The IRM Quarterly

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Institute for Rock Magnetism

In the Shadow of the Comet: The Geophysical Bounty of Edmond Halley

Mike Jackson

M 1698, Halley set sail in the Paramore to map magnetic declination (or “variation” as it was then termed) over the Atlantic, and to determine the longitude of principal ports. Following a second voyage, Halley produced in 1701 the first published map of magnetic declination.

The Scientific Landscape of the Late 17th Century

In a letter to Robert Hooke in 1676, Isaac Newton wrote the famous line “If I have seen further it is by standing on the shoulders of Giants.” The preceding century had seen the overthrow of the Aristotelian geocentric cosmology by Copernicus and Galileo, and the development of the revolutionary metaphysical view of a universe governed by explicit mathematical laws, in the work of Kepler, Galileo, and Descartes. With Newton the modern division of physics (mathematical description of natural phenomena) and metaphysics (philosophical inquiry into ultimate causes) became complete: “I scruple not, to propose the principles of motion..., and leave their causes to be found out.” (Opticks)

Although Halley’s universally-known comet has largely overshadowed his other scientific and mathematical contributions, historians of science have documented his wide interests and important work in geomagnetism, geodesy, cartography, meteorology and mathematics, as well as astronomy. Sir Edward Bullard called Halley “the first geophysicist.”

1998 marks the tricentennial of “the first sea voyage ever undertaken for purely scientific purposes.” In October 1698, Halley spent 1698-1700 in command of the Paramore, mapping magnetic “variation” (declination) around the Atlantic Ocean.

Smallbild: From Ronan ©Doubleday & Co.

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IRM
**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 geo-physics 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 A bstracts 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. A 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 3700 references, is available free of charge. Your contributions both to the list and to the A bstracts section of the IRM Quarterly are always welcome.

**Geomagnetism, SV, Reversals, Paleointensity**


**Magnetic Anomaly Sources**


Scanning and transmission electron microscopy of ocean-floor pillow basalts (0-70 Ma) reveals progressive alteration of submicrometer titanomagnetite to phases such as goethite and clays. In contrast, larger titanomagnetite grains (>1 mm) oxidize to titanomaghemite without apparent change in crystal morphology. Rock magnetic experiments are consistent with a selective removal of the submicrometer grains as the basalt's age. This alteration is one of the reasons that amplitudes of marine magnetic anomalies diminish with age over time scales of tens of millions of years.

**Magnetization Processes and Remanence**

Banerjee, S., Elnor, R. D., and Engel, M. H., 1997, Chemical remagnetization and burial diagenesis: testing the hypothesis in the Pennsylvanian

**IRM Quarterly**

IRM Quarterly (© 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 3700 references, is available free of charge. Your contributions both to the list and to the A bstracts section of the IRM Quarterly are always welcome.

**Belden Formation, Colorado**

Thermal demagnetization isolates an intermediate unblocking temperature (250-400°C) NRM component, interpreted to be a TVRM, and a high unblocking temperature (400-570°C) component, interpreted to be a CRM. Hysteresis ratios indicate that the CRM is carried by SD/PSD magnetite, interpreted to have formed authigenically by replacement of pyrite. Contact vein tests do not support a CRM origin involving the passage of radiogenic fluids through the limestones. Diagenetic reactions at low to moderate burial temperatures may have caused the magnetite authigenesis and the CRM.


The M Ilion M ononite was thermoviscously remagnetized as a result of burial and uplift. Thermal demagnetization separates the low unblocking temperature (LT) overprint from the high unblocking temperature (HT) primary remanence. Maximum unblocking temperatures for the LT component (T L T) values are distributed over a wide range (>250°C), and are anomalously high for burial remagnetization, compared to the predictions of single-domain theory. However, samples that were pretreated by low-temperature zero-field cycling before thermal demagnetization yield the theoretically expected T T values and realistic estimates of remagnetization time and temperature (t, T) in nature, using the t-T contours of Pullaiah et al. [1975].


