GEOLOGICA BELGICA (2010) 13/4: 287-290

MAGNETIC SUSCEPTIBILITY, CORRELATIONS AND PALAEOZOIC ENVIRONMENTS: FOREWORD

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(2 figures)

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1. IGCP-580 Project – Application of magnetic susceptibility on Palaeozoic sedimentary rocks

Quantitative magnetic susceptibility (MS) measurements have become widely used in the sedimentology of rocks from the Recent to the Palaeozoic. The basic principle of the technique is the following: MS measurements on sedimentary rocks are considered as a proxy for impurities delivered to the sedimentary environments. Although the common sandstones or limestones have very low magnetic response, many weathering products coming from the erosion of the main land commonly have high MS values. So the measurement of MS in sediment is considered as a proxy for such detrital input. This relationship is interesting because it is hypothesised that climatic and eustatic sea level variations will affect the detrital input. A sea-level fall increases the proportion of exposed continent and siliciclastic supply and therefore increases magnetic mineral deposition. Furthermore, an increase of rainfall or a glaciation will also increase erosion.

MS of Holocene, Pleistocene, and Tertiary sediments and sedimentary rocks is widely used as a palaeoclimatic proxy (e.g. Kent, 1982; Mead & Tauxe, 1986) or to identify orbital forcing (Boulila et al., 2008) and to astronomically calibrate portions of geologic time scale (Shackelton, 1999). Bulk MS measurements have been more recently used in Palaeozoic sedimentology for correlations and for reconstruction of sea level or climatic changes (e.g. Ellwood et al., 2006; 2007; 2008; Hladil et al., 2006; Whalen & Day, 2008; Da Silva et al., 2009). However, even if the use of MS in Palaeozoic sediments is becoming more common, it still suffers from some controversy. One of the problem is the origin of the magnetic minerals. The dominant hypothesis for sedimentologists is that magnetic minerals are mainly related to lithogenic inputs. But are these related to fluvial or eolian sources? Are these lithogenic input variations related to climatic, sea level or tectonic changes? These different influences are probably acting at different time-scales and to differentiate them, a strong interdisciplinary characterization of facies, sequences and MS signal and its carriers is needed. Furthermore, considering the study of Palaeozoic rocks, the influence of diagenesis in creating or destroying magnetic minerals has to be assessed. So, magnetic susceptibility can be a very powerful tool to perform correlations as well as palaeoenvironmental reconstitutions and astronomical calibration. However, these controversies are pointing to a possibly relatively complex origin of the MS signal.

The IGCP-580 project was developed in this framework and intends to consider the application of magnetic susceptibility by a pluri-disciplinary approach. The full name of the IGCP-580 is "application of magnetic susceptibility as a palaeoclimatic proxy on Palaeozoic sedimentary rocks and characterization of the magnetic signal" and all information is available on www.ulg.ac.be/geolsed/MS. The IGCP-580 project (International Geological Program) is supported by UNESCO and IUGS and the main leaders of the project are A.-C. Da Silva, M.T. Whalen, J. Hladil, D. Chen, .S. Spassov, F. Boulvain and X. Devleeschouwer. The inaugural meeting took place in Liège, the 2-6th December 2009 and was attended by 44 participants, from 18 countries. During the first two days (main meeting), 23 talks, 3 keynotes and 11 posters were presented. The third day was a field day with visit of the Belgian Devonian outcrops (Frasnian reefs, mounds and atolls from Belgium: sedimentology and magnetic susceptibility, Boulvain & Da Silva, guide book in this volume). During the two last days, a complete training was offered to the participants by B.B. Ellwood, S. Spassov, M. Chadima and X. Devleeschouwer (available online http://www2.ulg.ac.be/geolsed/MS/lectures.html).

2. Magnetic susceptibility, correlations and Palaeozoic environments

This special issue includes some of the topics presented during the Liège meeting, dealing with the application of magnetic susceptibility as a correlative tool and palaeoenvironmental proxy and with the origin of the magnetic minerals as well as different ways to apply magnetic techniques and to treat the signal. Below, the papers are introduced in appearing order.

Babek et al. present a gamma-ray spectrometry (GRS) and MS logging from Tournaisian-Visean boundary sections from Northern Europe, ranging from deep-water carbonate and carbonate-siliciclastic sections. Both GRS and MS provide long-distance correlations and sea level interpretations. However, some differences between MS behaviour and transgressive-regressive settings are also

pointing to local influence of sedimentary conditions (e.g. carbonate production).

Boulvain et al. focus on the comparison of two non condensed Eifelian-Frasnian sections, in Belgium and Moravia. These curves show a remarkable similarity, despite a very different background of palaeogeographical setting, facies, sedimentary rate and retrogradation-progradation history.

