FIRST IGCP 580 MEETING

MAGNETIC SUSCEPTIBILITY, CORRELATIONS AND PALEOENVIRONMENTS

LIEGE, BELGIUM

Meeting, field trip and training

2 – 3 – 4 – 5 - 6

DECEMBER 2009

Liège University, B20, Sart Tilman, Belgium

http://www2.ulg.ac.be/geolsed/MS/meeting.htm

ac.dasilva@ulg.ac.be
fboulvain@ulg.ac.be

ORGANIZATION AND SPONSORS

ORGANIZATION

Organizing committee: Anne-Christine da Silva, Frédéric Boulvain

Scientific committee: Michael Whalen (USA), Jindrich Hladil (CZE), Daizhao Chen (CHN), Simo Spassov (BEL), Nadine Mattieli (BEL) and Xavier Devleeschouwwer (BEL)

Secretariat and correspondence: IGCP 580 Meeting, Liège University, pétrologie sédimentaire, B20, Boulevard du Rectorat, 15, Université de Liège, Sart Tilman, 4000 Liège, Belgium. Phone : +32 43662258 or + 32 43662252. Fax : + 32 43662029

Web: http://www2.ulg.ac.be/geolsed/MS/meeting.htm

Emails: m.guadagnano@ulg.ac.be, ac.dasilva@ulg.ac.be, fboulvain@ulg.ac.be

The meeting will be held in the "Maison de la métallurgie et de l'Industrie de Liège" and the training will be held in the Geological Departement of Liège University.

The House of the Metallurgy is an old manufacture (1848) transformed in museum and conference centre. http://www.mmil.be/

SPONSORS

The meeting is sponsored by the IGCP (UNESCO) program and by the fond de la recherche scientifique (F.R.S., Belgium) and Liège University (ULg) which are greatly acknowledged.

MEETING PROGRAM – PRELIMINARY PROGRAM

Day 1 : 2 Decembre 2009 – Maison de la Métallurgie

Opening Session

Chair: da Silva, AC

09h00-09h05 *Opening session, welcome to Liege, word from the vice dean of the Science Faculty of Liège University*

09h05-09h20 *Opening session, IGCP-580 project*

09h20-10h00 Keynote speaker: **Ellwood, B.B.**, Ratcliffe, K.T.,, Tomkin, J.H., Roach, C., Kaplan, U., Wray, D.S.: Global correlation using magnetic susceptibility and geochemical data for the Cenomanian-Turonian boundary

10h00-10h20 **Koptíková, L.**, Hladil, J., Slavík, L., Frána, J.: Mineralogy of fine-grained non-carbonate particulates embedded in neritic to pelagic limestones, and connection to magnetic susceptibility and gamma-ray signals: a case study based on Lochkovian, Pragian and lower Emsian strata from the Pozar-3 section (Prague Synform, Czech Republic)

10h20-10h40 **Michel, J.**: Himmelbaach quarry (Mid Emsian, Luxemburg): palaeoenvironmental study and small scale correlations by lithological units and magnetic susceptibility.

10h40-11h10 Coffee

Chair: Hladil, J.

11h10-11h30 **da Silva, AC.**, Mabille, C., Boulvain, F.: magnetic susceptibility on different sedimentary settings, examples from the Devonian of Belgium

11h30-11h50 **Machado, G**., Slavik, L., Koptikova L., Hladil, J., Fonseca, P.: Emsian-Eifelian mixed carbonate-volcaniclastic sequence in western Ossa-Morena zone (Odivelas limestone)

11h50-12h10 **Devleeschouwer, X.**, Cambier, G., Petitclerc, E., Casier, J.-G., Spassov, S., Préat, A.: Detrital magnetite grains control the magnetic susceptibility evolutions established for the Trois-Fontaines – Terres d'Haurs Formations (Lower Givetian) in Givet (France)

12h10-12h30 **El Hassani, A.**, Ellwood, B.B., Algeo, T., Tomkin, J.H., Rowe, H.: Timing and Extent of the Kačák Interval Within the Eifelian-Givetian Boundary GSSP, Mech Irdane, Morocco, Using Geochemical and magnetic susceptibility patterns

12h30-14h00 Lunch

Chair: Whalen, M.

14h00-14h20	**Pas, D.**, Mabille, C., Aretz, M., Boulvain, F., da Silva, AC.: Detailed sedimentological study and magnetic susceptibility of an Eifelian mixed ramp-related system in the Eifel area.
14h20-14h40	**Boulvain, F.**, da Silva, A.C. Mabille, C., Poulain, G., Hladil, J. Gersl, M., Koptikova, L., Schnabl, P.: Magnetic susceptibility correlation of km-thick Eifelian–Frasnian sections (Belgium–Czech Republic)
14h40-15h00	**Grabowski, G.**, Matyja H., Narkiewicz M., Nawrocki, J., Sobień K.: Devonian magnetic susceptibility studies in Poland: achievements and future
15h00-15h20	**Petitclerc, E.**, Devleeschouwer, X., Spassov, S., Casier, J-G., Préat, A.: Contrasting Magnetic Susceptibility Curves (MSC) reported at the Givetian/Frasnian boundary in Belgium: diagenetic modifications of the magnetic mineralogy

15h20-16h00 Poster - Coffee

Chair: Devleeschouwer, X.

16h00-16h20	**Riquier, L.**, Averbuch, O., Devleeshouwer, X., Tribovillard, N.: Origin of the magnetic susceptibility variations in some carbonate Frasnian-Famennian boundary sections : implications for paleoenvironmental studies
16h20-16h40	**Whalen, M.**, Sliwinski, M.G., Day, J.: Comparison of MS and other proxies from the Middle-Late Frasnian: Implications for paleoclimatic analyses
16h40-17h00	**Sobien, K.**, Nawrocki, J., Narkiewicz, M.: Test of the Famennian magnetic susceptibility record in selected cores of the southern Poland
17h00-17h20	**Bábek, O**., Kalvoda, J., Cossey, P., Devuyst, F-X., Herbig, H-G., Sevastopulo: Correlation potential of magnetic susceptibility and outcrop gamma-ray logs at Tournaisian-Viséan boundary sections in Western Europe

Social Dinner – Christmas market, Liege Centre

Day 2 : 3 Decembre 2009 : Maison de la Métallurgie

Chair: Boulvain, F.

09h00-09h40	Keynote speaker: **Hladil, J.**: Natural atmospheric mineral dust: its potential for the MS stratigraphy.
09h40-10h00	**Devleeschouwer, X.**, Petitclerc, E., Spassov, S. and Préat, A.: A strong diagenetic high coercivity phase influence the Magnetic Susceptibility Curve of the Eifelian-Givetian boundary (Pic de Vissou, Montagne Noire, France)
10h00-10h20	**Schnabl, P.**, Pruner P., Venhodová D., Slechta S., Koptikova L., Kostak M.: Detailed magnetostratigraphic and magneto-susceptibilitic investigation of J/K boundary in the Tethyan realm
10h20-10h40	**Sardarabady, M.**, Amini, A.H.: Magnetic record in deep water sediments: An example from Kashafroud Formation, Kopet-Dogh Basin, NE Iran

10h40-11h10	Coffee

Chair: Bertrand, S.

11h10-11h30	**Foubert, A.,** Yuji, F. Hus, J., Huvenne, V., De Mol, B., the IODP Exp. 307 Scientific Party: Magnetic susceptibility and rock magnetic properties in recent carbonate mounds – Challenger Mound, Porcupine Seabight (SW of Ireland) as specific case study.
11h30-11h50	**Bertrand, S.**: Magnetic susceptibility of Late Quaternary lake and fjord sediments from southern South America: Geochemical origin and potential for high-resolution reconstructions of climate and environmental changes
11h50-12h10	**Lisa, L.**, Chadima, M., Grygar, T., Jones, M.J. and Gregor, M.: Relationship of magnetic susceptibility with sedimenthological and micromorphological features, and geochemical proxy parameters; case study from Last Glacial loess deposits in southern Moravia
12h10-12h30	**Luu, P.**, Ellwood B.B., Nguyen K. S.: Magnetic susceptibility as a Climate Proxy for Con Moong Cave Sediments, Vietnam: Correlation to SE European Caves

12h10-14h00	Lunch

Chair: Spassov, S.

14h00-14h40 Keynote speaker: **Dekkers, M.J.**, Gong, Z., Heslop, D., Mullender, T.A.: End-member modeling of isothermal remanent magnetization (IRM) acquisition curves: a novel approach to diagnose remagnetization and its bearing on the interpretation of the low-field susceptibility signal

14h40-15h00 **Chadima, M.**, Kadlec, J., Hrouda, F., Slechta, S.: Frequency dependence of magnetic susceptibility of weakly magnetic sediments: implications for magnetic granulometry

15h00-15h20 **Debacker, T.N.**, Sintubin, M., Robion, Ph.: On the use of magnetic techniques for stratigraphic purposes: examples from the Lower Palaeozoic Anglo-Brabant Deformation Belt (Belgium)

15h20-16h00 Poster - Coffee

DISCUSSIONS

16h00-16h30 Future of the IGCP-580 project

16h30-16h45 Next meeting and field trip related to the IGCP-580 project

16h45-17h00 Other meetings (P. Koeningshof, O. Izokh)

16h50-17h00 Logistic for field trip and training

Meeting closure

During the meeting: POSTERS

Akermi, S., Abdallah, H., da Silva, A.C., Ben Hassen, A., Boulvain, F.: Application of magnetic susceptibility to the Maastrichtian–Eocene Phosphatic deposits of Sélja section in Gafsa-Métlaoui basin (southern Tunisia)

Cejchan, P. **Hladil, J., Vondra, M., Vich, R.**: Stratigraphic alignment of magnetic-susceptibility records by dynamic time-warping.

da Silva, AC., George, A., Chow, N.: Sequence–stratigraphic correlation and characterization of cyclic facies arrangements using magnetic susceptibility, Late Devonian (Frasnian) Hull platform, Canning Basin, Australia

Devleeschouwer, D., Boulvain, F., da Silva, AC, Clayes, Ph.: Orbital forcing of the Devonian climate? A search for Milankovic cycles in the magnetic susceptibility record of a km-thick Eifelian-Frasnian section (Belgium)"

Foubert, A., da Silva, AC., Boulvain, F., Henriet, J.P. & the IODP Exp. 307 Scientists: Magnetic susceptibility records in recent (Cenozoic) and ancient (Devonian – Palaeozoic) mound systems

Foubert, A., da Silva, AC, Boulvain, F.: A comparative study of magnetic susceptibility records in Recent (Cenozoic) and ancient (Devonian – Palaeozoic) mound systems

Izokh, O., Mizens, A.G.: Isotopic composition of carbon and oxygen in the Upper Devonian (F-F) sections from the Western part of South Urals (Russia)

Makaroglu, O., Orbay, N., Pesonen, J.L.: Magnetic properties of sediments from Lake Van, Eastern Anatolia, Turkey

Pas, D., Mabille, C., Aretz, M., Boulvain, F., Schröder, S., da Silva, A.C. : Detailed sedimentological study and magnetic susceptibility of an Eifelian mixed ramp-related system in the Eifel area

Preeden, U. , Kalberg, A.-L., Plado, J., Ainsaar, L.: Magnetic susceptibility as additional tool in stratigraphic correlations: A case study of the Middle and Upper Ordovician sedimentary succession, Estonia

Schnabl P., Cajz V., Pruner P., Šlechta S., Venhodová D., Koptíková L., Vacek F., Machado, G., Hladil J.: Use of field dependent susceptibility in determination basaltic tuff material in sedimentary record.

Vacek, F.: Magnetic susceptibility and gamma-ray spectrometry used for correlation of two Silurian-Devonian boundary GSSPs: Klonk near Suchomasty and Karlštejn sections (Barrandian, Czech Republic)

Yaich, C., Boulvain, F. Kacem, A., Trabelsi, M., Ben Youssef, M.: Facies Sedimentology and cyclostratigraphy of Coniacian-Santonian transition. Northern Tunisia

During the meeting: device demonstrations

Bartington Instruments and Agico, Inc., will present the latest models of their instruments for laboratory measurement of magnetic susceptibility.

These instruments will be available during the meeting for practical demonstration and basic introduction into the measuring techniques. Meeting participants - preferably those who do not own any magnetic susceptibility instrument - are encouraged to bring their own samples (in reasonable quantity) to be measured free of charge with the assistance of a company technician. (This offer does not apply to temperature variation of magnetic susceptibility due to rather time-consuming matter of the measurement; one curve may take more than two hours).

The test samples can be either solid or unconsolidated (e.g. soil, loess, powder, fly ash). Solid samples can be in the form of standard paleomagnetic cylinders (2.5 cm in diameter, ca. 2.2 in height), cubes (2 cm side) or any fragment that would fit into a cylindrical holder (3.5 cm in diameter, ca. 3.5 in height). Unconsolidated samples should be in a non-magnetic box or plastic bag, volume should be less than 30 ccm.

Agico instrument (Martin Chadima):

Multi-function Kappabridge MFK1-FA

Agico MFK1-FA is a Multi-Function Kappabridge for high precision measurement of magnetic susceptibility, its anisotropy and variations of magnetic susceptibility with field, temperature and frequency. They are equipped with automatic zeroing system (in both real and imaginary components) and automatic compensation.

Barington instrument (Ludovic Letourneur):

MS2 - Magnetic Susceptibility System

The MS2 magnetic susceptibility system comprises a meter with a wide range of sensors for measuring the magnetic susceptibility of soils and rocks, in both the field and laboratory, with a resolution to 2 x 10^{-6} SI units. Equipment is available for the measurement of susceptibility over the temperature range -200ºC to +850ºC.

The MS2 meter is portable and is supplied with a carrying bag for field use, an instrument stand for laboratory use, a universal mains adaptor, vehicle dashboard connector, RS232 cable and a booklet on Environmental Magnetic Susceptibility measurements.

MS3 - Bartington Magnetic Susceptibility System

The new MS3 is the next generation product in our range of magnetic susceptibility instrumentation available with a range of sensors designed for different applications.

Summary of MS3 main features: Measurement range to 26 SI (volume specific) - Measurement time from 100ms - USB or RS232 interface options

Day 3 – 4 Decembre 2009

Field trip

Devonian of Belgium, sedimentology and magnetic susceptibility.
Departure: Geological Building (B20), Friday 4th Dec., 8h30.

Day 4 – 5 Decembre 2009: Geological Building B20

Training sessions

9h00 - 10h30: B.B. Ellwood (Department of Geology and Geophysics, Louisiana State University, U.S.A.): Magnetic susceptibility: instruments, units, standardization and various approaches for using MS data sets for correlations

11h00 - 12h30: S. Spassov (Centre de Physique du Globe, IRM, Dourbes, Belgium): The potential of mineral magnetism for studying past and present environment.

12h30 - 14h00 Lunch

14h00 - 14h30: M. Chadima (AGICO) Magnetic susceptibility and its variations with temperature, measuring field and operating frequency: examples from various rock types

14h30 - 17h00: X. Devleeschouwer (Sedimentologie et dynamique des bassins, ULB, Belgium): Rock magnetism in the sedimentary record: history of magnetism, magnetic mineralogy; magnetic susceptibility thermomagnetism and hysteresis applications conducted simultaneously

Day 5 – 6 Decembre 2009: Geological Building B20

Training sessions

S. Spassov: Visit of Dourbes facilities (Belgian Geophysical institute)

Departure 9 am from Liege, return around 3pm.

