Freedericksz Medal

Prof. S. Chandrasekhar, Centre for Liquid Crystal Research, Bangalore, has been awarded the Freedericksz Medal for his 'outstanding scientific work in the field of Physics of Liquid Crystals'. The medal, the Russian Liquid Crystal Society's highest award, was instituted in honour of the famous Russian scientist V. K. Freedericksz (1885–1944), who is considered as the father of liquid crystal research in Russia. The previous recipients of the medal are Tsvetkov (Physics, 1997), G. W. Gray (Chemistry, 1977), A. Saupe (Physics, 1998), V. Shibaev (Chemistry, 1998), L. Blinov (Physics, 1999), D. Demus (Chemistry, 1999). For the year 2000, the awardees are S. Chandrasekhar (Physics) and A. Sonin (Chemistry). The presentation of the medals will take place during the 19th International Liquid Crystal Conference to be held in Edinburgh.

Ecological Society of America member

The Ecological Society of America has chosen Prof. Madhav Gadgil, Centre for Ecological Sciences, Indian Institute of Science, Bangalore as its Honorary Member for the year 2001. This Society, which is world's largest and most active organization of ecologists, recognizes one individual by naming him/her as the Honorary Member of the year.

Environmental magnetism*

Environmental magnetism is the study of the intrinsic magnetic properties of samples to understand past (palaeo) environments and climates. It has been gainfully used in placer mineral exploration, understanding past climatic changes, surface processes, sediment movement in harbours, beaches, etc. river-bed sediment transport, environmental pollution, impact of anthropogenic activities, etc.

Efforts to use environmental magnetic techniques in India have been limited, probably because of lack of awareness of this fascinating discipline. The laboratory methods of determining magnetic properties are simple, rapid, inexpensive and non-destructive. The data obtained may throw light on such varied aspects of the environment/climate as Milankovitch periodicity to palaeo-rainfall reconstruction to land-use changes and soil erosion.

Against this backdrop, the first workshop on environmental magnetism for faculty members of Indian universities and colleges was organized. The workshop was conducted by F. Oldfield, (PAGES International Project Office, Bern, Switzerland) who is a pioneer in the field of environmental magnetism. In the morning sessions, he delivered lectures on the principles of environmental magnetism and its applications in earth, atmospheric and ocean sciences. Several case histories presented during the lectures were useful to the participants. In the afternoons, with the help of the personnel of the Ocean Science and Technology Cell (OSTC) Mangalore University, he demonstrated the use of magnetic instruments and the participants made magnetic measurements on their own samples.

The formation, transport, deposition and distribution of magnetic minerals in different parts of the environment were explained. Magnetic minerals are ubiquitous and sensitive to/indicative of chemical, thermal and physical transformations, and may be detected and characterized at ppm level concentrations. All these features make it possible to gainfully utilize magnetic minerals to study the environment – both present and past – and the changes brought about by natural processes and anthropogenic activities.

Oldfield explained the different types of magnetic minerals in environmental samples like diamagnetic, paramagnetic, ferrimagnetic and imperfect antiferromagnetic substances, with examples. He also explained the different magnetic grain sizes like superparamagnetic, stable single domain, pseudo-single domain and multi-domain grains and how they are related to different environments of formation.

He introduced the basic instruments that are used in environmental magnetic studies: magnetic susceptibility meter and accessories, magnetizer and electromagnet, spinner fluxgate magnetometer, vibrating sample magnetometer and other special methods of magnetic studies like TEM, measurement of Curie temperature and study of magnetic properties at both high temperatures and low temperatures. He explained the definitions, meanings and environmental significance of the various magnetic properties (and inter-parametric ratios) that could be measured using the above instruments – magnetic susceptibility at high and low frequencies (χ_{LF} and χ_{HF}), frequency-dependent susceptibility (χ_{FD}), anhysteretic remanent magnetization (ARM), isothermal re-

*A report on the National Workshop on 'Teacher Education in Environmental Sciences (Environmental Magnetism) held at the Mangalore University during 9–18 February 2001 and organized by the Ocean Science and Technology Cell (OSTC), in collaboration with the Association of British Scholars, Mangalore Centre.

manent magnetization (IRM) at different magnetic field strengths, saturation isothermal remanent magnetization (SIRM), χ/SIRM, ARM/SIRM, ARM/χ, IRM/SIRM ratios, etc.

A brief account was also given of sample collection, preservation and storage procedures. Participants were alerted about possible sources of contamination and how magnetic properties would change when samples are stored wet for prolonged periods.

