Glossary of magnetic terms

anhysteretic remanent magnetisation (ARM) The remanence produced during the smooth decay of a strong alternating **field** in the presence of a weak steady **field**.

anisotropy of susceptibility The variation of magnetic **susceptibility** with direction. Only found in recent sediments if a fabric is present. Dominated by the shape of **ferrimagnetic** grains, e.g. alignment of elongated magnetite grains in tills.

antiferromagnetism A type of magnetic behaviour arising from crystals having lattices in which adjacent atoms have antiparallel spins. The **susceptibility** is very low and the **remanence** zero. Exhibited by MnO and FeO, Antiferromagnetic material becomes **paramagnetic** above the **Néel temperature**.

blocking temperature The critical temperature at which thermal energy is just sufficient to cause spontaneous reversals of **magnetic moment**. On cooling, a magnetic grain acquires a spontaneous magnetisation at the **Curie temperature**. However, at such elevated temperatures, thermal energy is generally able to reorientate the **magnetic moment** and the moment is not stabilised until the grain is cooled below the blocking temperature. **Superparamagnetic** grains, on account of their small volumes, have blocking temperatures below room temperature.

blocking volume The threshold volume which separates **superparamagnetic** and **stable single-domain** behaviour. Grains smaller than the blocking volume have lower magnetic energies than thermal energies and their **magnetisation** consequently fluctuates in the same way as in a **paramagnetic** gas. Chemical growth through the blocking volume locks in the average **magnetisation** of an assemblage of grains as a stable **remanence**.

canted antiferromagnetism An imperfect form of **antiferromagnetism** in which the spins are not quite antiparallel. Can result in weak but very stable **remanences**, e.g. haematite.

chemical remanent magnetisation (CRM) The remanence acquired when a magnetic material is chemically formed or crystallised in a magnetic field.

coercivity or coercive force $(B_0)_C$ The reverse field required to reduce the **magnetisation** to zero from **saturation**.

coercivity of remanence $(B_0)_{CR}$ The reverse **field** required to reduce the **remanent magnetisation** to zero after **saturation**.

Curie temperature or **Curie point** (T_C) The temperature above which a **ferromagnetic** or **ferrimagnetic** substance becomes **paramagnetic**.

declination (D) The angle between geographical (or true) north and a magnetic **remanence** or magnetic **field**. A westerly variation is recorded as a positive declination, an easterly variation as negative.

demagnetisation The process of depriving a specimen of its **magnetisation**.

(a) *Alternating field.* Demagnetisation is achieved by subjecting a specimen to an alternating magnetic **field** which smoothly decreases to zero.

(b) *Thermal.* Demagnetisation is achieved by cooling a specimen from above its **Curie temperature** in zero magnetic **field**.

detrital remanent magnetisation (DRM) The **remanence** found in sediments in which the magnetic particles have inherited a **remanence** from the material from which they have been eroded and have tended to be aligned in the **geomagnetic field** as the sediment formed.

diamagnetism (cross-magnetism) A phenomenon occurring in all substances, due to a change in orbital motion of electrons about the nucleus in an applied field. Causes a rod of material, when suspended between the poles of a magnet, to arrange itself across the line joining the poles. Results in a weak negative **susceptibility** which is often masked by the much greater effect of **paramagnetism** or **ferromagnetism**. Exhibited by quartz, feldspars, calcite.

dipole field The magnetic **field** pattern associated with, for example, a small bar magnet. On the surface of the Earth (or any sphere of radius a) surrounding a **magnetic dipole** (of moment m):

(a) the total **field intensity** (F) is related to the distance ($\pi/2 - \lambda$) from the **pole position** by the equation $F = m\,(1 + 3\sin^2)^{\frac{1}{2}}/a^3$;

(b) the **inclination** (I) of the field is given by the equation $\tan I = 2\tan\lambda$;

(c) the **declination** (D) of the **field** is 0° by definition.

domain A region of parallel atomic **magnetic moments** in a crystal, which behaves as a unit during change in **magnetisation**. Domains form because they minimise the potential energy associated with a **magnetised** sample.

excursion A change in direction of the **geomagnetic field** in which the virtual **geomagnetic pole** migrates through more than 45° for some 10^2 to 10^4 years and then returns to its original **polarity**. Such changes have not yet been demonstrated to be worldwide phenomena.

ferrimagnetism A phenomenon similar to **ferromagnetism** but where the exchange interactions favour both parallel and antiparallel alignment of the **magnetic moments** of groups of atoms. A net **magnetisation** is observed. Exhibited by spinel-structured minerals, e.g. magnetite, maghaemite.

ferromagnetism A phenomenon of some crystalline substances due to unbalanced electron spins combined with an ionic spacing such that very large forces, called exchange interactions, cause coupling and alignment of all the individual **magnetic moments** of millions of atoms to give highly magnetic domains. Results in positive and relatively large **susceptibilities** and large **remanence** and **hysteresis**. Exhibited by iron and some other metals.

field (B_0) The magnetic field of force resulting from the presence of either a permanent magnet or an electric current in the neighbourhood. The free space **induction**, measured in tesla. $B_0 = \mu_0 H$.

frequency-dependent susceptibility (χ_{fd}) The time delay between the application of a **field** and the **magnetisation** response causes **susceptibility** to vary with frequency. At vanishingly low frequencies (in static measurements) **magnetisation** and **field** remain in phase. At higher frequencies relaxation phenomena result in a decrease in **susceptibility** and in associated energy losses which appear as heat in the sample.

geocentric axial dipole field The **field** due to a **dipole** situated at the centre of the Earth and aligned along the Earth's axis of rotation. This is a good approximation to the time average of the **geomagnetic field** over a period of about 10^6 years.

geomagnetic field The magnetic **field** associated with the Earth. A good approximation of the present geomagnetic field is that of a **dipole**, situated at the centre of the Earth, inclined at 11½° to the Earth's rotation axis.

hysteresis A physical phenomenon where the **magnetisation** produced by an applied **field** lags behind the **field**, with a consequent energy loss.

inclination (I) The angle between the horizontal plane and a **magnetic remanence** or magnetic **field**. A downwards dip of the north-seeking pole is recorded as a positive inclination and an upwards orientation as negative.

induction (B) The induction of magnetism in a medium by an external magnetic **field**.

intensity The magnitude of a **magnetic remanence** (M) or the magnitude of a magnetic **field** (B).

intensity or excitation (H) The strength of a **magnetic field** measured in ampere per metre. Defined through Ampere's law. Rarely used alone in the SI system.

isothermal remanent magnetisation (IRM) The **remanence** grown by the application and subsequent removal of a magnetic **field**. (The ordinary sense of magnetisation.)

magnetic moment (m) The couple exerted on a magnet placed at right angles to a uniform magnetic **field** with unit flux density. Measured in ampere metre^2.

magnetisation (M) The **magnetic moment** per unit volume of a magnetised body. Measured in ampere per metre. Generally made up of two components:

(a) the **remanent magnetisation** (which remains after removal of the external **field**),

(b) the **induced magnetisation** (which disappears after removal of the **field**).

multidomain A magnetic grain which contains more than one **domain**. Large grains divide into more than one **domain** in order to reduce their total energy. Multidomain grains have much lower **remanences** and **coercivities** than **stable single-domain grains**.

natural remanent magnetisation (NRM) The residual **magnetisation** possessed by rocks and other *in situ* materials.

Néel temperature The critical temperature below which the atomic moments of an **antiferromagnet** or **ferrimagnet** are arranged alternately parallel and antiparallel.

paramagnetism (parallel-magnetism) A phenomenon occurring in substances with unpaired electrons. Causes a rod of the substance in a magnetic **field** to arrange itself parallel to the magnetic **field**. A small positive **susceptibility** arises from the alignment of the **magnetic moment** of individual atoms of the substance in an applied **field**. Displayed for example by substances with rare earth or transition series members, e.g. clays, pyroxenes, amphiboles.

permeability of a vacuum (free space) (μ_0) The ratio of the magnetic flux density, B_0, in a vacuum to the external **field intensity**, H. i.e. $\mu_0 = B_0/H$. The exact value of μ_0 is $4\pi \times 10^{-7}$ henry per metre.

polarity reversal A **geomagnetic field** change in which both the **declination** and **inclination** move through 180° and then remain stable. Polarity reversals are worldwide phenomena.

pole position The point of intersection of the extension of a dipole axis and the Earth's surface. Two pole positions result, named the north and south poles.

(a) **geomagnetic pole position** Associated with the Earth's present **geocentric dipole field**. The north geomagnetic pole lies in north-west Greenland at 78½°N, 70°W.

remanent magnetisation or remanence The **magnetisation** remaining in the absence of an external magnetic **field**.

saturation isothermal remanent magnetisation (M_{RS} or σ_{RS} or SIRM) The maximum **remanence** attainable. It is produced by the application and removal of a powerful magnetic **field**. We use the symbol SIRM for remanent magnetisations produced in the strongest readily available laboratory field (often 1 tesla). We recognise that our SIRM will fall short of the true saturation remanence (σ_{RS}) of the physicist when high **coercivity**, **antiferromagnetic** minerals are incorporated in our samples.

saturation magnetisation (M_S or σ_S) The strongest possible **magnetisation** which can be produced in a specimen by applying a powerful **field**.

secular variation **Geomagnetic field** fluctuations of smaller angles than are involved in **excursions** but of a similar timescale of 10^1–10^4 years. Such **field** changes are recognisable over regions of 'continental extent'.

specific magnetisation (σ) The **magnetic moment** per unit mass of a magnetised body. Measured in A m^2 kg^{-1}.

specific susceptibility (χ) Magnetic **susceptibility** expressed in terms of unit mass. We measure specific susceptibility in units of m^3 kg^{-1}.

spinel An oxide mineral with cubic symmetry with the general formula $R^{2+}O.R_2^{3+}O_3$ where R^{2+} is a divalent metal and R^{3+} a trivalent metal. Magnetite ($Fe^{2+}O.Fe_2^{3+}O_3$) forms a continuous series with ulvospinel ($Fe_2^{2+}Ti^{4+}O_4$).

stable single-domain grain A magnetic grain with just one **domain** which at normal temperatures is capable of retaining its **remanent magnetisation** unaltered for millions of years.

superparamagnetism The phenomenon of the rapid decay in **remanence** of magnetic grains. Superparamagnetic behaviour occurs in **ferro-** and **ferrimagnetic** grains below a critical size. For spherical magnetite grains the critical diameter is about 10^{-8} m. Superparamagnetic grains are also characterised by a noticeably high **susceptibility** and by zero **coercivity**.

susceptibility (κ) A measure of the degree to which a substance can be magnetised. The ratio of the **magnetisation** (M) produced in a substance to the **intensity** of the magnetic **field** (H) to which it is subject. $\kappa = M/H$. With this convention, susceptibility defined using unit volume is dimensionless.

thermoremanent magnetisation (TRM) The **remanence** a sample gains by cooling from above the **Curie temperature** in a magnetic **field**.

viscosity The change of **magnetisation** with time. In natural materials viscous **magnetisation** changes are generally produced by thermal effects which cause changes in **domain** wall positions or **domain** alignment or else cause reversal in **magnetisation** direction of **single-domain grains** close to the critical **superparamagnetic** grain-size boundary. Viscous **magnetisation** and **remanence** changes are normally proportional to the logarithm of time and to the **intensity** of the ambient **field**.

viscous remanent magnetisation (VRM) The **remanence** produced by a weak magnetic **field** applied over a long period of time.

References

Aaby, B., J. Jacobsen and O. S. Jacobsen 1978. Pb-210 dating and lead deposition in the ombrotrophic peat bog Draved Mose, Denmark. *Danm. Geol. Unders. Arbog.* 45–68.

Abrahamsen, N. and K. L. Knudsen 1979. Indication of a geomagnetic low-inclination excursion in supposed middle Weichselian interstadial marine clay at Rubjerg, Denmark. *Phys. Earth Planet. Interiors* 18, 238–46.

Abrahamsen, N. and P. W. Readman 1980. Geomagnetic variations recorded in older (>2300 BP) and younger Yoldia clay (~14 000 BP) at Nore Lyngby, Denmark. *Geophys. J. R. Astr. Soc.* 62, 329–44.