PARTICIPANTS

Name	Country	Institution	Email
Averbuch, Olivier	France	USTL Lille	Olivier.averbuch@univ-lille1.fr
Bábek, Ondřej	Czech Republic	Masaryk University	babek@prfnw.upol.cz
Bertrand, Sébastien	Germany	Alfred Wegener Institute	sbertrand@awi.de
Bougara, Mohamed	Algeria	Khemis Miliana	mbougara@hotmail.com
Boulvain, Frédéric	Belgium	Liege University	fboulvain@ulg.ac.be
Cejchan, Petr	Czech Republic	Czech Academy of Science	cej@gli.cas.cz
Chadima, Martin	Czech Republic	Agico, Brno	chadima@sci.muni.cz
Cornet, Pierre	Belgium	Liège University	
Custine, Eddy	Belgium	Liège University	Eddy.Custine@rma.ac.be
da Silva, Anne-Ch.	Belgium	Liege University	ac.dasilva@ulg.ac.be
Debacker, Timothy	Belgium	Ghent University	timothy.debacker@ugent.be
Dekkers, Marc	Netherland	Utrecht University	dekkers@geo.uu.nl
De Smedt, Philippe	Belgium	Ghent University	Philippe.DeSmedt@UGent.be
Devleeschouwer, X.	Belgium	Geological Survey of Belgium	Xavier.Devleeschouwer@naturalsciences.be
Devleeschouwer, D.	Belgium	Vrije Universiteit Brussels	David.De.Vleeschouwer@vub.ac.be
Diouf, Bachir	Senegal	Cheikh. Anta Diop. University	basdiouf@ucad.sn
El Hassani, Ahmed	Morocco	Mohammed V Rabat University	elhassani@israbat.ac.ma
Ellwood, Brooks	U.S.A	Louisiana State University	ellwood@lsu.edu
Ellwood, Suzanne	U.S.A		
Foubert, Anneleen	Belgium	Kahtolieke Leuven University	Anneleen.Foubert@ees.kuleuven.be
Grabowski, Jacek	Poland	Polish Geological Institute	jacek.grabowski@pgi.gov.pl
Hladil, Jindrich	Czech Republic	Czech Academy of Science	hladil@gli.cas.cz
Hubert, Benoît	France	Lille Catholic University	benoit.hubert@icl-lille.fr
Izokh, Olga	Russia	Siberian Branch of RAS	izokhop@gmail.com
Kamona, Fred	Namibia	University of Namibia	afkamona@unam.na
Königshof, Peter	Germany	Senkenberg Institute	Peter.Koenigshof@senckenberg.de
Koptikova, Leona	Czech Republic	Czech Academy of Science	koptikova@gli.cas.cz
Letourneur, Ludovic	U.K.	Barington Instrument	ludovic.letourneur@bartington.com
Lisa, Lenka	Czech Republic	Czech Academy of Science	lisa@gli.cas.cz
Luu, Phuong Lan	Vietnam	Vietnamese Academy of Sc.	luuphuonglan@gmail.com
Machado, Gil	Portugal	Aveiro University	machadogil@gmail.com
Makaroglu, Ozlem	Turkey	Istambul University	ozlemm@istanbul.edu.tr
Michel, Jonathan	Belgium	Liege University	jmichel@student.ulg.ac.be
Pas, Damien	Belgium	Liège University	dpas@ulg.ac.be
Petitclerc Estelle	Belgium	Geological Survey of Belgium	estelle.petitclerc@naturalsciences.be
Predeen, Ulla	Estonia	Tartu University	ulla.preeden@ut.ee
Riquier, Laurent	France	Bourgogne University	laurent.riquier@u-bourgogne.fr
Sardarabady, M.	Iran	University of Teheran	m.sardarabady@gmail.com
Schnabl, Petr	Czech Republic	Czech Academy of Science	schnabl@gli.cas.cz
Slechta, Stanislav	Czech Republic	Czech Academy of Science	slechta@gli.cas.cz
Sobień, Katarzyna	Poland	Polish Geological Institute	Katarzyna.Sobien@pgi.gov.pl
Spassov, Simo	Belgium	Royal Meteorological Institute	simo.spassov@oma.be
Streek, M.	Belgium	Liège University	Maurice.Streel@ulg.ac.be
Vacek, František	Czech Republic	Charles University	fvacek@natur.cuni.cz
Whalen, Michael	U.S.A.	University of Alaska	mtwhalen@gi.alaska.edu
Yaich, Chokri	Tunisia	Sfax University	chokri.yaich@enis.rnu.tn
Yans, Johan	Belgium	FNDP Namur	johan.yans@fundp.ac.be

Application of magnetic susceptibility to the Maastrichtian–Eocene Phosphatic deposits of Sélja section in Gafsa-Métlaoui basin (southern part of centralTunisia)

Akermi, S. [1-2], Béji Sassi, A., Abdallah, H.[2], da Silva, A.C.[3], Ben Hassen, A.[2], Boulvain, F.[3]

[1] laboratoire de géoressources, University of Tunis, Tunisia, ahuosgeol@yahoo.fr
[2] Laboratoire de géoénergie, technopole of Borj Cédria, Tunisia, Hassen.Abdallah@inrst.rnrt.tn; aida.benhassen@crten.rnrt.tn
[3] Pétrologie sédimentaire, University of Liege, Belgium, ac.dasilva@ulg.ac.be

The aim of this study is to apply magnetic susceptibility (MS) to the Maastrichtian-Eocene phosphatic deposits of Sélja section, for correlation purpose and to help understanding of its particular depositional environment. The analysis of phosphogenesis evolution during the Eocene will lead us to explain whether or not they reflect long-term changes in ocean circulation. This study is based on facies and microfacies, MS measurements and comparison of facies and MS evolution, as well as on the relationship between MS and mineralogical variations.

The Sélja deposits are located in the Southern part of central Tunisia. The study outcrop is Maastrichtian to Eocene age and is perpendicular to the Tamerza-Metlaoui belt. During the Maastrichtian-Paleogene, the Sélja sequence was deposited in the shallow Gafsa basin. This basin was located between the Sahara platform to the south and the Kasserine Island to the North. The interchange with the open sea was therefore restricted and probably further hampered by small uplifted areas to the east and west which could have acted as barriers to circulation.

The MS measurements and microfacies interpretations are carried out on 228 samples which include various lithology such as phosphate, carbonates (dolomite, calcite), shales and gypsum. Different microfacies have been identified, from phosphatic open marine facies, to dolomitic and “gypsum” lagoonal facies. Fourth- and third-order sequences have also been identified and were probably related to sea level changes and local tectonic effect as well as to the sedimentary supplies. Facies evolution allowed us to identify six depositional sequences. These sequences were also recognized in the magnetic susceptibility pattern.

In addition to the very good third order correlation between the MS measurements and the sedimentological sequence identification, we made a comparison between the variations of the MS measurements and the percentage of quartz and calcite. This comparison seems to confirm the strong relationship between MS and detrital inputs (MS increases with quartz increasing and calcite decreasing).

Correlation potential of magnetic susceptibility and outcrop gamma-ray logs at Tournaisian-Viséan boundary sections in Western Europe

Bábek, O.[1,2], Kalvoda, J.[1], Cossey, P.[3], Devuyst, F-X.[4], Herbig, H-G.[5], Sevastopulo, G.[6]

[1] Department of Geological Sciences, Masaryk University, Kotlarska 2, 61137 Brno, Czech Republic. babek@sci.muni.cz [2] Department of Geology, Palacky University, Tr. 17. listopadu 12, 77200 Olomouc, Czech Republic. [3] Faculty of Science, Staffordshire University, College Road, Stoke-on-Trent, Staffordshire, ST4 2DE, United Kingdom [4] Carmeuse Coordination Center, bd. de Lauzelles, 65, B-1348 Louvain-la-Neuve, Belgium [5] Institut of Geology and Mineralogy, University of Cologne, Zuelpicher Str. 49a, 50674 Cologne, Germany. [6] Department of Geology, Trinity College Dublin, Dublin 2, Ireland

The Tournaisian/Viséan boundary interval represents an important period of sea-level and oceanographic changes on regional to global scale. In mostly shallow-water facies of Europe, the regional correlation is based on sequence stratigraphy, which is backed up by conodont and foraminifer biostratigraphy. In this study, we present the results of gamma-ray spectrometry (GRS) and magnetic susceptibility (MS) logging of generally uninterrupted, deep-marine boundary sections across Western Europe. GRS and MS logs were obtained from a multitude of sedimentary environments including mixed carbonate-siliciclastic and carbonate slope deposits (Rush and Lane sections, Dublin area, Ireland), carbonate turbidites (Brown End Quarry, Derbyshire, England; Zippenhaus, Rhenish Slate Mts., Germany), deep-water peri-mudmound carbonates and shales (Sovet and Salet sections, Dinant synclinorium, Belgium) and starved basin silicites and carbonates (Saubette section, French Pyrenees). The objective was to (i) refine the (bio)stratigraphic resolution; (ii) expand the *Eoparastaffela*-based biostratigraphic correlation of Tn/V boundary to deep-marine facies where the index taxon is absent; (iii) to filter out local from regiona/global steering mechanisms of deposition; and (iv) test the correlation potentials of GRS and MS outcrop logging.

The Tn/V boundary, constrained by foraminifer biostratigraphy, is indicated by distinct broader minima on K and Th logs, which are bounded by maxima in upper Tournaisian and higher in lower Viséan. This pattern is common to almost all the sections but it is strongest in the carbonate-dominated successions (Lane, Brown End, Sovet, Zippenhaus) and in Rush. The patterns are poorly correlatable in Saubette section, where the signal is influenced by frequent tuffaceous layers and silicic sedimentation. MS logs generally show less correlatable patterns than GRS logs, but in several cases, MS log trends are in phase with K and Th logs (Brown End carbonate section). In the carbonate-dominated sections, these log patterns are assumed to reflect maximum carbonate / minimum siliciclastic input near the Tn/V boundary and they correlate with intraclast breccias / proximal carbonate gravity-flow deposits (Brown End, Sovet, Rush). From detailed sedimentologic and microfacies investigation of the Sovet section, this breccia interval was interpreted as falling stage systems tract related to collapse of platform margin during sea-level fall. Consequently, from the log patterns we can infer that the sea-level fall close to the Tn/V boundary is correlatable across Western Europe, although the overlying and underlying log shapes are more-or-less modulated by depositional setting, local signals and accumulation rates. In general, MS logs have lower correlation potential than GRS logs. In our opinion, this is caused by relatively steep environmental gradient between the localities at the time of deposition and, in some sections, by low carbonate content, which is associated with the dilution effect of siliciclastic admixture in carbonate depositional settings.

Magnetic susceptibility of Late Quaternary lake and fjord sediments from southern South America: Geochemical origin and potential for high-resolution reconstructions of climate and environmental changes

Bertrand, S. [1,2]

[1] Alfred Wegener Institute, Bremerhaven, Germany, sbertrand@awi.de
[2] Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, MA, USA

Magnetic susceptibility (MS) is generally one of the first parameters measured on sediment cores after coring. It can be rapidly and inexpensively measured at high-resolution (typically 5 mm), either manually or using a multi-sensor core logger. On soft sediment cores, magnetic susceptibility is usually measured using a Bartington MS2 meter, equipped with either a MS2E (point) or MS2C (loop) sensor. Although MS data provide a good first-order visualization of the main changes in lithology and sediment composition, complementary multi-proxy analyses are needed to understand the origin of the MS signal and accurately interpret it in terms of past changes in climate and the environment. Such complementary analyses are however too rarely performed, which leads some authors to present a biased interpretation of MS data in terms of paleoclimate and paleoenvironmental changes.

This study uses sedimentological, mineralogical, geochemical and grain-size data of Late Quaternary sediments from southern South America to investigate the origin of the magnetic susceptibility (MS) signal in two distinct sedimentary environments and to better understand the potential of MS for high-resolution reconstructions of past climate and environmental changes. Because the mid- and high-latitudes of the Southern Hemisphere have undergone considerable environmental changes since the last glaciation, this region constitutes an ideal natural laboratory to study the links between MS and other sedimentary proxies. Using principal component analysis of the multi-proxy data, it is shown that MS is mainly driven by sediment composition (lithogenic fraction, biogenic silicate, biogenic carbonate, TOC) and grain-size. Two examples from Chilean lakes and fjords will be presented: (1) In lake Puyehue, (Chile, 40°S), MS values are positively correlated with Al and Ti, and negatively correlated with biogenic silica and TOC. Down core variations of the MS signal can therefore be used to infer relative variations in the terrigenous supply, which is driven by changes in precipitation over the Andes. (2) In Golfo Elefantes, MS results obtained on a sediment core collected in front of the Gualas glacier (Northern Patagonian Ice Cap, 46°S) are clearly linked with the grain-size distribution of the sediment and its Zr content. They can be used to discern sub-glacial from glacio-fluvial sedimentary processes, which directly represent past changes in the activity of the Gualas glacier and can provide clues about the possible climatic origin of glacier variability in the Andes. These results are supported by MS data obtained on discrete samples of glacio-fluvial sediment using Bartington MS2B and MS2G sensors.

This study demonstrates the need for an accurate understanding of the sedimentological and geochemical origin of the MS signal in sediments before using MS to reconstruct past changes in climate and the environment.

Magnetic susceptibility correlation of km-thick Eifelian–Frasnian sections (Belgium–Czech Republic)

F. Boulvain[1], A.-C. da Silva[1], C. Mabille[2], G. Poulain[1], J. Hladil[3], M. Gersl[3], L. Koptikova[3], P. Schnabl[3]

[1] Pétrologie sédimentaire, B20, Université de Liège, Sart Tilman, 4000 Liège, Belgium
[3] TOTAL E&P, Dept of Structural Geology, Sedimentology and Geology Laboratory, Avenue Larribau, 64018 Pau Cedex (France)
[2] Institute of Geology AS CR, v.v.i. Rozvojova 269, 165 00 Prague 6, Czech Republic

Bulk magnetic susceptibility (MS) measurements on sedimentological samples for correlations and reconstruction of climatic or sea-level variations from all geological periods became widely used in the last decades. Studies dealing with the origin of magnetic minerals in sedimentary rocks generally suggest a lithogenic origin for magnetic minerals. The amount of these minerals is supposed to be in relation with sea level changes. A marine regression, increasing erosion rate, increases lithogenic inputs and MS. A transgression has the opposite effect.

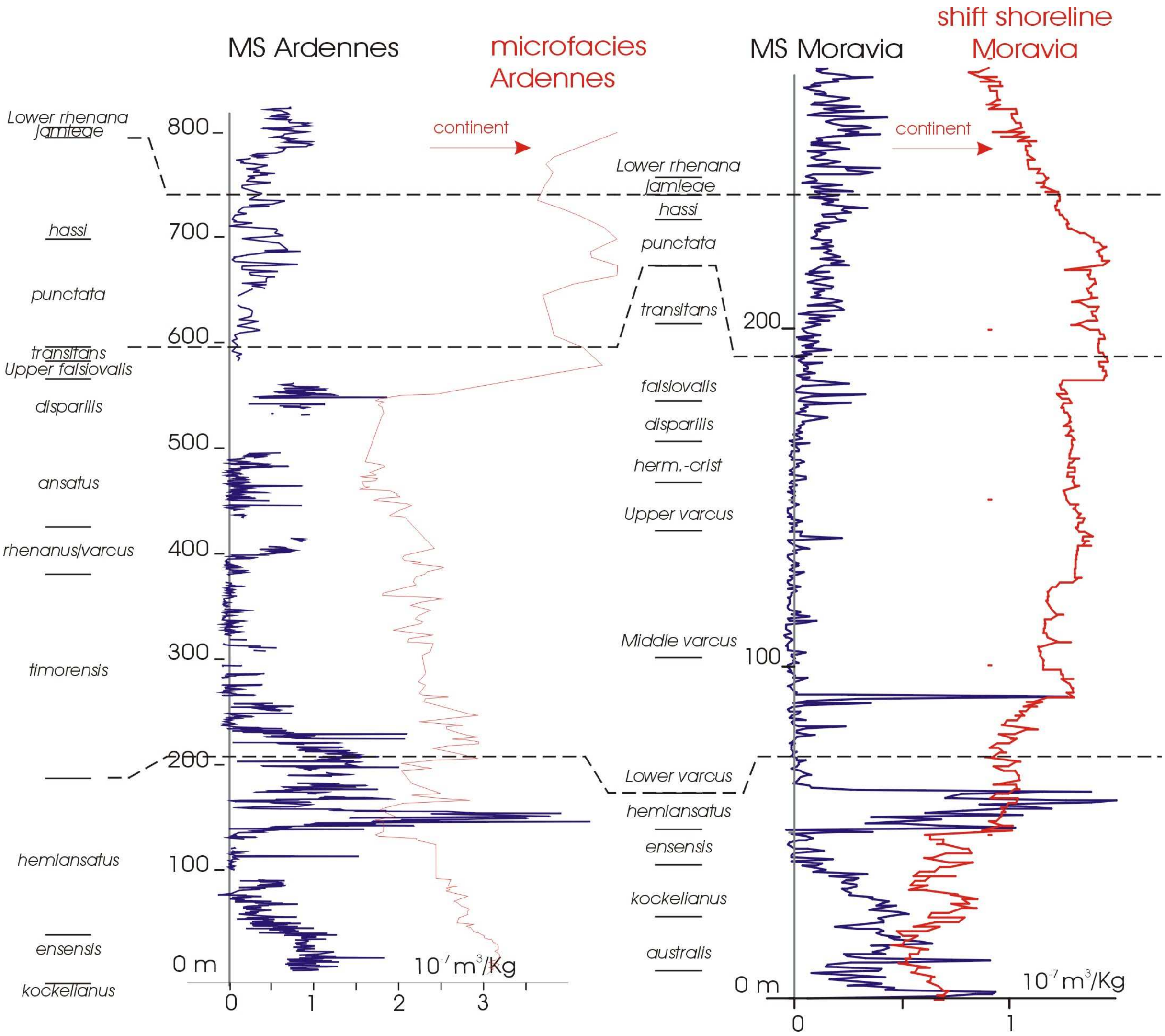
We propose a reflection on a very large scale about the link between MS and environmental parameters. This compilation of MS data and environmental backgrounds from two carbonated Devonian sections (Belgium and Moravian Karst) during different stages (Eifelian, Givetian, and Frasnian), is based on 1590 individual samples or multiply sampled (averaged) nodes.

Belgian sections start with an Upper Eifelian mixed detrital-carbonated outer ramp, followed by a well-developed Givetian carbonated platform with environments ranging from external crinoidal facies to stromatoporoid-dominated biostromes and to lagoonal facies (*Amphipora* floatstone, algal packstone, intertidal mudstone and laminated peloidal packstone and palaeosols). After the demise of the carbonate factory at the beginning of the Frasnian and the generalization of argillaceous sedimentation, the Middle Frasnian is characterized by the succession of three carbonate mound levels, starting in quiet aphotic water and ending in shallow zone.

Moravian section encompasses very pure carbonate facies of a large reef-rimmed carbonate platform complex. Inside this, the stratal successions are dominated by dark-grey, thin bedded and rhythmically deposited *Amphipora* banks which alternate with thicker and lighter intervals built by stromatoporoid–coral banks. The concentrations of non-carbonate impurities do not exceed 3 wt.% (often much less). Almost all this material was originally eolian dust, and was delivered to hundreds kilometres wide, very shallow platform–lagoon areas from distant sources over the ocean channels. Inputs of argillaceous or clayey sediments are absent, and detrital rims at few and gradually covered cliffs of crystalline basement rocks are rare. The major vertical accretion marked by biohermal shoals developed during the Frasnian.

