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Johann von Lamont (1805-1879): A pioneer in geomagnetism

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In 2005 we can commemorate the 200th birthday of Johann von Lamont (Fig. 1), a pioneer in geomagnetism in the middle of the 19th century. He belonged to the group around Gauss, von Humboldt, Sabine, Angström and others (forming the Göttingen Magnetic Union) who established within a few years an international network of geomagnetic observatories around the world (Barraclough et al., 1992) upon which much of our present day knowledge about the geomagnetic field rests.

Johann von Lamont was born as John Lamont on 15 December 1805 in Corriemulzie near Braemar in Central Scotland. His father, Robert Lamont, was a forester and administrator to James, the second Earl of Fife. When Robert Lamont died suddenly in 1816 from an accident with his horse the family had to search for a sponsor who could take care of the education of the bright 12 year old boy John. In 1817, Father Gallus Robertson, the dean of the Scottish Monastery St. James from Regensburg in Bavaria visited Scotland in search of talented students for his monastery school. John received a fellowship and was taken to Regensburg for an education in theology and sciences. However, the main interests of the boy were not in theology but in mathematics and natural sciences. This was soon recognized by Father Benedict Deasson, one of his teachers, and John was trained in these disciplines including also mechanical

engineering which helped him later in the construction and production of instruments for observatory and field work. Since 1827 he spent most of the time of his vacations as a student in the Royal Astronomical Observatory which had been built in 1816-1817 in Bogenhausen, at that time a small village close to Munich. In 1828 he was appointed as an assistant in the observatory and in 1830 he got a PhD at the University of Munich. Due to the bad health of the director of the observatory, Georg von Soldner, Lamont was soon in charge of doing all the astronomical routine work. When von Soldner died in 1833 Lamont was on his own and entirely responsible. He was finally appointed as director of

the Observatory in 1835 at the age of 29. More details about the Lamont family, the life and the scientific career of Johann von Lamont can also be taken from Wienert (1966) and Beblo & Soffel (1991).

The early 1830's were very important for geomagnetism due to the initiatives of Carl Friedrich Gauss and Alexander von Humboldt. During his expeditions, which led him to remote parts of our globe, von Humboldt had recognised that the origin of the spatial and temporal variations of the geomagnetic field could only be investigated by world-wide simultaneous and permanent observations in a global network of

Lamont

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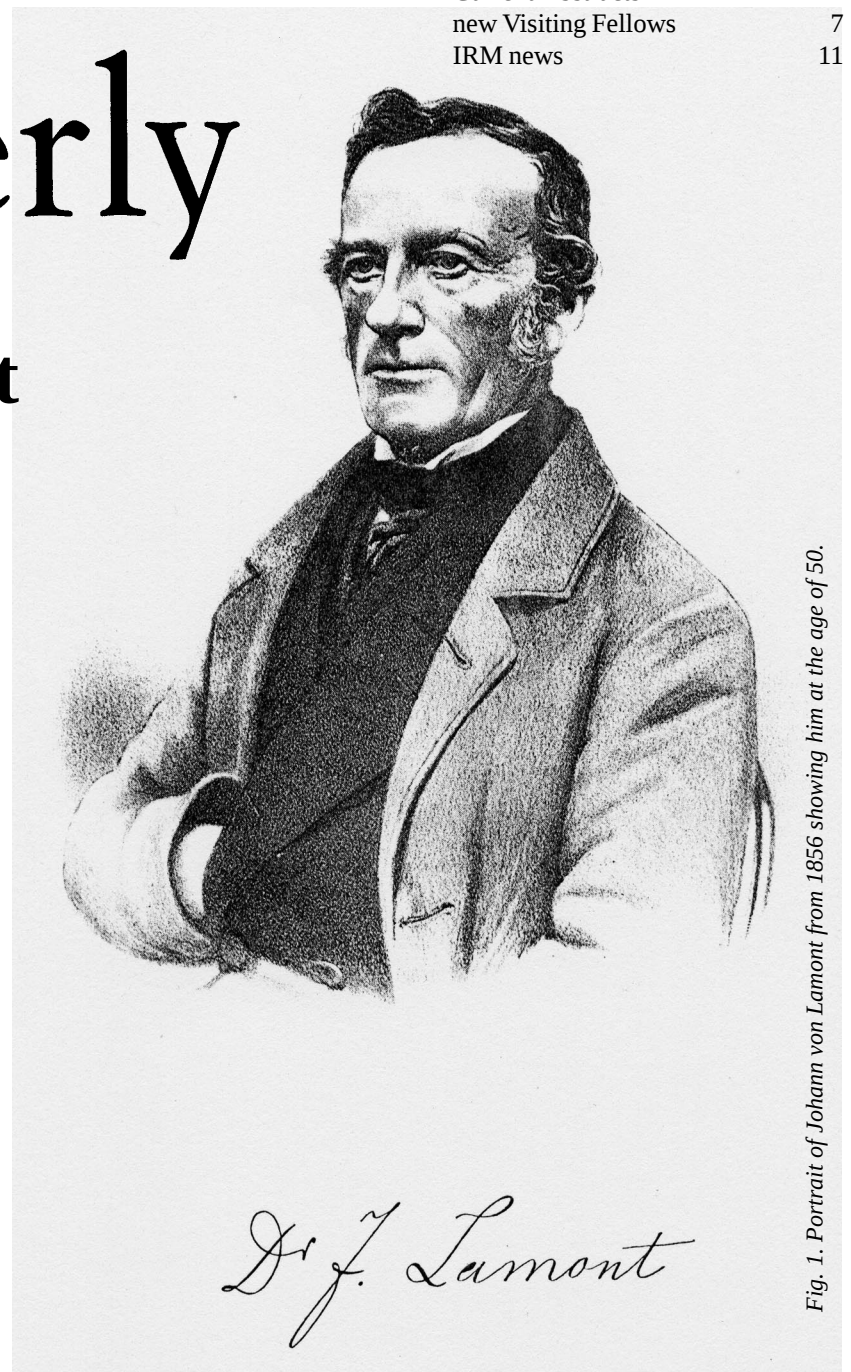


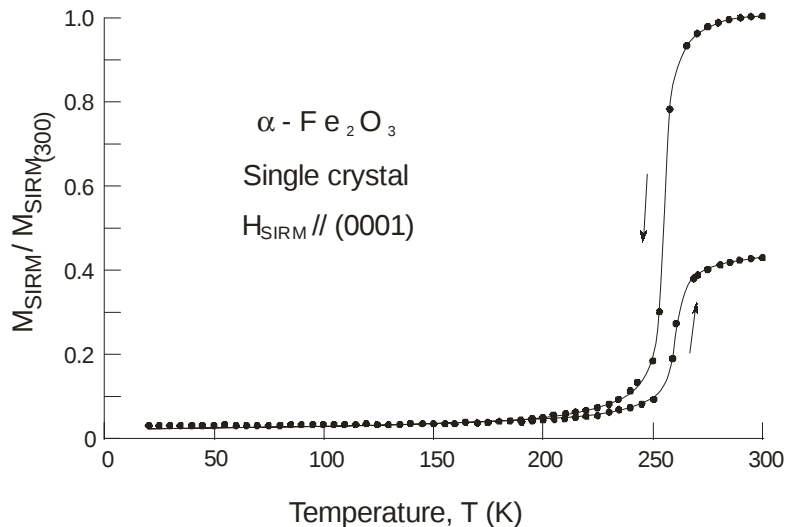
Fig. 1. Portrait of Johann von Lamont from 1856 showing him at the age of 50.

Magnetic Memory in MD Hematite

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In previous years at the IRM, I studied low-temperature demagnetization of TRM and SIRM of natural single crystals of hematite with grain sizes between 1-6 mm. The zero-field cooling and warming curves of SIRM for a 4 mm hematite crystal are shown in Figure 1. In cooling from 300 K, the remanence



Normalized zero-field cooling and warming curves of SIRM for a 4 mm single crystal of hematite. Field is applied along (0001).

decreased sharply in passing through the Morin transition (T_M). At T_M , 97% of the original SIRM is demagnetized with the disappearance of spin-canting and the onset of c-axis antiferromagnetism. Between T_M and 20 K, there was no further demagnetization. The residual 3% of the original remanence remained constant. In warming back through the Morin transition, 43% of the original remanence was recovered. This value is much higher than the SIRM memory ratios of 30-32% measured for SD hematites with grain sizes between 0.12-0.23 μm .

At T_M , as spins rotate from the (0001) plane to the c-axis, the magnetocrystalline anisotropy constant passes through zero and changes sign. In MD hematite, domain walls blocked by magnetocrystalline controlled pinning become free to jump and lead to demagnetization of a large fraction of the original SIRM. The remaining 43% of the room-temperature SIRM was not destroyed by cycling through T_M .

This year at the IRM, I investigated the effect of annealing on the TRM memory. Annealing could

reduce or partially remove the internal strains and stresses produced by crystal defects. A large single crystal of hematite (6 mm) was heated in zero field in air at 600°C for 3 and 5 hours. I used a Schoensted thermal demagnetizer to anneal the crystal in zero field. The sequence of the annealing experiments was: (1) thermally demagnetize the crystal at 705°C, anneal for 3 hours; (2) produce 0.1 mT TRM and measure M_{TR} ; (3) LTD by cooling the crystal to 77 K in liquid N_2 and measure the TRM memory; (4) repeat (1) to (4) for 5-hour annealing experiments.

The intensity of TRM decreased 7% after 3-hours annealing. However, the intensity of the TRM memory was reduced much more. After 3-hours annealing, the crystal had a 30% lower TRM memory. Five hours annealing had further effect on the memory: about 2/3 of the initial memory was retained. It appears that annealing reduced the number of strain centers but did not completely remove all of them. The memory must be due to strongly pinned domain walls, probably pinned magnetostatically by dislocations or other crystal defects.

