Preface

In 2007 the AGU Joint Assembly moved to Mexico, taking place in the popular holiday resort of Acapulco. In this successful meeting, a large number of contributions belonging to many different fields of Earth Sciences was presented. Among 14 specific sessions devoted to Geomagnetism and Paleomagnetism, one of them, titled *Magnetism of Volcanic Materials*, was held as homage to Michel Prévot's scientific career in the fields of rock-magnetism, paleointensity and paleomagnetism.

The idea to publish the present special issue of *Earth, Planets and Space* stems from that session, and it has resulted in a collection of 21 works. Many of these contributions had been previously presented in the session and others were included subsequently. It soon appeared that a special issue thought of as a homage to Michel Prévot's work should not be only restricted to volcanic materials *senso stricto*, allowing for the inclusion of rock-magnetic studies without limitation to any specific lithology.

In the present special issue of *Earth, Planets and Space* 21 contributions dealing with paleomagnetic, rock-magnetic and paleointensity studies can be found. Paleomagnetic studies include investigations on Paleozoic volcanics in Argentina (Tomezzoli *et al.*) as well as on Tertiary volcanic rocks in Mexico (Sbarbori *et al.*), a study of paleosecular variation in New Zealand (Tanaka *et al.*) and an investigation on volcanic ashes and rocks in one of the sites of earliest human occupation in the Americas (Goguitchaichvili *et al.*). Many of the submitted papers deal with absolute paleointensity determinations, carried out on materials ranging in age from Archean to historic times: Biggin *et al.* discuss the geomagnetic field intensity in late-Archean and early-Proterozoic, Brandt *et al.* report new high quality determination on Early Cretaceous rocks from southern Brazil, Shcherbakova *et al.* present paleointensity results from Mesozoic baked contacts in Armenia, Perrin *et al.* study the paleointensity of Cenozoic-Mesozoic basalts in Egypt, Calvo-Rathert *et al.* present a paleointensity study on Mio-Pliocene volcanics from Spain and Goguitchaichvili *et al.* analyse the Gilbert-Gauss geomagnetic reversal on Georgian flows. In addition, also two archeointensity studies on Pre-Columbian potteries (Morales *et al.*) and Portuguese potteries (Hartmann *et al.*) and a methodological study about a Vibrating Thermo-Magnetometer (Poidras *et al.*), a useful device to optimize paleointensity determinations, are included in this issue. A large fraction of the contributions is devoted to rock-magnetic measurements: Muxworthy *et al.* discuss thermal fluctuation fields in basaltic rocks, Kosterov *et al.* present results of low-temperature magnetic properties of andesitic rocks and Alva-Valdivia *et al.* study rock-magnetic properties in an ore-deposit in Brazil. Several articles deal with magnetic properties of magnetite: Özdemir *et al.* study its susceptibility at low temperature, Smirnov the grain-size dependence of its low-temperature remanence, Carvallo *et al.* the formation of magnetite in Magnetospirillum gryphiswaldense while Rivas-Sánchez *et al.* analyse magnetite nanoparticles. A study of anisotropy of magnetic susceptibility of Mexican ignimbrites (Caballero-Miranda *et al.*) is also included in the issue.

This special issue would not have been possible without the selfless help of many reviewers, who were able to provide careful and thorough reviews, despite the lack of time. We wish to thank them all for their work. We also wish to thank Prof. Kiyoshi Yomogida for his invaluable help and assistance with the reviewing process.

Michel Prévot

Michel Prévot has dedicated much of his extraordinarily productive research time to topics related to volcanic rocks. He is now retired after 6 years of emeritus. Born in Paris in 1939, he started his research career at CNRS in Saint-Maur in 1965 under Emile Thellier. In 1985, he moved his research to Montpellier to found a new paleomagnetic laboratory. Team leader in Montpellier from 1985 to 2000, he also served as Director of the Geology and Geophysics Center from 1989 to 1993. His scientific research activity, extremely successful, focused first and foremost on the study of magnetic properties of volcanic rocks. Among his major contributions in rock magnetism, we note that in 1968, Michel was the first person to investigate the problem of low-temperature oxidation of magnetite. By means of electronic microprobe analyses, he observed that maghemitization is not a simple oxidation but that the inflow of oxygen comes with a migration, in the opposite direction, of major cations as iron and titanium (Prévot *et al*., 1968). This pioneering observation led to a relatively complex magnetic model of low-temperature oxidation of magnetite, which is now widely accepted. Then, because the intrinsic characteristics of titanomaghemites were difficult to be established experimentally, Michel has developed a theoretical method for calculating their cristallographic parameters in collaboration with P. Poix (Prévot, 1971; Prévot and Poix, 1971). This method provides values consistent with the ones measured from artificial minerals synthesized in recent years.