We compare experimental data and numerical aftereffect model results in which Preisach type hysteresis transducers are driven by stochastic inputs, simulating random thermal perturbations. Calculations show the well known log(t)-type magnetization decay whose rate reaches a maximum near the coercive field. Comparison of these with experimental results from yFeO 3 recording media show excellent agreement. We propose a practical procedure to identify the stochastic parameters of the aftereffect model.

Magnetic measurements on a diluted system of $\gamma$-$\text{Fe}_2\text{O}_3$ nanoparticles (d $\sim$ 7 nm), and on a ferritin sample show in both cases a nonmonotonic field dependence of the zero-field cooled (ZFC) peak. We derive expressions for the magnetization obtained in the usual ZFC, field cooled (FC) and thermostreament magnetization (TRM) procedures, and show that the ZFC-peak position is extremely sensitive to the width of the particle size distribution. A procedure which combines the FC magnetization with a modified TRM measurement allows a more direct access to the barrier distribution in a field. The typical barrier values thus obtained show a monotonic decrease for increasing fields, as expected from the simple effect of anisotropy barrier lowering, in contrast with the ZFC results.


The model proposed by Shliomis and Stepanov to describe the low field magnetic response of a solid dispersion of noninteracting nano-sized particles has been used to calculate the temperature dependence of the AC susceptibility of a system with a known particle size distribution. A comparison with experimental AC susceptibility results shows the necessity of including both an inter-potential- and an intra-potential-well contribution to the magnetic response. Moreover, different relaxation times need to be assigned to the two contributions.

Miscellaneous


A radiation-free method to measure gastric emptying (useful e.g. for patients needing repeated measurements or in pregnancy) is based on ferrimagnetic particles ($\gamma$-$\text{Fe}_2\text{O}_3$), ingested within a solid test meal (pancakes, chosen to correspond to a radiolabelled test meal that had previously been used in a scintigraphic study). A ferromagnetisation, the remanent magnetic field is measured with fluxgate magnetometers outside the stomach (anterior and posterior), and the intragastric contents are estimated from the strength of the field. In vivo measurements carried out on 16 healthy male volunteers showed that the early part of the mean emptying curve decreased slightly faster than the corresponding scintigraphic one, but the similarity of the two seems promising enough for further development of the present method.


Particles collected from suspension in the Martian atmosphere have an average saturation magnetization of about 4 A m/kg, and appear to consist of claylike aggregates stained or cemented with ferric oxide ($\text{Fe}_2\text{O}_3$), some of which is probably maghemite ($\gamma$-$\text{Fe}_2\text{O}_3$). The presence of the gamma phase would imply that Fe$^{3+}$ ions leached from the bedrock passed through a state as free Fe$^{3+}$ ions dissolved in liquid water. These particles could be a freeze-dried precipitate from ground water poured out on the surface. An alternative is that the magnetic particles are titanomagnete occurring in palagonite and inherited directly from a basaltic precursor.

Modeling and Quantitative Interpretation


Linear modelling techniques for quantitative interpretation of magnetic data have been tested using laboratory mixtures of up to six source materials, including both natural environmental materials and synthetic compounds. Results show that in the best controlled conditions, the results of linear modelling are quite poor and at best four sources can be “unmixed” with reasonable success. In testing linear additivity, low-frequency susceptibility is the most reliable mineral magnetic measurement, while remanence measurements suffer from systematic error. The non-additivity and the failure of the linear modelling may be due to source heterogeneity, calibration errors and nonlinearity of equipment, magnetic viscosity of materials and/or interaction effects.


We present an analysis of thermal stability of magnetic remanence in fine grains of magnetite (15-120 nm), using a three-dimensional constrained minimization method. For each particle, we obtain the energy barriers $E(T)$ from 25° to 578°C. Magnetic blocking temperatures ($T_B$) are calculated by integrating $E(T)$ for laboratory and geological timescales. Computed ($\gamma$, $T$) curves deviate from those of Pullaiah et al. [1975] for grain sizes in the SD-PSD transition region. Some PSD size particles are blocked in vortex states on geologic timescales but are blocked in the 3D state on laboratory timescales, and T(he)ller determinations on such samples can therefore underestimate the paleofield intensity. The superparamagnetic to SD threshold size for cubic grains is 50 nm, but a small aspect ratio of 1.1 is sufficient to depress the threshold to 27 nm.