I would like to thank Mike, Peat, Ramon and Thelma for their help and hospitality.

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Origin of complex magnetic fabrics

The aim of our visit was to determine what factors control complex fabrics in igneous rocks, and to assess whether magma flow directions could be recovered from them.

Introduction

Until recently, studies of the anisotropy of magnetic susceptibility (AMS) of dikes and lavas have largely assumed a simple relation between the principal AMS directions and magma flow. In the so-called "normal" magnetic fabric case, the magnetic foliation mimics the flow plane (i.e., the AMS minimum — K_{min} , which is the normal to the foliation plane, lies perpendicular to a dike's walls or to a lava's bottom) and the magnetic lineation (given by the AMS maximum — K_{max}) parallels the magma flow direction.

However, complex fabrics (those that differ significantly from the normal case) appear to be more prevalent than is generally accepted. Indeed, entire sites can yield a single well-defined complex fabric. As a result, independent flow indicators (e.g., vesicle orientation or petrofabric studies) are needed to confidently infer magma flow directions.

Interestingly, some of the most commonly observed complex fabrics are ones that mimic the normal case, in that the AMS axes are aligned with the flow coordinates but are flipped with respect to each other (Figure 1). One of the most compelling explanations for these "permuted" fabrics involves mixtures of single domain and multidomain grain sizes (Rochette et al., 1992; Ferré, 2002).

Assuming grain size mixtures are responsible for these permuted fabrics, one might be able to recover the true flow direction by isolating the influence of the different grain size fractions on the magnetic fabric. It might be particularly appropriate for samples containing some

fraction of super paramagnetic (SP) grains. Cooling the sample below the SP-blocking temperature would lead to an increase in the fraction of single domain grains that would, in turn, change the sample's AMS fabric (driving it towards an inverse fabric) and allow one to infer the flow direction.

To test this idea, we applied an existing high-field method (Ferré et al., 2000; Thill et al. 2000; Kelso et al. 2002), for the first time, at low temperatures. In addition we performed magnetic mineral identification, based on low-temperature crystallographic transitions using an MPMS, and determination of magnetic grain size, with the use of hysteresis curves, FORC distribution analyses, and low-temperature AC-susceptibility measurements, to assess the actual factors responsible for the permuted fabrics.

Two sets of samples yielding permuted fabrics were studied: mid-Miocene dikes from the Roberts Mountains, NV (eastern Northern

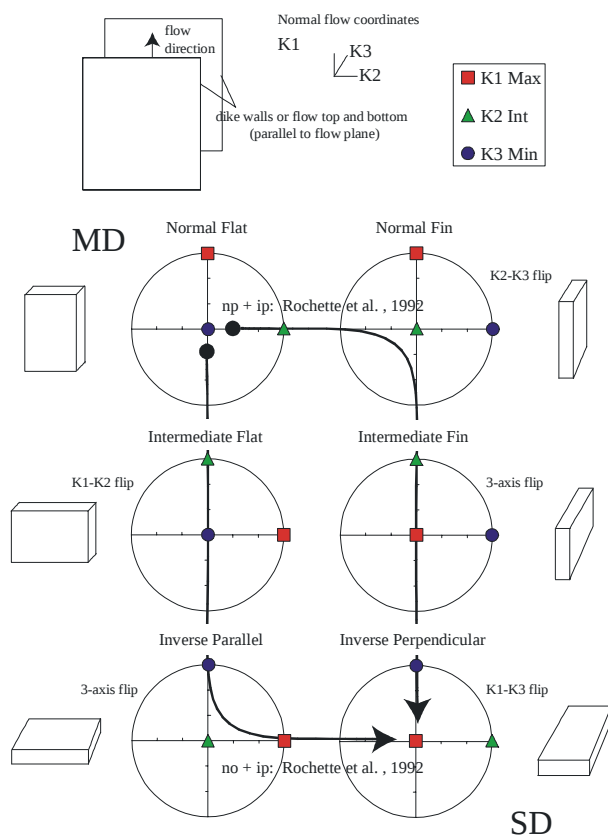


Figure 1: The normal, and five permuted AMS fabrics as defined in the flow plane. The gray arrows (after Rochette et al., 1992) illustrate that these six fabrics can be obtained by mixtures of multidomain prolate (np) or oblate (no) with single domain prolate (ip) grains.

Nevada Rift), and andesite flows from the Eastern Cascade Range, OR (Black Butte locality) for which the flow directions are known. We also estimated the influence of paramagnetic grains and single domain titanomagnetites on the AMS signal using 1) High Field Anisotropy of Magnetic Susceptibility (HFAMS), and 2) Anisotropy of Anhysteretic Remanent Magnetization (AARM) plus High Field Anisotropy of Saturation Remanence (HFASR) measurements, respectively.

Experiments:

We performed MPMS measurements on samples displaying different AMS fabrics in order to identify magnetic minerals based on low-temperature crystallographic transitions.

We applied First Order Reversal Curves (FORC) measurements (at room temperature and $\sim 300^\circ\text{C}$) to characterize magnetic grain sizes associated with each fabric type.

We made Anisotropy of Anhysteretic Remanent Magnetization (AARM) measurements to check the influence of Single Domain (SD) titanomagnetites on the AMS signal.

We performed High Field Anisotropy of Magnetic Susceptibility (HFAMS) and saturation remanence (HFASR) measurements to resolve paramagnetic and ferromagnetic fabrics.

We performed Low-Temperature High Field Anisotropy of Magnetic Susceptibility (LTHFAMS) and saturation remanence (LTHFASR) in order to force fabric changes.

Preliminary results:

Our preliminary results indicate that, while the magnetic carriers span a range of titanomagnetite compositions, the magnetic mineralogy does not seem to correlate with the AMS fabric. FORC distributions, AARM, and HFASR results argue against mechanisms involving grain size mixtures being at the origin of the complex fabrics in our samples. Other mechanisms such as magnetic grain interactions, competing magnetic fabrics, rolling of elongated particles in strong velocity gradients, or magneto-crystalline anisotropic effects may be more likely causes for the permuted fabrics observed at our localities.

Additionally, we obtained an interesting result from the LTHFASR data that we believe warrants further investigation. The low-temperature, high-field measurements led to the flipping of the ASR axes upon cooling that, during warming reverts back to the original fabric (Figure 2). The cooling/warming process, therefore, is non-destructive to the natural fabric, unlike other magnetizing and demagnetizing methods (such as IRM experiments that impress a fabric on the sample that simply mimics the field

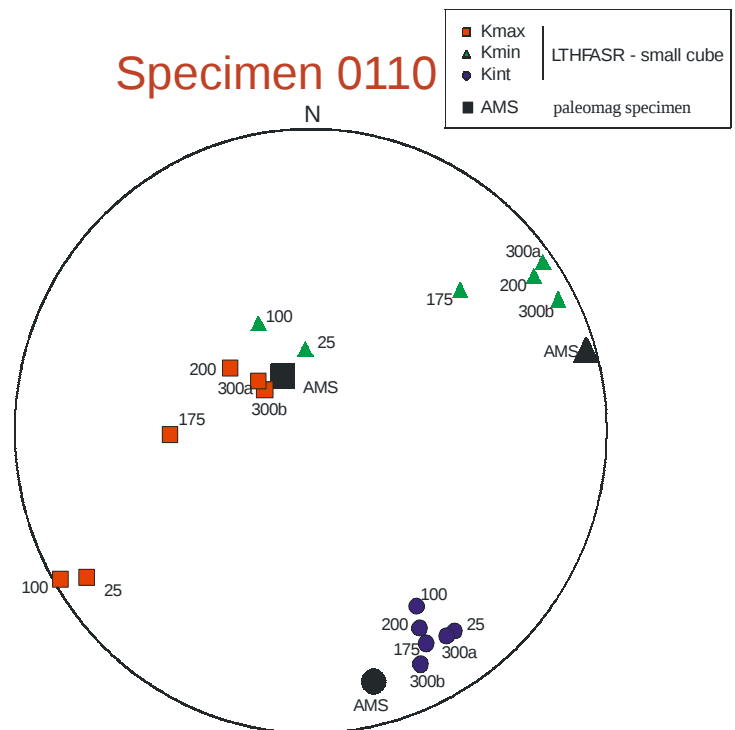


Figure 2: Comparison of the LTHFASR measurements (in color) at different temperatures (in $^\circ\text{K}$) with the low-field room-temperature AMS (black) fabric for the specimen 0110 from the Black Butte locality (Oregon). The plot is an equal area projection of the lower hemisphere in geographic coordinates. 300b is a repetition of 300a after cycling through the lower temperatures.

direction). The switch of axes progresses steadily over a range of 200 to 25°K , indicating that the phenomena is not likely the result of passing through isotropic or Verwey transitions. Instead, it might arise from competing anisotropies (shape, magnetocrystalline, stress), a change in anisotropy constants, or perhaps a different fabric held by large- and fine-grained fractions.

We are planning future measurements to: 1) resolve the origin of this LTHFASR phenomena, 2) further assess the underlying cause for the fabrics observed in our samples, and 3) determine if the LTHFAMS technique will prove useful in recovering flow directions in samples with SP grains.

References:

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- Kelso, P. R., Tikoff, B., Jackson, M., and Sun, W.W., 2002. Geophys. J. Int., 151, 2, 345-359.
- Rochette, P., Jackson, M. and Aubourg, C., 1992. Rev. of Geophys., 30-3, 209-226.
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We thank the IRM crew for insights, discussions, and help in implementing the LTHF measurements.



Travel theodolite, Johann von Lamont 1854

Alteration & Remagnetization

Moreau, M. G., Ader, M. and Enkin, R. J., 2005, **The magnetization of clay-rich rocks in sedimentary basins: low-temperature experimental formation of magnetic carriers in natural samples:** *Earth & Planetary Science Letters*, v.230, no.1-2, p.193-210.