However, both these sections show an extraordinary parallelism of MS curve, characterized by decreasing moderate values during the end of Eifelian (*australis–ensensis* conodont zones), a very strong increase at the beginning of Givetian (*hemiansatus* Zone), very low values during the major part of the Givetian (*varcus* Zone) and increasing moderate values during the end of Givetian and Frasnian (*disparilis*–Lower *rhenana* zones). There is evidently (and surprisingly) a number of MS stratigraphic patterns which can be used for detailed correlation across the Devonian carbonate basins in distant and separate paleogeographic locations.

As sedimentary environments are different in the two areas, an external basin-scale forcing parameter must be involved in MS variations.


MS Ardennes
microfacies Ardennes
MS Moravia
shift shoreline Moravia
continent
continent
Lower rhenana
jamieae
hassi
punctata
transitans
Upper falsiovalis
disparilis
ansatus
rhenanus/varcus
timorensis
hemiansatus
ensensis
kockelianus
800
700
600
500
400
300
200
100
0 m
10^{-7} m^3/Kg
0
1
2
3
Lower rhenana
jamieae
hassi
punctata
transitans
falsiovalis
disparilis
herm.-crist
Upper varcus
Middle varcus
Lower varcus
hemiansatus
ensensis
kockelianus
australis
200
100
0 m
10^{-7} m^3/Kg
0
1

Stratigraphic alignment of magnetic-susceptibility records by dynamic time-warping.

Petr Cejchan[1], Jindrich Hladil[1], Martin Vondra[2], Robert Vich[2]

[1]Institute of Geology AS CR v.v.i., Rozvojova 269, Prague 6, Czech Republic, [cej|hladil]@gli.cas.cz
[2]Institute of Photonics and Electronics AS CR v.v.i., Prague 8, Czech Republic, [vondra|vich]@ufe.cz

Methods and techniques of the MS stratigraphic correlation remains a major issue of the development in the discipline and within the IGCP 580 project. Since the 1990s, many detailed studies on climatically-driven fluctuations of magnetic susceptibility (MS) in stratigraphic sections of marine carbonates were carried out. Their basic assumption is that the very pure carbonate rock is a weakly diamagnetic medium where the background sediment components can be detected. It roughly follows that wide dispersal of the finest weathering products is primarily mediated by atmospheric mineral dust and aerosols regularly enriched in iron. MS-signal variations throughout the carefully chosen sections can provide a significant refinement of the stratigraphic correlation. Comparison of MS logs often poses evidence of a substantial risk of incorrect stratigraphic correlation. This risk relates to irregularly spaced segments of low sedimentation rates, visible condensation or truncation (often impossible to quantify), even within sections that were originally considered optimal for MS studies. Presence of sedimentation rate irregularities not reliably definable poses a real problem in detailed correlation. The seriousness of these irregularities, however, seems to be often underestimated to the point of being dismissed completely, unfortunately, in our opinion, also in many studies dealing with the “geological time-course” curves (e.g. Barthes et al., 1999; Lu et al., 2004). Here, we are going to put emphasis on recognition of these irregularities and methodically contribute to the tasks of minimizing the loss of information and extending the utilization of MS patterns. We tested the effectiveness of alignment of magnetic susceptibility stratigraphic sections by means of the dynamic time warping (DTW), with positive results. The DTW is a robust tool for alignment of the sequential data with irregular time and/or intensity components. Thus, the DTW is appropriate for sections which involve significant irregularities caused by stratigraphic condensation or swelling, and differently placed and sized gaps. Keeping in mind the fact that the lateral changes in short- to medium-term sedimentation rates and local variations in diagenetic compaction are rather common, DTW becomes a significant tool for stratigraphic comparison of sections with good potential of becoming an alternative to cyclostratigraphic correlation methods. Conditions governing the formation of Lower Devonian (Pragian) carbonate clinoforms obviously appear to be the case, and testing of the DTW on this type of MS sections suggests that the computationally robust results are almost proof to confounding, even if we use a nonlinear decrease of importance of the high values (peaks). In such cases the DTW outperforms the distortion-based vector quantisation (VQ), continuous density hidden Markov models (CDHMM), wavelet transformation (WT) or cross-correlation (CC) based approaches. Alignment of the sections using the DTW gives us (some) warning about distorted intervals, thus reducing a risk of assembling of quite different types of rhythmic patterns or cycles together. It is considered to be important for this sort of comparative studies because thinning, swelling and gaps are often latent, thus it is important to encounter for time distortion. Practical results for the Barrandian area MS sections help us understand the stratigraphic anatomy of the Pragian stage in its traditional concept, in Bohemian facies. For the examined sections, the MS-based DTW alignment of the sections (i.e., stratigraphic correlation, in geological terms) is approximately two orders of magnitude better compared to bio- and lithostratigraphic tools.

- BARTHES, V., POZZI, J.P., VIBERT-CHARBONNEL, P., THIBAL, J. & MELIERES, M.A., 1999. High-resolution chronostratigraphy from downhole susceptibility logging tuned by palaeoclimatic orbital frequencies. *Earth and Planetary Science Letters* 165: 97−116.

- LU, H., ZHANG, F., LIUA, X. & DUCE, R.A., 2004. Periodicities of palaeoclimatic variations recorded by loess-paleosol sequences in China. *Quaternary Science Reviews* 23: 1891−1900.

Frequency dependence of magnetic susceptibility of weakly magnetic sediments: implications for magnetic granulometry

Chadima, M. [1,2], Kadlec, J. [2], Hrouda, F. [1], Slechta, S. [2]

[1]AGICO Inc., Ječná 29a, Brno, Czech Republic, e-mail: chadima@sci.muni.cz, fhrouda@agico.cz
[2]Institute of Geology, Academy of Sciences of the Czech Republic, v.v.i., Rozvojová 269, Praha 6, Czech Republic, e-mail: kadlec@gli.cas.cz

The frequency dependence magnetic susceptibility is one of the most useful tools for magnetic granulometry as it enables the amount of very fine-grained superparamagnetic grains to be assessed. Increased amount of superparamagnetic grains is supposed to reflect pedogenetic processes due to the changes in climatic conditions. The use of frequency dependence of magnetic susceptibility is demonstrated in a loess/paleosol complex of the Red Hill, Brno (Czech Republic). The Red Hill sequence includes eolian and fossil soil beds ranging between Holocene and Early Pleistocene. Stratigraphy of the sequence was fixed using magnetostratigraphy on the Brunhes-Matuyama boundary. Frequency dependence of magnetic susceptibility was measured using the MFK1-FA Kappabridge at three operating frequencies: 976 Hz, 3904 Hz and 15616 Hz.

Mass susceptibility varies along in section being in the order of magnitude of 10^{-7} [m^3/kg]; the frequency dependence ranges from 1% to about 10%. The precision in determination of the frequency dependence was investigated through repeated measurements with the variations in the order of 1% being well reproducible. The obtained trends in frequency dependence were verified independently through investigation of the time dependent isothermal remanent magnetization. Variations in the frequency dependence correlate with the alternation of loess and paleosol horizons along the section. Absence of the straightforward correlation between magnetic susceptibility and its frequency dependence in some paleosoil samples may indicate, however, other origin of magnetic minerals than increasing amount of superparamagnetic particles.

Magnetic susceptibility record on different sedimentary settings, examples from the Devonian of Belgium

da Silva, AC[1], Mabille, C[2], Boulvain, F. [1]

[1] Pétrologie sédimentaire, B20, Université de Liège, Sart Tilman, 4000 Liège, Belgium
[3] TOTAL E&P, Dept of Structural Geology, Sedimentology and Geology Laboratory, Avenue Larribau, 64018 Pau Cedex (France)

Magnetic susceptibility (MS) technique is frequently used in order to correlate and to reconstruct palaeoclimatic changes in Recent sedimentary rocks. For a few years, magnetic susceptibility was also applied to palaeozoic rocks for correlations. Magnetic susceptibility signal is interpreted as mainly related to lithogenic inputs (magnetic minerals like magnetite and clay in opposition with unmagnetic minerals like carbonates) and lithogenic inputs are mainly related to sea level variations and climate. So a transgression will be associated with decreasing magnetic susceptibility and a regression will produce a MS peak. This relationship between MS and sea level allows to produce correlations.

Magnetic susceptibility measurements were performed on different carbonate systems (platform types). The first case is the shallow water carbonate platform of the Frasnian of Belgium, the second case corresponds to the carbonate mounds and atolls which are lateral time equivalent of the previous one. The last case corresponds to the mixed siliciclastic-carbonate (carbonate) ramp of the Eifelian of Belgium.

In the shallow water carbonate platform of Belgium, magnetic susceptibility allows to perform precise correlations between the sections (fourth order correlations). A strong relationship between MS and facies (increasing MS with more proximal facies) and MS and fourth order sequences (increasing MS at the top of a regressive sequence) is observed (da Silva and Boulvain, 2009). This relationship confirms the strong link between magnetic susceptibility and sea level variations. In the Frasnian carbonate mounds and atolls, magnetic susceptibility brings also good correlations between the mounds. It seems that magnetic susceptibility values are also linked to facies but in an opposite way. Actually the higher MS values are corresponding to the deepest facies and MS increases during transgressive phase. The sedimentation rates of the carbonate mounds and the surrounding deposit are very different and probably controls MS signal. In the eifelian mixed siliciclastic-carbonate (carbonate) ramp, magnetic susceptibility provides also good correlations. As for carbonate mounds, magnetic susceptibility increases slightly during transgressive phases.

We present here a synthesis of magnetic susceptibility measurements applied on the three main carbonate platform types (carbonate platform, ramp and isolated platform (atolls)). In the three cases, it appears that magnetic susceptibility is related to main sea level changes but in an opposite direction. For the carbonate attached platform, a transgression will decrease magnetic susceptibility but for the atolls and the ramp, a transgression will increase magnetic susceptibility. In these two cases, the lithogenic inputs will not be the main parameter but sedimentation rate and wave strength will also influence the amount of magnetic susceptibility (a strong carbonate production will dilute the magnetic minerals and an important agitation will probably scatter the minerals). It highlight also that correlations between different carbonate systems are highly speculative because of the different origin of magnetic peaks.

- DA SILVA, AC., MABILLE, C. & BOULVAIN, F., 2009. Influence of sedimentary setting on the use of magnetic susceptibility: examples from the Devonian of Belgium. *Sedimentology* 56: 1292-1306.

Sequence–stratigraphic correlation and characterization of cyclic facies arrangements using magnetic susceptibility, Late Devonian (Frasnian) Hull platform, Canning Basin, Australia

da Silva, AC[1], George, A.D. [2], Chow, N. [3]

[1] Pétrologie sédimentaire, Liege University, Belgium, ac.dasilva@ulg.ac.be
[2] School of Earth & Environment, University of Western Australia, ageorge@cyllene.uwa.edu.au
[3] Department of Geological Sciences, University of Manitoba, Canada, n_chow@umanitoba.ca

Frasnian reef-rimmed platforms evolved during active extension of the Fitzroy Trough along the northern margin of the Canning Basin, northwestern Australia. Although back-reef cyclicity is well known in these platforms, detailed examination of the Lower Frasnian Hull platform, which is composed of mainly back-reef to leeward margin facies associations, shows considerable upsection variation in the degree of development of cyclic facies arrangements. Shallowing upward trends (~10-50 m) are evident in the stacking of facies associations. Overall evolution of this platform was strongly controlled by syn-depositional faulting and block rotation (George et al. 2009) suggesting a likely complex interplay between local tectonism and eustatic changes in controlling stacking patterns. Magnetic susceptibility (MS) analysis of two ~260 metre measured sections through the Hull platform was undertaken to test their sequence-stratigraphic correlation and examine cyclicity variation. Most of the samples were taken from the well-exposed shallower subtidal carbonate facies (including stromatoporoid boundstones, rudstones-floatstones and fenestral peloidal grainstones–packstones) and hence MS values are generally low. Recessive intervals are represented by samples from thin bioclastic rudstones–floatstones. MS data from both sections, southeastern (SE) Hull Range and Guppy Hills, show a number of peaks and a cyclic pattern. In the SE Hull section, three prominent peaks coincide with a platform-wide sequence boundary–flooding surface and two local subaerial exposure surfaces (George et al. 2009). The same three peaks are interpreted in the Guppy Hills section even though only the sequence boundary–flooding surface is represented in outcrop (as an erosion surface). Correlation of elevated MS values associated with the local exposure surfaces is a significant result because the Guppy Hills section records deposition in deeper subtidal conditions diminishing the likelihood of developing karst features. The MS peaks in the data support overall lowered relative sea-level and associated influx of siliciclastic sediments during short-lived subaerial exposure events. In addition, the higher MS values in the Guppy Hills section probably reflect closer proximity to the major bounding fault that controlled supply of siliciclastic sediment. The sequence boundary–flooding surface is associated with a smaller peak in the MS data in both sections. Flooding and extension of the carbonate platform in the hangingwall coincident with sequence boundary formation suggests rotation and tectonic control and the minor MS peak associated with this major event may reflect relative sea-level rise at the shoreline inhibiting spread of siliciclastic sediment. Additional peaks, e.g. ~90 m in both sections, may highlight the presence of other relative sea-level falls for which there is no or only equivocal evidence of paleokarst. Comparison of MS values and facies trends is consistent with observations from other Frasnian platforms (e.g. da Silva et al. 2009). Mean MS values are higher for the basal strata of the Hull platform sections when ramp conditions prevailed following initial flooding and carbonate production was lower. Overall decrease in mean values towards the top of the sections is consistent with increase in stromatoporoid facies of the leeward platform margin.

- DA SILVA, AC., MABILLE, C. & BOULVAIN, F., 2009. Influence of sedimentary setting on the use of magnetic susceptibility: examples from the Devonian of Belgium. *Sedimentology* 56: 1292-1306.

- GEORGE, A.D., CHOW, N. & TRINAJSTIC, K.M. 2009. Syndepositional fault control on lower Frasnian platform evolution, Lennard Shelf, Canning Basin, Australia. *Geology* 37 : 331-334.

On the use of magnetic techniques for stratigraphic purposes: examples from the Lower Palaeozoic Anglo-Brabant Deformation Belt (Belgium)

Debacker, T.N.[1], Sintubin, M.[2] & Robion, Ph.[3]

[1]. Vakgroep Geologie & Bodemkunde, Universiteit Gent, Krijgslaan 281, S8, 9000 Gent - Belgium
[2]. Geodynamics & Geofluids Research Group, Katholieke Universiteit Leuven, Celestijnenlaan 200E, 3001 Leuven – Belgium. - [3]. Université de Cergy-Pontoise, département des Sciences de la Terre et de l'environnement, 5 mail Gay Lussac, Neuville sur Oise, 95031 Cergy Cédex – France

Within the Lower Palaeozoic Anglo-Brabant Deformation Belt, magnetic susceptibility on its own does not allow for a straightforward distinction between different lithostratigraphic units, except for the high-susceptibility levels of the Lower Cambrian Tubize Formation. Moreover, the variation in magnetic susceptibility within individual lithostratigraphic units is often larger than that between different units, but at the same time, this internal variation in susceptibility often does not show a clear relationship to features obvious in outcrop or hand specimens. Hence, the applicability of magnetic susceptibility for stratigraphic purposes in the Anglo-Brabant Deformation Belt is low.

Better results are obtained using the temperature-dependent variation in terms of percentage of magnetic susceptibility within the “room temperature interval”. Also the anisotropy of magnetic susceptibility allows for a better distinction between the different lithostratigraphic units than does a simple comparison of magnetic susceptibility. The best results are obtained by a comparison of ferromagnetic mineralogy. This method even allows distinguishing lithostratigraphic units in which ferromagnetic carriers do not contribute to overall magnetic susceptibility.

Ideally, each magnetic technique should be used for stratigraphic purposes only in combination with other magnetic techniques, and, moreover, should be used only if the magnetic carriers (s.l.) are known.

End-member modeling of isothermal remanent magnetization (IRM) acquisition curves: a novel approach to diagnose remagnetization and its bearing on the interpretation of the low-field susceptibility signal

Dekkers, M.J.[1], Gong, Z.[1], Heslop, D.[2] , Mullender, T.A.T.[1]

[1]Paleomagnetic Laboratory 'Fort Hoofddijk', Department of Earth sciences, Utrecht University, Budapestlaan 17, 3584 CD Utrecht, The Netherlands. dekkers@geo.uu.nl
[2]Universität Bremen, Fachbereich Geowissenschaften, Postfach 330440, 28334 Bremen, Germany

The low-field susceptibility is a composite signal consisting of variable contributions of the diamagnetic and paramagnetic matrix and a ferromagnetic component residing in the magnetic minerals. For weakly magnetic (marly) limestones the matrix contribution can be appreciable, but recorded variation in the susceptibility can nonetheless be driven by changes in the ferromagnetic component. If the rocks under investigation are 'remagnetized' –that is they contain a paleomagnetic signal of younger age than the sediment age–, an interpretation of susceptibility variation in terms of a changing depositional environment may be flawed.

Being able to identify remagnetization is also essential in paleomagnetic studies with evident geodynamic implications. Traditional directional analysis of paleomagnetic data combined with field tests where possible may be equivocal if the apparent polar wander path (APWP) for the region under investigation is poorly constrained or if the remagnetization predates folding. Regularly, measurement of hysteresis loops allows identification of the so-called 'remagnetized' and 'non-remagnetized' trends. However, in a fair number of data sets hysteresis parameters plot in between the two trends complicating interpretation. To improve the diagnostic tools for remagnetization independent of paleomagnetic directional information, we investigated 192 isothermal remanent magnetization (IRM) acquisition curves (up to 700 mT) of remagnetized and non-remagnetized limestones from the Organyà Basin, northern Spain. Also 96 IRM acquisition curves from non-remagnetized marls were studied.

