptibility measurements, ARM acquisition, AF demagnetization, hysteresis loops, and Curie temperature determinations. **Jim Marvin** showed the frequency dependence of susceptibility, IRM acquisition, sampling techniques, and magnetic study design.

At a crowded yet lively poster session, and of course between events and at the social evening on the last day, the participants themselves discussed their diverse projects. Most undertakings involved the derivation of paleoclimate from studies of lake and ocean sediments, loess stratigraphy or lake-level changes. But there was also research being done in archaeology and anthropology.

"Eraser fight!"

Other special guests on hand were *RAC* member Prof. **Mike Fuller** (University of California–Santa Barbara) and Dr. **Horst Worm** (Bundesanstalt für Geowissenschaften und Rohstoffe, Germany), both of whom also took the opportunity of doing some lab work while here.

VF's...*cont. from page 2*

each heat treatment. The coercivity spectra will be analyzed in terms of their soft, intermediate, and hard fractions, which relatively indicate the contributions to the IRM of magnetite-maghemite, specularite, and pigmentary hematite, respectively. Thermo-chemically produced magnetic minerals will also be revealed.

Hysteresis studies were conducted on several samples of Paleozoic carbonate rocks and one Cretaceous red sandstone, all from China. Fourier analysis on the hysteresis data may supplement the bulk properties obtained from J_{rs}/J_s and H_{cr}/H_c by providing information on mixed grain-sizes and/or more than one magnetic mineral.

Additional rock magnetic studies included Lowrie-Fuller and Cisowski tests on several carbonate rock samples.

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 to become a Visiting Fellow. Proposals are accepted semi-annually in spring and fall for work to be done during the following half year. Shorter, less formal visits are arranged on an individual basis through the laboratory manager.

The ***IRM*** is funded by the **W. M. Keck Foundation**, the **National Science Foundation**, and the **University of Minnesota**.

The *IRM Newsletter* is published three times a year by the staff of the ***IRM***. If you or someone you know would like to be on [or off] 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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