Mössbauer spectra have been recorded in fields of up to 13 T from a single crystal of $\text{Fe}_2\text{O}_3$ cut perpendicular to the [111] axis, complementing studies on a crystal cut normal to a [100] axis. The spectra were best fitted with five magnetic components. One component corresponds to Fe$^{3+}$ situated on the tetrahedral A sites of the inverse spinel-related structure whilst the other four correspond to Fe$^{3+}$ and Fe$^{2+}$ on two nonequivalent octahedral sites.

Hematite ($\alpha$-$\text{Fe}_2\text{O}_3$), magnetite ($\text{Fe}_3\text{O}_4$), wustite ($\text{FeO}$), maghemite ($\gamma$-$\text{Fe}_2\text{O}_3$), goethite ($\alpha$-$\text{FeOOH}$), lepidocrocite ($\gamma$-$\text{Fe}_2\text{O}_4$) and $\delta$-$\text{FeOOH}$ have been studied previously by Raman spectroscopy, but there are some disagreements in the reported data. Here, Raman microspectroscopy was employed to investigate the laser power dependence of the spectra of these oxides and oxyhydroxides. The results obtained show that increasing laser power causes the characteristic bands of hematite to show up in the spectra of most of the compounds studied whereas the hematite spectrum undergoes band broadening and band shifts.


A wide range of spinel compositions in the Fe$_2$O$_3$-$\gamma$Fe$_2$O$_3$ series has been identified in Brazilian soils. Hematite ($\alpha$-$\text{Fe}_2\text{O}_3$) and goethite ($\alpha$-$\text{FeOOH}$) are the most widespread iron oxides, but magnetite ($\text{Fe}_3\text{O}_4$) and maghemite ($\gamma$-$\text{Fe}_2\text{O}_3$) occur in magnetic pedons. Isomorphic substitution of mainly Ti$^{4+}$, Al$^{3+}$ and Mg$^{2+}$, but also of Cr$^{3+}$ and Mn$^{2+}$ and other minor elements for iron are related to changes in their structural stability and magnetic properties. Magnetic iron oxides of selected Brazilian pedodains are discussed, distinguishing those produced from mafic rocks (tuffite, basalt), where primary

Abstracts continued on page 4...
Abstracts


Powdered crystals of an iron-rich spinel separated from tuffite were examined by chemical analysis, X-ray diffractometry (XRD), magnetochemistry, scanning electron microscopy, and Mössbauer spectroscopy. They are found to contain mainly 48 mass% FeO; 16.9% Fe2O3; 14.3% TiO2; 9% MgO and 3% Al2O3. XRD reveals two cubic phases with a0=0.8382(5) and 0.8412(5) nm, respectively. Mössbauer spectra are very complex, but the hyperfine field distribution patterns can be decomposed in two relatively well-resolved Gussian distributions. The Mg-rich maghemite (higher a0) appears to be a direct alteration product of a Mg-rich magnetite (lower a0), via an oxidation process of structural Fe2+ to Fe3+ proceeding from the outer to the inner parts of the crystal.


γ-Fe2O3/polymer composites with particles of controlled size and state of aggregation were prepared and studied by a variety of magnetic measurements. Mössbauer spectroscopic investigations are discussed in the light of all the results.

Paleoclimates, Proxies, and Environmental Magnetism


The Zhai Tang loess section has yielded a very high resolution magnetic susceptibility record for the last glacial and interglacial period. A ll subcycles can be clearly defined in marine isotope stage 5. A brupt climate transitions (S5b/S5d/S5e) recorded in this section (from the N E edge of the Plateau) show more detail than most other Chinese loess records. T hree well-defined peaks in substage 5a imply sensitivity of the East Asian monsoon to rapid hemispheric-scale climate change.