A non-parametric end-member modeling approach is used to analyze the IRM acquisition curve data sets. For the complete limestone data set, a three end-member model was judged optimal. This model consists of a high coercivity end-member, a low-coercivity end-member that saturates at ~300-400 mT and a low-coercivity end-member that approximately saturates in 700 mT. Higher contributions of the latter end-member appear to occur dominantly in the remagnetized limestones while the reverse is true for the non-remagnetized limestones, so they plot in clearly distinguishable areas. When corrected for the high-coercivity end-member contribution, the remagnetized and non-remagnetized groups are statistically significantly different. The IRM curves from non-remagnetized marls show a behavior very similar to the non-remagnetized end-member in the limestones. Therefore, this new approach can be a very useful tool to diagnose remagnetization in weakly magnetic limestones and marls. We recommend applying it to other areas of potentially remagnetized low intensity sediments thereby adding interpretive value to a susceptibility record.

Orbital forcing of the Devonian climate? A search for Milankovic cycles in the magnetic susceptibility record of a km-thick Eifelian-Frasnian section (Belgium)

De Vleeschouwer, D. [1], Boulvain, F. [2], da Silva, AC. [2], Claeys, Ph. [1]

[1] Earth System Science, Vrije Universiteit Brussel, Pleinlaan 2, B-1050, Brussels, Belgium
[2] Pétrologie sédimentaire, B20, Université de Liège, Sart Tilman, 4000 Liège, Belgium

The importance of orbital forcing for climate changes and sea level variations is well established for an icehouse world. In a greenhouse world, feedback mechanisms responsible for the translation of minor solar-energy variations into climate change are far less genuinely. A better understanding of orbital forcing under greenhouse condition is needed. This study outlines the role of orbital forcing in the Devonian climate, using magnetic susceptibility as a proxy. Magnetic susceptibility is the degree of magnetization of a material in response to an applied magnetic field and therefore is a good proxy for the rate of supply of the iron-bearing lithogenic or detrital fraction to the marine system. The main controlling factor of the lithogenic or detrital input is continental erosion, induced by climate related processes or adjustments in base level. Both erosion-inducing factors may be controlled by orbital forcing cycles, and thus magnetic susceptibility is thought to be a suitable proxy to identify these cycles. The studied section spans from Upper Eifelian up to the Middle Frasnian. The section is split up according to sedimentary environment, and spectral analysis (using the Blackman-Tuckey method) is carried out on magnetic susceptibility data. The sedimentary cycle-frequencies, proposed by the spectral analysis, are filtered out (using Gaussian filtering) and plotted against the raw data to ascertain the presence of this cycle.

This study hypothesizes that the sedimentary-cycles are orbital forced, which implies 3 scenarios: The dominant sedimentary cycle either is precession, obliquity or 100ka-eccentricity driven. Logically, each scenario has implications about sedimentation rate, climate-signal modulation and palaeogeography, which affect its probability. Using assumptions about sedimentation rate based on conodont zones and isotopic dates one the one hand, and the frequency-ratios, on the other, this study searches for the most probable scenario. First results are pointing to a precession-controlled sedimentary environment with a more modest influence of the 100-ka eccentricity cycle. These results confirm the important role of orbital forcing in a greenhouse world and give rise to hypotheses about feedback mechanisms responsible for these significant orbital forced climate changes. Besides, these results offer another estimation of the Devonian periodicity of the precession cycle, which is thought to be shorter than today due to the slowing of the earth's rotation (Berger, 1992). Furthermore, a floating time scale for this section is provided and cyclostratigraphy allows timing resolution up to ± 10 ka within the section.

Detrital magnetite grains control the magnetic susceptibility evolutions established for the Trois-Fontaines – Terres d'Haurs Formations (Lower Givetian) in Givet (France)

Devleeschouwer, X.[1,2], Cambier, G.[2], Petitclerc, E.[1], Casier, J.G.[1,2], Spassov, S.[3], Préat, A.[2]

[1] Institut royal des Sciences Naturelles de Belgique, Service Géologique de Belgique, Rue Jenner 13, B-1000 Bruxelles, Belgique. E-mail : Xavier.Devleeschouwer@naturalsciences.be; [2] Université Libre de Bruxelles, DSTE, Laboratoire de Sédimentologie et de Géodynamique des basins, CP160/02, 50 Av F.D. Roosevelt, B-1050 Bruxelles. [3] Royal Meteorological Institute of Belgium, Centre de Physique du Globe, Section du Magnétisme Environnemental, B-5670 Dourbes (Viroinval).

Our studied Givet section is located along the Mont d'Haurs fortifications on the eastern side of the Meuse river. This old quarry exposes around sixty meters of well-bedded limestones of the Trois-Fontaines and Terres d'Haurs Formations (Lower Givetian, Middle Devonian). A systematic sampling (187 samples) has been undertaken for a multidisciplinary study integrating microfacies, rock magnetism, ostracods and carbon and oxygen isotopes analyses. Eight microfacies are recognized through petrography of thin sections. Their standard sequence (from microfacies 1 to 8) records a regressive evolution from marine open-reefal environments towards supratidal settings with paleosols. The established microfacies curve reveals numerous regressive thin intervals in the Trois-Fontaines Formation (TRF) followed by a thick transgressive episode at the top of the Formation. A clear paleoenvironmental change is therefore present at the base of the Terres d'Haurs Formation (THR) where deepest open-marine environments occur. However, the general environment remains 'shallow'. Rock magnetism analyses have been conducted on the same samples used for sedimentology. Magnetic susceptibility (MS) data were acquired with a Kappabridge MFK1-A. MS values range between 0.1 x 10-7 and 3.0 x 10-7 m^3/kg. The comparison between MS and sedimentological curves suggests a relative good correlation and indicates that MS and microfacies evolutions are more or less correlated in the studied section. The section reveals a MS long-term evolution and numerous short-term variations which can be subdivided in smaller sequences particularly in the TRF Formation. The highest MS values are observed in the TRF Formation. The lowest MS values are recorded close to the boundary between TRF and THR Formations. The base of the THR Formation records a large increasing trend from 0.2 x 10-7 towards nearly 2.0 x 10-7 m^3/kg. Thermomagnetic analyses were undertaken with a CS-3 furnace device on 30 selected samples based on MS values, microfacies and sedimentological observations. These data were coupled with hysteresis measurements made with a J-Coercivity meter. Thermomagnetic data shows that MS are controlled by ferromagnetic minerals s.l. and paramagnetic minerals (mostly clays and pyrite). Hysteresis data show that the coercivity of remanence (Bcr) records values below 60 mT for all the samples, which reveal the presence of a low coercitive mineral phase (i.e. magnetite). The high-field magnetic susceptibility, calculated on the hysteresis curves, reported versus low-field magnetic susceptibility shows a clear positive correlation line indicating that MS is mainly controlled by the ferromagnetic phase. Samples with magnetite as the main carrier of the MS (Bcr < 60 mT) were plotted in a classical Day Plot diagram. The results indicate that most of the samples are close to the unremagnetized limestones line of Channell and McCabe (1994) corresponding to the classical detrital signature. Following Zwing et al. (2005), our samples contain (1) a primary detrital fraction of coarse-grained magnetite (mostly multi-domain) and (2) a secondary authigenic fraction of fine-grained magnetite (probably a mixture of multi-domain and superparamagnetic domain). These data confirm that magnetite grains are partly primary detrital grains and the main carrier controlling the MS signal in these Givetian limestones.

- CHANNELL, J.E.T. & McCABE, C., 1994. Comparison of magnetic hysteresis parameters of unremagnetized and remagnetized limestones. *Journal of Geophysical Research* 99(B3): 4613-4623.

- ZWING, A., MATZKA, J., BACHTADSE, V. & SOFFEL, H.C., 2005. Rock magnetic properties of remagnetized Palaeozoic clastic and carbonate rocks from the NE Rhenish massif, Germany. *Geophysical Journal International* 160: 477-486.

A strong diagenetic high coercivity phase influence the Magnetic Susceptibility Curve of the Eifelian-Givetian boundary (Pic de Vissou, Montagne Noire, France)

Devleeschouwer, X.[1,2], Petitclerc, E.[1], Spassov, S.[3] and Préat, A.[2]

[1] Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, Rue Jenner 13, B-100 Brussels, Belgium. E-mail : Xavier.Devleeschouwer@naturalsciences.be - [2] Department of Earth and Environmental Sciences, Sedimentology and Basin Analysis, Université Libre de Bruxelles CP 160/02, 50 av F.D Roosevelt, B-1050 Brussels, Belgium. E-mail : apreat@ulb.ac.be - [3] Royal Meteorological Institute of Belgium, Centre de Physique du Globe, Section du Magnétisme Environnemental, B-5670 Dourbes (Viroinval). E-mail: simo.spassov@oma.be

The marble quarry of Pic de Vissou is located at the eastern extremity of the Montagne Noire Massif, 3 km to the North of Cabrières. The section has been described by Feist (1990) and the Eifelian-Givetian boundary was established by House (1991) at the base of a bed containing a fauna indicative of the *Rouvillei* Zone. Feist (1990) indicates also that most of the Givetian is represented in this condensed carbonate section. The 22,6 m thick section was previously studied for microfacies sedimentological aspects, for ostracod assemblage evolution (Casier and Préat, 1996) and for magnetic susceptibility (Crick et al., 1997).

Rock magnetism analyses have been recently conducted on the same samples used for sedimentological purposes. Magnetic susceptibility (MS) data were acquired on 112 samples with a Kappabridge MFK1-A. MS values range between 2.12 x 10^{-9} and 4.40 x 10^{-7} m³/kg. MS curve could be subdivided into two successive couplets, which show increasing and decreasing MS evolutions. The first increasing MS trend corresponds to Eifelian limestones and the Eifelian/Givetian boundary is located just at the base of the following decreasing MS evolution. A second increase of the MS values subdivided into successively three steps is observed during the next 10 meters in the Givetian. The last five meters of the section show a decreasing tendency. The comparison between MS and sedimentological curves doesn't reveal any correlation and suggests that MS and microfacies evolutions are more or less anti-correlated. There is no correlation between the seven colour classes recognized for each samples and the mean MS value neither with the six described microfacies. Thermomagnetic analyses are undertaken with a CS-3 furnace device on 16 selected samples based on MS values, rock colours and sedimentological observations. Thermomagnetic results show paramagnetic grains for some samples, the presence of magnetite grains with a Curie temperature of 580℃, the presence of pyrrhotite or Ti-hematite or Ti-magnetite with a Curie temperature of 330℃. Raman spectrometry with a Brucker Senterra (green laser of 532 nm – 2mW – with a target of 2 µm in diameter) confirms the presence of hematite in some samples. Magnetic mineralogical measurements would help to determine the origin of the magnetic signal and to estimate the influence of diagenetic effects on the original signal.

Hysteresis loops were measured with a J-Coercivity Magnetometer in the Paleomagnetic Laboratory of the Belgian Royal Meteorological Institute. Most of the coercivity values are below 20 mT indicating a low coercitive phase and remanence coercivities show low values (below 60 mT) typical of magnetite grains and higher values (>125 mT) indicating hematite coercivities. Two samples have intermediate remanence coercivities close to 100 mT corresponding probably to pyrrhotite. Magnetization and remanent magnetization reported versus MS show a good positive correlation revealing that ferromagnetic grains seem to control the MS signal. Samples with magnetite as the main carrier of the MS (Bcr < 60 mT) were plotted in a classical Day Plot diagram. The results indicate that most of the samples are located below the unremagnetized limestones line of Channell and McCabe (1994). These samples seem to reveal the presence of probably a mixture of MD and SD magnetite particles. These data suggest that low MS values are related to the presence of hematite (up to 1.2 10^{-7} m³/kg) and higher MS values (up to 4.4 10^{-7} m³/kg) to magnetite particles that are controlling the MS signal. Hematite grains are produced during early diagenesis by chemical reactions and transformation from submicronic iron oxy-hydroxyde precipitated by microbial activity (Mamet and Préat, 2003). Red Paleozoic limestones series must thus be carefully examined to determine the presence of hematite before using MS curve for high-resolution stratigraphic correlations.

- CASIER, J.-G. & PREAT, A., 1996. Ostracodes et sédimentologie au passage Eifélien-Givetien dans la marbrière du Pic de Vissou (Montagne Noire, France). *Bulletin des Centres de Recherche et d'Exploration Production d'Elf Aquitaine* 20(2): 367-387.

- CHANNELL, J.E.T. & McCABE, C., 1994. Comparison of magnetic hysteresis parameters of unremagnetized and remagnetized limestones. *Journal of Geophysical Research* 99(B3): 4613-4623.

- CRICK, R.E., ELLWOOD, B., EL HASSANI, A., FEIST, R. & HLADIL, J., 1997. MagnetoSusceptibility Event and Cyclostratigraphy (MSEC) of the Eifelian-Givetian GSSP and associate boundary sequences in north Africa and Europe. *Episodes* 20(3): 167-175.

- DELLA PORTA, G., MAMET, B. & PREAT, A., 2003. Microbial mediation in the formation of red limestones, Upper Carboniferous, Cantabrian Mountains, Spain. *In*: WONG, Th. E. (Ed.): *Proceedings of the XVth International Congress on Carboniferous and Permian Stratigraphy*. Utrecht, the Netherlands, 10-16 August 2003, 243-250.

- FEIST, R., 1990. The Frasnian-Famennian boundary and adjacent strata of the eastern Montagne Noire (France). Guidebook of the Field Meeting Montagne Noire 1990, I.U.G.S., *Subcommission on Devonian Stratigraphy*, 69 pp.

- HOUSE, M., 1991. Devonian sedimentary microrythms and a Givetian time scale. *Proc. Ussher Soc*. 7: 392-395.

Timing and Extent of the Kačák Interval Within the Eifelian-Givetian Boundary GSSP, Mech Irdane, Morocco, Using Geochemical and Magnetic Susceptibility Patterns

El Hassani, A.[1] Ellwood, B.B.[2], Algeo, T.J.[3], Tomkin, J.H.[4], and Rowe, H.[5]

[1] Institut Scientifique, Université Mohammed V Agdal, B.P.703 Rabat-Agdal, 10106 Rabat - Morocco
[2] Louisiana State University, Department of Geology and Geophysics, E235 Howe-Russell Geoscience Complex, Baton Rouge, LA 70803 United States. - [3] Department of Geology, University of Cincinnati, Cincinnati, OH 45221-0013, U.S.A. - [4] School of Earth, Society, and Environment, University of Illinois, 428 Natural History Building, 1301 W. Green Street, Urbana, IL 61801, United States. - [5] Department of Earth and Environmental Sciences, University of Texas at Arlington, Arlington, TX 76019, U.S.A.

Here we present new geochemical and low-field magnetic susceptibility (MS) data from the Global boundary Stratotype Section and Point (GSSP) for the Middle Devonian Eifelian-Givetian boundary interval at Mech Irdane in the Anti-Atlas Mountains of south-eastern Morocco. These data come from 395 samples collected over a vertical height of 20 m, beginning at a distance of ~4.5 m below the boundary and extending to the Upper *pumilio* marker bed ~14.5 m above the boundary. MS data show long-term T-R cyclicity on which is superimposed shorter-term climate cyclicity. Fourier analysis of these data yield four co-supporting Milankovitch bands; eccentricity at ~400 and ~100 kyr, obliquity (O1) at ~32 kyr, and precession (P2) at ~20 kyr, the later two corrected for Middle Devonian Earth rotation rates. A floating-point time scale for the boundary interval has been developed using the P2 cyclicity and allows timing resolution to 10 kyr within the section.

Using the anomalous variations observed for the geochemical data, in combination with high MS fluctuations and reported biostratigraphic extinctions from the boundary interval, we have revised the onset of the Kačák Interval to begin ~1 m below the boundary level, to continue to ~1 m above the boundary. This takes into account the environmental perturbations that ultimately lead to the extinctions. Time series analysis indicates that the Kačák Interval as thus defined lasted for ~200 kyr. Based on the MS data developed for the section, we estimate that the *pumilio* beds, identified at the top of the section, each were deposited during maximum high stands that occurred at that time.