In the 70s, understanding the origin of the oceanic magnetic anomalies was a crucial issue in geophysics. Michel participated in the Franco-American project FAMOUS devoted to the study of the Mid-Atlantic Ridge. He performed a comprehensive magnetic description of the basalts produced at the axis of this ridge and, in contradiction to the findings of the U.S. team, he showed that the magnetic polarity of these rocks was everywhere normal as assumed by oceanic expansion models (Prévot *et al*., 1976). His work highlighted the influence of petrology on the amplitude of oceanic magnetic anomalies (Prévot and Lecaille, 1976a, b; Prévot *et al*., 1979). Later, in collaboration with D. Dunlop, he studied the role of the lower crust and serpentinization on the magnetization of the oceanic crust. This work has resulted in a magnetic model of oceanic lithosphere (Dunlop and Prévot, 1982) that is at the basis for much current studies.

Among the most important works of Michel Prévot in rock magnetism, are certainly those on Viscous Remanent Magnetization, which is undoubtedly the most common secondary magnetization in natural rocks. Above all, he discovered in sedimentary rocks, that VRM could present an unexpected large resistance to alternating magnetic fields (Prévot and Biquand, 1970). Yet, this treatment was the only commonly used for magnetic cleaning of natural remanent magnetizations at that time. A major breakthrough occurred when Michel observed that a VRM acquired in a few days in the Earth's magnetic field was able to resist to AF treatment with peak values 10,000 times more intense (Biquand and Prévot, 1971). Such a result seemed incomprehensible to many, and therefore unacceptable. In collaboration with D. Biquand, Michel has shown that this high coercivity is readily explained by the theory of thermally activated viscosity in single-domain particles (Prévot, 1981) as proposed by Néel in 1955. This observation, which is also valid for volcanic rocks, is a key reason for the success of paleomagnetic cleaning by thermal treatment, now commonly used in palaeomagnetism. For multi-domain grains, Néel's theory revealed many shortcomings (Prévot and Bina, 1993). With M. Bina, Michel improved this theory by taking into account the activation volume of crystal defects, which are at the origin in the blocking of the magnetic domain walls (Bina and Prévot, 1994).

The contribution of Michel Prévot to Geomagnetism was mainly based on the analysis of the paleomagnetic field recorded in volcanic rocks. The vectorial description (direction and intensity) of the geomagnetic polarity reversal recorded in basalts at Steens Mountain in Oregon, undoubtedly represents his major contribution in this area (Prévot *et al*., 1985a, b; Mankinen *et al*., 1985). This work led to the most detailed and most reliable description obtained to date of the Earth's magnetic field when it reverses its polarity.

During last decades, Michel closely studied self-reversal phenomena in hemo-ilmentite crystals (Prévot *et al*., 2001). These investigations, which also included direct observations using transmition electronic microscopy allowed proposing a most comprehensive magnetic theory to explain the self-reversal of thermoremanent magnetization.

One of the last Michel's major contribution was to re-analyse the True Polar Wander over the last 200 Ma from a rigorous and thoughtful selection of global palaeomagnetic data, including only those provided by rocks bearing a primary magnetization of thermo-remanent origin (Prévot *et al*., 2000). His TPW path differs in several aspects of those proposed elsewhere. In particular, a single period of movement is documented over the last 200 Ma. It culminates with a swing of about twenty degrees around 110 Ma, during which the angular velocity could exceed 5° per Ma.

As homage to this long and fruitful scientific career, this issue deals on the broad spectrum of topics related to the magnetism of volcanic rocks, including new developments in rock magnetism, results and methodology of absolute paleointensity determinations, the analysis of polarity transitions and paleosecular variation. Since the early times of paleomagnetism, volcanic rocks have been the subject of numerous investigations, in part because their stronger intensity of remanence allowed an easier measurement. The paleomagnetic study of volcanic rocks undeniably benefited from the fact that more than half a century ago, Luis Néel was able to provide a theory for the acquisition of thermoremanent magnetization of an assemblage of single domain grains. As the primary magnetization of volcanic rocks is a thermoremanence which might provide a spot reading of the field in which it was acquired, absolute paleointensity determinations or investigations of geomagnetic field reversals rely on the study of volcanic rocks.

Below we list a selection of Michel Prévot most important papers, all referred in this preface.

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