The magnetostatigraphy of a 300 m thick eolian sequence of Late Cenozoic sediments shows that eolian dust accumulation, and by inference the related East A sia paleomonsoon, had begun by 7.2 Ma. A s paleomonsoon are largely controlled by the Tibetan Plateau, this implies that the Plateau had reached some critical elevation by 7.2 Ma. T he section also documents a rapid increase in eolian dust accumulation in the Late Cenozoic at 3.2 Ma that is probably due to the influence of global ice volume on the East Asian monsoon.

Paleomagnetism and Tectonics


Geochronological (40Ar/39Ar) and magnetostatigraphic results for the Ethiopian traps show that the bulk of the traps, which have been inferred to mark the appearance of the Ethiopian-A fric plume head at the Earth’s surface, erupted approximately 30 Myr ago, over a period of 1 Myr or less. T his was about the time of a change to a colder and drier global climate, a major continental ice-sheet advance in A ntartica, the largest Tertiary sea-level drop and significant extinctions.

Properties of M agnetic Minerals


The magnetoresistance behavior of Fe3O4 in polycrystalline thin film, powder compact, and single-crystal form are compared. Negative magnetoresistance with peaks at the coercive field, observed in thin films and powder compacts but not in the single crystal, is due to field-induced alignment of the magnetization of contiguous grains. T he effect is associated with intergranular transport of spin-polarized electrons.


In this paper, we present the main irradiation effects observed on ferrites in the world between 1970 and 1995. Several crystallographic effects can be induced: increase of lattice parameter, change of site and valence for cations and anions, amorphisation, creation of tracks showing either elongated extended defects or continuous amorphous cylinders. T hese result in various magnetic effects: the magnetization and Curie temperature can either increase, decrease, or be constant; the anisotropy can change and even cancel. T he effects are reproducible and stable at 300 K. Recently, it was found that Fe3O4 is the most irradiation resistant ferrite.


Radial electron distributions and net atomic charges of magnetite Fe3O4, have been studied using single-crystal X-ray intensity data up to sin Θ/λ=1.22 Å-1. T h e number of electrons, C(R), was calculated as the radius of an atomic sphere for each atom by the Fourier summation method from the observed crystal structure factors. T he radial distribution function was then obtained by differentiating the C(R) curve to derive an electron distribution radius, rD, which can give a clear separation between neighboring atoms.


Oxidation of ferrous hydroxide in air produced mainly magnetite (Fe3O4) with a small amount of goethite (α-FeOOH), determined by Mössbauer and XRD analysis. A s the oxygen flow rate was increased, the relative content of goethite increased, and the crystallite size (nanometric scale) of both oxidation products decreased. A dditionally, H RTEM images showed that distorted nano-fibers were characteristic for the goethite, and nano-platelets for the magnetite.


Temperature-dependent Mössbauer shifts were used for the evaluation of high-temperature cation distributions in mixed valence iron compounds. R esults are reported for the cation distribution of magnetite, Fe3O4, G ood agreement is observed between results derived from the present approach and independent data from thermopower experiments.
... H alley 

continued from page 1

Parts of the Globe may well be reckoned as the Shell, and the Internal as a Nucleus or inner Globe included within ours, with a fluid medium between. Which having the same common Center and Axis of diurnal Rotation, may turn about with our Earth each 24 hours only this outer Sphere having its turbinating Motion some small matter either swifter or slower than the Internal Ball. Thus the changing geometry of the four poles controlled the declination and secular variation of the field over the surface of the Earth.

With the mathematician's instinct to generalize, Halley allowed that, if future observations should show this model to be too simple, several such concentric shells could be postulated, each with its magnetic poles and rotational periods. He suggested that there was room for internal spheres the size of Mercury and Venus. In reply to the anticipated objection against hollow spaces inside the Earth, he pointed to the rings of Saturn as a partial analog, and cited Newton's conclusion that the Earth was less dense than the moon by the ratio 5:9. He later extended his model to explain some features of the aurora borealis. Nevertheless, he conceded "all that we can hope to do is to leave behind us Observations that may be confided in, and to propose Hypotheses which after A ges may examine, amend or confute."

