Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 423 (C-112), 2018, pp. 61-62
DOI: 10.25171/InstGeoph_PAS_Publs-2018-032
16th Castle Meeting New Trends on Paleo, Rock and Environmental Magnetism, Chęciny, Poland, 2018

Rock Magnetic Techniques Applied to Environmental, Material and Life Sciences

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Abstract

Rocks and sediments are composed of various minerals, but ferromagnetic minerals contribute only a small amount to their total volume. The low concentration can make detection through microscopic methods difficult. Since the first studies to understand the remanent magnetization carried by ferromagnetic minerals in volcanic rocks by Koenigsberger (1938) and Thellier (1938), a variety of techniques have been developed to aid in identifying ferromagnetic phases in rocks, sediments and soils, by exploiting the material properties of these minerals. For example, thermomagnetic curves, which are used to define Curie or Néel temperature, help determine mineral composition, whereas hysteresis properties can provide information on domain state, i.e., particle size and concentration. Because geophysical instrumentation and rock magnetic methods allow for detection of very small concentrations, techniques have a validity in other research areas that are interested in identifying ferromagnetic phases with respect to their composition, concentration, and particle size. Methods that aid in distinguishing whether the ferromagnetic particles are either dispersed so as to act as individual particles or in clusters, in which particles magnetically interact, are also of interest in many applications. The number of rock magnetic studies has grown exponentially over the past 20 years (Fig. 1). Examples will be shown on how rock magnetic methods can be used in applications that are related to environmental studies and material development.

Magnetic methods have become important in environmental studies because all material possess some form of magnetism, whether diamagnetic, paramagnetic or ferromagnetic. Distinguishing between these basic classes of magnetism already provides information about the types of minerals or materials that are present in the environment. For example, in a study that uses leaves, tree barks or other organic material as a type of collection site for aerial pollution, show that unpolluted sites are diamagnetic and polluted sites are ferromagnetic. In contamination studies, iron is often found in association with Pb, Zn Cd or As. Rock magnetic techniques help not only in correlating the degree of contamination with a magnetic property, but also the pathways that lead to the relationship.

In material science the synthesis of magnetic nanoparticles has become a major global industry with a predicted compound annual growth rate of 21% from 2016 to 2022 (https://www.researchandmarkets.com/research/4299cg/global). Applications range from sensor and

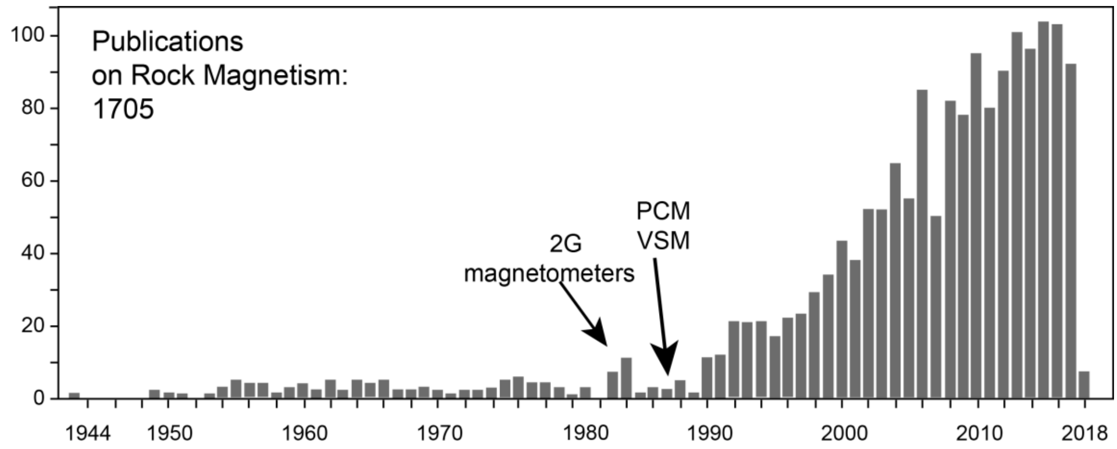

Fig. 1: Number of publications in the area of rock magnetism according to Thompson Reuters SCI (20 February 2018) and introduction of new instrumentation for determination of rock magnetic properties.

actuators, information storage, water treatment, and biomedical applications. Important in the synthesis of magnetic nanoparticles is their long-term chemical stability, which guarantees that their magnetic properties do not change with usage. Furthermore, it is important to understand the long-term fate of these particles. In biomedical applications magnetic nanoparticles are being used not only in magnetic and particle resonance imaging, but also in drug delivery systems. In these latter applications, it is important to understand the way in which a magnetic body responds to an external field. Composition, particle size, and degree of particle interaction all contribute in determining the efficiency of delivery. For this reason it is very important to monitor magnetic properties of the materials in the synthesis process.

References

Koenigsberger, J.G. (1938), Natural residual magnetism of eruptive rocks. Part 1, *Terr. Magn. Atmos. Elect*. **38**, 119–127.

Thellier, E. (1938), Sur l'aimantation des terres cuites et ses applications géophysiques, *Ann. Inst. Phys. Globe* **16**, 157–302.