Abrahamsen, N., G. Schoenharting and M. Heinesen 1984. Palaeomagnetism of the Vestmanna core and magnetic age and evolution of the Faeroe Islands. In *The deep drilling project 1980–1981 in the Faeroe Islands.* 93–108 Ann. Soc: et. Sci. Faeorensis Suppl. IX 159. O. Berthelsen, A. Noe-Nygaard and J. Rasmussen (eds).

Ade-Hall, J. M. 1964. The magnetic properties of some submarine oceanic lavas. *Geophys. J.* 9, 85–92.

Ade-Hall, J. M., H. C. Palmer and T. P. Hubbard 1971. The magnetic and opaque petrological response of basalts to regional hydrothermal alternation. *Geophys. J. R. Astr. Soc.* 24, 137–74.

Aitken, M. J. 1974. *Physics and archaeology.* Oxford: Clarendon Press.

Aitken, M. J. 1978. Archaeological involvements of Physics. *Physics Reports* (Section C of *Physics Letters*) 40C, 5, 277–351.

Aksenov, V. V. and S. S. Lapin 1967. Theory and equipment of the induction method of measuring the magnetic susceptibility of rock specimens. *Isv. Earth Physics* 10, 106–12. English translation 1968. *Physics of the Solid Earth*, 697–701.

Allan, T. D. 1969. A review of marine geomagnetism. *Earth Sci. Rev.* 5, 217–54.

Anderson, T. W., R. J. Richardson and J. H. Foster 1976. *Late Quaternary palaeomagnetic stratigraphy from east-central Lake Ontario.* Rep. of Activities, Part C: Geol. Surv. Can. Paper 76–1C.

Appleby, P. G., J. A. Dearing and F. Oldfield 1985. Magnetic studies of erosion in a Scottish lake-catchment. I. Core chronology and correlation. *Limnol. Oceanogr.* 30, 144–153.

Arkell, B. 1984. *Magnetic tracing of river bedload.* Unpublished PhD thesis. University of Liverpool.

Arkell, B., G. Leeks, M. Newson and F. Oldfield 1982. Trapping and tracing: some recent observations of supply and transport of coarse sediment from upland Wales. *Spec. Publ. Int. Assoc. Sediment.* 6, 117–29.

As, J. A. 1967. The a.c. demagnetization technique, in *Methods in palaeomagnetism,* D. W. Collinson, K. M. Creer and S. K. Runcorn (eds). Amsterdam: Elsevier.

Bailey, M. E. and D. J. Dunlop 1983. Alternating field characteristics of pseudo-single-domain (2–14μm) and multidomain magnetite. *Earth Planet. Sci. Letters* 63, 335–52.

Banerjee, S. K., S. P. Lund and S. Levi 1979. Geomagnetic record in Minnesota lake sediments – absence of the Gothenburg and Erieu excursions. *Geology* 7, 588–91.

Banerjee, S. K., J. King and J. Marvin 1981. A rapid method for magnetic granulometry with applications to environmental studies. *Geophys. Res. Letters* 8, 333–6.

Banerjee, S. K. 1981. Experimental methods of rock magnetism and palaeomagnetism. *Adv. Geophys.* 23, 25–99.

Barber, K. E. 1976. History of vegetation. In S. B. Chapman (ed.). *Methods in plant ecology* 5–83. Oxford: Blackwell.

Barraclough, D. R. 1974. Spherical harmonic analyses of the geomagnetic field for eight epochs between 1600 and 1910. *Geophys. J. R. Astr. Soc.* 36, 497–513.

Barton, C. E. 1978. *Magnetic studies of some Australian lake sediments.* Unpubl. PhD thesis, Australian National University, Canberra.

Barton, C. E. and M. W. McElhinny 1979. Detrital remanent magnetisation in five slowly redeposited long cores of sediment. *Geophys. Res. Letters* 6, 229–32.

Barton, C. E. and M. W. McElhinny 1981. A 10 000 yr geomagnetic secular variation record from three Australian maars. *Geophys. J. R. Astr. Soc.* 67, 465–85.

Bates, L. F. 1961. *Modern magnetism*, 4th edn. London: Cambridge University Press.

Battarbee, R. W. 1978. Observations on the recent history of Lough Neagh and its drainage basin. *Phil. Trans. R. Soc. Lond. B* 281, 303–45.

Bauer, L. A. 1896. On the secular motion of a free magnetic needle, II. *Phys. Rev.* 3, 34–48.

Baule, G. M. and R. McFee 1963. Detection of the magnetic field of the heart. *Am. Heart J.* 66, 95–6.

Bean, C. P. and J. D. Livingston 1959. Superparamagnetism. *J. Appl. Phys.* 30, 1205–95.

Beckwith, P. R., J. B. Ellis, D. M. Revitt and F. Oldfield

1984. Identification of Pollution Sources in Urban Drainage Systems Using Magnetic Methods. In *Urban Storm Drainage*, P. Balmer (ed.), Göteborg.

Beckwith, P. R., J. B. Ellis, D. M. Revitt and F. Oldfield 1986. Heavy metal and magnetic relationships for urban source sediments. *Phys. Earth Plant Int.* **42**, 67–75.

Bengtsson, L. and T. Persson 1978. Sediment changes in a lake used for sewage reception. *Polskie Archivum Hydrobiologii* **25**, 17–33.

Bhandari, N., J. R. Arnold and D. Parkin 1968. Cosmic dust in the stratosphere. *J. Geophys. Res.* **73**, 1837–45.

Bhathal, R. S. and F. D. Stacey 1969. Frequency independence of low-field susceptibility of rocks. *J. Geophys. Res.* **74**, 2025–7.

Bjorck, S., J. A. Dearing and A. Jonsson 1982. Magnetic susceptibility of late Weichselian deposits in S. E. Sweden. *Boreas* **11**, 99–111.

Blackett, P. M. S. 1952. A negative experiment relating to magnetism and the Earth's rotation. *Phil. Trans. R. Soc. London* **A245**, 309–70.

Blakemore, R. P. 1975. Magnetotactic bacteria. *Science* **190**, 377–9.

Blakemore, R. P., and R. B. Frankel 1981. Magnetic navigation in bacteria, *Scient. Am.* **245**, **6**, 58–65.

Blakemore, R. P. 1900. Magnetotactic bacteria. *Ann. Rev. Microbiol.* **36**, 217–38.

Bloch, F. 1930. Zur theorie des ferromagnetismus, *Zeit. Phys.* **61**, 206–19.

Bloemendal, J. 1980. Paleoenvironmental implications of the magnetic characteristics of sediments from deep sea drilling project site 514 southeast Argentine basin. *Initial Reports of the D.S.D.P. Washington* **LXXI**, 1097–8.

Bloemendal, J., F. Oldfield and R. Thompson 1979. Magnetic measurements used to assess sediment influx at Llyn Goddionduon. *Nature* **280**, **5717**, 50–3.

Bloemendal, J. 1982. *The quantification of rates of total sediment influx to Llyn Goddionduon, Gwynedd.* Unpubl. PhD thesis. University of Liverpool.

Bonhommet, N. and J. Babkine 1967. Sur la presence d'aimantations inversees dans la chaines des puys. *C. R. Acad. Sci. Paris* **264**, 92–4.

Borman, F. H. and G. E. Likens 1969. The watershed–ecosystem concept and studies of nutrient cycles. *The ecosystem concept in natural resource management.* G. M. Van Dyne (ed.).

Bradshaw, R. H. W. and R. Thompson 1985. The use of magnetic measurements to investigate the mineralogy of some Icelandic lake sediments and to study catchment processes. *Boreas.* **14**, 203–15.

Braginsky, S. I. 1963. Structure of the F layer and reasons for convection in the Earth's core. *Dokl. Akad. Nauk SSR* **149**, 1311–14.

Brownlee, D. E. Extraterrestrial Components. In *The sea*, vol. 7. *The oceanic lithosphere*, C. Emiliani (ed.). New York: Wiley.

Bruckshaw, J. M. and E. I. Robertson 1948. The measurement of the magnetic properties of rocks. *J. Sci. Instrum.*, **25**, 444–6.

Bruckshaw, J. M., and B. S. Rao 1950. Magnetic hysteresis of igneous rocks. *Proc. Phys. Soc. London* **63**, 931–8.

Brush, G. S., C. Leak and J. Smith 1980. The natural forests of Maryland: an explanation of the vegetation map of Maryland. *Ecol. Monogr.* **50**, 77–92.

Brush, G. L., E. A. Martin, R. S. De Fries and C. A. Rice 1982. Comparison of ^{210}Pb and pollen methods for determining rates of estuarine sediment accumulation. *Quat. Res.* **18**, 196–217.

Bucha, V. 1973. The continuous pattern of variations of the geomagnetic field in the Quaternary and their causes. *Stud. Geophys. Geod.* **17**, 218–31.

Bullard, E. C. 1948. The secular change in the Earth's magnetic field. *Mon. Not. Roy. Astr. Soc. Geophys. Suppl.* **5**, 248–57.

Burns, R. G. and V. M. Burns 1981. Authigenic oxides. In *The sea* vol. 7. *The oceanic lithosphere*, C. Emiliani (ed.), 875–914.

Butler, R. F. and S. K. Banerjee 1975. Theoretical single-domain grain size range in magnetite and titano-magnetite, *J. Geophys. Res.* **80**, 4049–58.

Campbell, B. L., R. J. Loughran and G. L. Elliott 1982. Caesium–137 as an indicator of geomorphic processes in a drainage basin system. *Aust. Geog.* **20**, 49–64.

Carling, P. A. and N. A. Reader 1982. Structure, composition and bulk properties of upland stream gravels. *Earth Surfaces Processes and Landforms* **7**, 349–65.

Chaddha, G. and M. S. Seehra 1983. Magnetic components and particle size distribution of coal fly ash. *J. Phys. D: Appl. Phys.* **16**, 1767–76.

Chamberlain, A. C. 1966. Transport of *Lycopodium* spores and other small particles to rough surfaces. *Proc. R. Soc. Lond. A* **296**, 45–70.

Channel, J. E. T., J. G. Ogg and W. Lowrie 1982. Geomagnetic polarity in the early Cretaceous and Jurassic. *Phil. Trans. R. Soc. Lond. A* **306**, 137–46.

Chester, R. and L. R. Johnson 1971. Atmospheric dusts collected off the Atlantic coasts of north Africa in the Iberian Peninsula. *Marine Geol.* **11**, 251–60.

Chester, R. 1972. Geological, geochemical and environmental implications of the marine dust veil. In *The changing chemistry of the oceans* **291**, 20th Nobel Symposium Volume. D. Dyssen and P. Jaguer (eds).

Chester, R., E. J. Sharples, G. Sanders, F. Oldfield and A. C. Saydam 1984. The distribution of natural and non-crustal ferrimagnetic minerals in soil-sized particulates from the Mediterranean atmosphere. *Water, Air and Soil Pollut.* **23**, 25–35.

Chevallier, R. and S. Mattieu 1943. Propietes magnetique des poudres d'hematites – influence des dimensions des grains. *Ann. Phys.* **18**, 258–88.

Chikazumi, S. 1964. *Physics of magnetism.* New York: Wiley.

Chorlton, J. 1981. *Source identification of suspended sediment by magnetic measurements.* Unpubl. BSc dissertation. Department of Geography, University of Liverpool.

Cisowski, S. W. 1980. The relationship between the magnetic properties of terrestrial igneous rocks and the composition and internal structure of their component Fe-Oxide grains. *Geophys. J. R. Astr. Soc.* **60**, 107–22.

Clark, A. J. 1980. Magnetic dating. *Sussex Arch. Collection* **18**, 7–12.

Clark, D. A. 1983. Comments on magnetic petrophysics. *Bull. Aust. Soc. Explor. Geophys.* 14, 49–62.

Clark, D. A. 1984. Hysteresis properties of sized dispersed monocinic pyrrhotite grains. *Geophys. Res. Letters*, 11, 173–6.

Clark, H. C. and J. P. Kennett 1973. Palaeomagnetic excursion recorded in latest Pleistocene deep-sea sediment. Gulf of Mexico. *Earth Planet. Sci. Letters* **19**, 267–74.

Clark, R. M. and R. Thompson 1978. An objective method for smoothing palaeomagnetic data. *Geophys. J. R. Astr. Soc.* **52**, 205–13.

Clark, R. M. and R. Thompson 1979. A new approach to the alignment of time series. *Geophys. J. R. Astr. Soc.*, **58**, 593–607.