Global Correlation Using Magnetic Susceptibility and Geochemical Data for the Cenomanian-Turonian Boundary

Ellwood, B.B.[1], Ratcliffe, K.T.[2], Tomkin, J.H.[3], Roach, C.[2], Kaplan, U.[4], and Wray, D.S.[5]

[1] Louisiana State University, Department of Geology and Geophysics, E235 Howe-Russell Geoscience Complex, Baton Rouge, LA 70803, United States: ellwood@lsu.edu - [2] Chemostrat Inc., 6700 Portwest Derive, Houston, 77024, United States: kenratcliffe@chemostrat.co.uk; ceriroach@chemostrat.co.uk - [3] School of Earth, Society, and Environment, University of Illinois, 428 Natural History Building, 1301 W. Green Street, Urbana, IL 61801, United States: tomkin@illinois.edu [4] Eichenallee 141, 33332 Gütersloh, Germany: U.K.Kaplan@t-online.de - [5] School of Science, The University of Greenwich at Medway, Chatham Maritime, Kent ME4 4TB, UK: wd01@gre.ac.uk

To test the utility of geochemical and accompanying low-field magnetic susceptibility (MS) data for global correlation, we have extended our work on the Upper Cretaceous Cenomanian-Turonian (C-T) Global boundary Stratotype Section and Point (GSSP) in Pueblo, Colorado, to the well studied chalk section located at Eastbourne, UK, and the primarily limestone-shale section within Halle DIMAC quarry, Germany. The C-T boundary is associated with a global oxygen minimum zone (OMZ), the Oceanic Anoxic Event 2 (OAE2), that began in the uppermost Cenomanian and is primarily defined by a broad positive carbon isotopic ($d^{13}C$) shift. The OAE2 represents the most significant thermal climatic event in the Mesozoic. Our work demonstrates that MS, lithology and whole-rock inorganic geochemical data, used in conjunction with reasonable biostratigraphic control for the three Cenomanian-Turonian boundary sections studied, provide a useful way to correlate among these sequences. Each section is distinctive in lithology, weathering characteristics and secondary alteration effects. Elemental analyses of U, Ce, Eu, Al and Mn, as well as other elements and ratios of these elements, in conjunction with MS data, provide high-resolution correlations that yield reasonable measures of T-R cyclicity within the sequences sampled. Given that MS provides a climate proxy for detrital T-R cycles, we performed a time series analyses on MS data sets using the Fourier transform (FT) method. FT data for Eastbourne section samples produced 5 unique Milankovitch cycles, including two eccentricity (~405 and ~100 kyr), two obliquity (~50.6 and ~39.0 kyr) and one precessional (18.5 kyr) climate bands. This allows us to evaluate sediment accumulation rates (SAR) within sequences and to test the uniformity of the MS data sets studied. We use the graphic comparison method for this purpose, and show that the MS cyclicity is relatively uniform through the studied sections. This work yields average SARs for these sections of ~0.50 cm/kyr for the Pueblo GSSP, ~0.69 cm/kyr for the Eastbourne sequence, and ~0.56 cm/kyr for the Halle quarry section sampled.

Magnetic susceptibility records in recent (Cenozoic) and ancient (Devonian – Palaeozoic) mound systems

Foubert, A.[1], da Silva, AC.[2], Boulvain, F. [2], Henriet, J.P.[3]. & the IODP Exp. 307 Scientists

[1] Department of Earth and Environmental Sciences, K.U. Leuven, Belgium, anneleen.foubert@ees.kuleuven.be - [2] Pétrologie sédimentaire, University of Liege, Belgium, ac.dasilva@ulg.ac.be, fboulvain@ulg.ac.be - [3] Renard Centre of Marine Geology, Ghent University, Belgium, jeanpierre.henriet@UGent.be

In this study, records of magnetic susceptibility (MS) in ancient (Devonian, Frasnian, Belgium) and Recent (Cenozoic, NE Atlantic, SW Ireland) mound systems are compared. For both Recent and ancient mounds, sampling mode is relatively similar, with a 50 cm resolution (ancient mounds are studied in cores and outcrops while recent mounds are studied only in core sections). Magnetic susceptibilities were measured using a Kappabridge KLY-3S. For Recent mounds measurements were made on constant volume individual cubes leading to volume susceptibility values. Additionally, bulk magnetic susceptibilities were measured using a Bartington Model MS-2 meter on whole round sections and this with a resolution of 5 cm. For ancient mounds, measurements were made on various size samples and the values were divided by the sample mass leading to mass susceptibility values.

In the Devonian of Belgium, four successive levels of mud mound are recorded and were deposited in a relatively deep setting, surrounded by shales. Reef initiation occured during a transgression with the development of skeletal mound facies (mud and stromatactis with corals and stromatoporoids) followed by algal facies. Then an important regression leads to strong sediment reworking and during the next transgressive stage algal and microbial mound facies were deposited corresponding to a circular reef margin, with relatively restricted facies inside this crown.

Recent carbonate mounds localized in deeper slope settings on the continental margins clearly play a major role in the dynamics of mixed siliciclastic-carbonate and/or carbonate-dominated continental slopes. During IODP Expedition 307, the 150 m tall Challenger mound in Porcupine Seabight (Belgica mound province, SW of Ireland) was drilled aboard the R/V Joides Resolution. The mound is built from top to bottom of cold-water coral fragments embedded in an alternating biogenic (carbonate-rich) to terrigenous (siliciclastic) matrix. This creates a cyclicity which is considered to be driven by glacial-interglacial changes. Magnetostratigraphy and datings show that the mound started to grow between ~2.70 and ~2.50 Ma. It is nowadays in a stage of decline. The mounds in the Belgica mound province are surrounded by drift sediments.

In both Recent and ancient mounds, magnetic susceptibility values are reflecting the changes in facies. In the Devonian mounds, magnetic susceptibility is higher for the off-mounds (argillaceous) and deeper facies and lower for the atoll crown and the lagoonal deposits. A comparison between on-mound and off-mound records in recent carbonate mounds revealed also much higher susceptibility values for the off-mound facies. So, in ancient and Recent mounds, magnetic susceptibility values are lower in the mud mound and this could be explained by different factors such as a higher carbonate production and/or less siliciclastic input in the mound.

Moreover, in Recent mounds, the susceptibility pattern from the mound itself can not be recognized in the surrounding sediments. The last can be explained by the fact the mud mounds record more 'time" than the platform and/or surrounding sediments. So the record in the mound covers not exactly the same record in the off-mound regions, which make mound systems unique time recorders. On the other hand, extensive carbonate production within the mound habitats could "dilute" the detrital minerals.

In Ancient mound the susceptibility pattern in the mound was compared to the time lateral equivalent shallow water platform. And in this case it also appears that the record in the mound is different than the record off mound which could be related to a different sedimentary dynamic.

A clear cyclic pattern of the magnetic susceptibility curve was recognized in both cases and this cyclic evolution is most probably a proxy for palaeo-environmental changes. Magnetic susceptibility allowed relatively good correlations of sections within the same mound and also between the mounds (Foubert and Henriet, 2009; da Silva and al., 2009).

DA SILVA, AC., MABILLE, C. & BOULVAIN, F. 2009. Influence of sedimentary setting on the use of magnetic susceptibility: examples from the Devonian of Belgium. *Sedimentology*, 56, 1292-1306.

FOUBERT, A., HENRIET, JP. 2009. Nature and significance of the Recent carbonate mound record. *Lecture notes in earth Sciences*, 298p.

Magnetic susceptibility and rock magnetic properties in recent carbonate mounds – Challenger Mound, Porcupine Seabight (SW of Ireland) as specific case study

A. Foubert[1], J. Hus[2], F. Yuji[3], B. De Mol[4], J.P. Henriet[5] & the IODP Exp. 307 Scientific Party

[1] Department of Earth and Environmental Sciences, K.U. Leuven, Celestijnenlaan 200E, B-3001 Heverlee, Belgium. anneleen.foubert@ees.kuleuven.be - [2] Geophysical Centre of Dourbes (KMI), Dourbes, Belgium - [3] Department of Earth Sciences, Toyoma University, Gofuku 3190, Toyama 930, Japan - [4] GRC Geociencias Marines, University of Barcelona, 08028 Barcelona, Spain - [5] Renard Centre of Marine Geology, Ghent University, Belgium

Sub-recent cold-water carbonate mounds localized in deeper slope settings on the continental margins can not be any longer neglected in the study of carbonate systems. They clearly play a major role in the dynamics of mixed siliciclastic-carbonate and/or carbonate-dominated continental slopes. During IODP Expedition Leg 307 aboard the R/V Joides Resolution, a recent carbonate mound, Challenger mound (Porcupine Seabight, SW of Ireland), was drilled for the first time in history (Expedition Scientists, 2006). The Challenger mound sediments can be described as a facies of cold-water coral fragments and other biogenic fragments embedded in an alternating biogenous (carbonate-rich) to terrigenous (siliciclastic) matrix (Exp. 307 Scientists, 2006; Foubert & Henriet, 2009). This study highlights how Challenger mound act as a palaeo- and rock magnetic recorder (Foubert & Henriet, 2009). An overview will be given of the relevance and the use of magnetic properties in the sediments of recent carbonate mounds.

Palaeomagnetic and rock magnetic measurements were partly carried out aboard the R/V JOIDES Resolution during IODP Expedition Leg 307 and in the palaeomagnetic labs of the Geophysical Centre of Dourbes (KMI, Belgium). Shipboard analyses comprised measurements of the natural remanent magnetization (NRM) before and after alternating-field (AF) demagnetization (long-core cryogenic magnetometer (2G Enterprises model 760-R)) and low-field magnetic susceptibility measurements (k) (Bartington Model MS-2 meter) on whole-round sections. Discrete samples (7 cm^3) were taken on the working halves of each core-section to calibrate and evaluate shipboard measurements. Remanence measurements and AF demagnetizations were performed on each of the cubes with a cryogenic magnetometer (2G Enterprises model 760-R) installed at the Geophysical Centre of Dourbes (KMI, Belgium). Low-field magnetic susceptibilities (k) and the anisotropy of magnetic susceptibility (AMS) were measured with a KLY-3S Kappabridge. A thermomagnetization experiment was carried out on oven-dried powders of two discrete samples. The interpretation of inclination records and palaeointensity records allowed building up a magnetostratigraphic framework for the mound records. A four-phase general evolution model for Challenger mound and his surrounding environment could be proposed. The interplay between terrigenous sedimentation (with the supply of paramagnetic Fe-rich clay minerals (mainly illite and chlorite), diamagnetic quartz and ferrimagnetic magnetite), biogenic sedimentation (diamagnetic calcium carbonate) and diagenesis (dissolution of ferrimagnetic magnetite and formation of paramagnetic pyrite) controls the susceptibility records. The anisotropy in magnetic susceptibility suggested that the sediments in the mound might be deposited by northward directed currents ensuing alongslope transport of sediments. Tuning the susceptibility records to standard oxygen isotopic records, made it possible to define a stacked susceptibility record calibrated in age for the mound sediments (SUSMOUND). Spectral analysis of the susceptibility records and the tuned records revealed some spectral characteristics of Milankovitch cyclicity between the mound base (~2.50 to 2.70 Ma) and a major hiatus present around 25.00 mbsf (~1.67 Ma), suggesting climatic forcing.

EXPEDITION 307 SCIENTISTS, 2006. Expedition 307 summary. *In* Ferdelman, T.G., Kano, A., Williams, T., Henriet, J.-P., and the Expedition 307 Scientists, 2006. *Proc. IODP,* 307: Washington, DC (Integrated Ocean Drilling Program Management International, Inc.).

FOUBERT, A., & HENRIET, J.P. (2009) Nature and Significance of the Recent Carbonate Mound Record: The Mound Challenger Code. *Lecture Notes in Earth Sciences*, 126. Springer, 298 pp.

Devonian magnetic susceptibility studies in Poland: current state of knowledge and future studies

Grabowski, J.[1], Matyja H.[1], Narkiewicz M.[1], Nawrocki, J.[1] and Sobień K. [1]

[1]Polish Geological Institute – National Research Institute, Rakowiecka 4, 00-975 Warszawa, Poland
jacek.grabowski@pgi.gov.pl; hanna.matyja@pgi.gov.pl; marek.narkiewicz@pgi.gov.pl; jerzy.nawrocki@pgi.gov.pl; katarzyna.sobien@pgi.gov.pl

So far, there are two published papers dealing with MS of Devonian and its stratigraphical and palaeonvironmental applications in the area of Poland. Both studies concern southern Holy Cross Mts., key area of stratigraphic and facies studies of the epicontinental basin of southern Poland. Most extensively studied is the Kowala section, which comprises Upper Devonian reef-slope to marly shelf-basinal succession. MS in Kowala section was studied in detail in two intervals: Frasnian/Famennian boundary (Devleeschouwer, in Racki et al. 2002) and Lower/Middle Frasnian boundary (Nawrocki et al. 2008). The latter boundary was also studied in the Wietrznia section which is developed in a more proximal reef-slope facies. MS changes at the Lower/Middle Frasnian boundary, related to variations of detrital input into the basin, were interpreted as a result of Eovariscan tectonic activity in the Saxo-Thuringian zone and Mid-German Crystalline High. Interpretation of MS variations at the Frasnian/Fammenian boundary is ambiguous since transgressive/regressive trend postulated by MS curve was not supported by microfacies study. However, only short F/F boundary interval was studied (ca. 7 m). However the eustatic signal might be biased by well documented synsedimentary tectonics. An unrecognized contribution of secondary magnetite might also affect the MS signal. Southern part of HCM was affected by Late Variscan (mostly Early Permian) remagnetization. Its intensity is stronger in the areas more thermally altered (CAI indexes 2 to 3). Moreover, Devonian rocks are locally intensively impregnated with secondary hematite, which originated most probably due to multi-stage hydrothermal activity (Lewandowski 1999) and weathering in the Late Permian/Early Triassic.

Northern part of the HCM, where Late Variscan “magnetite-related” remagnetization event was hitherto not documented, offers good possibilities of correlation of Eifelian/Givetian sections. Preliminary results indicate, that MS is nicely linked with depositional rythms expressed as shallowing upwards, shallow subtidal to intertidal carbonate cycles

Ongoing project aims to construct reference MS curves for the Devonian in several tectonostratigraphic units of Poland, basing on borehole data. These comprise boreholes from the Brunovistulicum cover: Goczałkowice IG 1 (Lower Devonian – Lower Tournaisian) and Trojanowice 2 (Eifelian – Givetian) and from the Holy Cross Mts: Kowala 1 (Lower Devonian – Famennian) and Janczyce IG 1 (Emsian – Famennian). Another small project in the Pommeranian region is focused on the MS variations and correlations at the Devonian/Carboniferous boundary.

- LEWANDOWSKI M. 1999. A palaeomagnetic study of fracture fills in the Holy Cross Mountains of Central Poland and its application of dating tectonic processes. *Geophys. J. Int.* 137: 783-792.

- NAWROCKI J., POLECHOŃSKA O. & WERNER T. 2008. Magnetic susceptibility and selected geochemical – mineralogical data as proxies for Early to Middle Frasnian (Late Devonian) carbonate depositional settings in the Holy Cross Mts, southern Poland. *Palaeogeography, Palaeoclimatology, Palaeoecology* 181: 251-297. 269, 176-188.

- RACKI G., RACKA M., MATYJA H. & DEVLEESCHOUWER X. 2002. The Frasnian/Famennian boundary interval In the South Polish –Moravian shelf basins: integrated event-stratigraphical approach. *Palaeogeography, Palaeoclimatology, Palaeoecology* 181: 251-297.

Dust – atmospherically mediated inputs into sediments: an attempt of geologial reappraisal with regard to magnetic susceptibility signal

Hladil, J. [1]

[1] Institute of Geology AS CR, v.v.i., Rozvojova 269, 165 00 Prague 6, Czech Republic. Email: hladil@gli.cas.cz

A significant part of atmospheric dust sedimentation is inaccurately measured. Most of the research is conducted to understand the emissions and atmospheric load of PM_{10}, but few studies map the long-distance transport and sedimentation of PM_{50} or coarser particulate matter. The latter components seem to be sparse according to number of grains but represent a substantial mass since these grains are bulky. With reference to particle size, the present-day aerosol science and geological approach oriented to real sediment almost pass each other. The plausible estimates of average input of dust sediment on the Earth surface are set out below (for recent conditions, according to sources; in $g/m^2/yr$, i.e. $t/m^2/myr$): crustal weathering products ≈ 3.3; volcanic ash ≈ 0.3; biota ≈ 0.4; cosmogenic ≈ 0.0003; wildfires ≈ 0.3; and an additional part from typical natural aerosols ≈ 0.02. Total ≈ 8. In marine basins, the loss of mass due to partial removal of solutes and intense destruction of organics precede the final embedding into the sediment, so that the input values are reduced, e.g. ≈ 4. An attempt of broad reassessment of amounts and quality of these inputs relates to understanding of depositional system dynamics and magnetic susceptibility signal.

Isotopic composition of carbon and oxygen in the Upper Devonian (F-F) sections from the Western part of South Urals (Russia)

Izokh O.P.[1], Mizens A.G[2]

[1] Institute of Geology and Mineralogy, Siberian Branch of RAS
[2] Institute of Geology and Geochemistry, Urals Branch of RAS

Upper Devonian carbonate sections are widely distributed in the Western part of South Urals. Commonly they presented by limestones with numerous brachiopods, crinoids and conodonts. Frasnian-Famennian boundary interval is represented by low-thickness brachiopod shell rocks (Barma Beds) deposited in the shallow-water shelf conditions, with polytaxonomic brachiopod complex, containing index-species *Parapugnax markovskii* (Yud.) (= *Parapugnax triaequalis* (Mark.)). Two sections (Akkyr and Bol'shaya Barma) cropped out in the Western part of South Urals were studied for C and O isotopic composition variation near Frasnian-Famennian boundary.

In Bol'shaya Barma section thickness of Barma Beds is 0.47 m and in Akkyr section – 0.9 m. The age of Barma Beds in Akkyr section has been determined within *linguiformis*-Early–Middle *triangularis* biozone and in Bol'shaya Barma section – Early–Middle *triangularis*, on the basis of conodont distribution [Abramova, Artyushkova, 2004].

Brachiopod shells were used for the isotopic study. Before the isotopic composition analyzing, state of preservation of the brachiopod shells was assessed using cathodoluminescence microscopy (Technosyn 8200 MK II). Oxygen and carbon isotope analyses were performed with a preparation line (Gas Bench II) connected online to a Thermo Finnigan MAT-253 mass spectrometer. All values are reported in ‰ relative to V-PDB by assigning a $\delta^{13}C$ value of +1.95‰ and a $\delta^{18}O$ value of −2.20‰ to NBS 19.