When we heated argillites to 150°C in argon with an applied magnetic field, a CRM was acquired, and most of the newly formed magnetic carriers were PSD magnetite. Ferrimagnetic iron sulphide and hematite formed in samples with less than 3% calcite, and new magnetite is sometimes completely absent in samples containing less than 0.5% calcite. SEM studies indicate that the new magnetic carriers are associated with pre-existing pyrite. Thus magnetite can be produced in argillaceous sediments at the normal temperatures and pressures found in sedimentary basins, without any external supply from long-range fluid flow.

Zwing, A., Matzka, J., Bachtadse, V. and Soffel, H. C., 2005, **Rock magnetic properties of remagnetized Palaeozoic clastic and carbonate rocks from the NE Rhenish massif, Germany:** *Geophysical Journal International*, v.160, no.2, p.477-486.

Magnetite, the predominant magnetic phase, carries a Late Palaeozoic CRM and can be accompanied by haematite and pyrrhotite as the carrier of remagnetization. High haematite contents are characteristic for samples carrying a remagnetization of Triassic age. Samples from biohermal carbonate rocks have high M_{RS} / M_S and H_{CR} / H_C ratios similar to those from remagnetized carbonate rocks from North America, and magnetic viscosity and χ_{td} give strong evidence for SP magnetite. MD material obscures the contributions of other material completely in most siliciclastic rocks and partly in platform carbonate rocks.

from the magnetosomes' unique arrangement in chains.

Data Processing and Analysis

Muxworthy, A. R., King, J. G. and Heslop, D., 2005, **Assessing the ability of first-order reversal curve (FORC) diagrams to unravel complex magnetic signals:** *Journal of Geophysical Research-Solid Earth*, v.110, no.B1.

FORC distributions for mixtures containing only hard magnetic minerals like hematite or goethite can be adequately described by a linear addition of the two end- members, because there are virtually no magnetostatic interactions between the phases. Mixtures dominated by softer minerals like magnetite and maghemite are more susceptible to interactions and exhibit nonlinear behavior. When a hard phase with low M_s like hematite is mixed with a softer phase with high M_s like magnetite, it can still be identified using the FORC technique, whereas it is impossible to do so using standard magnetic hysteresis measurements.

Yu, Y. J. and Tauxe, L., 2005, **On the use of magnetic transient hysteresis in paleomagnetism for granulometry:** *Geochemistry Geophysics Geosystems*, v.6.

In new micromagnetic simulations we found that magnetic TH results from the difference of magnetization configuration between ascending and descending branches as a result of self-demagnetization. According to our simulations, TH increases as the grain size increases and as the aspect ratio decreases. TH from the simulation for samples with aspect ratio $q = 1.5$ agrees well with the experimental observations for annealed magnetites of smaller sizes. In general, small TH is a clear indication for the absence of complex magnetized structures.

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 7500 references, is available free of charge. Your contributions both to the list and to the Abstracts section of the IRM Quarterly are always welcome.

Biogeomagnetism

Vali, H., et al., 2004, **Formation of tabular single-domain magnetite induced by *Geobacter metallireducens* GS-15:** *Proceedings of the National Academy of Sciences of the United States of America*, v.101, no.46, p.16121-16126.

The size and shape of extracellular magnetite depend on the culture conditions and type of bacteria. Under typical CO_2 -rich culture conditions, GS-15 is known to produce superparamagnetic magnetite (crystal diameters of approximately <30 nm). We were able to produce a unique form of tabular, single-domain magnetite under nontraditional (low- CO_2) culture conditions. This magnetite has a distinct crystal habit and magnetic properties. This magnetite could be used as a biosignature to recognize ancient biological activities in terrestrial and extraterrestrial environments and also may be a major carrier of the magnetization in natural sediments.

Weiss, B. P., et al., 2004, **Ferromagnetic resonance and low-temperature magnetic tests for biogenic magnetite:** *Earth and Planetary Science Letters*, v.224, p.1-2. We confirm that the Moskowitz test is a distinctive indicator for magnetotactic bacteria and provide the first direct experimental evidence that this is accomplished via sensitivity to the magnetosome chain structure. We also demonstrate that the FMR spectra of four different strains of magnetotactic bacteria and a magnetofossil-bearing carbonate have a form distinct from all other samples measured in this study. We suggest that this signature also results

Environmental Magnetism and Paleoclimate Proxies

Bidegain, J. C., Evans, M. E. and van Velzen, A. J., 2005, **A magnetoclimatological investigation of Pampean loess, Argentina:** *Geophysical Journal International*, v.160, no.1, p.55-62. The magnetic susceptibility profile shows a clear sequence of maxima and minima that correspond to lithological variations, but interpretation of these correlations is not straightforward. Measured values of χ_{td} fall between those observed in Siberia and China. Thermomagnetic analysis of an embedded ash layer shows the ash to be magnetically indistinguishable from the El Cristo deposits. However, its measured χ_{td} cannot explain the intermediate values found there. The overall outcome is that neither of the existing magnetoclimatological models can adequately account for the complexities of the Pampean loess.

Geiss, C. E., Zanner, C. W., Banerjee, S. K. and Joanna, M., 2004, **Signature of magnetic enhancement in a loessic soil in Nebraska, United States of America:** *Earth & Planetary Science Letters*, v.228, no.3-4, p.355-367. The A horizons of the modern soil have higher values of concentration-dependent parameters, such as χ , IRM and ARM, combined with increases in χ_{td} and ARM/IRM ratios. The magnetic properties of the soil profile are dominated by ferrimagnetic magnetite or maghemite. Analyses of "soft" HIRM (sIRM) and "hard" IRM (hIRM), however, do show that approximately 80-90% of the remanence carrying magnetic component exists in the form

of hematite or goethite and that the magnetically enhanced horizons are enriched in both ferri- and antiferromagnetic minerals.

Liu, Q. S., *et al.*, 2004, **Mechanism of the magnetic susceptibility enhancements of the Chinese loess**: *Journal of Geophysical Research-Solid Earth*, v.109, no.B12. Magnetic properties of magnetic separates and residues show that (1) with moderate degrees of pedogenesis ($\chi < 10 \times 10^{-7} \text{ m}^3 \text{ kg}^{-1}$), χ is enhanced more by increased concentration of SSD magnetic particles than by viscous SP particles. For more mature paleosols with $\chi > (10-12) \times 10^{-7} \text{ m}^3 \text{ kg}^{-1}$, contributions of pedogenically related PSD particles become significant; (2) pedogenic particles have a narrow grain size distribution concentrated above the SP/SSD threshold; and (3) ARM is carried dominantly by SD grains. Moreover, we propose that only the nonextractable fraction of χ , M_s and M_{rs} show a strong relationship with the degree of pedogenesis.

Peck, J. A., *et al.*, 2004, **A magnetic mineral record of Late Quaternary tropical climate variability from Lake Bosumtwi, Ghana**: *Palaeogeography Palaeoclimatology Palaeoecology*, v.215, no.1-2, p.37-57. Five distinctive magnetic mineral zones (A-E) were identified in the 11-m-long sediment cores that span the last 26,000 calendar years. This work demonstrates that the magnetic properties of Lake Bosumtwi sediment are a sensitive recorder of abrupt climate change of global significance.

Extraterrestrial Magnetism

Chevrier, V., Rochette, P., Mathé, P. E. and Grauby, O., 2004, **Weathering of iron-rich phases in simulated Martian atmospheres**: *Geology*, v.32, no.12, p.1033-1036. Metallic iron α -Fe, magnetite, and pyrrhotite were aged in $\text{CO}_2 + \text{H}_2\text{O}$ or $\text{CO}_2 + \text{H}_2\text{O}_2$ atmospheres at room temperature for 1 yr. Only the magnetite remained stable during experiments. Goethite is the main crystalline iron-bearing end product, associated with ferrihydrite. If hematite is the dominant iron oxide that colors the Red Planet, our results imply strong changes in water activities of the primary CO_2 and H_2O rich atmosphere, or long-term evolution, for goethite to further convert into hematite. Our experiments suggest that iron weathering may have been active until recent times and would not have required bodies of liquid water.

Gattacceca, J. and Rochette, P., 2004, **Toward a robust normalized magnetic paleointensity method applied to meteorites**: *Earth & Planetary Science Letters*, v.227, no.3-4, p.377-393.

A new paleointensity method based on normalization by the derivative dIRM/dAF (REM' method) provides an estimate of the absolute paleointensity with an uncertainty of about a factor two. For L ordinary chondrites, an upper limit of 1 μT is proposed for the paleofield. Tentative paleofield estimates in the 0.05-0.5 μT range are proposed for LL ordinary chondrites, which is much lower than previous results. Results from Martian meteorites are scattered between 1 and 24 μT and may represent the crustal magnetic field of the planet after dynamo shutdown.

Kletetschka, G., *et al.*, 2005, **Grain size dependent potential for self generation of magnetic anomalies on Mars via thermoremanent magnetic acquisition and magnetic interaction of hematite and magnetite**: *Physics*

of the Earth & Planetary Interiors, v.148, no.2-4, p.149-156.

A secondary magnetic field generated by crustal remanent sources is capable of magnetizing deeper portions of crust that cools through its blocking temperatures in an absence of dynamo. Magnetite grains less than 0.01 μm in size, and hematite grains larger than 0.01 μm in size are capable of magnetizing magnetic minerals contained in surrounding volume, triggering a self-magnetizing process that can continue in the absence of magnetic dynamo and continue strengthening and/or weakening magnetic anomalies on Mars.

Instruments & Techniques

Le Goff, M. and Gallet, Y., 2004, **A new three-axis vibrating sample magnetometer for continuous high-temperature magnetization measurements: applications to paleo- and archeo-intensity determinations**: *Earth & Planetary Science Letters*, v.229, no.1-2, p.31-43.