Clement, B. M. and D. V. Kent 1984. Latitudinal dependency of geomagnetic polarity transition durations. *Nature* 310, 488–91.

Clough, W. S. 1973. Transport of particles to surfaces. *Aerosol Science* **4**, 227–34.

Coe, R. S., M. Prevot, E. A. Mankinen and C. S. Gromme 1983. Behaviour of the complete field vector during the Steens mountain reversal. *IAGA Bulletin* **48**, 179–80.

Cohen, I. D. 1967. A shielded facility for low-level magnetic measurements. *J. Appl. Phys.* **38**, 1295–6.

Cohen, D. 1970. Large-volume conventional magnetic shields. *Rev. Phys. Appl.* **5**, 53–8.

Cohen, D. 1973. Ferromagnetic contamination in the lungs and other organs of the human body. *Science* **180**, 745–8.

Cohen, D., S. R. Arai and J. D. Brain 1979. Smoking impairs long-term dust clearance from the lung. *Science* **204**, 514–17.

Colani, C. and M. J. Aitken 1966. A new type of locating device. *Archaeometry* **9**, 9–19.

Colley, S., J. Thompson, T. R. S. Wilson and N. C. Higgs 1984. Post-depositional migration of elements during diagenesis in brown clay and turbidite sequence in the north east Atlantic. *Geochim. Cosniochim. Acta.* **48**, 1223–1236.

Collinson, D. W. 1975. Instruments and techniques in palaeomagnetism and rock magnetism. *Rev. Geophys. Space. Phys.* **13**, 659–86.

Collinson, D. W. 1983. *Methods in rock magnetism and palaeomagnetism – techniques and instrumentation.* London: Chapman and Hall.

Collinson, D. W., K. M. Creer and S. K. Runcorn (eds) 1967. *Methods in palaeomagnetism.* Amsterdam: Elsevier.

Correll, D. L. 1977. An overview of the Rhode river watershed program. In *Watershed research in eastern North America.* D. L. Correll (ed.). Smithsonian Institution, Washington. 105–20.

Courtillot, V., J. Ducruix and J.-L. le Mouël 1978. Sur un accélération récente de la variation séculaire du champ magnétique terrestre. *C.R. Hebd. Seances Acad. Sci. Ser. D.*, 287, 1095–8.

Cox, A. 1969. Geomagnetic reversals. *Science* **163**, 237–44.

Cox, A. 1973. *Plate tectonics and geomagnetic reversals.* New York: W. H. Freeman.

Cox, A., R. R. Doell and G. B. Dalrymple 1963. Geomagnetic polarity epochs and Pleistocene geochronometry. *Nature* **198**, 1049–51.

Craik, D. J. 1971. *Structure and properties of magnetic materials.* London: Pion.

Crangle, J. 1975. SI Units in magnetism. *Physics Bulletin* **26**, 539.

Crangle, J., 1977. *The magnetic properties of solids.* London: Edward Arnold.

Creer, K. M. 1959. A.C. demagnetization of unstable Triassic Keuper Marls from S. W. England. *Geophys. J. R. Astr. Soc.* **2**, 261–75.

Creer, K. M., T. W. Anderson and C. F. M. Lewis 1976. Late Quaternary geomagnetic stratigraphy recorded in Lake Erie sediments. *Earth Planet. Sci. Letters.* **31**, 37–47.

Creer, K. M., R. Thompson, L. Molyneux and F. J. H. Mackereth 1972. Geomagnetic secular variation recorded in the stable magnetic remanence of recent sediments. *Earth Planet. Sci. Letters* **14**, 115–27.

Curie, P. 1895. Propriétés magnetiques des corps à diverses temperatures. *Ann. de Chim. et Phys.* **5**, 289.

Currie, R. G. and B. D. Bornhold 1983. The magnetic susceptibility of continental-shelf sediments, west coast Vancouver Island, Canada. *Marine Geology* **51**, 115–27.

Dalrymple, G. B. 1972. Potassium–argon dating of geomagnetic reversals and North American glaciations. In *Calibration of hominid evolution: recent advances in isotopic and other dating methods applicable to the origin of man.* W. W. Bishop and J. A. Miller (eds). New York: Scottish Academic Press.

Dankers, P. H. 1978. *Magnetic properties of dispersed natural iron oxides of known grain size.* PhD thesis. University of Utrecht.

Davidson, R. L., D. F. S. Natusch, J. R. Wallace and C. A. Evans Jr. 1974. Trace elements in fly ash: dependence of concentration on particle size. *Environ. Sci. Technol.* **8**, 1107–13.

Davis, M. B. 1976. Erosion rates and land use history in southern Michigan. *Environ. Conserv.* **3**, 139–48.

Davis, M. B. and M. S. Ford 1982. Sediment focusing in

Mirror Lake, New Hampshire. *Limnol. Oceanogr.* 27, 137–50.

Davis, P. M. and M. E. Evans 1976. Interacting single-domain properties of magnetite intergrowths. *J. Geophys. Res.* 81, 989–94.

Davis, R. B. and R. W. Doyle 1969. A piston corer for upper sediment in lakes. *Limnol. Oceanogr.* 14, 643–8.

Day, R., M. Fuller and V. A. Schmidt 1977. Hysteresis properties of titanomagnetites: grain-size and compositional dependence. *Phys. Earth Planet. Interiors* 13, 260–7.

Dearing, J. A. 1979. *The applications of magnetic measurements to studies of particulate flux in lake–watershed ecosystems.* Unpubl. PhD thesis. University of Liverpool.

Dearing, J. 1983. Changing patterns of sediment accumulation in a small lake in Scania, southern Sweden. *Hydrobiologia* 103, 59–64.

Dearing, J. A., J. K. Elner, and C. M. Happey-Wood 1981. Recent sediment influx and erosional processes in a Welsh upland lake–catchment based on magnetic susceptibility measurements. *Quat. Res.* 16, 356–72.

Dearing, J. A., and R. J. Flower 1982. The magnetic susceptibility of sedimenting material trapped in Lough Neagh, Northern Ireland and its erosional significance. *Limnol. Oceanogr.* 17, 969–75.

Dearing, J. A., B. A. Maher and F. Oldfield 1985. Geomorphological linkages between soils and sediments: the role of magnetic measurements. In *Geomorphology and soils*, K. Richards (ed.). London: George Allen & Unwin.

Dearing, J. A., R. I. Morton, T. W. Price and I. D. L. Foster 1986. Tracing movements of topsoil by magnetic measurements: two case studies. *Phys. Earth Planet Int.* 42, 93–104.

Dell, C. I. 1972. An occurrence of greigite in Lake Superior sediments. *Am. Mineralogist* 57, 1303–4.

Denham, C. R. 1974. Counter clockwise motion of palaeomagnetic directions 24 000 years ago at Mono lake, California. *J. Geomag. Geoelectr.* 26, 487–98.

Denham, C. R. 1975. Spectral analysis of palaeomagnetic time series. *J. Geophys. Res.* 80, 1897–901.

Denham, C. R. 1976. Blake polarity episode in two cores from the greater Antilles outer ridge. *Earth Planet Sci. Letters* 9, 422–34.

Denham, C. R. 1981. Numerical correlation of recent paleomagnetic records in two Lake Tahoe cores. *Earth Planet. Sci. Letters* 54, 48–52.

Denham, C. R. and A. Cox 1971. Evidence that the Laschamp polarity event did not occur 13 300–30 400 years ago. *Earth Planet. Sci. Letters* 13, 181–90.

Digerfeldt, G. 1978. *A simple corer for sediment sampling in deep water.* Department of Quaternary Geology Report, University of Lund.

Doake, S. M. 1977. A possible effect of ice ages on the earth's magnetic field. *Nature* 267, 415–17.

Dodson, M. A. and E. A. McClelland-Brown 1980. Magnetic blocking temperatures of single-domain grains during slow cooling. *J. Geophys. Res.* 85, 2625–37.

Doe, S.-J. and W. K. Steel 1983. The late Pleistocene geomagnetic field as recorded by sediments from Fargher Lake, Washington, U.S.A. *Earth Planet. Sci. Letters*, 63, 385–98.

Donoghue, J. F. 1981. *Estuarine sediment transport and Holocene depositional history, Upper Chesapeake Bay.* Unpubl. PhD thesis. University of Southern California.

Doyle, J. L., T. L. Hopkins and P. R. Betzer 1976. Black magnetic spherule fallout in the eastern Gulf of Mexico. *Science*, 1157–9.

Dunlop, D. J. 1972. Magnetic mineralogy of unheated and heated red sediments by coercivity spectrum analysis. *Geophys. J. R. Astr. Soc.*, 27, 37–55.

Dunlop, D. J. 1973a. Superparamagnetic and single-domain threshold sizes in magnetite. *J. Geophys. Res.* 78, 1780–93.

Dunlop, D. J. 1973b. Theory of magnetic viscosity in lunar and terrestrial rocks. *Rev. Geophys. Space Phys.* 11, 855–901.

Dunlop, D. J. 1981. The rock magnetism of fine particles. *Phys. Earth Planet Interiors* 26, 1–26.

Dunlop, D. J. 1983a. Determination of domain structure in igneous rocks by alternating field and other methods. *Earth Planet. Sci. Letters* 63, 353–67.

Dunlop, D. J. 1983b. Viscous magnetization of 0.04–100μm magnetites. *Geophys. J. R. Astr. Soc.* 74, 667–87.

Dunlop, D. J. and M. Prevot 1982. Magnetic properties and opaque mineralogy of drilled submarine intrusive rocks. *Geophys. J. R. Astr. Soc.* 69, 763–802.

Dzyaloshinsky, I. E. 1958. A thermodynamic theory of 'weak' ferromagnetism of antiferromagnetics. *J. Phys. Chem. Solids* 4, 241–55.

Edgington, D. N. and J. A. Robbins 1975. Records of lead deposition in Lake Michigan sediments since 1800. *Environ. Sci. Technol.* 10, 266–73.

Edwards, K. J. 1978. *Palaeoenvironmental and archaeological investigations in the Howe of Cromar, Grampian region, Scotland.* Unpubl. PhD thesis. University of Aberdeen.

Edwards, K. J. and K. M. Rowntree 1980. Radiocarbon and palaeoenvironmental evidence for changing rates of erosion at a Flandrian stage site in Scotland in *Timescales in geomorphology*, R. A. Cullingford, D. A. Davison and J. Lewis (eds).

Ellis, J. B. 1979. The nature and sources of urban sediments and their relation to water quality. In *Man's impact on the hydrological cycle in the UK*, G. E. Hollis (ed.), 199–216.

Ellsasser, H. W. 1975. The upward trend in airborne particulates that isn't. In *The changing global environment.* S. F. Singer (ed.), 235–69. Dordrecht: D. Reidel.

Ellsasser, W. M. 1946. Induction effects in terrestrial magnetism. *Phys. Rev.* 69, 106–16.

Ellwood, B. B. 1980. Induced and remanent magnetic

properties of marine sediments as indicators of depositional processes. *Marine Geology* 38, 233–44.

Epp, R. J., J. W. Tukey and G. S. Watson 1971. Testing unit vectors for correlation. *J. Geophys. Res.* 76, 8480–3.

Ewing, J. A. 1900. *Magnetic induction in iron and other metals.* The Electrician Publishing Company.

Fisher, R. 1953. Dispersion on a sphere. *Proc. R. Soc. London A* 217, 295–305.

Foex, G. and R. Forrer 1926. Sur un appareil sensible pour la mesure precise des coefficients d'aimantation à diverses temperatures. *J. Phys. et Radium* 7, 180–7.

Foner, S. 1959. Versatile and sensitive vibration magnetometer. *Rev. Sci. Instrum.* 30, 548–57.

Freed, W. K. and N. Healy 1974. Excursions of the Pleistocene geomagnetic field recorded in Gulf of Mexico sediments. *Earth Planet. Sci. Letters* 24, 99–104.

Fuller, M. 1963. Magnetic anistropy and palaeomagnetism. *J. Geophys. Res.* 68, 293–309.

Fuller, M. 1974. Lunar magnetism. *Rev. Geophys. and Space Phys.* 12, 23–70.

Fuller, M., I. Williams and K. A. Hoffman 1979. Paleomagnetic records of geomagnetic field reversals and the morphology of the transitional fields. *Rev. Geophys. and Space Phys.* 17, 179–203.

