Pure Appl. Geophys. 171 (2014), 2079–2081

DOI 10.1007/s00024-014-0822-y

Pure and Applied Geophysics

Book Review

Magnetic methods and the timing of geological processes Eds. L. Jovane, E. Herrero-Bervera, L. A. Hinnov and B. A. Housen, Geological Society Special Publication N. 373, The Geological Society London, 2013; ISBN: 978-1-86239-354-7

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Rock magnetism itself does not carry any geochronological information, but combined with biostratigraphic, lithostratigraphic, or isotope geochronology methods, palaeomagnetism or rock magnetism becomes an excellent tool for stratigraphic correlations. The power of magnetic methods in geological correlations, however, depends strongly on the precision of geochronological tools. For instance, palaeomagnetic inversion identified in two far-away situated geologic sites cannot be used as a correlative horizon as long as the rocks are proven to be of the same age, and a continuity of sedimentary record is not documented. Identification of geomagnetic field inversion in rocks is not an easy game, either. It requires sophisticated palaeomagnetic laboratory methods and tests, combined with rock magnetic, geochemical, and mineralogical studies. If all these studies successfully prove a synchronism of palaeomagnetic inversion recorded in the rocks, then it may be utilized for the comparison of e.g., dynamics of subsidence (sedimentation rates) in sedimentary basins, correlation of lateral facies changes, diachronism of biostratigraphic horizons (e.g., a biostratigraphic horizon crossing a magnetozone boundary), or deciphering the history of the geomagnetic dynamo.

This Special Publication volume deals with successes, bad luck, and problems in using magnetic methods in the time correlation of geologic processes. The editors collected manuscripts originating from recent AGU meetings in Brazil (2010) and San Francisco (2010, 2011) that can be grouped into four topical domains: integrated magnetostratigraphy (Part 1), dating tectonic processes with magnetic methods (Part 2), relative (geomagnetic) palaeointensity for dating geological sequences (Part 3), and palaeoclimatic change from rock magnetic proxies (Part 4). An opening article by the editors (Jovane et al. 2013) discusses a role of magnetic methods in the timing of geological processes. A paper by Guidry et al. on Oligocene–Miocene magnetostratigraphy of deep-sea sediments from the equatorial Pacific West of the Mexican coast begins Part 1. This study identified a rarely documented magnetic transition of the Oligocene–Miocene boundary, and provided a very well-resolved magnetostratigraphic record over a 10 Ma time interval. The following comprehensive study of integrated biomagnetochronology for the Paleogene of ODP Hole 647A and implications for correlating palaeoceanographic events from high to low latitudes is presented by Firth et al. This paper provides new palaeomagnetic and multigroup biostratigraphic data, and presents a revised age model for Site 647, situated south of the entrance to the Labrador Sea. Integrated magnetobiostratigraphy of the middle Eocene–lower Oligocene interval from the Monte Cagnero section in central Italy is the subject of the following paper by Jovane et al. In this study, the authors provide a robust, magnetostratigraphic age-depth model for the most complete stratigraphic sequence representing a 55–28 Ma time span. Savian et al. report a high-resolution magnetostratigraphic record and a new integrated age model for the middle

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Eocene-to-lower Oligocene strata recovered within Hole 711A (Leg 115), in the western equatorial Indian Ocean. The last paper of Part 1 is presented by Coccioni et al., who present a complete and well-preserved Paleogene pelagic composite succession of the Umbria-Marche Basin (Central Italy), with integrated magneto-, bio-, and chronostratigraphy.

Three-dimensional magnetostratigraphic correlations in the Guide Basin, in the northeastern part of the Tibetan Plateau, with implications for the identification of sedimentary provenances for the basin infillings are presented by Yan et al., opening Part 2 of the volume. A subsequent paper by Fang et al. examines evidence from high-resolution magnetostratigraphy and tectonosedimentology in order to constrain the age range for deformation and uplift of the Yumu Shan and North Qilian Shan mountains (NE Tibetan Plateau). Neogene vertical axis block rotations in the Jiunquan Basin (Hexi Corridor, Tibetan Plateau, China) are examined by Yan et al., who concluded that observed rotation patterns may suggest two major tectonic activity phases during the last 13 Ma. Part 2 is completed by the paper by Zhao et al. on detailed magnetostratigraphic results from sedimentary rocks of Integrated Oceanic Drilling Project (IODP) of Nankai trough seismogenic zone experiment, which suggest tectonic-driven, important palaeoenvironmental changes in the Shikoku basin during the late Miocene.