Our new 3-axis VSM allows continuous high-T measurements of individual cylindrical $\sim 0.75 \text{ cm}^3$ samples up to $\sim 650^\circ\text{C}$ and the acquisition of TRM in any direction and field intensity up to 200 μT . We propose a fast (less than 2.5 h) automated experimental procedure which allows one to take into account both the cooling rate dependence of TRM acquisition and anisotropy of TRM. Several examples of analyses of ancient magnetization demonstrate the quality and reliability of the data.

Magnetic Field Records and Paleointensity Methods

Dunlop, D. J., Zhang, B. X. and Özdemir, Ö., 2005, **Linear and nonlinear Thellier paleointensity behavior of natural minerals**: *Journal of Geophysical Research-Solid Earth*, v.110, no.B1.

Susceptibility, hysteresis, and coercivity data indicate that the plagioclase extracted from Matachewan diabase dikes contains mainly SD magnetite while the mafic minerals (clinopyroxene, biotite, and actinolite) contain mainly MD magnetite. In simulated Thellier experiments the plagioclase behaved ideally, whereas the mafic minerals had strongly curved Arai plots sagging below the ideal SD line. Neither LTD nor AF cleaning to 15 mT before each Thellier step gave reliable paleointensity values. No presently available pretreatment renders the paleointensity data of MD grains usable.

Gratton, M. N., Shaw, J. and Herrero-Bervera, E., 2005, **An absolute palaeointensity record from SOH1 lava core, Hawaii using the microwave technique**: *Physics of the Earth & Planetary Interiors*, v.148, no.2-4, p.193-214. Microwave palaeointensity results obtained from 392 samples covering the last 45 ka show trends similar to those in other Hawaiian absolute palaeointensity data. Direct comparison with previous Thellier data from the SOH1 core shows some discrepancies between the two methods, with the Thellier data yielding generally higher palaeointensity estimates than the microwave data. In view of these discrepancies between the two methods, the introduction of raw palaeointensity data into the public domain is suggested.

Leonhardt, R., Heunemann, C. and Krása, D., 2004, **Analyzing absolute paleointensity determinations: Acceptance criteria and the software ThellierTool4.0**: *Geochemistry*

Geophysics Geosystems, v.5.

ThellierTool4.0 (available at <http://earthref.org/tools/>) provides the possibility to analyze a wide range of different modifications of the absolute paleointensity experiment. Besides the Arai plot and orthogonal vector projections, additional plots regarding alteration and MD checks enable the user to visualize the quality of individual determinations. Uniform selection criteria can be applied, and a set of such criteria with emphasis on minimal bias due to alteration, MD remanence, and analysis/experimental inaccuracies is suggested.

Pan, Y., Hill, M. J., Zhu, R. and Shaw, J., 2004, **Further evidence for low intensity of the geomagnetic field during the early Cretaceous time: using the modified Shaw method and microwave technique**: *Geophysical Journal International*, v.157, no.2, p.553-64. Basalts from northeastern China (K/Ar age, 125-120 Ma) give an average virtual dipole moment of $(3.1 \pm 1.0) \times 10^{22} \text{ A m}^2$ using the modified Shaw method, and $(2.9 \pm 0.9) \times 10^{22} \text{ A m}^2$ using the microwave technique. These low estimates of geomagnetic field strength are in agreement with previous results of the same time interval obtained by the Thellier method with pTRM checks.

Roberts, A. P. and Winklhofer, M., 2004, **Why are geomagnetic excursions not always recorded in sediments? Constraints from post-depositional remanent magnetization lock-in modelling**: *Earth & Planetary Science Letters*, v.227, no.3-4, p.345-359.

We used a cubic lock-in function to model "best-case" scenarios for the paleomagnetic record when a high-frequency geomagnetic input signal is convolved with the sediment lock-in function for a wide range of sedimentation rates. Our results suggest that in order to consistently detect the presence of geomagnetic excursions, it is ideal to work with sediments that maintain minimum sedimentation rates above 10 cm/kyr. Failure to document excursions in many apparently high-resolution analyses probably results from slower DRM lock-in, or to unrecognized intervals of slow sedimentation in environments with higher average sedimentation rates.

Sagnotti, L., *et al.*, 2005, **Apparent magnetic polarity reversals due to remagnetization resulting from late diagenetic growth of greigite from siderite**: *Geophysical Journal International*, v.160, no.1, p.89-100.

A mixed-polarity zone, representing alternations between remagnetized and non-remagnetized strata, has been documented within the lower few metres of the CRP-1 core (Ross Sea, Antarctica). The normal polarity remagnetization is carried by interacting SD greigite particles, while the reversed-polarity magnetization of non-remagnetized strata is carried by magnetite with a broad range of grain sizes and negligible magnetostatic interactions. This study is part of a growing catalogue of remagnetizations involving greigite, which suggests that occurrences of greigite should be treated with caution in palaeomagnetic and environmental magnetic studies.

Thomas, D. N., Hill, M. J. and Garcia, A. S., 2004, **Comparison of the Coe-Thellier-Thellier and microwave palaeointensity techniques using high-titanium titanomagnetites: results from a Tertiary basaltic intrusion from the Sydney Basin, New South Wales**: *Earth & Planetary Science Letters*, v.229, no.1-2, p.15-29. Thermomagnetic and low-temperature susceptibility measurements suggest that the dominant magnetic mineral is Ti-enriched

titanomagnetite (~TM65-TM50). No alteration is observed in the dominant temperature range (~70-300°C) used for calculation of palaeointensities. Statistically indistinguishable mean palaeointensities of $27.1 \pm 4.0 \mu\text{T}$ (N=28) and $27.4 \pm 4.0 \mu\text{T}$ (N=28) were obtained from the CIT and microwave techniques, respectively, suggesting that the dipole field was approximately 59% of the present day value at ca. 49 Ma.

Thouveny, N., *et al.*, 2004, **Geomagnetic moment variation and paleomagnetic excursions since 400 Kyr BP: a stacked record from sedimentary sequences of the Portuguese margin: Earth and Planetary Science Letters**, v.219, p.3-4.

In these clayey-carbonates we find a series of directional anomalies occurring during relative paleointensity (RPI) lows. Three of these correspond to the Laschamp excursion (42 kyr BP), the Blake event (115-122 kyr BP) and the Icelandic basin excursion (190 kyr BP). A fourth directional and RPI anomaly recorded at 290 kyr BP defines the 'Portuguese margin excursion'. Four non-excursion RPI lows are recorded at the ages of the Jamaica/Pringle Falls, Mamaku, Calabrian Ridge 1, and Levantine excursions. The RPI record is characterized by a periodicity of 100 kyr, paleointensity lows often coinciding with the end of interglacial stages.

Wehland, F., Alt-Epping, U., Braun, S. and Appel, E., 2005, **Quality of pTRM acquisition in pyrrhotite-bearing contact-metamorphic limestones: possibility of a continuous record of Earth magnetic field variations: Physics of the Earth & Planetary Interiors**, v.148, no.2-4, p.157-173.

Based on magnetic susceptibility, the pyrrhotite/magnetite ratio and thermal modelling we define three metamorphic zonations: a contact zone of a mixed magnetic assemblage and low χ , a pyrrhotite-bearing transitional zone, where full TRMs are acquired by heating to $T > T_{C,po}$, the Curie temperature of pyrrhotite, and a marginal zone containing pyrrhotite and magnetite generated at $T < T_{C,po}$. The fact that TRMs can consist of independent pTRMs is successfully tested by modified Thellier experiments. It is shown that a metamorphic environment with low fluid circulation provides a scenario for the recording of independent pTRMs.

Magnetic Microscopy and Spectroscopy

Eisebitt, S., *et al.*, 2004, **Lensless imaging of magnetic nanostructures by X-ray spectro-holography: Nature**, v.432, no.7019, p.885-888. We demonstrate a versatile technique for imaging nanostructures, based on the use of resonantly tuned soft X-rays for scattering contrast and the direct Fourier inversion of a holographically formed interference pattern. As an example, we have used the resonant X-ray magnetic circular dichroism effect to image the magnetic domain structure in a Co/Pt multilayer film with a spatial resolution of 50 nm.

O'Hara, K. D. and Huggins, F. E., 2005, **A Mössbauer study of pseudotachylytes: redox conditions during seismogenic faulting: Contributions to Mineralogy & Petrology**, v.148, no.5, p.602-614.

This is the first detailed study of the redox state of pseudotachylytes. We examine frictional melts from five localities by analyzing host rocks and corresponding pseudotachylytes using Mössbauer spectroscopy. The main iron-bearing phases in the pseudotachylytes are phyllosilicates (biotite, muscovite and clays) and

iron oxides (magnetite and hematite) and minor pyrite. If the localities studied are representative of seismogenic faulting, the calculated oxygen fugacities indicate that, in the system C-O-H-S, H_2O and CO_2 should be the dominant fluid species.

Ono, S., Funakoshi, K., Ohishi, Y. and Takahashi, E., 2005, **In situ x-ray observation of the phase transformation of Fe_2O_3 : Journal of Physics-Condensed Matter**, v.17, no.2, p.269-276. In situ observations of the phase transition in Fe_2O_3 were carried out in a multianvil and in a diamond anvil cell high-pressure apparatus using synchrotron radiation. The phase boundary between the haematite and high-pressure phase in the temperature range of 800-2500 K was determined to be $P \text{ (GPa)} = 29.4(\pm 0.4) + 0.0046(\pm 0.0015) \times (T \text{ (K)} - 1000)$. This result should resolve a dispute regarding the transition pressure of haematite among previous studies on Fe_2O_3 .