Furr, A. K., T. F. Parkinson, R. A. Hinrichs, D. R. Van Campen, C. A. Bache, W. H. Gutermann, L. E. St. John, I. S. Pakkala and D. J. Lisk 1977. National survey of elements and radioactivity in fly ashes. Absorption of elements by cabbage grown in fly ash–soil mixture. *Environ. Sci. Technol.* 11, 1194–201.

Galt, J. K. 1952. Motion of a ferromagnetic domain wall in Fe_3O_4. *Phys. Rev.* 85, 664–9.

Gauss, C. F. 1833. Intensities vis magneticae terrestris ad mensuram absolutam revocata. *Gottingen Comment* 8, 3–44.

Gauss, C. F. 1839. Allgemeine Theorie des Erdmagnetismus (general theory of terrestrial magnetism). In *Scientific memoirs selected from the transactions of foreign academies and learned societies and from foreign journals*, 2, 184–251 (1841).

Gellibrand, H. 1635. *A discourse mathematical on the variation of the magnetical needle.* London: William Jones.

Gillingham, D. E. W. and F. D. Stacey 1971. Anhysteretic remanent magnetization (A.R.M.) in magnetite grains. *Pure Appl. Geophys.*, 91, 160–5.

Goldberg, E. D. 1975. Man's role in the major sedimentary cycle. In *The changing global environment*, S. F. Singer (ed.), 275–94. Dordrecht: D. Reidel.

Gordon, A. D. 1973. A sequence–comparison statistic and algorithm, *Biometrika* 60, 197–200.

Gordon, A. D. 1982. An investigation of two sequence–comparison statistics. *Aust. J. Stat.* 24, 332–42.

Goree, W. S. and M. Fuller 1976. Magnetometers using RF-driven squids and their applications in rock magnetism and palaeomagnetism. *Rev. Geophys. and Space Phys.* 14, 591–608.

Goudie, A. S. (ed.) 1981. *Geomorphological techniques.* London: George Allen & Unwin.

Gould, J. L. and K. P. Albe 1981. Human homing an elusive phenomenon. *Science* 212, 1061–3.

Gouy, M. 1889. Sur l'energie potentielle magnetique et la mesure des coefficients d'aimentation. *Compt. Rend. Acad. Sci. Paris* 109, 935–7.

Graham, I. 1976. The investigation of the magnetic properties of archaeological sediments. In *Geoarchaeology*, D. A. Davidson and M. L. Shackley (eds).

Granar, L. 1958. Magnetic measurements on Swedish varved sediments. *Arkiv forr Geofysik* 3, 1–40.

Gregory, K. J. and D. E. Walling 1973. *Drainage basin form and process: a geomorphological approach.* London: Edward Arnold.

Griffiths, D. H., R. F. King, A. I. Rees and A. E. Wright 1960. Remanent magnetism of some recent varved sediments. *Proc. R. Soc. London.* A 256, 359–83.

Haggerty, S. E. 1970. Magnetic minerals in pelagic sediments. *Ann. Rept. Geophys. Lab. Carnegie Institute Year Books*, 68. Washington 1560. 332–6.

Haggerty, S. E. 1976. Opaque mineral oxides in terrestral igneous rocks. In *Oxide minerals* 3. D. Rumble III (ed.), Mineralogical Society of America. Blacksburg: Southern Printing Co.

Hakanson, L. and M. Jansson 1983. *Principles of lake sedimentology.* Berlin: Springer

Hallam, J. S., J. N. Edwards, B. Barnes and K. J. Stuart 1973. A late glacial Elk with associated barbed points from High Furlong, Lancashire. *Proc. Prehist. Soc.* 39, 100–28.

Halley, E. 1692. An account of the cause of the change of the variation of the magnetical needle; with an hypothesis of the structure of the internal part of the Earth. *Phil. Trans. R. Soc. London* 17, 563–78.

Hamilton, A. C., W. Magowan and D. Taylor 1986. Use of the Bartington Meter to determine the magnetic susceptibility of organic-ride sediments from western Uganda. *Phys. Earth Plant Int.* 42, 5–9.

Hamilton, N. and A. I. Rees 1970. The use of magnetic fabric in paleocurrent estimation. In *Paleogeophysics*, S. K. Runcorn (ed.), 445–64. London: Academic Press.

Hammond, S. R., F. Theyer and G. H. Sutton 1974. Palaeomagnetic evidence of the northward movement of the Pacific plate in deep-sea cores from the central Pacific basin. *Earth Planet. Sci. Letters* 22, 22–8.

Hansen, L. D., D. Silberman and G. L. Fisher 1981. Crystalline components of stack-collected, size-fractionated coal fly ash. *Environ. Sci. Technol.* 15, 1057–62.

Harland, W. B., A. V. Cox, P. G. Llewellyn, C. A. G. Pickton, A. G. Smith and R. Walters 1982. *A geologic time scale.* Cambridge: Cambridge University Press.

Harrison, C. G. A. and J. M. Prospero 1977. Reversals of the earth's magnetic field and climatic changes. *Nature* **250**, 563–4.

Harvey, A. M., A. F. Baron, F. Oldfield and G. W. Pearson 1981. Dating of post-glacial landforms in the central Howgills. *Earth Surface Processes* **6**, 401–12.

Hayes, J. G. and J. Halliday 1974. The least-squares fitting of cubic spline surfaces to general data sets. *J. Inst. Maths Applics* **14**, 89–103.

Heirtzler, J. R., G. O. Dickson, E. M. Herron, W. C. Pitman and X. Le Pichon 1968. Marine magnetic anomalies, geomagnetic field reversals and motions of the ocean floor and continents. *J. Geophys. Res.* **73**, 2119–35.

Heller, F. 1980. Self-reversal of natural remanent magnetisation in the Olby–Laschamp lavas. *Nature* **284**, 334–5.

Heller, F. and T. S. Liu 1982. Magnetostratigraphic dating of loess deposits in China. *Nature* **300**, 431–3.

Henry, W. M. and K. T. Knapp 1980. Compound forms of fossil fuel fly ash emissions. *Environ. Sci. Technol.* **14**, 450–6.

Henshaw, P. C. and R. T. Merrill 1979. Characteristics of drying remanent magnetization in sediments. *Earth Planet. Sci. Letters* **43**, 315–20.

Henshaw, P. C. and R. T. Merrill 1980. Magnetic and chemical changes in marine sediments. *Rev. Geophys. Space Phys.* **18**, 483–504.

Hide, R. and P. H. Roberts 1956. The origin of the main geomagnetic field. *Physics and Chemistry of the Earth* **4**, 35–98. Oxford: Pergamon.

Hidy, G. M. and J. R. Brock 1971. An assessment of the global sources of tropospheric aerosols. In *Proceedings of the 2nd international clean air congress*, H. M. Englund and W. T. Beery (eds), 1088–97. New York: Academic Press.

Higgitt, S. E. 1985. *The palaeocology of the Lac d'Annecy and its drainage basin.* Unpubl. PhD thesis. University of Liverpool.

Hilton, J. and J. P. Lishman 1985. The effect of redox change on the magnetic susceptibility of sediments from a seasonally anoxic lake. *Limnol. Oceanogr.*, 30, 907–909.

Hirons, K. R. 1983. *Paleoenvironmental investigations in east Co. Tyrone, Northern Ireland.* Unpubl. PhD thesis. Queens University, Belfast.

Honda, K. and T. Sone 1914. Uber die magnetische untersuchung der Strukturanderungen in Eisen-und Chromverbindungen bei hohoheren Temperaturen. *Sci. Rept. Tohuku Imperial University* **3**, 224–34.

Horie, S., K. Yaskawa, A. Yamanoto, T. Yokoyama and M. Hyodo 1980. Paleolimnology of Lake Kizaki. *Arch. Hydrobiol.* **89**, 407–15.

Hulett, L. D., A. J. Weinberger, M. Ferguson, K. J. Northcutt, and W. S. Lyon 1981. *Trace element and phase relations in fly ash.* DE-81028555 EPR1-EA-1822.

Hughes, S. J. 1978. *The recent paleoecology and magnetic stratigraphy of Ringinglow Bog, near Sheffield.* Unpubl. BSc dissertation. University of Liverpool.

Hunt, A. 1986. The application of mineral magnetic methods to atmospheric aerosol discrimination. *Phys. Earth Planet Int.* **42**, 10–21.

Hunt, A., J. Jones and F. Oldfield 1984. Magnetic measurements and heavy metals in atmospheric particulates of anthropogenic origin. *The Science of the Total Environment*, **33**, 129–39.

Huttunen, P. and J. Merilainen 1978. New freezing device providing large, unmixed sediment samples from lakes. *Ann. Bot. Fenn.* **15**, 128–30.

Huttunen, P. and J. Stober 1980. Dating of palaeomagnetic records from Finnish lake sediment cores using pollen analysis. *Boreas* **9**, 193–202.

Hyodo, M. 1984. Possibility of reconstruction of past geomagnetic field from homogeneous sediments. *J. Geomag. Geoelectr.* 36, 45–62.

Irving, E. 1964. *Paleomagnetism and its application to geological and geophysical problems.* New York: Wiley.

Irving, E. 1977. Drift of major continental blocks since the Devonian. *Nature* **270**, 304–9.

Irving, E. and A. Major 1964. Post-depositional detrital remanent magnetization in a synthetic sediment. *Sedimentology* **3**, 135–43.

Irving, E., L. Molyneux and S. K. Runcorn 1966. The analysis of remanent intensities and susceptibilities of rocks. *Geophys. J. R. Astr. Soc.* **10**, 451–64.

Irving, E. and G. Pullaiah 1976. Reversals of the geomagnetic field, magnetostratigraphy, and relative magnitude of palaeosecular variation in the phanerozoic. *Earth. Sci. Rev.* **12**, 35–64.

Isbell, R. F., P. J. Stephenson, G. G. Murtha and G. P. Gillman 1976. *Red basaltic soils in North Queensland.* Div. Soils. Tech. paper no. 28. Australia: CSIRO.

Ising, G. 1943. On the magnetic properties of varved clay. *Ark. Mat. Astr. Fys.* **29**, no. 5, 1–37.

Jacobs, J. A. 1975. *The Earth's core.* London: Academic Press.

Jaep, W. F. 1971. Role of interactions in magnetic tapes. *J. Appl. Phys.* **42**, 2790–4.

Jiles, D. C. and D. L. Atherton 1984. Theory of ferromagnetic hysteresis. *J. Appl. Phys.* **55**, 2115–20.

Johnston, M. J. S., B. E. Smith and R. Mueller 1976. Tectonomagnetic experiments and observations in western U.S.A. *J. Geomag. Geoelec.*, **28**, 85–97.

Johnston, M. J. S., and F. D. Stacey 1969. Transient magnetic anomalies accompanying vo.canic eruptions in New Zealand. *Nature* **224**, 1289–90.

Johnson, E. A. and A. G. McNish 1938. An alternating current apparatus for measuring small magnetic moments. *Terr. Mag. Atmos. Electr.*, **43**, 393–9.

Johnson, E. A., T. Murphy and O. W. Torreson 1948. Prehistory of the Earth's magnetic field. *Terr. Mag.* **53**, 349–72.

Johnson, H. P., H. Kinoshita, and R. T. Merrill 1975. Rock

magnetism and paleomagnetism of some North Pacific deep sea sediments. *Geol. Soc. Am. Bull.* 86, 412–20.

Jones, B. F. and C. J. Bowser 1978. The mineralogy and related chemistry of lake sediments. A. Lerman (ed.). *Lakes: Chemistry, Geology, Physics.* New York: Springer.

Joseph, J. H., A. Manes and D. Ashbel 1973. Desert aerosols transported by Khamsinic depressions and their climatic effect. *J. Appl. Meteorol.*, 12, 792–7.

Judson, S. 1968. Erosion of the land, or what's happening to our continents? *American Scientist*, 56, 356–74.

Kalliomaki, K., K. Aittoniemi, P. L. Kalliomaki and M. Moilanen 1981. Measurement of lung-retained contaminants in vivo among workers exposed to metal aerosols. *Am. Ind. Hyg. Assoc.* J (42), 234–8.