Oldfield then went on to explain, with several examples, the various applications of environmental magnetism. He started with magnetic enhancement due to pedogenesis and forest/artificially-created fires. During these processes, paramagnetic iron oxides are converted to ferrimagnetic minerals, thus enhancing the magnetic properties of topsoil/burnt material.

Magnetic data for several soil profiles were shown to demonstrate pedogenic enhancement. He illustrated how magnetic characterization of topsoil may be useful in identifying signatures in lake/nearshore sediment cores of soil erosion, land-use changes in the catchment, forest clearance/deforestation, overgrazing of grassland, human settlement, flood events, etc. Similarly, when soils are subjected to high temperature due to fire, they are magnetically enhanced because at temperatures more than 500°C, ferrimagnetic minerals are formed. Examples were presented of forest-fire history reconstructed from magnetic data of lake/nearshore sediment cores. Down-core variations in charcoal and ash contents are matched by similar variations in magnetic properties. Besides, it is possible to roughly estimate the intensity of fire also.

In the marine realm, environmental magnetic studies show changes in palaeoclimate/palaeo-oceanography on time scales from glacial–interglacial cycles to decadal scale. These are related to variations in the concentration, mineralogy and magnetic grain size of magnetic minerals in marine sediments which, in turn, are related to changes in global temperature, rainfall, atmospheric and oceanic circulation patterns, sources and pathways of sediments, etc. The importance of bacterial magnetite in aquatic environments was underscored as also diagenesis and the formation of greigite. The usefulness of magnetic studies in identifying turbidite and tephra layers and correlation of sediment cores was brought out.

In the context of palaeoclimate, several detailed magnetic studies have been carried out on the Chinese loess and palaeosols. Depth-wise variations of χ and other parameters have been linked to SPECMAC and Greenland ice-core isotopic signatures of climate change. Magnetic susceptibility has been demonstrated to be a proxy for palaeomonsoonal intensity.

Oldfield also showed how environmental pollution can be assessed using magnetic methods. For example, magnetic properties may be used as proxies for heavy-metal pollution. Particulate pollution from the iron and steel industry could easily be studied with magnetic methodology. Magnetic studies could characterize and discriminate aerosols and dusts of different sources: automobile exhaust, dust from natural sources, power station fly-ash, etc. Long-term transport of oxides of nitrogen and sulphur from power stations can be traced on the basis of magnetic properties. Such an approach is useful to trace acid-rain sources.

Sediment transport in river channels, ports, harbours and beaches could be studied using magnetic 'tagging and tracing' experiments.

In archaeology, magnetic susceptibility can be an important exploratory tool, as a surface search loop attached to a magnetic susceptibility meter can point out locations of buried pottery, bricks and walls.

Oldfield traced the growth of environmental magnetism from being qualitative in the initial stages to a stage when robust statistical techniques and mathematical modelling are used to derive quantitative information on the environment.

K. B. Vijaya Kumar (Mangalore University) discussed the essential features of the various types of magnetic materials in terms of the magnetic properties of atomic dipoles and the interaction between them. His talk gave an overall idea of these materials from the atomic viewpoint, with an emphasis on ferromagnetic materials.

R. Shankar (Mangalore University) demonstrated how any one of the several magnetic properties could be used as a proxy for heavy mineral and opaque mineral contents of beach and offshore placer samples, thus avoiding the use of costly and toxic bromoform and saving considerable time and tedium for geologists involved in placer mineral exploration. He also pointed out the usefulness of artificial magnetization and natural radioactivity measurements in characterizing natural catchment materials and particles associated with iron-ore mining and beneficiation. Taking the example of Kudremukh iron-ore mines, he showed how multivariate analysis of these data can give a quantitative picture of the particulate pollution from Kudremukh mines.

The afternoon sessions were devoted to laboratory work. The uniqueness of the Workshop was the opportunity provided to the participants not only to get hands-on experience with the magnetic instruments, but also to study their own samples, which included hard rocks, ores, weathered materials including laterites and soils, sediments from rivers, estuaries and oceans, riverine suspended sediments and aerosols. This motivated the participants to learn the subject in detail and plan future work using magnetic methods.

The course material provided was a publication titled *Environmental Magnetism: A Practical Guide* by J. Walden, F. Oldfield and J. Smith. Free copies of this publication were kindly made available by the Quaternary Research Association through the efforts of Oldfield.

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