Magnetization & Demagnetization Processes

Borradaile, G. J., Lucas, K. and Middleton, R. S., 2004, **Low-temperature demagnetization isolates stable magnetic vector components in magnetite-bearing diabase: Geophysical Journal International**, v.157, no.2, p.526-36. Multicomponent NRM simulations were simulated IRMs or ARMs in different, nonoverlapping coercivity ranges, along three orthogonal axes or along two nonorthogonal directions. The known directions of the experimentally applied vector components were always more successfully verified by AF demagnetization if LTD was first applied. For the same specimens, LTD reduced the same artificial remanences by 50 per cent for the coercivity range 0-15 mT, by 25 per cent for the range 15-30 mT, and negligibly for higher-coercivity fractions.

Li, Y. X., Kodama, K. P. and Smith, D. P., 2004, **New paleomagnetic, rock magnetic, and petrographic results from the Valle Group, Baja California, Mexico: Exploring the causes of anomalously shallow paleomagnetic inclinations: Journal of Geophysical Research-Solid Earth**, v.109, no.B11.

The inclination is 38.7° shallower than that predicted by the reference paleopole for North America. Laboratory experiments indicate that compaction could account for only 7.5° of the inclination shallowing. Although primary anomalously shallow inclinations could indicate significant southerly, then northerly, paleolatitudinal offset, a more likely scenario is a late Cenozoic low-temperature remagnetization, which is suggested by alteration along the edges of some detrital silicate grains and a bimodal magnetic grain size distribution.

Liu, Q. S. and Yu, Y. J., 2004, **Multi-cycle low-temperature demagnetization (LTD) of multidomain Fe_3O_4 (magnetite): Journal of Magnetism & Magnetic Materials**, v.283, no.2-3, p.150-156.

MC-LTD was performed for four temperature intervals, 300-120 K, 150-125 K, (cycling through the isotropic point T_k), 125-95 K (cycling through the Verwey transition $T_v \sim 120 \text{ K}$) and 95-60 K. Results show that the remanence loss during MC-LTD depends on the number of LTD cycles. Above T_v , demagnetization of remanence after MC-LTD is caused by the reorganization of magnetic domains. For the 95-125 K interval, the remanence loss results from the changes of easy axes from the cubic [001] to the monoclinic c-axis. These two processes approximately follow the Boltzmann-analog relation, but the latter involves more degree of freedom.

Walton, D., Boehnel, H. and Dunlop, D. J., 2004, **Response of magnetic nanoparticles to microwaves: Applied Physics Letters**, v.85, no.22, p.5367-5369.

Two important processes in ferromagnetic resonance are the first-order absorption of a photon and creation of a single magnon, and a second-order process in which the absorption of a photon results in the creation of two magnons of equal and opposite wave vector. We have found that under resonance conditions for the second-order process, samples containing ~0.1% magnetite absorb energy from the microwave field at the same rate as a solid magnetite sample. The resultant very high energy density in the magnetic nanoparticles, coupled with a significant thermal energy barrier with the matrix, leads to a large temperature difference between the grains and their surroundings that makes it possible to magnetize and demagnetize the sample with a relatively small increase in sample temperature.

Mineral & Rock Magnetism

Dutta, P., *et al.*, 2004, **Magnetic properties of nearly defect-free maghemite nanocrystals: Physical Review B**, v.70, no.17, p.4428. $M(H, T)$ and the electron magnetic resonance (EMR) parameters of maghemite nanocrystals are reported for the 4 K-300 K range. TEM of the nanocrystals shows them to be nearly spherical samples (aspect ratio $a/b=1.15$) with diameter $D=7(1) \text{ nm}$, and XRD yields $D=6.4 \text{ nm}$ with negligible strain. $M(H)$ data for $T > T_B$ fits the modified Langevin function $M=M_s L(\mu_p H/k_B T) + \chi_p H$ with $\mu_p=8000(500)\mu_B$ /particle and $M_s=80 \text{ emu/g}$, identical to M_s for bulk $\gamma\text{-Fe}_2\text{O}_3$. The large value of M_s , the small value of coercivity $H_C \sim 20 \text{ Oe}$ at 5 K, the lack of exchange bias in a field-cooled sample, and negligible strain point to nearly defect-free nanocrystals.

Lagroix, F., Banerjee, S. K. and Moskowitz, B. M., 2004, **Revisiting the mechanism of reversed thermoremanent magnetization based on observations from synthetic ferrian ilmenite ($y=0.7$): Journal of Geophysical Research-Solid Earth**, v.109, no.B12. Magnetic ordering temperatures of the cation ordered domains, in all samples, are ~380 K. Cation disordered domains, resulting from quenching from high temperatures, have magnetic ordering temperatures of 418 K (Q1300), 410 K (Q1050), and 425 K (Q900). The data unambiguously support a less than perfect ferrimagnetic - antiferromagnetic exchange interaction as the fundamental source of RTRM. The strength of the "effective" exchange anisotropies are estimated at ~2.7 mT (Q1300), ~12 mT (Q1050), and 0 mT (Q900). However, favorable conditions for the acquisition of RTRM are dependent not only on the strength of the exchange anisotropy but also on the crucial role played by the size of the cation ordered domains.

Liu, Q. S., Torrent, J., Yu, Y. J. and Deng, C. L., 2004, **Mechanism of the parasitic remanence of aluminous goethite: Journal of Geophysical Research-Solid Earth**, v.109, no.B12. We found that T_B is systematically higher than T_N for a set of well-characterized aluminous goethite samples. The difference between T_B and T_N increases from ~8-9 K for a pure goethite (that contains vacancies) to >20 K for Al-substituted goethites. This indicates that T_B and T_N change independently with the diamagnetic substitutions, suggesting a fundamental difference of origin for parasitic remanence and for antiferromagnetism.

Nonetheless, both parasitic remanence and AFM could exist along the goethite c axis.

Pilkington, M., Ames, D. E. and Hilderbrand, A. R., 2004, **Magnetic mineralogy of the Yaxcopoil-1 core, Chicxulub: Meteoritics & Planetary Science**, v.39, no.6, p.831-41. Exceptional magnetic properties are found in a basement clast (metamorphosed quartz gabbro), which has $k > 45000 \mu\text{SI}$ and an NRM of 77.5 A/m . Magnetic mafic basement clasts are a common component in the Yax-1 impactite sequence. The high k and NRM in the mafic basement clasts are caused by the replacement of amphiboles and pyroxenes by an assemblage with fine $< 1 \mu\text{m}$ magnetite, ilmenite, K-feldspar, and stilpnomelane, which occurred before impact. Similar alteration mechanisms, if operative within the melt sheet, could explain the presence of the high amplitude magnetic anomalies observed at Chicxulub.

Mineral Physics & Chemistry

Burton, B. P., Chaka, A. and Singh, D. J., 2005, **Chemical, magnetic and charge ordering in the system hematite-ilmenite, $\text{Fe}_2\text{O}_3\text{-FeTiO}_3$: Phase Transitions**, v.78, no.1-3, p.239-249. Spin polarized electronic structure calculations of total energies for ordered supercells in the system $\text{Fe}_2\text{O}_3\text{-FeTiO}_3$ suggest that some layered ordered phases are more stable than an isocompositional mechanical mixture of hematite and ilmenite. This result contradicts established ideas about hematite-ilmenite phase relations because it suggests that there is at least one stable ordered phase with a bulk composition intermediate between hematite and ilmenite. The electronic structure of a 30-atom layered supercell was studied by a variety of techniques, to investigate possible charge ordering on Fe sites, that is a postulate of the 'lamellar magnetism hypothesis', but significant $\text{Fe}^{2+}\text{-Fe}^{3+}$ ordering is not predicted.

Poulton, S. W. and Canfield, D. E., 2005, **Development of a sequential extraction procedure for iron: implications for iron partitioning in continentally derived particulates: Chemical Geology**, v.214, no.3-4, p.209-221.

A sequential extraction procedure for iron in modern and ancient sediments recognizes seven operationally derived iron pools: (1) carbonate associated Fe (Fe_{carb}), including siderite and ankerite; (2) easily reducible oxides (Fe_{ox1}), including ferrihydrite and lepidocrocite; (3)

reducible oxides (Fe_{ox2}), including goethite, hematite and akaganeite; (4) magnetite (Fe_{mag}); (5) poorly reactive sheet silicate Fe (Fe_{PRS}); (6) pyrite Fe (Fe_{py}); and (7) unreactive silicate Fe (Fe_{U}). As such, this is the first extraction scheme specifically developed to allow the separate identification of magnetite, and the first to allow a complete evaluation of Fe carbonate phases such as siderite and ankerite.

Schwertmann, U., Stanjek, H. and Becher, H. H., 2004, **Long-term in vitro transformation of 2-line ferrihydrite to goethite/hematite at 4, 10, 15 and 25° C: Clay Minerals**, v.39, no.4, p.433-438.

2-line ferrihydrite stored in water at ambient temperatures from 4 to 25°C and at ten different pH values between 2.5 and 12 for up to 10-12 y transformed to both goethite and hematite at all temperatures and pH values except at pH 12 where only goethite was formed. The rate and degree of transformation (20-100%) increased with increasing pH and temperature. The hmt/(hmt+gt) ratio varied between 0 and ~0.8, increased with increasing temperature and showed a strong maximum at pH 7-8. The maximum coincides with the zero point of charge of ferrihydrite where its solubility and, thus, its via-solution transformation rate to goethite are minimal.

NRM Carriers and Origins

Maher, B. A. and Hallam, D. F., 2005, **Magnetic carriers and remanence mechanisms in magnetite-poor sediments of Pleistocene age, southern North Sea margin: Journal of Quaternary Science**, v.20, no.1, p.79-94. Within oxidised fluvial sediments, the magnetic carriers appear to be relict magnetic minerals (ferrian ilmenites, chromites, haematite and goethite), which sometimes carry a reliable primary DRM but often have a VRM overprint. Within some reduced marine and intertidal sediments, the iron sulphide, greigite, has been found to carry a reliable, 'syn'-depositional CRM. In all the sediments, magnetic inclusions within silicates are abundant, are significant for the mineral magnetic signal but contribute little to any recoverable palaeomagnetic information.