The Voyages of 1698-1700

The Journal Book of the Royal Society shows for April 12, 1693, a request on behalf of Halley for "the assistance of this Society to procure for him a small vessel of about 60 Tuns... in order to compass the Globe to make observations on the Magnetical Needle, & c." The request was approved by the Navy, in the hope that it would prove to be useful in determining longitude at sea, and construction was commenced on a ship of a type known as a pink (originally of Dutch design, having a flat bottom to allow passage through shallow water and bulging sides for large cargo capacity). In October, 1698, the Paramore set sail, with instructions "to make the best of your way to the Southward of the Equator, and there to observe on the East Coast of South America, and the West Coast of Africa, the variations of the Compass, with all the accuracy you can, as also the true Situation both in Longitude and Latitude of the Ports where you arrive... and if the Season of the Y ear permit, you are to stand soe farr into the South, till you discover the coast of the Terra Incognita, supposed to lie between Magellan's Straights and the Cape of Good Hope, which Coast you are carefully to lay downe in its true position."

The first voyage was troublesome: leaks and pump problems forced an almost immediate repair layover; then after reaching Cape Verde, the Paramore was mistaken for a pirate ship and fired upon, and the voyage was finally cut short due to insubordination. Lieutenant Edward Harrison, a veteran naval officer, may have resented serving under an inexperienced captain; he also reportedly blamed Halley for the rejection of a manuscript he had submitted to the Royal Society, dealing with the longitude problem. Having crossed the Atlantic near the equator and thence to Barbados, Halley was forced to turn back, "finding it absolutely necessary to change some of my Officers, which I found I could not do, without returning to England." By September, 1699, equipped with a new crew, Halley and the Paramore were again bound for the South Atlantic.

Sailing along the coast of South America, they reached 52° south latitude before being forced back by the elements: "this danger made my men reflect on the hazards we run, in being alone without a Consort, and of the inevitable loss of us all, in case we staved our Ship, which might so easily happen amongst these Mountains of Ice in the Fogs which are so thick and frequent here." Halley made daily measurements of latitude, and where possible, calculated longitude (using eclipses of the moons of Jupiter to determine time). He determined magnetic declination by measuring at sunrise and sunset the Sun's "magnetic amplitude" (the angular distance along the horizon between the Sun and magnetic north; half the difference of these amplitudes gives the declination).

Following a third voyage mapping in detail the coastlines of the English Channel, Halley returned to the study of mathematics and astronomy. In 1703, he became a candidate for the Savilian Professorship in Geometry at Oxford, following the death of John W allis. He was opposed by John Flamsteed, a renowned Royal and his former collaborator, who wrote "Dr Wallis is dead. Mr Halley expects his place. He now talks, swears, and drinks brandy like a sea captain, so that I fear his own ill-behaviour will deprive him of the vacancy." Halley nevertheless succeeded Wallis.

The Variation Charts

Halley presented the results of his investigations in 1701 in the form of a map, "Shewing the Variations of the Compass in the West ern & Southern Ocean as observed in ye year 1700 by his Majesty's Command." This is not only the first isogonic chart ever published, but apparently the first isoline map of any sort to be widely distributed. Although there are isolated examples of earlier contour charts, including a bathymetric chart from 1584 and a 1630 isogonic chart of a small region by Christoforo Borri of Milan, these were not widely known, and the independent invention by Halley is considered the basis for all subsequent contour maps.

The term "isogonic line" was later coined by H ansteen (ca 1820); Halley referred to his contours simply as "curves." The following explanation was attached by Halley to the chart: "The Curves which are drawn over the Seas in this Chart do shew at one View all the Places where the Variation of the Compass is the same; The N umbers to them, shew how many degrees the Needle declines either Eastwards or Westwards from the true North; and the Double Lines passing near Bermudas and the Cape Verde Isles is that where the Needle stands true without Variation."