Da Silva et al. paper concerns the Early-Middle Frasnian in the Ardennes of Belgium, with a detailed sedimentological and magnetic susceptibility analyzes. Three successive carbonate mound levels are studied and magnetic susceptibility and sedimentological results point to severe and rapid sea-level fluctuations at the lower and upper boundaries of the La Boverie mound which is included in the *punctata* interval.

Debacker et al. use magnetic techniques (specially the temperature-dependent variation of MS within the "room temperature interval" and the anisotropy of magnetic susceptibility) for distinguishing between different Lower Palaeozoic lithostratigraphic units from the Anglo-Brabant Deformation Belt in Belgium.

Devleeschouwer et al. document the evolution of MS through the Givetian-Frasnian boundary in Belgium. They identify the carriers of the MS signal and highlight the MS signature of the progressive change from a Givetian rimmed platform towards a Frasnian ramp setting.

Hladil, Cejchan et al. present a comprehensive synthesis of the nature and amount of atmospheric dusts (weathered rocks, volcanic ash, biogenic and organic dust, dust from wildfires, cosmic dusts and aerosols) and of their mode and pathways of sedimentation. These atmospheric dust are often under evaluated as a potential magnetic mineral source and could strongly influence MS in carbonate sediments.

Hladil, Vondra et al. show that the alignment of MS stratigraphic sections by means of the dynamic time warping (DTW) approach gives positive results (about two orders of magnitude higher compared to that which can be achieved by the bio-, chemo- or lithostratigraphic tools). Examples are taken from Lower Devonian calciturbidites (Prague Synform, Bohemian Massif).

Koptikova et al. study the variations in non-carbonate impurities trapped in the Lower Devonian limestone in the Prague Synform, with particular emphasis on the composition and quantities of fine-grain mineral assemblages. They show that different assemblages are encountered for the Lochkovian, lower Emsian and Pragian.

Machado et al. document an Emsian-Eifelian sequence in Portugal (reef fauna, conodont, facies and magnetic susceptibility). Sedimentological model points to calciturbitites and debris flow related to a reefal complex installed on the top of a volcanic system. Magnetic susceptibility seams to be mostly unaffected by volcanic activities. Magnetic susceptibility signal is interpreted as mainly related to atmospheric particles and provides long distance correlations with Nevada, Uzbekistan and Morocco.

Michel et al. studied mid-Emsian shales and sandstones in Luxembourg. Reliable reconstructions of palaeoenvironmnts of these deposits are very difficult because exposures are limited as well as fossils and they were strongly affected by tectonic structuration. Detailed sedimentoloy associated with magnetic susceptibility allowed to reconstruct a vertical succession and a palaeogeographic model.

Sliwinski et al.: provide a comprehensive paper on the *punctata* Event, with abundant geochemical data (Total Organic carbon, MS, major and minor trace elements) across the Early-Middle Frasnian transition. Geochemical proxies and MS display similar trends, with indication of major changes of bioproductivity, palaeoredox and detrital influx near the onset of the *punctata* event and coinciding with a transition between third order sequences. These main changes are interpreted as related to the main development of archaeopterid forest.

3. Acknowledgements

We sincerely thank all the reviewers of this special issue for their great effort of ensuring a high scientific quality to this special issue. Of course we also strongly acknowledge all authors for their contributions and their effort to respect the strict deadlines. Reviewers, authors, meeting participants and IGCP-580 project participants (http://www.ulg.ac.be/geolsed/MS/projectparticipant1.html), they all help to make the IGCP-580 project strongly enjoyable and hopefully, a scientific success. We also would like to acknowledge J.-C. Duchesne, the Executive Editor of Geologica Belgica for his help, advices and infinite patience. Finally, we would like to thank the UNESCO and the IUGS for their financial support as well as the FNRS (Belgian national science foundation).