Urrutia-Fucugauchi, J., Soler-Arechalde, A. M., Rebollo-Vieyra, M. and Vera-Sanchez, P., 2004, **Paleomagnetic and rock magnetic study of the Yaxcopoil-1 impact breccia sequence, Chicxulub impact crater (Mexico): Meteoritics & Planetary Science**, v.39, no.6, p.843-56. The Yax-1 breccia sequence consists of

redeposited melt-rich, clast-size sorted, fine-grained suevites; melt-rich, no clast-size sorting, medium-grained suevites; coarse suevitic melt agglomerates; coarse melt-rich heterogeneous suevites; brecciated suevites; and coarse carbonate and silicate melt suevites. Low-field k ranges from -0.3 to $4018 \mu\text{SI}$, and the NRM intensity ranges from 0.02 to 37510 mA/m . In most cases, characteristic single component magnetizations are observed. Both the clasts and matrix forming the breccia appear to have been subjected to a wide range of temperature/pressure conditions and show distinct rock magnetic properties. An extended interval of remanence acquisition and secondary partial or total remagnetization may explain the paleomagnetic results.

Paleomagnetism & Tectonics

Kent, D. V. and Tauxe, L., 2005, **Corrected Late Triassic latitudes for continents adjacent to the North Atlantic: Science**, v.307, no.5707, p.240-4.

We use a method based on a statistical geomagnetic field model to recognize and correct for inclination error in sedimentary rocks from early Mesozoic rift basins in North America, Greenland, and Europe. The congruence of the corrected sedimentary results and independent data from igneous rocks on a regional scale indicates that a geocentric axial dipole field operated in the Late Triassic. The corrected paleolatitudes indicate a faster poleward drift of 0.6° per million years for this part of Pangea and suggest that the equatorial humid belt in the Late Triassic was about as wide as it is today.

Muttoni, G., Erba, E., Kent, D. V. and Bachtadse, V., 2005, **Mesozoic Alpine facies deposition as a result of past latitudinal plate motion: Nature**, v.434, no.7029, p.59-63.

In the Alpine - Mediterranean region shallow-water sediments were replaced by mainly pelagic limestones in the Early Jurassic period, radiolarian cherts in the Middle - Late Jurassic period, and again pelagic limestones in the Late Jurassic - Cretaceous period. This sequence has previously been interpreted in terms of vertical variations of the carbonate compensation depth (CCD) relative to the ocean floor. We propose an alternative explanation for the facies tripartition based on palaeolatitudinal data: the Lombardian basin drifted initially towards, and subsequently away from, a near-equatorial upwelling zone of high biosiliceous productivity. Our tectonic model may explain the deposition of radiolarites throughout the Mediterranean and Middle Eastern region during the Jurassic period.

IRM Visiting Fellows January-June 2005

Dorothy Bauch (*University of Rochester*) Study of low-temperature magnetic properties of Archean silicate crystals

France Belley (*Southern Illinois University*) Low temperature magnetic properties of natural and synthetic olivine

Laurent Carporzen (*Institut de Physique du Globe de Paris*) How to explain the two distinct Verwey transitions in the shocked rocks from the Vredefort meteorite impact crater?

John W. Geissman (*University of New Mexico*) How are Red Beds Remagnetized and, Oh, What a Fault!

David Krása (*University of Munich*) Titanomaghemite inversion in oceanic basalts

France Lagroix (*Institut de Physique du Globe de Paris*) The effects of citrate-bicarbonate-dithionite on the magnetic mineral population in loess and paleosol samples from central Alaska

Melina Macouin (*LMTG UMR 5563*) Investigating the rock magnetic signature of the global aftermath of the Neoproterozoic glaciations

Phil McCausland (*University of Michigan*) Investigation of fine-scale remanence carriers within granitoid rocks

Nuno Joao de Oliveira e Silva (*Universidade de Aveiro*) Study of magnetic moment, anisotropy and Fe local environment distributions in ferrihydrite nanoparticles dispersed in an hybrid matrix

Reminder: Applications for Visiting Fellowships during the second half of 2005 are due April 30!

geomagnetic observatories. He succeeded in convincing the Russian Academy of Sciences in St. Petersburg in 1829 and the Royal Society in London in 1836 of the importance of his plans. A. Kupffer from St. Petersburg established four observatories in Russia while E. Sabine and H. Lloyd organised the foundation of geomagnetic observatories in the British Empire. The Royal Society in London invited also other European countries to follow their example. On the European continent C. F. Gauss and W. Weber from Göttingen also supported these ideas by building a geomagnetic observatory in Göttingen and by founding in 1836 the "Göttinger Magnetischer Verein" (Göttingen Magnetic Union) which aimed at the installation of a global network of geomagnetic observatories with standardised equipment for absolute measurements and for the observation of temporal variations of D, I and H. The foundation of the Geomagnetic Observatory in Munich in 1840 is also a result of these activities.

However, geomagnetic observations in Munich started already in 1836 by the initiatives of Lamont with sporadic measurements of D, H and I. It was even possible to measure D and H with a high

temporal resolution simultaneously in Göttingen (Gauss), Leipzig (Weber) and Munich (Lamont) during a magnetic storm. However, Lamont's plans were to build a complete geomagnetic observatory for permanent measurements at the site of the Astronomical Observatory. In those days Gauss and others were convinced, that it would take just a few (about 5) years of a world wide common observation of the geomagnetic phenomena to unravel the mysteries of geomagnetism. It turned out that this view was far too optimistic.

The money for the buildings and the instrumentation of the Geomagnetic Observatory in Munich was provided on 17 January 1840 by King Ludwig I. of Bavaria and his son, the later King Maximilian II. from their private funds. In April 1840 the construction works for a wooden subsurface observatory began. It was completed in July 1840. The floor of the observatory room was 3.80 m below surface level to avoid the influence of the daily temperature variations. Illumination came from windows in the roof. Four 8.8 m long and 1.80 m wide tunnels lead to approximately magnetic North, East, South and West. The place was connected with the main observatory building by a 35 meter long tunnel. The tunnel leading to the West had an opening through which a cross at the top of the St. Anna church could be observed as a reference mark with a theodolite. The variations of the declination and the horizontal intensity were measured with instruments built by Gauss and Meyerstein in Göttingen consisting of suspended magnets with a weight of 11,7 kg. On the 1st of August 1840, 6 o'clock in the morning, the Munich Geomagnetic Observatory started with the first measurements. Regular observations with the variometers were made with hourly readings during the day and bihourly readings at nighttime. Lamont performed personally three morning and one evening reading, three technicians made the others. Once a month, at dates which were announced worldwide in advance by the Göttingen Magnetic Union, readings were also taken at shorter time intervals. In May 1841 Lamont replaced the Gauss variometers by instruments of his own design using much smaller magnets for the observation of shorter periods and the new (Lamont's) position for the deflecting magnets to observe the variations of the horizontal intensity. This principle is still used today in some observatories. Automatic recording of such observations had not yet been invented, so all readings were written down by hand in books. A few years later Lamont developed his own magnetic theodolite with which he could measure the declination, the horizontal and the

vertical intensity not only in an observatory environment but also at stations in the field. He produced 45 instruments of this sort in his own workshop, which he had set up in his private living room at the observatory. His training in mechanical engineering by the Scottish monks at the monastery school in Regensburg turned out to be a great help for him. Later, the workshop became part of the observatory and the technicians, which he had first paid from his own salary and from the profits he made from selling the instruments, became employees of the observatory. Lamont's instrument (Reisetheodolit, Fig. 2) was sold to observatories in all parts of the world and they served for many years in geomagnetic observatories and for survey work.

After six years, the first wooden subsurface constructions broke down and had to be replaced by new likewise partly subsurface buildings. The instruments for absolute measurements and the variometers were separated. Due to the use of small magnets instead of the 11,7 kg magnets in the instruments provided by Gauss the buildings could be made very much smaller. However, even these more robust wooden buildings were not to last for a long time leading to other buildings made of stone in the following years. Details can be taken from Wienert (1966).

In the late 1840's and early 1850's Lamont started to make regional magnetic surveys at about 120 points in the Kingdom of Bavaria (Fig. 3), which he extended later to a number of 250 stations. He also made measurements in other States in Southern Germany. His maps published in 1854 with isolines for D, H and I for Bavaria and Southern Germany as well as for Central Europe, all reduced to 1 January 1850, are part the classical literature of geomagnetism. A few years later he made similar surveys also in neighbouring countries and published charts for D, I and H for France, Spain and Portugal (published in 1858), and Holland, Belgium, Prussia and Denmark (published in 1859). Some of Lamont's measured points, all of them well described and documented, can still be used today. However, many have been destroyed or given up due to the growth of cities and industrial noise.

Soon after his appointment as director of the Royal Astronomical Observatory, Lamont became member of the Royal Bavarian Academy of Sciences (1836) and he was later (1853) also appointed to the Chair in Astronomy at the University of Munich when it had become vacant. He received a high medal from the bavarian king Ludwig II including the privilege of naming himself "von" Lamont. On

Lamont's Magnetischer Reisetheodolit.