Kalliomaki, P. L., P. J. Karp, T. Katila, P. Makipaa, P. Saar and A. Tossavainen 1976. Magnetic measurements of pulmonary contamination. *Scand. J. Work Environ. Health* 4, 232–9.

Kalmijn, A. J. and R. P. Blakemore 1978. The magnetic behaviour of mud bacteria: in *Animal migration, navigation and homing.* K. Schmidt-Koenig and W. T. Keeton (eds). Berlin: Springer.

Karlin, R. and S. Levi 1983. Diagenesis of magnetic minerals in Recent hemipelagic sediments. *Nature* 303, 327–30.

Keeton, W. T. 1971. Magnets interfere with pigeon homing. *Proc. Natl. Acad. Sci. USA* 68, 102–6.

Kennett, J. P. 1981. Marine tephrochronology. In *The sea*, vol. 7. 1373–1436. *The oceanic lithosphere.* C. Emiliani (ed.). New York: J. Wiley and Sons.

Kennett, J. P. and R. C. Thunell 1975. Global increase in Quaternary explosive volcanism. *Science* 187, 497–503.

Kent, D. V. 1973. Post-depositional remanent magnetisation in deep sea sediment. *Nature* 246, 32–4.

Kent, D. V., B. M. Honnorez, N. D. Opdyke and P. J. Fox 1978. Magnetic properties of dredged oceanic gabbros and the source of marine magnetic anomalies. *Geophys. J. R. Astr. Soc.* 55, 513–37.

Kent, D. V. 1982. Apparent correlation of palaeomagnetic intensity and climatic records in deep-sea sediments. *Nature* 299, 538–9.

Kent, D. V. and W. Lowrie 1974. Origin of magnetic instability in sediment cores from the central north Pacific. *J. Geophys. Res.* 79, 2987–3000.

Kent, D. V. and N. D. Opdyke 1977. Paleomagnetic field intensity variation recorded in a Brunhes epoch deep-sea sediment core. *Nature* 266, 5598, 156–9.

Kershaw, A. P. 1978. Record of the last integlacial–glacial cycle from northeastern Queensland. *Nature* 272, 159–61.

Keyser, T. R., D. F. S. Natusch, C. A. Evans Jr. and R. W. Linton 1978. Characterizing the surfaces of environmental particles. *Environ. Sci. Technol.* 12, 768–73.

Kidson, C. 1982. Sea level changes in the Holocene. *Quat. Sci. Rev.* 1, 121–51.

King, J., S. Banerjee, J. Marvin and O. Ozdemir 1982. A comparison of different magnetic methods for determining the relative grain size of magnetite in natural materials: some results from lake sediments. *Earth Planet. Sci. Letters* 59, 404–19.

King, R. F. 1955. Remanent magnetism of artificially deposited sediments. *Mon. Not. R. Soc. Geophys. Suppl.* 7, 115–34.

King, R. F. and A. I. Rees 1962. The measurement of the anisotropy of magnetic susceptibility of rocks by the torque method. *J. Geophys. Res.* 67, 1565–72.

King, R. F. and A. I. Rees 1966. Detrital magnetism in sediments: an examination of some theoretical models. *J. Geophys. Res.* 71, 561–71.

Kirschvink, J. L. 1982a. Palaeomagnetic evidence for fossil biogenic magnetite in western Crete. *Earth Planet Sci. Lett.* 59, 388–92.

Kirschvink, J. L. 1982b. Birds, bees and magnetism. *Trends in Neurosciences* 5, 5, 160–7.

Kirschvink, J. L. and J. L. Gould 1981. Biogenic magnetite as a basis for magnetic field detection in animals. *Biosystems* 13, 181–201.

Kirschvink, J. L. and S.-B. R. Chang 1984. Ultrafine-grained magnetite in deep-sea sediments: Possible bacterial magnetofossils. *Geology*, 12, 559–62.

Kirschvink, J. L. and H. A. Lowenstam 1979. Mineralization and magnetization of chiton teeth: palaeomagnetic, sedimentologic, and biologic implications of organic magnetite. *Earth Planet. Sci Letters* 44, 193–204.

Kittel, C. 1949. Physical theory of ferromagnetic domains. *Rev. Mod. Phys.* 21, 541–83.

Kleinman, M. T., B. S. Pasternack, M. Eisenbad and T. J. Knelp 1980. Identifying and estimating the relative importance of sources of airborne particulates. *Environ. Sci. Technol.* 14, 62–5.

Kneller, E. 1980. Static and anhysteretic magnetic properties of tapes. IEEE MAG-16, 36–41.

Kneller, E. F. and F. E. Luborsky 1963. Particle size dependence of coercivity and remanence of single-domain particles. *J. Appl. Phys.* 134, 656–8.

Kobayashi, K. and M. D. Fuller 1967. Vibration magnetometer. In *Methods in paleomagnetism.* D. W. Collinson, K. M. Creer and S. K. Runcorn (eds.). Amsterdam: Elsevier.

Kobayashi, K., K. Kitazawa, T. Kanaya and T. Sakai 1971. Magnetic and micropaleontological study of deep-sea sediments from the west-central Pacific. *Deep-Sea Research*, 18, 1045–62.

Kobayashi, K. and M. Nomura 1972. Iron sulphides in the sediment cores from the Sea of Japan and their geophysical implications. *Earth Planet. Sci. Letters* 16, 200–8.

Kobayashi, K. and M. Nomura 1974. Ferromagnetic minerals in the sediment cores collected from the Pacific basin. *J. Geophys.* 40, 501–12.

Kodoma, P. and A. Cox 1978. The effects of a constant volume deformation on the magnetization of an artificial sediment. *Earth Planet. Sci. Letters* 38, 436–42.

Koenigsberger, J. G. 1938. Natural residual magnetism of eruptive rocks, parts I and II. *Terr. Magn. Atmos. Elec.* **43**, 119–27; 299–320.

Kopper, J. S. and K. M. Creer 1976. Palaeomagnetic dating and stratigraphic interpretation in Archaeology. *MASCA newsletter*, **12**. No. 1 1–4. Applied Science Center for Archaeology. The University Museum, Pennsylvania.

Kovacheva, M. 1982. Archaeomagnetic investigations of geomagnetic secular variations. *Phil. Trans. R. Soc. London.*, *A*306, 79–86.

Krawiecki, A. 1982. *The burning of the hillfort at Maiden Castle, Bickerton Hill, Cheshire.* Unpubl. BSc thesis. Department of Geography, University of Liverpool.

Kristjansson, L. and A. Gudmundsson 1980. Geomagnetic excursion in late-Glacial basalt outcrops in South-Western Iceland. *Geophys. Res. Letts.* **7**, 337–40.

LaBrecque, J. L., D. V. Kent and S. C. Cande 1977. Revised magnetic polarity time scale for late Cretaceous and Cenozoic time. *Geology* **5**, 330–5.

Lamb, H. H. 1970. Volcanic dust in the atmosphere: with a chronology and assessment of its meteorological significance. *Phil. Trans. R. Soc. Lond.* **266**, 425–533.

Lancaster, D. E. 1966. Electronic metal detection. *Electronics World*, (Dec.), 39–62.

Larson, R. L. and W. C. Pitman III 1972. World-wide correlation of Mesozoic magnetic anomalies, and its implications. *Geol. Soc. Am. Bull.* **83**, 3645–62.

Lauf, R. J., L. A. Harris and S. S. Rawiston 1982. Pyrite framboids as the source of magnetite spheres in fly ash. *Environ. Sci. Technol.* **16**, 218–20.

Le Borgne, E. 1955. Susceptibilité magnétique anormale du sol superficiel. *Ann. Geophys.* **11**, 399–419.

Le Borgne, E. 1960. Influence du feu sur les propriétés magnétiques du sol et du granite. *Ann. Geophys.* **16**, 159–95.

Lehman, J. T. 1975. Reconstructing the rate of accumulation of lake sediments: the effect of sediment focusing. *Quat. Res.* **5**, 541–50.

Liddicoat, J. C. and R. S. Coe 1979. Mono lake geomagnetic excursion. *J. Geophys. Res.* **84**, 261–71.

Likhite, S. D., C. Radhakrishnamurty and P. W. Sahasrabudhe, 1965. Alternating current electromagnet-type hysteresis loop tracer for minerals and rocks. *Rev. Sci. Instrum.* **36**, 1558–64.

Lins de Barros, D. N. S., J. Esquivel. J. Danon and L. P. H. de Oliviera 1981. Magnetotactic algae. *Acad. Bras. Notas. Fis.* CBPF-NF-48.

Linton, R. W., D. F. S. Natusch, R. L. Soloman and C. A. Evans Jr. 1980. Physiochemical characterization of lead in urban dusts. A microanalytical approach to lead tracing. *Environ. Sci. Technol.* **14**, 159–64.

Longworth, G. and M. S. Tite 1977. Mossbauer and magnetic susceptibility studies of iron oxides in soils from archaeological sites. *Archaeometry* **19**, 3–14.

Longworth, G., L. W. Becker, R. Thompson, F. Oldfield, J. A. Dearing and T. A. Rummery 1979. Mossbauer and magnetic studies of secondary iron oxides in soils. *J. Soil. Sci.* **30**, 93–110.

Lorrain, P. and D. R. Corson 1978. *Electromagnetism: principles and application.* New York: W. H. Freeman.

Lovlie, R. 1974. Post-depositional remanent magnetization in a re-deposited deep-sea sediment. *Earth Planet. Sci. Letters* **21**, 315–20.

Lowes, F. J. 1984. The geomagnetic dynamo-elementary energetics and thermodynamics. *Geophysical Surveys* **7**, 91–105.

Lowrie, W. 1979. *Geomagnetic reversals and ocean crust magnetization in deep drilling results in the Atlantic Ocean: Ocean crust*, M. Talwami, C. G. A. Harrison and D. E. Hayes (eds). Washington: American Geophysical Union.

Lowrie, W. and W. Alvarez 1981. One hundred million years of geomagnetic polarity history. *Geology*, **9**, 392–7.

Lowenstam, H. A. 1981. Magnetite biomineralization by organisms (Abs.), *EOS* **62**, 849.

Lukshin, A. A., T. I. Rumyantseva, and V. P. Kovrigo 1968. Magnetic susceptibility of the principal soil types in the Udmuit Asociation. *Soviet Soil Sci.* **3**, 88–93.

Mackereth, F. J. H. 1958. A portable core sampler for lake deposits. *Limnol. Oceanogr.* **3**, 181–91.

Mackereth, F. J. H. 1965. Chemical investigation of lake sediments and their interpretation. *Proc. R. Soc.* **161**, 295–309.

Mackereth, F. J. H. 1966. Some chemical observations on post-glacial lake sediments. *Phil. Trans. R. Soc. Lond. B* **250**, 165–213.

Mackereth, F. J. H. 1969. A short core-sampler for subaqueous deposits. *Limnol. Oceanogr.* **14**, 145–51.

Mackereth, F. J. H. 1971. On the variation in direction of the horizontal component of remanent magnetisation in lake sediments. *Earth Planet. Sci. Letters* **12**, 332–8.

Maher, B. A. 1981. *The effects of gleying on magnetic minerals in the soil.* Unpubl. BSc dissertation. Department of Geography, University of Liverpool.

Maher, B. A. 1984. Origins and transformations of magnetic minerals in soils, unpublished Ph.D Thesis, University of Liverpool.

Maher, B. A. 1986. Characterization of soil by mineral magnetic measurement. *Phys. Earth Planet Int.* **42**, 76–92.

Malin, S. R. C. and E. C. Bullard 1981. The direction of the Earth's magnetic field at London. 1570–1975. *Phil. Trans. R. Soc. Lond. A* **299**, 357–423.

Malin, S. R. C. and B. M. Hodder 1982. Was the 1970 geomagnetic jerk of internal or external origin? *Nature* **296**, 726–8.

Mardia, K. V. 1972. *Statistics of directional data.* London: Academic Press.

Maxted, R. 1983. *The measurement of the atmospheric heavy metal pollution on leaf surfaces using magnetic analysis*

techniques. Unpubl. BSc dissertation. Department of Geography, University of Liverpool.

McCaig, M. 1977. *Permanent magnets in theory and practice*. London: Pentech Press.

McDougall, I. 1979. The present status of the geomagnetic polarity time scale. In *The Earth: its origin, structure and evolution*, M. W. McElhinny (ed.). London: Academic Press.