The 1701 Atlantic chart was soon superseded by a World Chart, which included data compiled by Halley from other sources, covering the Indian Ocean and parts of the Pacific. The World Chart was widely distributed, and the earlier map was forgotten until its rediscovery by Bauer in 1896.

Halley & Newton

Halley first visited Newton at Cambridge in 1684, in order to discuss the motion of planets and comets. Halley had by then concluded that Kepler's Second Law (the square of a planet's orbital period is proportional to the cube of its mean distance from the sun) was consistent with a force whose magnitude varied as the inverse square of distance. Hooke had also surmised this, but neither was able to provide a mathematically rigorous demonstration. Newton had already succeeded in the proof, and Halley encouraged him to publish the details. The work grew in scope, and the ultimate result was the Principia, one of the great landmarks of the history of science. Halley served as editor, and when the Royal Society was unable to furnish the publication costs, Halley had the work published at his own expense.

... H alley 

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A preliminary version of H. alley's 1701 map of magnetic "variation"; lacking the royal dedication. Reproduced from the Hakluyt Society volume.
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Other Contributions
Halley worked on a great variety of problems of scale: the size of an atom (his wire-drawing experiment gave an upper limit of about 200 nm for the diameter of a gold atom); the height of the atmosphere (from measurements of the variation of barometric pressure and altitude, he calculated a value of about 70 km, close to the classical determination of A Iaenca 1000 A D, based on twilight duration); the size of the Earth (using the method of Eratosthenes, as refined by Snell and Picard); and the distance to the sun. The latter had been roughly determined in antiquity by Aristarchus (whose estimate was too low by about a factor of 20), but accurate measurement was extremely difficult because the observable parallax (only a few seconds of arc) was small in comparison to the refraction effects of the atmosphere and other sources of error. In 1663 the mathematician James Gregory had suggested that the solar parallax could be more accurately determined by observing transits of Mercury or Venus (i.e., passage of these planets across the face of the Sun during times when they were directly interposed). In 1677 Halley observed a transit of Mercury from St. Helena (where he was compiling a catalog of the southern hemisphere stars), and by combining his observation with others calculated an improved estimate of the solar distance (still too small by a factor of five.) Better results were expected from observations of Venus, and Halley calculated in 1691 that transits of that planet occur in pairs eight years apart, with much longer intervals separating successive pairs. He proposed a program of observations for the Venus transits of 1761 and 1769, which ultimately led to a greatly refined determination of the solar parallax, and thus of the scale of the solar system.

Another innovation due to Halley was the suggestion that the age of earth might be determined through studies of the salinities of lakes and the oceans: “I conceive that as all the Lakes do Receive Rivers and have no Exite of Discharge, so ‘twill be necessary that... their Surfaces... exhalate in Vapour that W ater that is pour’d in by the Rivers. But the Vapours thus exhale are perfectly fresh, so that the Saline Particles that are brought in by the Rivers remain behind, whilst the fresh evaporates; and hence ‘tis evident that the Salt in

the Lakes will be continually augmented, and the Water grow salter and salter... and we are thereby furnished with an Argument for estimating the Duration of all things.”

In 1716, Halley published one of the earliest scientific descriptions of the aurora borealis, which he attributed to “Magnetical Effluvia” which “may now and then, by the Concourse of several Causes very rarely coincident, and to us as yet unknown, be capable of producing a small Degree of Light... after the same manner as we see the Effluvia of Electrick Bodies by a strong and quick Friction emit Light in the Dark: to which sort of Light this seems to have a great A finity.” Halley sought to explain the confinement of the phenomenon to high latitudes in general, and the greater frequency of occurrence in Iceland and Greenland (nearer the magnetic pole) than in Norway. He returned to his concentric-shell geomagnetic model, suggesting that the space between the solid regions might be occupied by a luminous medium, which could “transude through and penetrate the Cortex of our Earth” along the steeply inclined magnetic field of the polar regions, where, also, the outer solid shell might be thinner, due to the oblateness of the Earth.