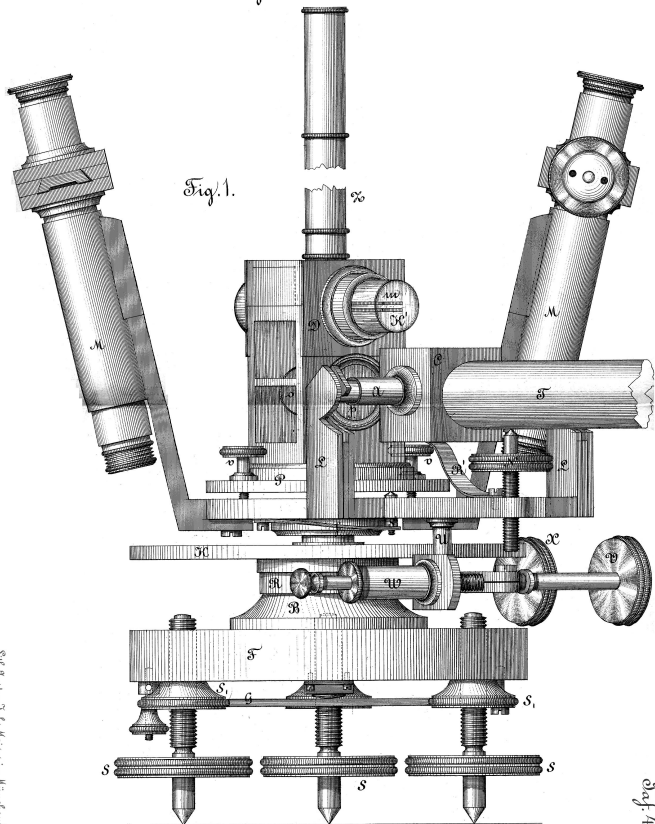


Figure 2. Lamont's famous "Reisetheodolit" (nonmagnetic theodolite for measuring D, H and I in field stations) developed and built by Lamont. He produced 45 of them in the workshop at the observatory.

Figure 3. Magnetic charts for Bavaria and southern Germany, reduced to 1. January 1850, published in 1854. The maps show the distribution of the measured points (top) and isolines for the the inclination I (bottom) and declination D (next page). Isolines show differences of 10 minutes for D and I. Values for Munich on 1 January 1850 were: $D = 15^\circ 53.9' W$, $I = 64^\circ 59.5'$, $H = 19523$ nT. Present day values are: $D = 1^\circ 30' E$, $I = 64^\circ 10'$, $H = 20900$ nT. So there is a change in declination in Munich between 1850 and 2005 of almost 17° .

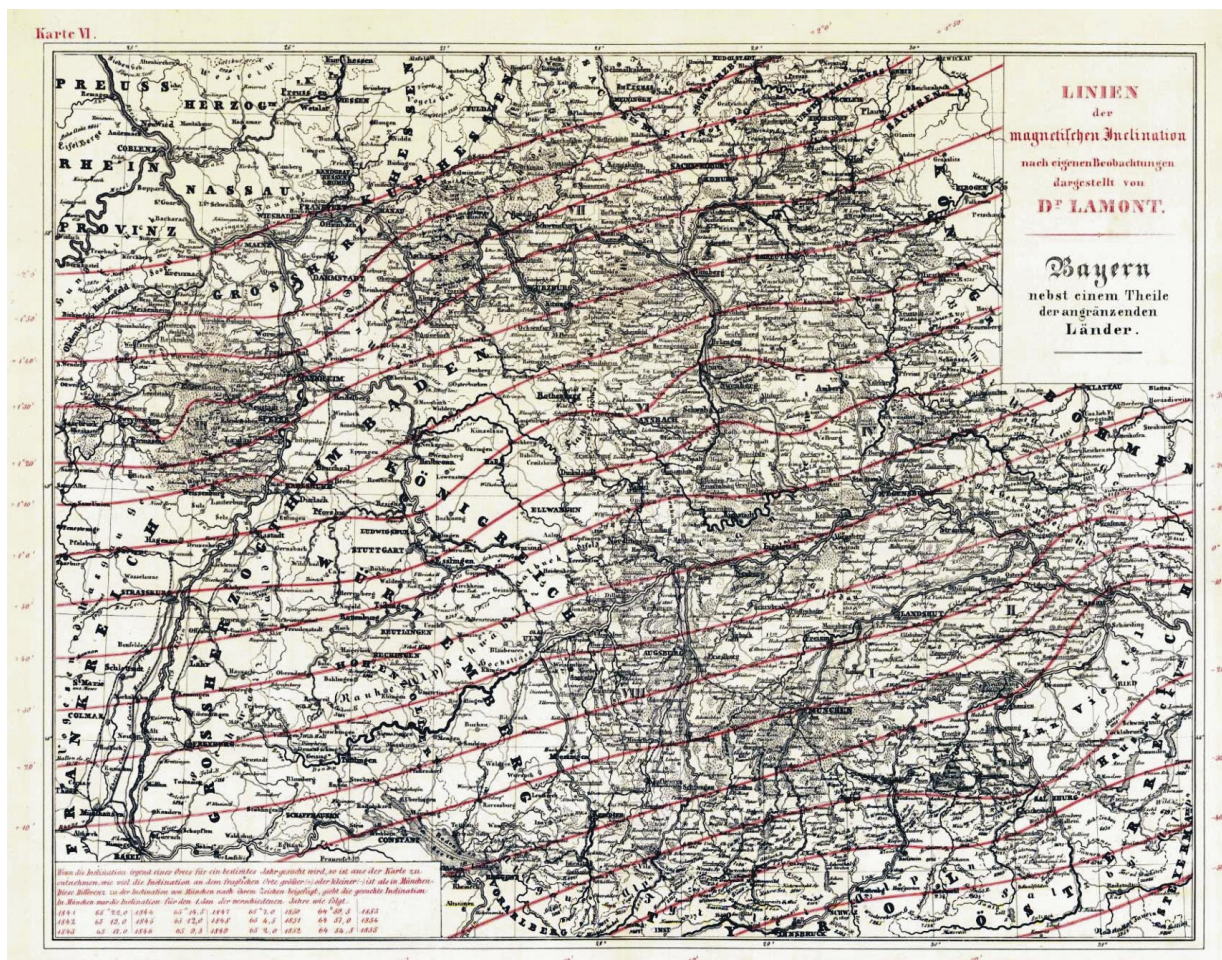
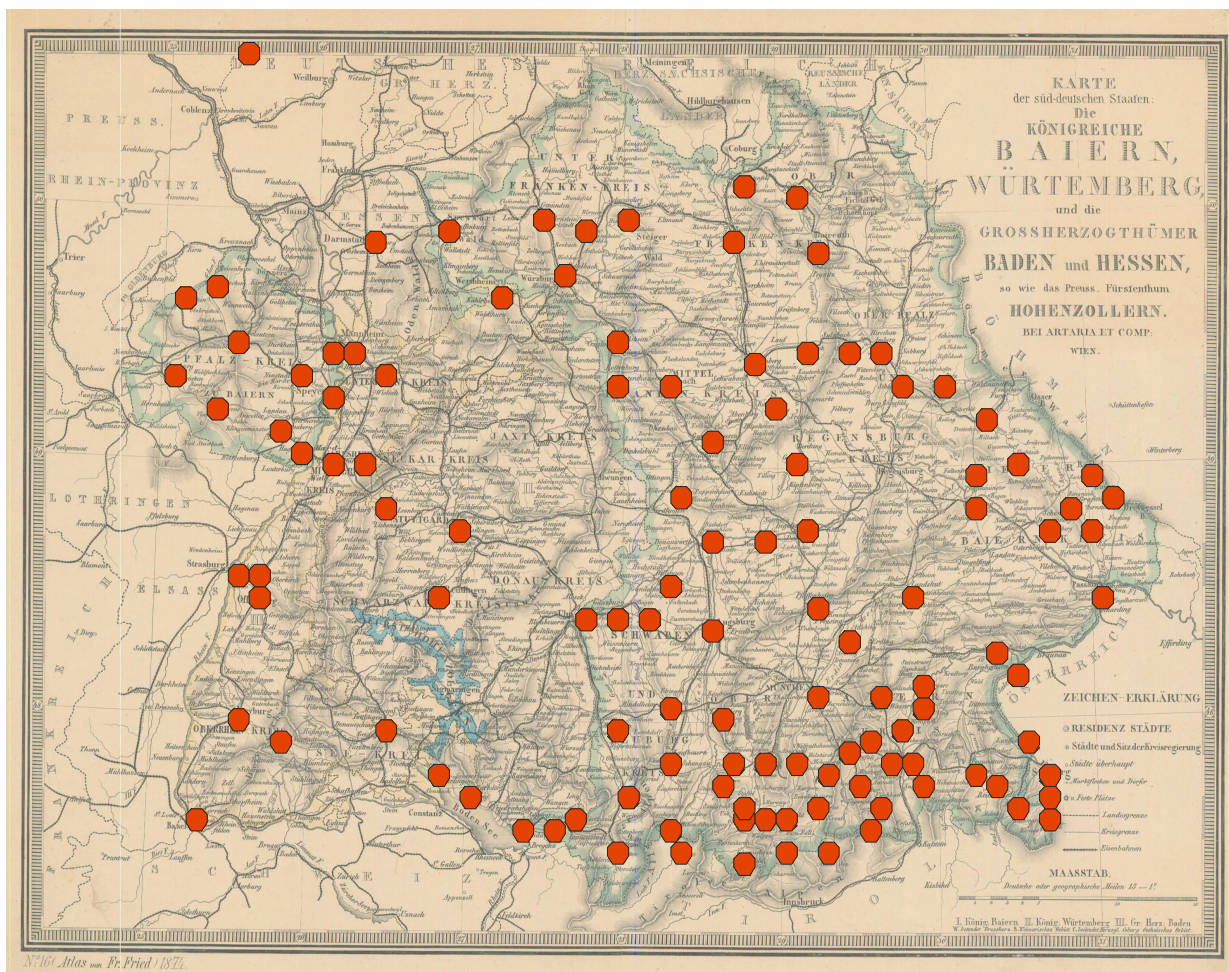
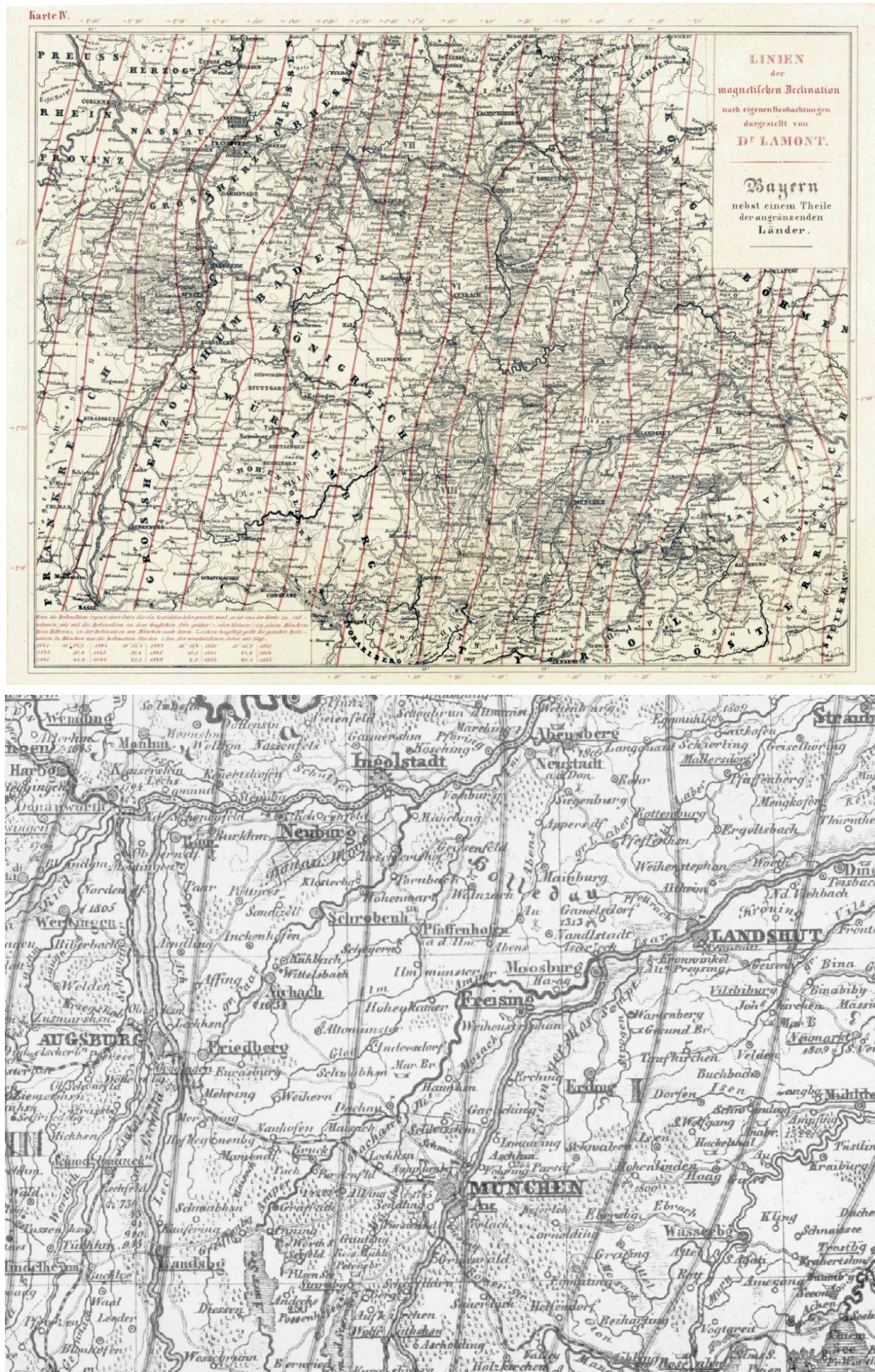