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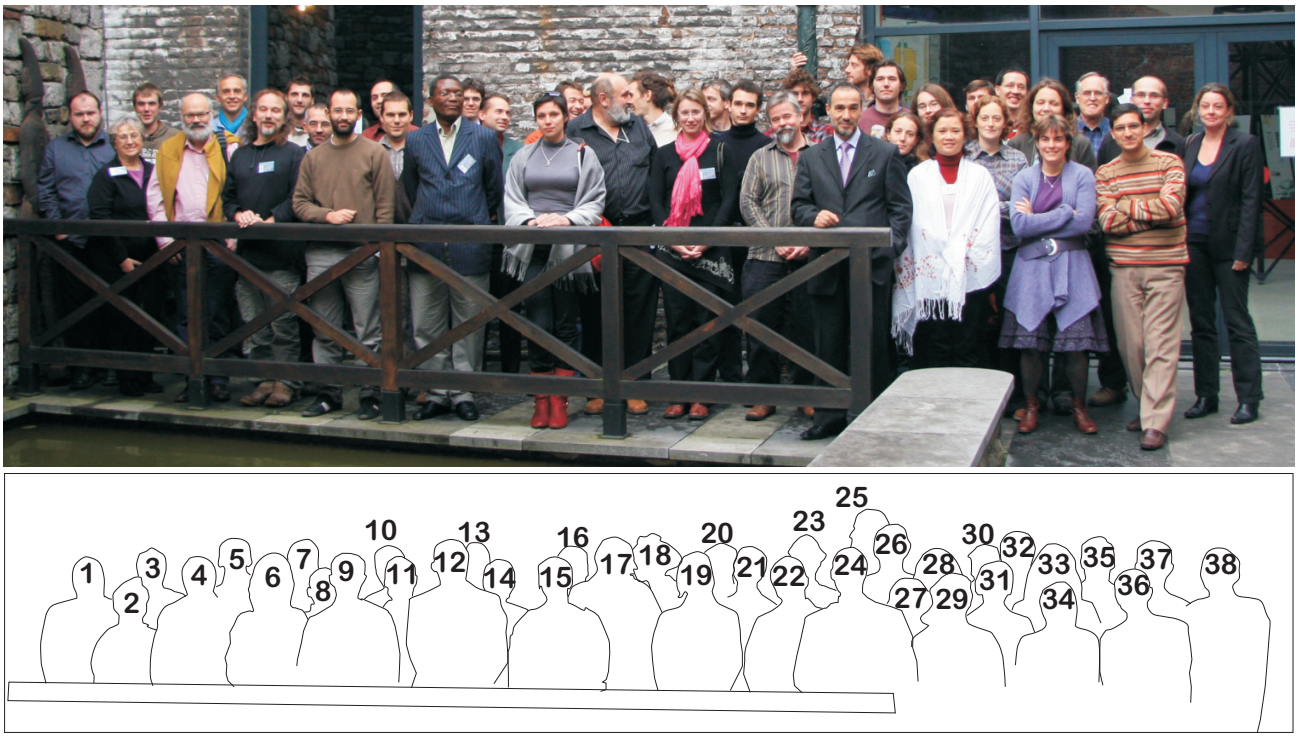

Figure 1. Group picture at the IGCP-580 first meeting in Liège, 3 December 2009. 1. Frantisek Vacek (Cz R) - 2. Suzanne Ellwood (USA) - 3. David De Vleeschouwer (Belgium) - 4. Mark Dekkers (Netherland) - 5. Frédéric Boulvain (Belgium) - 6. Petr Cechjan (Cz R) - 7. Benoit Hubert (France) - 8. Jacek Grabowski (Poland) - 9. Gil Machado (Portugal) - 10. Laurent Riquier (France) - 11. Sébastien Betrand (Germany) - 12. Fred Kamona (Namibia) - 13. Ludovic Letourneur (UK) - 14. Xavier Devleeschouwer (Belgium) - 15. Olga Izokh (Russia) - 16. Peter Koenighsof (Germany) - 17. Jindrich Hladil (Cz R) - 18. Damien Pas (Belgium) - 19. Leona Koptikova (Cz R) - 20. Ondrej Babek (Cz R) - 21. Jonathan Michel (Belgium) - 22. Michael Whalen (USA) - 23. Philippe De Smedt (Belgium) - 24. Mohamed El Hassani (Morocco) - 25. Timothy De Backer (Belgium) - 26. Petr Schnabl (Cz R) - 27. Ozlem Makaroglu (Turkey) - 28. Katarzyna Sobien (Poland) - 29. Phuang Luu (Vietnam) - 30. Stanislav Slechta (Cz R) - 31. Anneleen Foubert (Belgium) - 32. Simo Spassov (Belgium) - 33. Lisa Lenka (Cz R) - 34. Anne-Christine da Silva (Belgium) - 35. Brooks Ellwood (USA) - 36. Mehrdad Sardarabadi (Iran) - 37. Martin Chadima (Cz R) - 38. Estelle Petitclerc (Belgium).

Figure 2. First IGCP-580 meeting in Liège, 2-6 December 2009. A-D. Field trip Frasnian reefs, mounds and atolls from Belgium. E. Coffee break during the meeting, Maison de la métallurgie, Liège. F. Lunch at the Brasserie des Fagnes and G. Visit of Dourbes facilities.