In both sections two positive excursion $\delta^{13}C$ and of $\delta^{18}O$ values are fixed. Values increase from the lower part of Barma Beds: $\delta^{13}C$ values increase from 1 to 3.5‰ in Bol'shaya Barma section and from 1 to 6.7‰ in Akkyr section. $\delta^{18}O$ increase from -5.3 to -3.5‰ in Bol'shaya Barma section and from -4,4 to -2.9‰ in Akkyr section. Thus, magnitude and absolute values of $\delta^{13}C$ in the Akkyr section are greater than at the Bol'shaya Barma section and greater than in same age carbonate sections of Australia, Poland, Germany [Joachimski M. et al 2002] and Siberia [Izokh O.P. et al., 2009]. In Akkyr section, decreasing of $\delta^{13}C$ and of $\delta^{18}O$ occurred at the upper part of Barma Beds, whereas in Bol'shaya Barma section $\delta^{13}C$ and of $\delta^{18}O$ values at the top of Barma Beds remain comparable with maximum values.

Higher $\delta^{13}C$ values in Akkyr section in comparison with Bol'shaya Barma section can be explained by either the better state of preservation or the more shallow-water sedimentation conditions for Barma Beds in Akkyr sections. The latter assumption is confirmed by the distribution of more deep-water brachiopod species in Bol'shaya Barma section.

- ABRAMOVA A.N. & ARTYUSHKOVA O.V., 2004. The Frasnian-Famennian boundary in the Southern Urals. *Geol. Quart.* 48/3: 217–323.

- IZOKH O.P., IZOKH N.G., PONOMARCHUK V.A. & SEMENOVA D.V., 2009. Carbon and oxygen isotopes in the Frasnian–Famennian section of the Kuznetsk basin (southern West Siberia). *Russian Geology and Geophysics* 50: 610-617.

- JOACHIMSKI M., PANCOST R., FREEMAN K, OSTERTAG-HENNING C. & BUGGISCH W., 2002. Carbon isotope geochemistry of the Frasnian – Famennian transition. *Palaeogeography, Palaeoclimatology, Palaeoecology* 181: 91-109.

Mineralogy of fine-grained non-carbonate particulates embedded in neritic to pelagic limestones, and connection to magnetic susceptibility and gamma-ray signals: a case study based on Lochkovian, Pragian and lower Emsian strata from the Pozar-3 section (Prague Synform, Czech Republic)

Koptíková, L.[1,2], Hladil, J.[1], Slavík, L.[1], and Frána, J.[3]

[1] Institute of Geology, AS CR, v.v.i., Rozovjová 269, 16500 Praha, Czech Republic.
koptikova@gli.cas.cz, hladil@gli.cas.cz, slavik@gli.cas.cz
[2] Institute of Geology, Faculty of Science, Albertov 6, 12843 Praha 2, Czech Republic
[3] Nuclear Physics Institute AS CR, v.v.i., 25068 Řež u Prahy, Czech Republic. frana@ujf.cas.cz

A 125-m-thick succession of almost undeformed Lower Devonian beds was measured, analysed and logged in an active quarry ESE of Praha-Reporyje (see Chlupac et al. 1998 for outlines of lithostratigraphic members and biostratigraphy). The Lochkov Fm. spanning an age range of Lochkovian and earliest Pragian is represented here by thin-bedded dark to medium-grey calcisiltites and fine-grained skeletal grainstones with thin shale intercalations and scarce cherts. The basal Lochkovian and also Lochkovian-Pragian intervals contain sparry calcarenites-calcirudites in an elevated proportion or as the dominant component. The Praha Fm. of the Pragian, but now mostly of "Emsian" age (according to the GSSP of Pragian/Emsian boundary in Uzbekistan), has a thin layer of whitish and light-grey crinoidal calcarenites-calcirudites at the base (amalgamated beds 3 to 10 cm thick). These are covered by thinning-upward, pinkish-coloured, micritic crinoidal calcarenites. The next continuation is marked by further fining of calciturbidite sediment. Strong reduction of cement was caused by multimodal grain-size distributions and common pressure solution and compaction in rocks (bedding planes are mostly uneven, undulating). Scattered bioclasts of millimetre sizes are mostly tentaculitoids but delicate fragments of trilobite and echinoderm skeletons are also present. The colour of the sediment changes from blackish and variegated assemblages, through typical pelagic limestone redbeds (maximum condensation), to grey-coloured, dacryoconarid fauna-rich alternation of calcisiltites and carbonated pelagic muds. In these grey limestones, a remarkable, less than 1 m thick Graptolite Event (GE; Hladil and Kalvoda, 1997) interval occurs, and consists of laminar calciturbiditic beds with flat surfaces and 7 to 8 intercalations of "black-shales" from background sedimentation. The uppermost parts of the Praha F., i.e., above the event marker, are marked by a slight but visible coarsening of grains. Calciturbidite beds are thicker than below but compaction still affects sedimentary structures. The uppermost beds of the Praha Fm. show abundant ichnofabrics (mainly Chondrites, Zoophycos). The base of the Zlichov Fm. is relatively sharp but not associated with channelized breccia flows of the "Chapel-horizons" type. The Zlichovian calciturbidite beds have a higher thickness and frequency, showing a sharp contrast between coarse, sparry calcarenites of mixed skeletal-lithoclastic composition and remarkably low-carbonated sedimentation background rocks of "black-shale" type.

A detailed gamma-ray outcrop logging (GRS) and laboratory measurements of magnetic susceptibility (MS) in the studied interval revealed marked changes close to the Lochkovian/Pragian boundary. MS values of the Praha Fm. are four to five times higher than those in the underlying Lochkov Fm. (mean 15.7 vs. 3.6, respectively), with many high-amplitude oscillations. Also, wide variations in Th/U ratio were found. The entire Lochkov Fm. pattern is driven by dominant concentrations of uranium (mean 4.20 mg/kg U; Th/U ratio 0.5) whereas the Praha Fm. pattern is driven by dominant thorium concentrations (mean 3.7 mg/kg Th; Th/U ratio 3.9). Potassium concentrations are also increased in the Praha Fm. (0.8 %) compared to the Lochkov Fm. (0.45 %). Approximate amounts of non-carbonate impurities were calculated both from GRS data and INAA analyses (in brackets). Mean values are 6.81 (3.9) wt.% for the Lochkov Fm.,13 (8.53) wt.% for the Praha Fm. and 9.94 (7.09) wt. % for the Zlichov Fm. Insoluble residues (30 samples in total) obtained by fast dissolution in hydrochloric acid and also whole-rock crushed samples (no acid dissolution but gravitational, flotation, density and electromagnetic separation) were selected to cover places with MS maxima, minima and medium-value points.

Detrital grains of diamagnetic, paramagnetic and also ferromagnetic characteristics were identified using EDX, X-ray and EMP techniques. The undifferentiated assemblages of true fine-grained detrital components and crystals of authigenic minerals and their aggregates consist of pyrrhotite, iron oxides and oxyhydroxides (often with high contents of titanium), olivine, pyrite, chalcopyrite, amphibole, pyroxene, Fe-rich dolomite, chlorite, ilmenite, epidote, rutile, muscovite, feldspars (K-feldspar, plagioclase, albite), clay minerals (kaolinite, montmorillonite), quartz, barite, apatite and zircon were identified. The Lochkov Fm. differs from the Praha Fm. in a higher abundance of pyrite-pyrrhotite grains and a lower abundance of iron oxides and oxyhydroxides. On the other hand, the presence of hematite is typical for rocks of the Praha Fm. The abundance of iron oxides in the Praha Fm. together with lighter, variegated and pinkish (or red) colour hues of pelagic limestones are indicative of higher oxygenation of the oceanic water column. These features are also linked with a higher infestation by microborers. This transition from anoxic to oxic conditions, combined with a slower rate of pelagic and slope to toe-of-the-slope sedimentation and, most likely, increased flux of the delivered atmospheric dust material, may explain the observed high-MS and high-Th patterns which define the contrast between the Praha Fm. and the underlying and overlying "grey" calciturbidite formations with low-carbonated background sedimentation: Lochkov and Zlichov Fms, respectively.

Acknowledgement. This study was supported by the Czech National Committee of IGCP, Severoceske doly, a.s. and Eurovia CS, a.s. This study is a contribution to IGCP 580.

- CHLUPAC I., HAVLICEK V., KRIZ J., KUKAL Z. & STORCH P., 1998. Palaeozoic of the Barrandian (Cambrian to Devonian). *Czech Geological Survey, Monograph-Book*, Prague, 184 pp.

- HLADIL J. & KALVODA J., 1997. A short range anomaly in the earliest Emsian sedimentation of the Barrandian: possible reflection of widely controlled or global event. *Subcommission on the Devonian Stratigraphy, Newsletter* 13: 37−38.

Relationship of magnetic susceptibility with sedimenthological and micromorphological features and geochemical proxy parameters; case study from Last Glacial loess deposits in southern Moravia

Lisa, L.[1], Chadima, M.[1,2], Grygar, T.[3], Jones, M.J.[4] and Gregor, M.[5]

[1] Institute of Geology of ASCR, v.v.i., Rozvojova 269, 165 00, Prague, Czech Republic. lisa@gli.cas.cz - [2] Agico, Inc., Jecna 29a, CZ-62100 Brno, Czech Republic. chadima@sci.muni.cz - [3] Institute of Inorganic Chemistry, Academy of ASCR v.v.i., Rez, CR, grygar@iic.cas.cz - [4] Department of Archaeology, University of Cambridge, Downing street, CB2 3DZ, Cambridge, GB mkj12@cam.ac.uk - [5]Geological Institute, Faculty of Natural Sciences, Comenius University, Mlynska dolina, 842 15 Bratislava, SR, geolgregor@yahoo.com

In Quaternary rock magnetic studies, the relatively increased values of magnetic susceptibility measured in cross sections are conventionally interpreted as an indicator of pedogenetic processes due to the changes of climatic conditions. Such interpretations, however, may oversimplify the situation since the variations in magnetic susceptibility may also reflect the variations in the provenance of the sedimentary material along the studied cross section. In order to confirm or rule out the contributions of pedogenetic processes magnetic susceptibility values should be correlated with another sedimentological or geochemical proxy data.

In this study we present magnetic susceptibility data together with the expandable clay minerals proxies, measured along a loess/paleosol section in Dolni Vestonice, south-east part of Czech Republic. Magnetic susceptibility was measured in three different operating frequencies using an Agico MFK1-FA Kappabridge and its frequency dependence was calculated. The frequency dependence of magnetic susceptibility enables to assess the amount of very fine-grained superparamagnetic grains, which are supposed to be created during the pedogenetic processes. A simple correlation of magnetic susceptibility values with the amount of frequency dependence is presented to distinguish between provenance-related magnetic materials versus magnetic particles created subsequently *in-situ* by pedogenetic process. Frequency-dependent susceptibility and its relationship to different geochemical proxies and sedimentological and micromorphological features can be interpreted in terms of intensity and type of weathering. The determination of cation exchange capacity (CEC) is a quantitative method for the analysis of total expandable clay mineral structures and it is used as a proxy in environmental studies. There is a known pattern of increased content of clay minerals including expandable clay minerals in a warm/humid climate as a part of pedogenesis. In many environmental archives clay mineralogy sensitively reflects environmentally controlled shifts in the sediment source area. Pedogenetical processes influence weathering of expandable clays and also the migration of Ca cations in soil profile, i.e., upward transport generally prevailing evaporation from the soil surface, or adversely its washing down by percolating rainwater. Ca/Mg ratio in exchangeable fraction can decrease in succession A > E > B, C (soil horizons) in prevailing evaporation. Sedimentological features used for the description of sedimentological and postsedimentological processes during the loess accumulation were completed with microstratigrafical observations. The biotite crystals, liable to humid weathering more than other minerals, shows more weathered edges in horizons described sedimentologically as the first stages of soil processes.

An Emsian-Eifelian mixed carbonate-volcaniclastic sequence in Western Ossa-Morena Zone (Odivelas Limestone)

Machado, G.[1]; Slavik, L.[2]; Koptikova L.[2,3]; Hladil, J. [2]; Fonseca, P.[4]

[1]GeoBioTec, Geoscience Department, University of Aveiro, 3810-193 Aveiro, Portugal; machadogil@gmail.com - [2]Institute of Geology, Academy of Sciences of the Czech Republic, v.v.i., Rozvojová 269, 165 00 Praha 6 - Lysolaje, Czech Republic; hladil@gli.cas.cz ; koptikova@gli.cas.cz ; slavik@gli.cas.cz - [3]Institute of Geology, Faculty of Science, Charles University in Prague, Albertov 6, 128 43 Praha 2, Czech Republic – [4] Geology Department and CeGul, Faculty of Sciences of the University of Lisbon, Edifício C6, Campo Grande, 1749-016 Lisbon, Portugal; pefonseca@fc.ul.pt

Lower Devonian sediments are known from several sectors of the Ossa-Morena Zone (OMZ), Southern Iberia, namely the Estremoz-Barrancos area (Montemor-Ficalho Unit) and the Zafra-Córdoba-Alanís sector. These are mostly siliciclastics and generally Devonian carbonates are scarce in the OMZ and surrounding zones. Middle Devonian sedimentary rocks have long been considered to be absent in the OMZ probably due to a generalized uplift of the area during this time period, but Eifelian-Givetian reefal and perireefal sedimentation has been reported from Western OMZ (Machado et al., 2009). Here we present a new locality in the same area (Odivelas Reservoir, Beja, Portugal).

The Covas Ruivas II site has a long exposure of mildly deformed volcanic rocks, mostly coarse pyroclastic deposits and subordinate basaltic lava flows. The sequence fines up to silt sized, very finely laminated tuffs/tuffites (probably corresponding to basinal sedimentation) where the first limestone lenses appear. These are initially subordinate in relation to the tuffites but from the *P. costatus* biozone (early Eifelian) they become dominant over the tuffites where they form thick (up to 2m) beds. The conodont data show an age range from upper Emsian (*P. patulus* biozone) up to the middle-late Eifelian (*T. australis* biozone). The limestone beds are calciturbidites probably deposited along the slopes and around the edges of volcanic edifices of the Odivelas igneous complex. Occasionally at the base of coarser beds, large bioclasts of corals, crinoids, stromatoporoids and calcareous algae are found indicating that the source of the carbonate sediment is a reef or set of reefs established in the shallower parts of the edifices.

The lower part of the *P. patulus* zone (as observed in this section) is characterized by continuous beds of wackestones and grainstones with very abundant crinoidal fragments. The limestone beds within the upper *P. patulus* and *P. partitus* biozones become generally thinner, laterally discontinuous, rarer and are dominantly calcimudstones. Tuffites gradually increase their content in organic matter and tentaculites and radiolarians become common, locally forming chert laminae. Limestone beds disappear in the upper part of this interval and rapidly reappear at the base of the *P.costatus* biozone as laterally continuous crinoidal-rich wackestones and grainstones (rarely rud-grainstones). The sedimentological characteristics in the *P. partitus* to lower *P. costatus* biozones suggest that the Basal Choteč event maybe be recognized in this section, but further investigation is needed to confirm this. The section was sampled for MS, but no conclusive results are available yet.

- MACHADO, G., HLADIL, J., KOPTIKOVA, L., FONSECA, P. E., ROCHA, F. T. & GALLE, A. (2009). The Odivelas Limestone: evidence for a Middle Devonian reef system in western Ossa-Morena Zone (Portugal). *Geologica Carpathica* 60(2): 121-137

Magnetic properties of sediments from Lake Van, Eastern Anatolia, Turkey

Makaroglu, O.[1], Orbay, N.[1,] and Pesonen, J.L.[2]

[1] Istanbul University, Istanbul, Turkey. ozlemm@istanbul.edu.tr
[2] Helsinki University, Helsinki, Finland. lauri.pesonen@helsinki.fi

Lake sediments are very useful material for studying the geomagnetic field in the past, for paleoclimate investigations and for searching tephra layers from volcanos as well as tsunami deposits caused by ancient earthquakes. Here we present preliminary mineral magnetic results of sediments from Lake Van. The lake is located in the region of eastern Anatolia (Turkey). It is the fourth largest terminal lake in the world by volume (volume 607 km³, area 3570 km², maximum depth 460 m). The lake fills a tectonic depression that is tectonically highly active and is characterized by voluminuous recent and active volcanism, earthquakes and hydrothermal activity (Degens & Kurtmann 1978, Keskin 2003, Kipfer et al. 1994, Sengör et al. 2003). Two active volcanoes rise in the immediate vicinity of the lake (1674 m a.s.l.), Nemrut Dag (3050 m a.s.l.) and Süphan Dag (3800 m a.s.l.) (Yilmaz et al. 1998). In 2008, four cores were collected from Lake Van, using a piston corer provided by ITU (EMCOL-Eastern Mediterranean Centre for Oceanography and Limnology).The cores' diameters were 10 cm. After drilling, the entire core was stored in 4^{o}C storage for preservation reasons. Core V08P01 and V08P07 were 5 m long, V08P04 was 4 m long, and V08P05 was 3 m long. The samples at 2 cm intervals were taken into plastic boxes with a volume of 6 cm3. They are oriented relatively to each other. The mineral magnetic measurements include magnetic susceptibility (κ), intensity of remanent magnetisation (J), saturated isotermal remanent magnetisation (SIRM), anhysteretic remanent magnetisation (ARM). The samples were measured at the Solid Earth Geophysics Laboratory of the University of Helsinki using the KLY-3 Kappabridge by the AGICO Co for susceptibility and the susperconducting 2G-SQUID-magnetometer for remanent magnetization. κ and J was used for correlation of the stratigraphic sequence of Lake Van. Core samples have very low magnetic susceptibility values (10-50x10^{-6} SI). Each core has good correlation with MS, ARM,SIRM curves. The results show that magnetic susceptibility, SIRM, and ARM are strongest at the tephra layers that shows deposition of strongly magnetic particles had increased by volcanic activity.