Among the noteworthy contributions of Halley to pure mathematics were his translations of several geometric treatises from classical antiquity, including Apollonius’ on conic sections, and Menelaus’ on spherical trigonometry.

The Comet
Newton had shown in the Principia that the orbits of the planets, comets and other bodies around the Sun correspond to the conic sections, i.e., circles or ellipses for closed, recurring orbits, and parabolas or hyperbolas for non-recurring ones. Which of these actually describes the path of an individual comet or comets in general, however, remained a mystery. Tycho had proposed a circular orbit for the comet of 1577; Kepler had suggested generally straight-line paths with varying velocity. Halley compiled and analysed historical records of comet observations, and computed orbits for those with sufficient data (24 comets between 1337 and 1698): “My considerations incline me to believe the comet of 1531... to have been the same as that described by Kepler... in 1607 and which I again observed when it returned in 1682... W hence I would venture confidently to predict its return, namely in the year 1758. And if this occurs there will be no further cause for doubt that other comets ought to return also.”

The comet of course returned as predicted, being sighted on Christmas Day, 1758. Subsequent research has shown that it was Halley’s comet that appeared in 1066 A D (depicted in the Bayeux Tapestry), a dreaded apparition for King Harold. Particularly spectacular appearances include those of 1301 and 1456, when the tail extended more than 70 degrees across the sky. Legrande (1986) describes the public panic in 1910 over the passage of Earth through the tail of the comet, which was by then known to contain toxic gases such as carbon monoxide and cyanogen. Many prepared for death by spending their fortunes; others committed suicide, in preference to the gruesome prospect of cometary asphyxiation.

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Collectors Series #7.

William Bleam, University of Wisconsin-Madison, Dispersal and clustering of lanthanide ions at diamagnetic oxide/water interfaces
Beatriz Ortega-Guerrero, Universidad Nacional Autónoma de México, Late Quaternary paleoenvironmental study in San Felipe basin, Sonoran Desert, Mexico

Another outstanding group of proposals received the stamp of approval by the IRM’s Review and Advisory Committee (RAC):

Özdemir & Dunlop, University of Toronto-Eritranda, Origin of stable memory and TRM in multidomain magnetite
Carl Richter & Peter Blum, Texas A & M University, Rock magnetic properties of sediments from the western African margin
Horst-Urich Worr, University of Göttingen, High-temperature stability of the magnetization of oceanic gabbros

and the SP-SSD transition of magnetite particles

Chuanlun Zhang, Oak Ridge National Laboratory, Iron biominerolization by thermophilic bacteria: mechanisms of biogenic magnetite formation and implications for paleomagnetism
Xi Xi Zhao, University of California, Rock magnetic probing of upper mantle rocks in the ocean-continent transition west of Iberia

Spring & Summer Visiting Fellows

Geodynamo and Environmental Change: Interpreting Paleorecords through Rock Magnetism

We are pleased to announce that the Fourth Santa Fe Conference on Rock Magnetism will be held at St. John’s College in Santa Fe, June 25-28, 1998. The conference, sponsored by the Institute for Rock Magnetism (University of Minnesota), with support from NSF, will feature a format promoting in-depth discussions centered on rock-magnetic aspects of the following two themes: (1) Critical observations and constraints for comparing paleomagnetic field records and numerical dynamo models; (2) Dynamics of environmental and climate change. Gary Glatzmaier and Frank Oldfield will keynote the respective sessions. The open discussion format will require us to restrict the number of participants to approximately 40, including students and senior researchers. Limited travel funds are available; preference will be given to students, post-docs and others with demonstrable need. To indicate your interest in participating, and to apply for travel funds, contact Mike Jackson at the IRM by April 22.

Bibliography


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On May 18, 1910, the comet passed within 23 x 10^6 km and Earth passed through the tail, but as Legrande notes, "nothing remarkable happened... no unusual optical, meteorological, or magnetic phenomena were observed."

Halley

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Bibliography


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, Associate Professor/Associate Director; Jim Marvin, Senior Scientist; Mike Jackson, Senior Scientist/Facilities Manager, and Peat Solheim, Scientist.

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

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