Figure 3, continued. Declination chart for Bavaria and southern Germany, reduced to 1. January 1850 (top; detail shown below). The laboratory for paleo- and rock magnetism is located in Niederlappach, near Landshut.



Lamont, Johann von

b. Dec 15, 1805, Corriemulzie, Scotland

d. Aug 5, 1879, München-Bogenhausen

Lamont is remembered for important contributions in astronomy, geodesy, meteorology and geophysics. He determined the orbital periods of Uranus' satellites Ariel and Titan, and from those calculated the mass of Uranus. He determined the differences of longitude of Vienna, Munich, Geneva, and Strasburg, and completed the astronomical triangulation of Bavaria. A skillful instrument designer, Lamont developed and refined a theodolite for measuring magnetic field orientation and intensity, as well as various meteorological instruments. The circumdecadal periodicity in the geomagnetic field was first identified by Lamont and was subsequently correlated with sunspots and solar activity by Wolf in Zürich.

August 5th 1879 he died in his apartment in the Observatory where he had worked for 51 years. He is buried close to the Astronomical Observatory in the churchyard of St. Georg in Munich-Bogenhausen.

However, it should be mentioned that Johann von Lamont was not only a good geomagnetist (his monographs like "Handbuch des Erdmagnetismus", "Astronomie und Erdmagnetismus", "Handbuch des Magnetismus" are classical textbooks on this subject in German language), he was also a very active astronomer (he determined the positions of more than 80000 stars), meteorologist and geodesist. He was also one of the first who studied the temporal variations of earth currents and showed

their correlation with geomagnetic phenomena. From his data he estimated the depth of the molasse basin below Munich to be 1.5 km, a value which turned out to be correct by drilling in the 20th century. So he can also be regarded as an early pioneer of a method which is now known as magnetotellurics. Already in 1853 he donated a large amount of money to the University of Munich to support poor students of natural sciences with fellowships.

Lamont received many honours during his active career. He was member in a large number of academies and scientific societies. It would lead too far to list them all. In 1934 the Lamont Clan erected a monument in Invery, a small village close to the place where Lamont was born and lived during his first 12 years. The inscription on the monument facing north is:

THIS STONE COMMEMORATES JOHN LAMONT,
1805-1879, WHO WAS BORN AT
CORRIEMULZIE. HIS NAME IS WRITTEN IN THE
HISTORY OF SCIENCE AS JOHANN VON
LAMONT, ASTRONOMER ROYAL OF BAVARIA.

The inscription of the side facing south is taken from Psalm 19:

DAY UNTO DAY UTTERETH SPEECH AND NIGHT
UNTO NIGHT SHEWETH KNOWLEDGE.

There are also inscriptions on the other two sides in German and Gaelic with the same text of Psalm 19. A crater on the near side of the Moon at 4.4°N, 23.3°E with a diameter of 170 km and a crater on Mars at 58.3°S, 113.3°W with a diameter of 72 km bear Lamont's name.

More than 50 years after the death of Lamont the Munich geomagnetic (and

also a newly installed seismic observatory in 1905) were moved from Bogenhausen to a less disturbed place near Fürstenfeldbruck, about 35 km to the west of Munich. It is part of the worldwide network of geomagnetic observatories forming INTERMAGNET as well as the network of seismic broadband stations. I am happy to have been one of the successors of Johann von Lamont as director of the Fürstenfeldbruck Observatory from 1983-2002.

Heinrich Soffel

Prof. Emeritus, University of Muenchen;
January 2005

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RAC Rotates

The IRM's Review and Advisory Committee (RAC) is responsible for evaluating Visiting Fellowship proposals, and it provides strategic guidance on instrumentation and community infrastructure, to help maximize the value of IRM as a shared international resource for rock-magnetic research. Members typically serve six-year terms, and turnover is staggered every two years. With the completion of their service we heartily thank **Lisa Tauxe**, **Jim Channell** and **Ron Merrill** for their insights and efforts. We also welcome new members **Özden Özdemir**, **John Tarduno** and **Jeff Gee**, who join **Rob Coe** (RAC Chair), **Cor Langereis** and **Pierre Rochette** on the RAC.

IRM Staff and Post-docs

We are delighted to welcome **Brian Carter-Stiglitz** to the IRM's professional staff, following the (semi-)retirement of **Jim Marvin** last year. After completion of his wide-ranging doctoral dissertation ("Rock Magnetism: Studies in Theory, Data Manipulation, and Application") here in 2003, Brian carried out a post-doctoral project on sedimentary remanence with Jean-Pierre Valet at the Institut de Physique du Globe de Paris (IPGP). As an IRM staff member, Brian will participate in visitor support, instrument maintenance, database and software development, and rock-magnetic research.

Post-doctoral associate **Ramon Egli** (PhD ETH-Zürich, 2003: "Environmen-

tal Influences on the Magnetic Properties of Lake Sediments") joined the IRM research staff in the fall, with funding from the MagIC (Magnetic Information Consortium) database project involving researchers from Scripps Institute of Oceanography, IRM, and other institutions (<http://earthref.org/MAGIC/>). Ramon is working on methods of data analysis and processing, and on synthesis and characterization of magnetic reference materials.

In addition, we are currently in the process of hiring another post-doc to complete a project on the low-temperature behavior of magnetite and the Verwey transition, in collaboration with Brian and Bruce.

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**, Professor/Associate Director; **Jim Marvin**, Emeritus Scientist; **Mike Jackson**, **Peat Sølheid**, and **Brian Carter-Stiglitz**, Staff Scientists.

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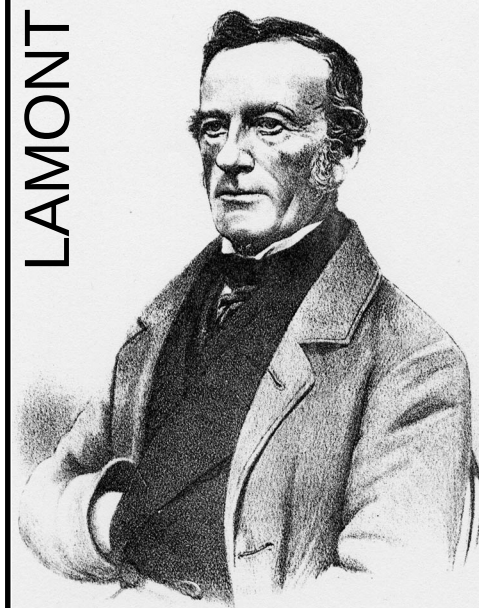
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