The present work was supported by the Research Fund of Istanbul University. Project No. 2475

- DEGENS, E.T. & KURTMAN, F. (1978): The geology of Lake Van. Ankara, *MTA Press*

- KESKIN, M. (2003): Magma generation by slab steepening and breakoff beneath a subduction-accretion complex: An alternative model for collision-related volcanism in Eastern Anatolia, Turkey. *Geophysical Research Letters* 30 (24): 8046

- SENGÖR, A.M.C., ÖZEREN, S., GENEC, T & ZOR, E. (2003): East Anatolian high plateauas mantle supported, north-south shortened domal structure. *Geophysical Research Letters* 30 (24): 8045.

- YILMAZ, Y., GUNER, Y. & SAROGLU, F. (1998): Geology of the quaternary volcanic centres of the east Anatolia. *Journal of Volcanology and Geothermal Research* 85: 173-210.

Himmelbaach quarry (Mid Emsian, Luxemburg): palaeoenvironmental study and small scale correlations by lithological units and magnetic susceptibility.

Michel J.[1]

[1] Pétrologie sédimentaire, Université de Liège, Bd. Du Rectorat B20, BE-4000 Sart-Tilman

The Himmelbaach quarry is part of the Wiltz Synclinorium. The rocks of this quarry are Mid Emsian Clervaux schales Formation.

Three different facies are identified in the Himmelbaach quarry. One argillaceous sandstone facies with oblique stratifications, cross stratifications, herring-bones and erosive base. A second facies is characterized by centimeter to decimeter-thick alternations of sandy argillites and quartzite or quartzitic sandstones. In this facies lenticular connected-bedding and wavy-bedding can be observed. The last facies corresponds to quartzite and quartzitic sandstones with oblique stratifications and planar laminations. The base of this facies show flaser-bedding and sigmoid contact between beds. These three facies represent a tide-dominated deltaic system composed respectively by tidal channels (facies 1), a tidal flat (facies 2) and a delta front (facies 3).

Due to the huge structural deformation of the quarry, numerous sections were studied, trying to reconstruct the geometry and to propose a complete as possible lithological succession. Correlations are sometimes difficult in this strongly faulted succession and in this context the application of magnetic susceptibility could be really essential. Six sections, 28 meter-thick for the thickest, were sampled. Sedimentological studies lead to correlate three of the six sections, by comparison between lithological units and particular beds. This allowed to reconstruct a vertical succession of three sections (partly correlatable and deposited in stratigraphic order). The magnetic susceptibility confirms these correlations and allowed to include a fourth section in the vertical succession. This, prove the usefulness of magnetic susceptibility in the correlation at small scale, even in a heterogeneous sedimentary environment as a deltaic system.

Contrasting magnetic mineralogy and magnetic susceptibility curves at the Givetian/Frasnian boundary in Belgium: detritism versus diagenesis

Petitclerc, E.[1], Devleeschouwer, X.[1,2], Spassov, S.[3], Casier, J-G.[1,2] and Préat, A.[2]

[1] Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, Rue Jenner 13, B-100 Brussels, Belgium. E-mail : Estelle.Petitclerc@naturalsciences.be - [2] Department of Earth and Environmental Sciences, Sedimentology and Basin Analysis, Université Libre de Bruxelles CP 160/02, 50 av F.D Roosevelt, B-1050 Brussels, Belgium. E-mail : apreat@ulb.ac.be - [3] Royal Meteorological Institute of Belgium, Centre de Physique du Globe, Section du Magnétisme Environnemental, B-5670 Dourbes (Viroinval). E-mail: simo.spassov@oma.be

The Givetian/Frasnian boundary (GFb) has been investigated at two sites (Sourd d'Ave and Nismes) in the allochtonous Ardennes fold-and-thrust belt (southern Belgium). The Nismes section was adopted by the Subcommission on Devonian Stratigraphy (SDS) (Prague, 1986) as an auxiliary stratotype for the Givetien/Frasnian boundary in neritic facies (Bultynck et al, 1988). It exposes around 26 meters covering the last meters of the Fromelennes Formation (Late Givetian) and the base of the Nismes Formation (Late Givetian and Early Frasnian). Hundred samples were collected for microfacies, ostracods (Casier and Préat, submitted) and rock magnetism. The Sourd d'Ave section is an old road cut where around 47 meters are exposed spanning the end of the Fromelennes Formation and the base of the Nismes Formation. Préat (unpublished thesis) studied the section for microfacies and sedimentological aspects in 1984. For the present study, about 392 samples were taken for rock magnetism, i.e. magnetic susceptibility (MS), thermomagnetism and hysteresis analyses.

In both studied outcrops, the Nismes Formation (Avignon and Sourd d'Ave Members) corresponds to a greenish shaly unit, with subordinate clayey-carbonate nodules and thin nodular limestone beds, overlying the platy and massive limestones of the Fromelennes Formation (Moulin Boreux and Hulobiet members).

The MS values and thermomagnetic curves were measured with a Kappabridge MFK1-A with a CS-3 furnace at the Geological Survey of Belgium. The MS values of the Sourd d'Ave section range between 6.0×10^{-10} and 4.5×10^{-7} m³/kg, which are much higher than the MS values of the Nismes section comprised between 0.99 and 10.4×10^{-8} m³/kg. MS curve (MSC) shows several trends during the Givetian, which are more or less correlated with the microfacies. A decreasing MS trend is diachronously observed between the two sections and low MS values are the rule during the Frasnian part.

Hysteresis loops were measured with a J-Coercivity Magnetometer in the Paleomagnetic Laboratory of the Belgian Royal Meteorological Institute. Most of the coercivity values are below 12 mT indicating a low coercitive phase and remanence coercivities show low values (below 60 mT) typical of magnetite grains. Magnetization and remanent magnetization reported versus MS show a good positive correlation (except for the Frasnian samples of Nismes) revealing that ferromagnetic grains seem to control the MS signal. The high-field magnetic susceptibility, calculated on the hysteresis curves, reported versus low-field magnetic susceptibility shows two different behaviors between Nismes and Sourd d'Ave samples. The MS signal of the Sourd d'Ave samples is clearly governed by ferromagnetic grains (i.e. magnetite), which is obviously not the case for the Nismes samples. It appears probably that paramagnetic grains (pyrite and clays) have a significant impact on the MS signal in Nismes. Samples with magnetite as the main carrier of the MS ($B_{cr} < 60$ mT) were plotted in a classical Day Plot diagram. The results indicate that most of the samples are located between the unremagnetized limestones line of Channell and McCabe (1994) and the remagnetized line of Jackson (1990). Following Zwing et al. (2005), our samples contain primary detrital coarse-grained magnetite (MD) and authigenic fine-grained magnetite (probably a mixture of MD and SP particles). These data suggest that magnetite and paramagnetic grains control the MS signal in Sourd d'Ave and paramagnetic grains govern the MS signal in Nismes. The Frasnian MS signal seems to be more dominated by paramagnetic grains and could indicate a strong decrease of the ferromagnetic detrital influx coeval with the drowning of the carbonate platform.

- BULTYNCK, P., DREESEN, R., GROESSENS, E., STRUVE, W., WEDDIGE, K., WERNER, R. & ZIEGLER, W., 1988. Field Trip A (22-24 July, 1988), Ardennes (Belgium) and Eifel Hills (Federal Republic of Germany). *Courier Forschunginstitut Senckenberg* 102: 7-85.

- CASIER, J.-G. & PREAT, A. 2009 (submitted). Late Givetian to Middle Frasnian ostracods from Nismes (Dinant Synclinorium, Belgium) and their lithological context. *Bulletin de l'Institut royal des Sciences Naturelles de Belgique, Sciences de la Terre* 79.

- PREAT, A. 1984. Etude lithostratigraphique et sédimentologique du Givetien Belge (Bassin de Dinant). *Unpublished PhD thesis*, Université Libre de Bruxelles, 466 pages.

- CHANNELL, J.E.T. & MCCABE, C., 1994. Comparison of magnetic hysteresis parameters of unremagnetized and remagnetized limestones. *Journal of Geophysical Research* 99(B3): 4613-4623.

- JACKSON, M., 1990. Diagenetic sources of stable remanence in remagnetized paleozoic cratonic carbonates: a rock magnetic study. *Journal of Geophysical Research* 95(B3): 2753-2761.

- ZWING, A., MATZKA, J., BACHTADSE, V. & SOFFEL, H.C., 2005. Rock magnetic properties of remagnetized Palaeozoic clastic and carbonate rocks from the NE Rhenish massif, Germany. *Geophysical Journal International* 160: 477-486.

MS as a Climate Proxy for Con Moong Cave Sediments, Vietnam: Correlation to SE European Caves

Luu T. P. L.[1], Ellwood B.B. [2], Nguyen K. S.[3]

[1] Institute of Geophysics, Vietnamese Academy for Science & Technology, Vietnam. Email: luuphuonglan@gmail.com - [2] Department of Geology & Geophysics, Louisiana State University, USA. Email: ellwood@lsu.edu - [3] Institute of Archaeology, Vietnamese Academy of Social Science, Vietnam. Email: Nguyen_khacsu@yahoo.com

For 20 years or so magnetic susceptibility (MS) measurements of cave sediments from archaeological sites have been used as a paleoclimate proxy. This method is based on the argument that the MS of cave sediments results from active climate processes outside caves, causing variations in magnetic properties of the sediments ultimately accumulating inside of caves. Once deposited, those materials are preserved, and their stratigraphy provides a climate proxy that can be extracted. Here, we have collected and measured the MS for 132 samples through a 3.3 m stratigraphic section in Con Moong Cave, Thanh Hoa province of Vietnam. This cave has previously been excavated by archaeologists at the University of Hanoi and ^{14}C ages as well as cultural level information is available for the cave. MS results have been compared with the composite reference section (CRS) developed for southern European archaeological cave sites (Ellwood et al., 2001; Harrold et al, 2004). There are 6 MS zones from Con Moong Cave that we correlate to the European CRS reflecting similar climatic patterns as those observed in Europe. Much of the sediment collected represents the Younger Dryas cold interval (MS zone SA14). The data from Con Moong Cave indicate that within the Younger Dryas event there were five MS sub-zones, with two of these (SA14d and 14b) representing brief periods of climate recovery during the Younger Dryas event.

- ELLWOOD, B.B., HARROLD, F.B., BENOIST, S.L., STRAUS, L.G., GONZALEZ-MORALES, M., PETRUSO, K., BICHO, N.F., ZILHÃO, Z., & SOLER, N., 2001. Paleoclimate and Intersite Correlations from Late Pleistocene/Holocene Cave Sites: Results from Southern Europe. *Geoarchaeology* 16: 433-463.

- HARROLD, F., ELLWOOD, B., P. THACKER, P. & BENOIST, S., 2004. Magnetic susceptibility analysis of sediments at the Middle-Upper Paleolithic transition for two cave sites in northern Spain. *In*: ZILHÃO, J. & D'ERRICO, F. (Eds.) The Chronology of the Aurignacian and of the Transitional Technocomplexes. *Dating, Stratigraphies, Cultural Implications, Trabalhos de Arqueologia* 33. *Lisboa*, *Instituto Português de Arqueologia* 301-310.

Detailed sedimentological study and magnetic susceptibility of an Eifelian mixed ramp-related system in the Eifel area

Pas, D.[1], Mabille, C.[2], Aretz, M.[3], Boulvain, F.[1], Schröder, S.[4], da Silva, A.C.[1]

[1]Sedimentary Pertrology, B20, Université de Liège, Sart-Tilman 4000, Liège, Belgium. d.pas@ulg.ac.be - [2]TOTAL E&P, Dept of Structural Geology, Sedimentology and Geology Laboratory, Avenue Larribau, 64018 Pau Cedex (France) - [3]LMTG (OMP), Université de Toulouse (UPS), 14 avenue Edouard Belin, 31400 Toulouse, France. markus.aretzno@spamlmtg.obs-mip.fr
[4]ste.schroeder@gmx.net

This study focuses on the base of the Eifelian stage and on the abandoned Ohlesberg quarry. The exposed section (92 m thick) is related to the Lauch and Nohn formations. Petrographic study leads to the definition of 11microfacies which are integrated in a palaeogeographical model. It corresponds to a complex ramp setting where carbonate, mixed and siliciclastic deposits coexist. The microfacies evolution is interpreted in terms of bathymetric and lateral variations, showing a general shallowing upward trend and transitions between carbonate-dominated and siliciclastic-dominated sedimentary domains. This interpretation is supported by trends in magnetic susceptibility data. Even if the proximity to emerged areas appears to be the major influence on magnetic susceptibility values, the influence of carbonate productivity and wave agitation is also noted. The Ohlesberg section clearly points to the local and regional complex facies architecture, and advocates to variegated depositional environments along the Mid-Eifelian High.

Magnetic susceptibility as additional tool in stratigraphic correlations: A case study of the Middle and Upper Ordovician sedimentary succession, Estonia

Preeden, U.[1], Kalberg, A.-L.[1], Plado, J.[1] and Ainsaar, L.[1]

[1] Department of Geology, University of Tartu, Vanemuise 46, Tartu, 51014, Estonia. e-mail: ulla.preeden@ut.ee

The well-preserved Estonian Paleozoic succession is composed of Ediacaran to Devonian siliciclastic and carbonate sediments which overlay the southern slope of the Fennoscandian Shield. The whole homoclinal section is gently (<1°) tilted southwards whereas the thickness of Paleozoic complex above the crystalline Proterozoic bedrock is up to 800 m. The succession is thoroughly studied by paleontological, sedimentological and stratigraphical means. During the last decade several chemostratigraphical studies, based on stable carbon and oxygen isotopes, have been also performed.

To test suitability of magnetic susceptibility for correlation of the carbonate succession in Estonia, three drill cores were analyzed. The sections represent various types of the Middle and Upper Ordovician carbonates: form pure limestones and dolomites to clay/pyrite/glauconite/goethite rich carbonates but, locally, also marls and argillites. These have been formed in a shallow cratonic sea that occupied the area during the Ordovician and Silurian. The analyzed cores were chosen to represent different depths of the ancient basin, i.e. shallower (Viki; W Estonia) and deeper (Tartu and Valga; S Estonia) environments.

Magnetic susceptibilities were measured with a portative magnetometer SM-30. The results were correlated against the shape-caused differences (e.g., measured from a side or top of the piece of core, different diameters of the cores) but not for mass or volume. Therefore, the susceptibility values should be treated as apparent, but as all three cores were measured in identical conditions we assume the values are comparable and reliable for correlation purposes.

Basically, the susceptibility logs of all three core sections are similar to each other indicating that (i) the sediments were formed within the same basin and (ii) possible post-sedimentational magnetization-influencing processes have been of minor activity. The magnetic susceptibility also correlates with the lithological composition of the sedimentary rock: higher values were found to correlate with higher content of clay, pyrite, goethite and glauconite. Further, similarities in susceptibility data allowed correlating locations of boundaries between the regional stages, i.e. working as a stratigraphic tool.

The absolute values of apparent magnetic susceptibilities were found to positively correlate with the depth of the former sea: the highest values were measured from the Valga core (deepest part of the former sea), whereas the lowest values described the Viki core that formed closer to the shoreline on the carbonate shelf.

Origin of the magnetic susceptibility variations in some carbonate Frasnian-Famennian boundary sections : implications for paleoenvironmental studies

Riquier L.[1], Averbuch, O.[2], Devleeshouwer, X.[3], Tribovillard, N.[2]

[1] Université de Bourgogne, Biogéosciences UMR CNRS 5561, 6, Boulevard Gabriel, F-21000 Dijon, France [2] Université de Lille 1, Géosystèmes, UMR CNRS 8157, bâtiment SN5, F-59655 Villeneuve d'Ascq cedex, France [3] Royal Belgian Institute of Natural Sciences, Dpt VII: Geological Survey of Belgium, Rue Jenner 13, B-1000 Brussels, Belgium

In recent years, magnetic susceptibility (MS) has been increasingly used in Paleozoic carbonate sequences as a marker of depositional conditions and stratigraphy cycles. To further constrain the potential use of MS signal as a detrital maker and to assess the potential impact of the MS variations, a multi-approach study was conducted with 4 distant carbonate sections of the Late Devonian times (Frasnian-Famennian boundary). These times record a period of major environmental perturbations (biotic, climatic, eustatic). The study includes along-section magnetic susceptibility measurements complemented by magnetic hysteresis parameters, inorganic geochemistry and clay mineral analyses.

Hysteresis loop measurements suggest that the MS evolution is dominantly controlled by the variation in the concentration of low-coercivity ferromagnetic magnetite grains and in minor way of paramagnetic clays. More specifically, hysteresis ratios suggest the coexistence of two magnetite populations with significantly different grain-size: (1) a dominantly coarse-grain detrital fraction including a mixture of multi-domain and single-domain particles (2) an authigenic fine-grain fraction composed of a mixture of single-domain and super-paramagnetic particles. Clay mineral assemblages indicate the 4 sections have been submitted to a significant burial (close to anchimetamorphic zone). Nevertheless, no clear correlation was established between MS values and the illite cristallinity or with the illite content (a proxy of illitization process), suggesting that diagenetic reactions during burial did not produce a noticeable distortion of the primary MS evolution. Lastly, the detrital origin of the magnetic signal fluctuations is corroborated by significant correlations between the MS signal and terrigenous geochemical proxies (e.g. Zr , Ti and Th).

The MS curves would thus provide a general record of the evolution of the detrital flux and of the carbonate productivity through the Late Devonian times. They all argue for the Frasnian-Famennian boundary to represent a transition between a period of Frasnian gradual decrease of detrital input, punctuated by the two Kellwasser horizons, and an Early Famennian period of significantly enhancemented of detrital supply. The variations are interpreted as significant climate change at the F-F boundary.