Part 3 begins with studies by Haberzettl et al. (2012) on palaomagnetic secular variations, recovered from a Holocene lake on Sulawesi Island, Indonesia. In this case, the secular variations are compared with a spherical harmonic geomagnetic model of the 0-3 ka field to obtain an age-depth model for the Lake Kalimpaa sequence, providing, for the first time from Indonesia, a high-resolution paleomagnetic secular variation data, continuously spanning the past 1.3 ka. In a following paper, Herrero-Bervera and Ca'¢n-Tapia report on details of a directional signature of the Pringle Falls excursion recorded at Pringle Falls (Oregon, USA), considered to represent an aborted reversal. Excellent results obtained from over 800 azimuthally-oriented cores enabled unique insight into the details of a geomagnetic dynamo short-time instability state. Hunting for aborted excursions is also a subject of palaeomagnetic and rock-magnetic studies on magnetostratigraphy of the calcareous sediments of Noggin Reef (offshore Queensland, Australia) by Herrero-Bervera and Jovane (2013). The last paper of the Part 3 is by Caminha-Maciel and Ernesto, who analyzed wavelengths in virtual geomagnetic pole (VGP) trajectories from magnetostratigraphic data of the Early Cretaceous Serra Geral lava piles (Southern Brazil), using a combination of information approach and interpreting the results in favor of inner Earth's anisotropies influencing virtual geomagnetic pole trajectories.

The first paper of Part 4, written by Gunderson et al., explores cyclostratigraphy for the Late Pliocene-Early Plaistocene Stirone section (Northern Apennine, Italy) using lithostratigraphic, magnetostratigraphic, and rock-magnetic data, subjected to multi-taper method spectral analysis. The resultant power spectra revealed significant frequency peaks that are aligned with eccentricity, obliquity, and precession Milankowitch orbital cycles. Global Milankovitch cycles recorded in rock magnetism of the shallow marine, carbonate Cretaceous Cupido Formation (northeastern Mexico) are reported by Hinnov et al. The results of this study uncovered a strong astronomical signal hidden in the anhysteretic remanent magnetization (ARM), which proved to be a strong correlation parameter between two coeval formations, separated by 25 km. Elwood et al. present visual identification in the field and quantification of Milankovitch climate cycles on the example of the Upper Ordovician Kope Formation (northern Kentucky, USA). A multiple proxy record of astronomical and millennial scale paleoclimatic change in a glacial setting, involving anisotropy of magnetic susceptibility and sedimentary cycle data, is presented by Franco and Hinnov. The rocks studied were Permo-Carboniferous glaciogenic rhythmites of Parana Basin (Brazil). Spectral analysis of the maximum axis of anisotropy of magnetic susceptibility showed that this parameter is an effective paleoclimatic proxy for sedimentation influenced by sediment transport, which in turn is forced by climatic processes. The final paper of Part 4 and of the entire volume is by Elwood et al., on magnetostratigraphy susceptibility for the Guadeloupian (Middle Permian) epoch in the Guadalupe Mountains N.P. and adjacent areas in West Texas (USA). This work demonstrates, among other findings, that susceptibility provides a proxy for climate cyclicity, gives quantitative estimates for the time it took for these sediments to accumulate, allows correlation to equivalent sections in the region, or identifies anomalous stratigraphic horizons within some sections.

The volume was published in 2013, but includes also papers published online that are dated from 2012. Perfect legibility of figures, color plates, and an interesting selection of topics and case studies make this volume attractive for researchers in geomagnetism, palaeomagnetism, sedimentology and tectonics, as well as for post-graduate students in the subjects of geology and geophysics.