McDougall, I., K. Saemundsson, H. Johannesson, N. D. Watkins and L. Kristjansson 1977. Extension of the geomagnetic polarity time scale to 6.5 m.y: K–Ar dating, geological and palaeomagnetic study of a 3,500-m lava succession in western Iceland. *Geol. Soc. Am. Bull.* **88**, 1–15.

McElhinny, M. W. 1973. *Palaeomagnetism and plate tectonics*. London: Cambridge University Press.

McElhinny, M. W. and W. E. Senanayake 1982. Variations in the geomagnetic dipole 1: the past 50 000 years. *J. Geomag. Geoelectr.* **34**, 39–51.

McNish, A. G. and E. A. Johnson 1938. Magnetization of unmetamorphosed varves and marine sediments. *Terr. Mag.* **43**, 401–7.

McWilliams, M. O., R. T. Holcolm and D. E. Champion 1982. Geomagnetic secular variation from ^{14}C dated lava flows on Hawaii and the question of the Pacific non-dipole low. *Phil. Trans. R. Soc. Lond. A* **306**, 211–21.

Merrill, R. T. and M. W. McElhinny 1983. *The Earth's magnetic field*. London: Academic Press.

Mitchell, A. Crichton 1939. Chapters in the history of terrestrial magnetism – II. The discovery of the magnetic declination. *Terr. Mag.* **37**, 105–46.

Mitchell, J. M. 1970. A preliminary evaluation of atmospheric pollution as a cause of the global temperature fluctuation of the last century. In *Global effects of environmental pollution*. S. F. Singer (ed), 139–55. New York: Springer.

Miura, N., G. Kido, M. Akihiro and S. Chikazumi 1979. Production and usage of megagauss fields for solid state physics. *J. Magnetism Magnetic Materials* **11**, 275–83.

Moench, T. T. and W. A. Konetzka 1978. A novel method for the isolation and study of a magnetotactic bacterium. *Arch. Microbiol.* **119**, 203–12.

Molyneux, L. and R. Thompson 1973. Rapid measurement of the magnetic susceptibility of long cores of sediment. *Geophys. J. R. Astr. Soc.* **32**, 479–81.

Molyneux, L., R. Thompson, F. Oldfield and M. E. McCallan 1972. Rapid measurement of the remanent magnetization of long cores of sediment. *Nature* **237**, 42–3.

Mooney, H. M. 1952. Magnetic susceptibility measurements in Minnesota. Part I: technique of measurement. *Geophysics* **XVII**, 531–43.

Mooney, H. M. and R. Bleifuss 1953. Magnetic susceptibility measurements in Minnesota. Part II: analysis of field results. *Geophysics* **XVIII**, 383–93.

Morgan, W. J. 1968. Rises, trenches, great faults and crustal blocks. *J. Geophys. Res.* **73**, 1959–82.

Morner, N.-A., J. P. Lanser and J. Hospers 1971. Late Weichselian paleomagnetic reversal. *Nature Phys. Sci.* **234**, 173–4.

Mortimer, C. H. 1942. The exchange of dissolved substances between mud and water in lakes III and IV. *J. Ecol.* **30**, 147–201.

Mosley, P. 1980. Mapping sediment source in a New Zealand mountain watershed. *Environ. Geol.* **3**, 85–95.

Mosteller, F. and J. W. Tukey 1977. *Data analysis and regression*. Reading: Addison-Wesley.

Mullen, R. E., D. A. Darby and D. L. Clark 1972. Significance of atmospheric dust and ice rafting for Arctic Ocean sediment. *Geol. Soc. Am. Bull.* **83**, 205–12.

Mullins, C. E. 1974. The magnetic properties of the soil and their application to archaeological prospecting. In *Technische und Naturwinsenschaftliche Beitrag zur Feldarchaologie*. Klohn: Rheinland-Verlag.

Mullins, C. E. 1977. Magnetic susceptibility of the soil and its significance in Soil Science: a review. *J. Soil Sci.* **28**, 223–46.

Mullins, C. E. and M. S. Tite 1973. Magnetic viscosity, quadrature susceptibility and frequency dependence of susceptibility in single-domain assemblages of magnetite and maghaemite. *J. Geophys. Res.* **78**, 804–9.

Murray, J. 1876. On the distribution of volcanic debris over the floor of the ocean – its character, source and some of the products of its disintegration and decomposition. *Proc. R. Soc. Edinb.* **9**, 247–61.

Nagata, T. 1953. *Rock magnetism*. Tokyo: Maruzen.

Nagata, T., T. Rikitake and K. Akasi 1943. The natural remanent magnetism of sedimentary rocks. *Bull. Earthquake Res. Inst. Tokyo Univ.* **31**, 276–96.

Nagata, T., S. Uyeda and S. J. Akimoto 1952. Self-reversal of thermoremanent magnetism of igneous rocks. *Geomag. Geoelectr.* **4**, 22–38.

Nagata, T. 1976. Principles of the ballistic magnetometer for the measurement of remanence. In *Methods in palaeomagnetism*, D. W. Collinson, K. M. Creer and S. K. Runcorn (eds). Amsterdam: Elsevier.

Nakajima, T., K. Yaskawa, N. Natsuhara, N. Kawai and S. Horie 1973. Very short period geomagnetic excursion 18 000 yr BP. *Nature Phys. Sci.* **244**, 8–10.

National Academy of Sciences 1979. *Airborne particles*. New York.

Neel, L. 1948. Proprietes magnetiques des ferrites; ferrimagnetism et antiferromagnetism. *Ann. Phys.* **3**, 137–98.

Neel, L. 1955. Some theoretical aspects of rock-magnetism. *Adv. Phys.* **4**, 191–243.

Negrini, R. M., J. O. Davis and K. L. Verosub 1984. Mono Lake geomagnetic excursion found at Summer Lake, Oregon. *Geology* **12**, 643–6.

Nelder, J. A. and R. Mead 1965. A simplex method for function minimization. *Computer J.* **7**, 308–13.

Nelmes, R. J. 1984. *Palaeolimnological studies of Rostherne*

Mere (Cheshire) and Ellesmere (Shropshire). Unpubl. PhD thesis. Liverpool Polytechnic.

Newson, M. D. 1980. The erosion of drainage ditches and its effect on bed load yield in mid-Wales. Reconnaissance case studies. *Earth Surface Processes* 5, 190–275.

Noel, M. and D. H. Tarling 1975. The Laschamp geomagnetic 'event'. *Nature* 253, 705–6.

Noltimier, H. C. and P. A. Colinvaux 1976. Geomagnetic excursion from Imuruk Lake, Alaska. *Nature* 259, 197–200.

Norman, R. 1581. *The newe attractive.* London: John Kyngston for Richard Ballard.

NRC 1978. *The tropospheric transport of pollutants and other substances to the oceans.* Washington, DC: National Reseach Council.

Oades, J. M. and W. N. Townsend 1963. The detection of ferromagnetic minerals in soils and clays. *J. Soil Sci.* 14, 179–87.

Okada, Y. C., L. Kaufman, D. Brenner and S. J. Williamson 1982. Modulation transfer functions of the human visual system revealed by magnetic field measurements. *Vision Res.* 22, 319–33.

Oldfield, F. 1977. Lakes and their drainage basins as units of sediment-based ecological study. *Prog. Phys. Geog.* 3, 460–504.

Oldfield, F. 1981. Peat and lake sediments: formation, stratigraphy, description and nomenclature. 306–26. In *Geomorphological techniques,* A. Goudie (ed.). London: George Allen & Unwin.

Oldfield, F. 1983a. The role of magnetic studies in palaeohydrology. In *Background to palaeohydrology.* K. J. Gregory (ed.), 141–65. Chichester: Wiley.

Oldfield, F. 1983b. Man's impact on environment. *Geography* 68, 245–56.

Oldfield, F. unpubl. *Mineral magnetic measurements on particulates from a Greenland Ice Core – a preliminary report.* Available from the author.

Oldfield, F. and P. G. Appleby 1984. Empirical testing of ^{210}Pb dating models for lake sediments. In *Lake sediments and environmental history*, E. Y. Haworth and J. W. G. Lund (eds), 93–114. Leicester University Press.

Oldfield, F. and B. Maher 1984. A mineral magnetic approach to erosion studies. In report of conference on *Drainage Basin Erosion and Sedimentation*, Newcastle, N.S.W., Australia, May 1984.

Oldfield, F. and A. Mannion (in prep.). *Magnetic measurements of ice and snow samples from the Okstinden area of Norway.*

Oldfield, F. and S. G. Robinson 1985. Geomagnetism and palaeoclimate. In *The climatic scene*, M. J. Tooley and G. Sheil (eds). London: George Allen & Unwin.

Oldfield, F., J. A. Dearing, R. Thompson and S. E. Garret-Jones 1978. Some magnetic properties of lake sediments and their possible links with erosion rates. *Polskie Archive. Hydrobiologia* 25, 321–31.

Oldfield, F., P. G. Appleby, R. W. Cambray, J. D. Eakins, K. E. Barber, R. W. Battarbee, G. W. Pearson and J. W. Williams 1979a. Lead-210, caesium-137 and plutonium-239 profiles in ombrotrophic peat. *Oikos* 33, 40–5.

Oldfield, F., A. Brown and R. Thompson 1979b. The effect of microtopography and vegetation on the catchment of airborne particles measured by remanent magnetism. *Quat. Res.* 12, 326–32.

Oldfield, F., T. A. Rummery, R. Thompson and D. E. Walling 1979c. Identification of suspended sediment sources by means of magnetic measurements: some preliminary results. *Water Resources Res.* 15, 211–18.

Oldfield, F., P. G. Appleby and R. Thompson 1980. Palaeoecological studies of three lakes in the Highlands of Papua New Guinea. 1. The chronology of sedimentation. *J. Ecol.* 68, 457–77.

Oldfield, F., R. Thompson and D. P. E. Dickson 1981a. Artificial enhancement of stream bedload: a hydrological application of superparamagnetism. *Phys. Earth Planet. Int.* 26, 107–24.

Oldfield, F., K. Tolonen and R. Thompson 1981b. History of particulate atmospheric pollution from magnetic measurements in dated Finnish peat profiles. *Ambio* 10, 185–8.

Oldfield, F., C. Barnosky, E. B. Leopold and J. P. Smith 1983a. Mineral magnetic studies of lake sediments: a brief review. In *Proceedings of the 3rd International Symposium on Palaeolimnology. Hydrobiol.* 103, 37–44.

Oldfield, F., J. A. Dearing and R. W. Battarbee 1983b. New approaches to recent environmental change. *Geog. J.* 149, 167–81.

Oldfield, F., A. Krawiecki, B. Maher, J. T. Taylor and S. Twigger 1984. The role of mineral magnetic measurements in archaeology. In *Proceedings of the Association for Environmental Archaeology Conference.* Sheffield, 1983.

Oldfield, F., P. G. Appleby and A. T. Worsley (nee O'Garra) 1985a. Evidence from lake sediments for recent erosion rates in the Highlands of Papua New Guinea. In *Environmental change and tropical geomorphology*, I. Douglas and T. Spencer (eds). London: George Allen & Unwin.

Oldfield, F., A. Hunt, M. D. H. Jones, R. Chester, J. A. Dearing, L. Olsson and J. M. Prospero 1985b. Magnetic differentiation of atmospheric dusts. *Nature* 317, 516–518.

Oldfield, F., B. A. Maher, J. Donaghue and J. Pierce 1985c. Particle-size related magnetic source-sediment linkages in the Rhode River catchment, Maryland, U.S.A. *J. Geol. Soc. London*, 142, 1035–1046.

Olson, K. W. and R. K. Skogerboe 1975. Identification of soil lead compounds from automotive sources. *Environ. Sci. Technol.* 9, 227–30.

Olsson, I. U. 1974. Some problems in connection with the evaluation of C^{14} dates. *Geol. Foren. Stockh. Forh.* 96, 311–20.

Ondov, J. M., R. C. Ragaini and A. H. Biermann 1979. Emission and particle-size distribution of minor and trace elements at two western coal-fired power plants equipped with cold-side electrostatic precipitators. *Environ. Sci. Technol.* 13, 946–53.

Opdyke, N. D. 1972. Palaeomagnetism of deep-sea cores. *Rev. Geophys. and Space Phys.* 10, 213–49.

Opdyke, N. D., L. H. Burckle and A. Todd 1974. The extension of the magnetic time scale in sediments of the central Pacific Ocean. *Earth Planet. Sci. Letters* 22, 300–6.

Opdyke, N. D., D. Ninkovich, W. Lowrie and J. D. Hayes 1972. The palaeomagnetism of two Aegean deep-sea cores. *Earth Planet. Sci. Letters* 14, 145–9.

O'Reilly, W. 1976. Magnetic minerals in the crust of the Earth. *Rep. Prog. Phys.* 39, 857–908.

O'Reilly, W. 1984. *Rock and mineral magnetism*. Glasgow: Blackie.

O'Sullivan, P. E. 1979. The Ecosystem–watershed concept in the environmental sciences – a review. *J. Environ. Sci.* 13, 273–81.

O'Sullivan, P. E. 1983. Annually-laminated lake sediments and the study of Quaternary environmental changes – a review. *Quat. Sci. Rev.* 1, 245–313.

O'Sullivan, P. E., F. Oldfield and R. W. Battarbee 1972. Preliminary studies of Lough Neagh sediments I. Stratigraphy, chronology & pollen analysis. in H. J. B. Birks and R. G. West, *Quaternary plant ecology*. Oxford: Blackwells.

Ottow, J. C. G. and H. Glathe 1971. Isolation and identification of iron reducing bacteria from gley soils. *Soil. Biol. Biochem.* 3, 43–55.

Ozdemir. O. and S. K. Banerjee 1982. A preliminary magnetic study of soil samples from west-central Minnesota. *Earth Planet. Sci. Lett.* 59, 393–403.

Ozima, M. and M. Ozima 1971. Characteristic thero-magnetic curves in submarine basalts. *J. Geophys. Rev.*, 76, 2051–6.

Parry, L. G. 1965. Magnetic properties of dispersed magnetite powders. *Phil. Mag.* 11, 303–12.

Patton, B. J. and J. L. Fitch 1962. Anhysteretic remanent magnetization in small steady field. *J. Geophys. Res.*, 67, 307–11.

Payne, M. A. and K. L. Verosub 1982. The acquisition of post-depositional detrital remanent magnetization in a variety of natural sediments. *Geophys. J. R. Astr. Soc.* 68, 625–42.

Peddie, N. W. 1982. International geomagnetic reference field: the third generation. *J. Geomag. Geoelectr.* 34, 309–26.

Peirce, J. W. and M. J. Clark 1978. Evidence from Iceland on geomagnetic reversal during the Wisconsinan Ice Age. *Nature* 273, 456–8.

Pennington, W., E. Y. Haworth, A. P. Bonny and J. P. Lishman 1972. Lake sediments in northern Scotland. *Phil. Trans. R. Soc. B* 264, 191–294.

Peterson, J. T. and C. G. Junge 1971. Sources of particulate matter in the atmosphere. In *Man's impact on the climate*. E. H. Matthews, W. W. Kellogg and G. D. Robinson (eds), 310–20. Cambridge, Mass: MIT Press.

Phillips, J. D. and D. Forsyth 1972. Plate tectonics, palaeomagnetism and the opening of the Atlantic. *Geol. Soc. Am. Bull.* 83, 1579–1600.

Pierce, J. W. and F. T. Dulong 1977. Discharge of suspended particulates from Rhode River subwatersheds. In *Watershed research in eastern North America*. D. L. Correll (ed.), 531–53. Washington: Smithsonian Institution.

Pouillard, E. 1950. Sur le comportement de l'alumine et de l'oxyde de titane vis-a-vis des oxydes de fer. *Ann. Chim.* 5, 214–164.

Poutiers, J. 1975. *Sur les propriétés magnetiques de certains sediments continentaux et marins; applications*. Thèse de doctorat. Université de Bordeaux.

Prasad, B. and B. P. Ghildyal 1975. Magnetic susceptibility of lateritic soils and clays. *Soil Sciences* 120, 219–29.

Press, F. and R. Siever 1974. *Earth*. New York: W. H. Freeman.

Prospero, J. M. 1968. Atmospheric Dust studies on Barbados. *Bull. Am. Meteorol. Soc.* 49, 645.

Prospero, J. M. 1981. Eolian transport to the world's oceans. In *The sea*, vol. 7, *The oceanic lithosphere*. C. Emiliani (ed.), 875–914. New York: Wiley

Prospero, J. M., R. A. Glaccum and R. T. Nees 1981. Atmospheric transport of Soil Dust from Africa to South America. *Nature* 289, 570–7.

Puffer, J. H., E. W. B. Russell and M. R. Rampino 1980. Distribution and origin of magnetite spherules in air, water and sediments of the greater New York city area and the north Atlantic Ocean. *J. Sed. Petrol.* 50, 247–56.

Puranen, R. 1977. Magnetic susceptibility and its anisotropy in the study of glacial transport in northern Finland. In *Prospecting in areas of glaciated terrain*, L. K. Lawrence (ed.), 111–19. London: Institution of Mining and Metallurgy.

Radhakrishnamurty, C., S. D. Likhite, B. S. Amin and B. L. K. Somayajulu 1968. Magnetic susceptibility stratigraphy in ocean sediment cores. *Earth Planet. Sci. Letters* 4, 464–8.

Radhakrishnamurty, C., S. D. Lidhite, E. R. Deutch and G. S. Murthy 1978. Nature of magnetic grains in basalts and implications for palaeomagnetism. *Proc. Indian Acad. Sci.* 87, 235–43.

Rees, A. I. 1961. The effect of water currents on the magnetic remanence and anisotropy of susceptibility of some sediments. *Geophys. J. R. Astr. Soc.* 5, 235–51.

Renberg, I. 1982. Varved lake sediments – a geochronological record of the Holocene. *Geol. Foren. i Stockh. Forh.* 104, 85–90.

Revitt, D. M., J. Bryan Ellis and F. Oldfield 1981. Variations in heavy metals of stormwater sediments in a

separate sewer system. In *Urban storm drainage*, B. C. Yen (ed.), 49–58. New York: Pentech Press.

Richardson, N. 1986. The mineral magnetic record in recent ombrotrophic peat synchronised by fine resolution pollen analysis. *Phys. Earth Planet Int.* 42, 48–56.

Robinson, S. G. 1982. Two applications of mineral–magnetic techniques to deep-sea sediment studies. *Geophys. J. R. Astr. Soc.* 69, 294.

Robinson, S. G. 1986. The late Pleistocene palaeoclimatic record of North Atlantic deep-sea sediments revealed by mineral-magnetic measurements. *Phys. Earth Planet Int.*

Rosen, J. M. 1969. Stratospheric dust and its relationship to the meteoric influx. *Space Science Reviews* 9, 58–89.

Rubin, L. G. and P. A. Wolff 1984. High magnetic fields for Physics. *Physics Today* (Aug), 24–33.

Ruddiman, W. F. 1971. Pleistocene sedimentation in the equatorial Atlantic stratigraphy and faunal palaeoclimatology. *Geol. Soc. Am. Bull.* 82, 283–302.

Ruddiman, W. F., G. A. Jones, T. H. Peng, L. K. Glover, B. P. Glass and P. J. Liebertz 1980. Tests for size and shape dependency in deep-sea mixing. *Sed. Geol.* 25, 257–76.

Rudman, A. J. and R. F. Blakely 1976. *Fortran program for correlation of stratigraphic time series.* Dept. Nat. Resources. Geol. Survey Occasional Paper. Bloomington, Indiana.

Rumble, III, D., 1976a. Oxide minerals in metamorphic rocks. In *Oxide minerals*, D. Rumble III (ed.), R1–20, Mineralogical Society of America. Blacksburg: Southern Printing Co.

Rumble, III, D. (ed.) 1976b. *Oxide minerals.* Mineralogy Society of America Short Course Notes Vol. 3. Blacksburg: Southern Printing Co.

Rummery, T. A., J. Bloemendal, J. Dearing, F. Oldfield and R. Thompson 1979. The persistence of fire-induced magnetic oxides in soils and lake sediments. *Ann. Geophys.* 35, 103–7.

Rummery, T. A. 1981. *The effects of fire on soil and sediment magnetism.* Unpubl. PhD thesis. University of Liverpool.

Rummery, T. A. 1983. The use of magnetic measurements in interpreting the fire histories of lake drainage basins. *Hydrobiologia* 103, 53–8.

Runcorn, S. K. 1955. On the theory of the geomagnetic secular variation. *Ann. Geophys.* 15, 87–92.

Runcorn, S. K. 1956. Palaeomagnetic comparisons between Europe and North America. *Proc. Canad. Geol. Assoc.* 8, 77–85.

Saarnisto, M. 1975. Pehmeiden jarvisedimenttien naytteenottoon soveltuva jaadytysmenetelma. *Geologi* 26, 37–9.

Sandlands, Judith 1983. *Magnetic measurements applied to a study of river channel erosion on the river Severn.* Unpublished BSc dissertation. University of Liverpool.

Sarajma, S., S. Nishimura and K. Hirooka 1984. The Blake geomagnetic event as inferred from late Brunhes ignimbrites in Southwest Japan and West Indonesia. *J. Geomag. Geoelectr.* 36, 203–14.

Schwertmann, U. and R. M. Taylor 1977. Iron oxides. In *Minerals in soil environments.* J. B. Dixon (ed.), *Soil. Sci. Soc. Am.* 145–80.

Sclater, J. G. and B. Parsons 1981. Oceans and continents: Similarities and differences in the mechanism of heat loss. *J. Geophys. Res.* 86, 11535–52.

Scollar, I. 1965. A contribution to magnetic prospecting in archaeology. *Archaeo-Physicka* 1, 21–92.

Scoullos, M., F. Oldfield and R. Thompson 1979. Magnetic monitoring of marine particulate pollution in the Elefsis Gulf, Greece. *Marine Pollut. Bull.* 10, 287–91.

Shackleton, N. J. 1977. The oxygen isotope stratigraphic record of the late Pleistocene. *Phil. Trans. R. Soc. B* 280, 169–80.

Singh, G., A. P. Kershaw and R. Clark 1979. Quaternary vegetation and fire history in Australia. In *Fire and Australian biota.* A. M. Gill, R. A. Groves and I. R. Noble (eds). Canberra: Australian Academy of Science.

Slaughter, T. H., R. T. Kershin, B. G. McMullan, G. Cocoros, and D. Vanko 1976. *Shoreline conditions.* Annotated map published by the State of Maryland, Department of Natural Resources and the Maryland Geological Survey.

SMIC 1971. *Inadvertent climate modification.* Report of the study of man's impact on climate. Cambridge, Mass: MIT Press.

Smit, J. and H. P. J. Wijn 1954. Physical properties of ferrites. *Adv. Electron. Electron. Phys.* 6, 69–136.

Smit, J. and H. P. J. Wijn 1959. *Ferrites.* Eindhoven: Philips Tehnical Library.

Snoek, J. L. 1948. Dispersion and absorption in magnetic ferrites at frequencies above one megacycle. *Physica* 14, 207–17.

Stacey, F. D. 1963. The physical theory of rock magnetism. *Adv. Phys.* 12, 45–133.

Stevenson, A. 1971. Single domain grain distributions. *Phys. Earth Planet. Interiors*, 4, 353–60, 361–9.

Stober, J. C. 1978. *Palaeomagnetic secular variation studies on Holocene lake sediments.* Unpubl. PhD thesis. University of Edinburgh.

Stober, J. C. and R. Thompson 1977. Palaeomagnetic secular variation studies of Finnish lake sediment and the carriers of remanence. *Earth Planet. Sci. Letters* 37, 139–49.

Stober, J. C. and R. Thompson 1979. Magnetic remanence acquisition in Finnish lake sediments. *Geophys. J. R. Astr. Soc.* 57, 727–39.

Stoker, M. S., A. C. Skinner, J. A. Fyfe and D. Long 1983. Palaeomagnetic evidence for early Pleistocene in the central and northern North Sea. *Nature* 304, 332–4.

Stoner, E. C. and E. P. Wohlfarth 1948. A mechanism of magnetic hysteresis in heterogeneous alloys. *Phil. Trans. R. Soc. Lond. A* 240, 599–642.

Stott, A. P. 1986. Sediment tracing in a reservoir catchment system using a magnetic mixing model. *Phys. Earth Plant Int.* 42, 105–14.

Strangway, D. W. 1970. *History of the Earth's magnetic field.* New York: McGraw-Hill.

Stuiver, M. 1972. On climate changes. *Quat. Res.* 2, 409–11.

Stupavsky, M., C. P. Gravenor and D. T. A. Symons 1979. Palaeomagnetic stratigraphy of the medowcliffe till, Scarborough bluffs, Ontario; a late Pleistocene excursion? *Geophys. Res. Lett.* 6 (4), 269–72.

Sugden, D. E. and C. M. Clapperton 1980. West Antarctic ice sheet fluctuations in the Antarctic Penninsula. *Nature* 286, 378–81.

Sutton, M. 1982. *Magnetic catenas in the Cotswolds.* Unpubl. BSc dissertation, Department of Geography, University of Liverpool.

Swain, A. 1973. A history of fire and vegetation as recorded in lake sediments. *Quat. Res.* 3, 383–96.

Tarling, D. H. 1983. *Palaeomagnetism.* London: Chapman and Hall.

Taylor, R. M. and U. Schwertmann 1974. Maghemite in soils and its origin. *Clay Minerals* 10, 289–310.

Theis, T. L. and J. L. Wirth 1977. Sorptive behaviour of trace metals on fly ash in aqueous systems. *Environ. Sci. Technol.* 11, 1095–100.

Thellier, E. 1933. Magnetometre insensible aux champs magnetiques troubles des grandes villes, *C.R. Acad. Sci. Paris* 197, 224–34.

Thellier, R. 1938. Sur l'aimantation des terres cuites et ses applications geophysiques. *Ann. Inst. Physique du Globe. Univ. Paris* 16, 157–302.

Thellier, E. 1946. Sur la thermoremanence et la theorie du metamagnetisme. *C.R. Acad. Sci. Paris* 233, 319–21.

Thellier, E. 1966. Methods of alternating current and thermal demagnetization, in *Methods and techniques in Geophysics*, vol. 2. S. K. Runcorn (ed.). London: Interscience.

Thellier, E. 1981. Sur la direction du champ magnetique terrestre, en France, durant les deux derniers millenaires. *Phys. Earth Planet. Interiors* 24, 89–132.

Thellier, E. and O. Thellier 1959. Sur l'intensite du champ magnetique terrestre dans le passe historique et geologique. *Ann. Geophys.* 15, 285–376.

Thomas, A. K. 1968. Magnetic shielded enclosure design in the d.c. and VLF region. *IEEE Trans. Electromagn. Compat.* 10, 142–52.

Thompson, R. 1973. Palaeolimnology and palaeomagnetism. *Nature* 242, 182–4.

Thompson, R. 1982. A comparison of geomagnetic secular variation as recorded by historical, archaeomagnetic and palaeomagnetic measurements. *Phil. Trans. R. Soc. Lond. A* 306, 103–12.

Thompson, R. 1983. ^{14}C dating and magnetostratigraphy. *Radiocarbon* 25, 229–38.

Thompson, R. 1984. Geomagnetic evolution: 400 years of change on planet Earth. *Phys. Earth Planet. Interiors* 36, 61–77.

Thompson, R., M. J. Aitken, P. L. Gibbard and J. J. Wymer 1974. Palaeomagnetic study of Hoxnian lacustrine sediments. *Archaeometry* 16, 233–45.

Thompson, R. and D. R. Barraclough 1982. Geomagnetic secular variation based on spherical harmonic and cross validation analyses of historical and archaeomagnetic data. *J. Geomag. Geoelectr.* 34, 245–63.

Thompson, R., R. W. Battarbee, P. E. O'Sullivan and F. Oldfield 1975. Magnetic susceptibility of lake sediments. *Limnol. Oceanogr.* 20, 687–98.

Thompson, R. and B. Berglund 1976. Late Weichselian geomagnetic 'reversal' as a possible example of the reinforcement syndrome. *Nature* 263, 5577, 490–1.

Thompson, R. and R. M. Clark 1981. Fitting polar wander paths. *Phys. Earth Planet Interiors* 27, 1–7.

Thompson, R. and K. Kelts 1974. Holocene sediments and magnetic stratigraphy from Lakes Zug and Zurich, Switzerland. *Sedimentology* 21, 577–96.

Thompson, R. and D. J. Morton 1979. Magnetic susceptibility and particle-size distribution in recent sediments of the Loch Lomond drainage basin, Scotland. *J. Sed. Petrol.* 49, 3, 801–12.

Thompson, R., G. M. Turner, M. Stiller and A. Kaufman 1985. Near East palaeomagnetic secular variation recorded in sediments from the sea of Galilee (Lake Kinneret). *Quat. Res.* 23, 175–88.

Tite, M. S. and R. E. Linington 1975. Effect of climate on the magnetic susceptibility of soils. *Nature* 265, 565–6.

Tolonen, K., A. Siiriainen and R. Thompson 1975. Prehistoric field erosion sediment in Lake Lovojarvi, S. Finland and its palaeomagnetic dating. *Ann. Bot. Fenn.* 12, 161–4.

Tolonen, K. and F. Oldfield 1986. The record of the magnetic-mineral and heavy metal deposition at Regent Street Bog, Fredicton, New Brunswick, Canada. *Phys. Earth Planet Int.* 42, 57–66.

Tucker, P. 1980. Stirred remanent magnetization: a laboratory analogue of post-depositional realignment. *J. Geophys.* 48, 153–7.

Turner, G. M. 1979. *Geomagnetic investigation of some recent British sediments.* Unpubl. PhD thesis. University of Edinburgh.

Turner, G. M. and R. Thompson 1979. Behaviour of the Earth's magnetic field as recorded in the sediments of Loch Lomond. *Earth Planet. Sci. Letters* 42, 412–26.

Turner, G. M. and R. Thompson 1981. Lake sediment record of the geomagnetic secular variation in Britain during Holocene times. *Geophys. J. R. Astr. Soc.* 65, 703–25.

Undzendor, B. A. and V. A. Shapiro 1967. Seismomagnetic effect in a magnetite deposit. *Izv. Earth Physics* 1, 121–6. English translation, 1968, *Physics of the solid Earth.* 69–72.

Vadyunina, A. F. and V. F. Babanin 1972. Magnetic

susceptibility of some soils in the U.S.S.R. *Soviet Soil. Sci.* 6, 106–10.

Veinberg, B. P. and V. P. Shibaev 1969. *Catalogue. The results of magnetic determination at equidistant points and epochs, 1500–1940* (ed.-in-Chief A. N. Pushkov). Moscow: IZMIRAN. Translation no. 0031 by Canadian Department of the Secretary of State, Translation Bureau, 1970.

Verhoogen, J. 1973. Thermal regime of the Earth's core. *Phys. Earth Planet Int.* 7, 47–58.

Verosub, K. L. 1977. Depositional and post-depositional processes in the magnetization of sediments. *Rev. Geophys. Space Phys.* 15 (2), 129–43.

Verosub, K. L. 1982. Geomagnetic excursions: a critical assessment of the evidence as recorded in sediments of the Brunhes Epoch. *Phil. Trans. R. Soc. Lond. A* 306, 161–8.

Vevosub, K. L., J. O. Davis and S. Valastro 1980. A palaeomagnetic record from Pyramid Lake, Nevada, and its implications for proposed geomagnetic excursions. *Earth Planet. Sci. Letters* 49, 141–8.

Verosub, K. L., R. A. Ensley and J. S. Ulrich 1979. The role of water content in the magnetization of sediments. *Geophys. Res. Letters* 6, 226–8.

Verwey, E. J. W. and P. W. Haayman 1941. Electronic conductivity and transition point in magnetite. *Physics* 8, 979–82.

Vilks, G., J. M. Hall and D. J. W. Piper 1977. The natural remanent magnetism of sediment cores from the Beaufort sea. *J. Earth Sci.* 14, 2007–12.

Vine, F. J. and D. H. Matthews 1963. Magnetic anomalies over oceanic ridges. *Nature* 199 (4897), 947–9.

Vitorello, I. and R. Van der Voo 1977. Magnetic stratigraphy of Lake Michigan sediments obtained from cores of lacustrine clay. *Quat. Res.* 7, 398–412.

Vlasov, A. Y., G. V. Kovalenko and V. A. Chikhacher 1967. The superparamagnetism of a-FeOOH. Izv. *Earth Physics* 7, 64–69. English translation, 1968. *Physics of the solid Earth*, 460–4.

Walcott, C., J. L. Gould and J. L. Kirschvink 1979. Pigeons have magnets. *Science* 205, 1027–9.

Walcott, C. and R. P. Green 1974. Orientation of homing pigeons altered by a change in the direction of an applied magnetic field. *Science* 184, 180–2.

Walling, D. E., M. R. Peart, F. Oldfield and R. Thompson 1979. Suspended sediment sources identified by magnetic measurements. *Nature* 281, 110–13.

Wasilewski, P. J. 1973. Magnetic hysteresis in natural materials. *Earth Planet. Sci. Letters* 20, 67–72.

Watkins, N. D. 1968. Short period geomagnetic polarity events in deep-sea sedimentary cores. *Earth Planet. Sci. Letters* 4, 341–9.

Watkins, N. D. 1971. Geomagnetic polarity events and the problem of 'The Reinforcement Syndrome'. *Comments Earth Sci. Geophys.* 2, 36–43.

Watkins, N. D. 1972. Review of the development of the geomagnetic polarity time scale and discussion of prospects for its finer definition. *Geol. Soc. Am. Bull.* 83, 551–74.

Watson, G. S. 1970. Orientation statistics in the Earth sciences. *Bull. Geol. Instn. Univ. Upsala N.S.* 2 (9), 78–89.

Weiss, P. 1907. L'hypothese du champ moleculaire et la propriete ferromagnetique. *J. Phys.* 6, 661.

West, G. F. and D. J. Dunlop 1971. An improved ballistic magnetometer for rock magnetic experiments. *J. Phys.* E 4, 37–40.

Whitby, K. T. and B. Cantrell 1975. *Atmospheric aerosols – characterisation and measurements.* Proceeding of the International Conference on Environmental Sensing and Assessment, Las Vagas, Nevada.

Williamson, S. J. and L. Kaufman 1981. Biomagnetism. *J. Magnetism Magnetic Materials* 22 (2), 129–202.

Wilson, M. N. 1983. *Superconducting magnets.* Oxford: Clarendon Press.

Wilson, R. L. 1962. The palaeomagnetism of baked contact rocks and reversals of the Earth's magnetic field. *Geophys. J. R. Astr. Soc.* 7, 194–202.

Wiltschko, R., D. Nohr and W. Wiltschko 1981. Pigeons with a deficient sun compass use the magnetic compass. *Science* 214, 343–5.

Windom, H. L. 1969. Atmospheric dust records in permanent snowfields: implications to marine sedimentation. *Geol. Soc. Am. Bull.* 80, 761–82.

Winterer, E. L. 1973. Sedimentary facies and plate tectonics of equatorial Pacific. *Am. Assoc. Petrol. Geol. Bull.* 57, 2, 265–82.

Wise, S. M. 1979. *Magnetic and radiometric studies of erosion.* Unpubl. MS of paper presented to UK Geophysical Assembly, Southampton.

Wollin, G., W. B. F. Ryan, D. B. Ericson and J. H. Foster 1977. Palaeoclimate, palaeomagnetism and the eccentricity of the Earth's orbit. *Geophys. Res. Lett.* 44, 267.

Worsley, A. T. (nee O'Garra) 1983. *A palaeoecological study of recent environmental change in the highlands of Papua New Guinea.* Unpubl. PhD thesis. University of Liverpool.

Yanak, F. and I. Uman 1967. The distribution function of magnetic susceptibilities. *Izv. Earth physics.* 6, 137–43. English translation, 1968. *Physics of the solid Earth*, 416–20.

Yukutake, T. 1979. Review of the geomagnetic secular variations on the historical time scale. *Phys. Earth Planet. Interiors* 20, 83–95.

Yukatake, T. and H. Tachinaka 1968. The non-dipole part of the Earth's magnetic field. *Bull. Earthquake Res. Inst.* 46, 1027–62.

Zoeger, J., J. R. Dunn and M. Fuller 1981. Magnetic material in the head of the common Pacific Dolphin. *Science* 213, 892–4.

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