Magnetic record in deep water sediments: An example from Kashafroud Formation, Kopet-Dogh Basin, NE Iran.

Sardarabadi, M.[1], Amini, AH.[1]

[1]Geology Department, University of Tehran, Tehran, Iran. Email: m.sardarabady@khayam.ut.ac.ir
ahamini@khayam.ut.ac.ir

The upper Jurasic Kashafrud Formation in East Kopet-Dagh and its type section (Pol Gazi Section) mainly composed of shaley successions with thin sandstone interlayers. The shaley units are considered as probable source rock of gas reservoirs in the area. On the basis previous studies the formation is deposited in pro-delta to deep basin setting with abundant buoyant plumes. Due to significant of the shaley units and limitation of usual petrographic methods and field investigation in their study, this paper deals with their magnetic susceptibility and its use in sequence stratigraphic study. The efficacious factors on magnetic susceptibility trend including carbonate productivity, organic productivity, diagenetic process, sediment input and sand shale ratio are identified for better understanding of relative sea level changes of deep water successions. On the basis of petrofacies characteristics and magnetic susceptibility variation through the studying section, distribution pattern of magnetized particles in primary buoyant plumes is reconstructed. The result form this study is used for relative sea level change analysis of Kashafrud Basin. The model illustrating relationship between relative sea level changes and magnetic record in deep water sediments is also provided.

Detailed magnetostratigraphic and magnetosusceptibilitic investigation of J/K boundary in the Tethyan realm.

Schnabl P.[1], Pruner P.[1], Venhodová D.[1], Slechta S.[1], Koptikova L.[1], Kostak M.[2]

1 Institute of Geology, Academy of Sciences of the Czech Republic v.v.i., Rozvojová 269, Praha 6
2 Institute of Geology and Palaeontology, Charles University in Prague, Albertov 6, Prague 2

Geological setting

For the High-resolution magnetostratigraphic, magnetosusceptibilitic and micropalaeontological study across the Jurassic/Cretaceous (J/K) boundary was selected outcrops in Brodno near Žilina (Slovakia) (Houša et al. 1999), the Bosso Valley (central Italy) (Houša et al. 2004), at Puerto Escańo (South Spain). All outcrops are from the Tethyan sedimentary basin, however thousands kilometers apart. In all of the sections J/K boundary (the base of standard Calpionella zone), was detected approximately between one third and the middle of the magnetozone M19n.

Magnetosusceptibility

Magnetic susceptibility (MS) shows same interesting patterns in all of the sections (Fig. 1). Since Jurassic limestones contain more terrigenous material than Cretaceous, the major trend is decrease of MS with time. It is possible to see chaotic behavior of the MS in the magnetozones M20r and M20n that is probably caused by high terrigenous influence. During magnetozeone M19r MS decreases, while during in the lower part of M19n the susceptibility slightly increases an in the upper part MS again decreases. In the upper part of subzone M19n1r is in the Bosso and Puerto Escano sections prominent peak, nevertheless in the Brodno section the peak is missing.

Acknowledgements

We highly acknowledge the Grant Agency of the Czech Republic for financial support (Grant No.GACR 205-07-1365) and Research Plan of the Institute of Geology AS CR No. CEZ AV0Z30130516.

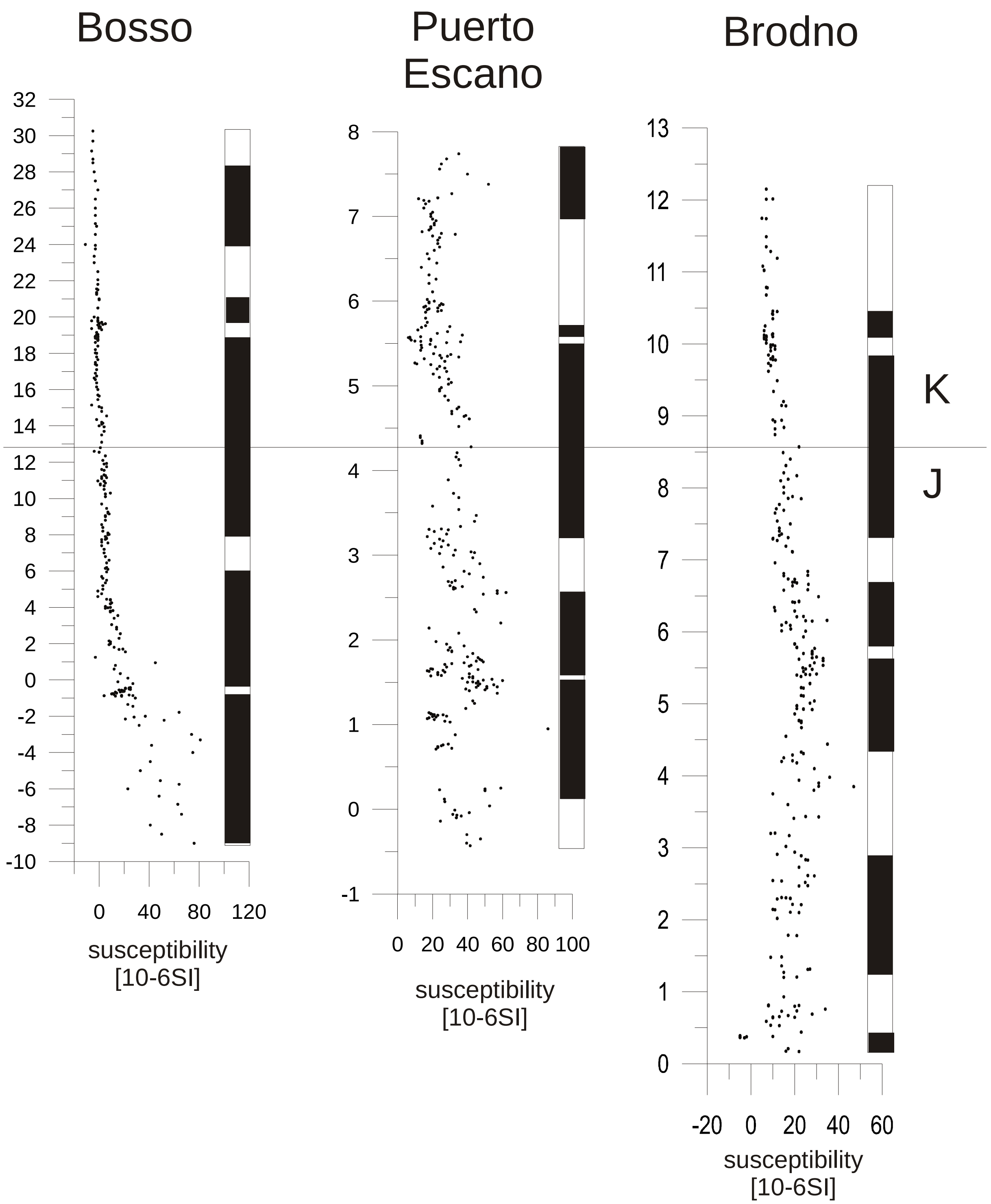


Fig. 1: Graphs of magnetic susceptibility and geomagnetic polarity zones on three sections from Tethyan realm

References

- HOUŠA, V., KRS, M., KRSOVÁ, M., MAN, O., PRUNER, P. & VENHODOVÁ, D., 1999. High-resolution magnetostratigraphy and micropaleontology across the J/K boundary strata at Brodno near Žilina, western Slovakia: summary results. *Cretaceous Research* 20: 699-717.

- HOUŠA, V., KRS, M., MAN, O., PRUNER, P.,VENHODOVÁ, D., CECCA, F., NARDI, G. & PISCITELLO, M., 2004. Combined magnetostratigraphic, paleomagnetic and calpionellid investigations across Jurassic/Cretaceous boundary strata in the Bosso Valley, Umbria, central Italy. *Cretaceous Research* 25: 771-785.

Using the field dependent susceptibility in determination of basaltic tuff material in sedimentary record: approaches and constraints

Schnabl P.[1], Cajz V.[1], Pruner P.[1], Šlechta S.[1,2], Venhodová D.[1], Koptíková L.[1,2], Vacek F.[2], Machado G.[3], Hladil J.[1]

[1] Institute of Geology AS CR, v.v.i., Rozvojová 269, 165 00 Prague; [2] Faculty of Science, Charles University in Prague, Albertov 6, 128 43 Prague, Czech Republic; [3] GeoBioTec, Geoscience Department, University of Aveiro, 3810-193 Aveiro, Portugal

Presence of volcanic material in carbonate sedimentary rocks certainly causes an increase in the magnetic suceptibility signal from the rock. It concerns also the fine-grained basaltic tuff components embedded in limestone. However, the mineral phase compositions are considerably varying, being related to cooling history of the extruded basaltic mass, early diagenetic alterations with palagonitized basaltic glass and zeolitic tuffs, as well as sorting of grains and particles in marine environments (facies) and their alterations since the shallow burial stages. The relevant but altered silicates of Paleozoic ages may encompass many mineral phases, e.g. from smectite, mica, vermiculite, chlorite, and siderite mixtures where clear difference from other background impurity may be difficultly distinguished, through partly preserved pyroxenes, amphiboles, plagioclases or other originally contained minerals, and finally, to diagenetic feldspars, micas (after zeolites) together with Ca and volatiles containing 'intermediate' phases which also may occur in these mixtures (e.g., apophyllite or scapolite). In addition, there are usually considerable amounts of complex and fine-structured mineral mixtures together with Fe-hydroxyoxides that were reconcentrated and recrystallized during the diagenetical history of the rocks. These are either disseminated in ‘intra-mineral’ locations, or concentrated at cleavage, in interstitial spaces, or along compaction or pressure solution seams. Secondarily formed iron sulphides are also common (pyrite in quartzites, and pyrrhotite and pyrite in limestones). It seems quite difficult to establish reasonable functions between the total natural magnetic susceptibility values of these sedimentary rocks and quantity of the basaltic tuff admixture.

One of the possible ways to solve this task is by considering the typical, and (at least partly) petrologically definable occurrences of titanomagnetites. Titanomagnetite (as a main magnetic accessory mineral coming with basaltic tuffs) shows field dependent susceptibility due to higher titanium content, while MS of other minerals is usually field independent. It provides a good reason to use this as a cheap and easy method for the identification of volcanic material that theoretically could be based on measurements of these titanomagnetite related, field-dependent MS values. Field dependent MS is quantified by formula: k_{HD} [%] = 100 x ($k_{300} - k_{30}$) / k_{300}, where k_{30} and k_{300} is the susceptibility measured in the magnetic field 30 and 300 A/m respectively (Vahle et al. 2007). This approach was successfully used for determination of magnetic characteristics of massive volcanic rocks (Chadima *et al.*, 2008; Schnabl *et al.*, 2009, *in press*). This method, if carefully combined with petrological data on the basaltic tuff impurity or component in limestones, can certainly be further developed. However, the present stage of the development suggests that there are significant complications associated with insufficient precision to identify these values for limestones or quartzites. These problems may be related to various degree of hydrothermal alteration and weathering of basaltic-tuff titanomagnetites where mainly the sedimentary facies and diagenetic variablity, as well as the precision of the parallel petrologic data are the potentially limiting factors. / The grant project IAA 300130706 and research plan project AV0Z30130516 are acknowledged in the context of these studies.

- CHADIMA M., CAJZ V. & TÝCOVÁ P. 2008. On the interpretation of normal and inverse magnetic fabric in dikes: Examples from the Eger Graben, NW Bohemian Massif. *Tectonophysics* doi:10.1016/j.tecto.2008.09.005
- VAHLE C., KONTNY A., GUNNLAUGSSON H.P. & KRISTJANSSON L., 2007. The Stardalur magnetic anomaly revisited – New insight into a complex cooling and alteration history. *Physics of the Earth and Planetary Interiors* 164: 119-141.
- SCHNABL P., NOVÁK J.K., CAJZ V., LANG M., BALOGH K., PÉCSKAY Z., CHADIMA M., ŠLECHTA S., KOHOUT T., PRUNER P. & ULRYCH J. (2009, *in press*). Magnetic properties of high-Ti basaltic rocks from the Krušné hory/Erzgebirge Mts. (Bohemia/Saxony), and their relation to mineral chemistry. *Studia Geophysica et Geodaetica.*

Era	Rock type	k_{HD}
Paleozoic	Silurian basalts	0.9-1.7
	Silurian, contact aureole	0-0.8
	Devonian limestones	insufficient precision
	Ordovician quartzites	insufficient precision
Cenozoic	basanite	13.7-17.5
	nephelinite	0.9-18.7
	phonotephrite	7.7
	olivine nephelinite	9.0-27.8
	tephrite	0.6-20.6
	trachybasalt	0-27.2
	flowstone	1.7
	karst sediment	0.7

Tab. 1: Several illustrative examples of different field-dependent MS values measured on different Paleozoic and Cenozoic rocktypes of the Bohemian Massif. The Paleozoic rocks are from the Barrandian area (~ Bohemicum, or Tepla-Barrandian Unit), western neighbourhoods of Prague.

Test of the Famennian magnetic susceptibility record in selected cores of the southern Poland.

Sobien, K.[1], Nawrocki, J.[1] and Narkiewicz, M.[1]

[1] Polish Geological Institute – National Research Institute, 4 Rakowiecka Street, 00-975 Warsaw, Poland katarzyna.sobien@pgi.gov.pl, jerzy.nawrocki@pgi.gov.pl, marek.narkiewicz@pgi.gov.pl

Two fully cored Famennian boreholes, both located in the southern Poland, but of different lithologies, facies development and thermal history, were selected for magnetic susceptibility measurements. Low field MS was measured using a KLY-2 Kappabridge

Shelf-basinal Famennian section in the Janczyce IG borehole, located in the Holly Cross Mountains is represented by laminated and wavy bedded marls, limestones, and black shales. Good quality of the core and detailed conodont biostratigraphy, as well as low CAI value (1.5 – 2) created suitable study material. Magnetic susceptibility measurements were performed on 570 samples collected at 0.25 – 0.5 m intervals along 260 meter of the core. It allowed for medium resolution study that revealed “organized” MS changes along the profile. The MS values variegated mostly from 1 to $60*10^{-6}$ SI, displayed significant evolution along the section. Ascending curve character suggests gradual detrital input – relative sea level fall. This general pattern is disturbed by a distinct MS values decrease in the interval linked with the occurrence of the cephalopod limestone layers in the Middle *crepida* Zone. In addition, several short- and long-term variations are clearly visible in the lithologicaly monotonous section. These might be easily comparable with the world known “event” levels, e.g. Upper Kellwasser on the Frasnian/Famennian boundary.

In the Goczałkowice IG 1 borehole, located in the Upper Silesian Block, the stratigraphic F/F and Devonian/Carboniferous boundaries were not precisely defined. Nevertheless 237 samples (black marls and marly limestones, quartz arenites, grained limestones, crystalline dolostones) were collected in one meter intervals. Magnetic susceptibility pattern with very low values (up to $10*10^{-6}$ SI) and flat curve shape for crystalline dolostones revealed slight correlation with lithology. In addition, distinct increase in MS values up to $260*10^{-6}$ SI in the Upper Famennian/Tournaisian interval of the laminated grained limestones is visible.

The obtained results were compared with the previously distinguished sedimentary transgressive-regressive cycles in the Goczałkowice IG 1 borehole, but without acceptable effects. These data were not comparable due to possibly secondary MS signal, which might be connected with an intense diagenetic alteration (CAI value - 4) and documented Early Permian “magnetite related” remagnetization.

The lack of similar trends in the MS pattern between the two studied Famennian cores might be a result of the lithological and facial differences as well as diverse thermal history.

Magnetic susceptibility and gamma-ray spectrometry used for correlation of two Silurian-Devonian boundary GSSPs: Klonk near Suchomasty and Karlštejn sections (Barrandian, Czech Republic)

Vacek, F. [1]

[1] Charles University in Prague, Faculty of Science, Institute of geology and paleontology, Albertov 6, Prague 2, 128 43 Czech Republic. E-mail: fvacek@natur.cuni.cz

The Barrandian region (central Bohemia, Czech Republic) is a type area for the Silurian-Devonian (S-D) boundary. The GSSP Klonk near Suchomasty and its parastratotype at Karlštejn are situated there. Both sections have been studied by various methods in the past (biostratigraphy, sedimentology, chemostratigraphy). Magnetic susceptibility has been used for study of the Klonk section by Crick et al. (2001). Current project is focused on testing of combined MS and GRS methods for stratigraphic correlations within this stratigraphic interval. It showed that there is good correlative value of both methods for sections with similar facies development (Vacek, 2008).

The S-D boudary is defined in both sections at the base of *Monograptus uniformis* Zone within calciturbidite sequences (Vacek, 2007). However, both sections markedly differ within the critical boundary interval and thus cannot be lithologicaly correlated. The boundary strata at Klonk are developed as platy mudstone/wackestone/shale sequence, while at Karlštejn they consist of massive coarse-grained crinoidal and cephalopod packstones/grainstones with a bed of flat-pebble limestone conglomerates. Our results show that the level of the MS and GRS-correlated boundary in the Karlštejn section lies approximately 0.5 m lower than the first occurrence of the *M. uniformis* (and biostratigraphicaly determined boudary; see Fig. 1). Actually, it is not astonishing because we have to take into account the low preservation potential of pelagic fossils in coarse-grained calciturbidites and mass flow conglomerates and also presence of numerous short-lived stratigraphic gaps. Thus, the combined MS and GRS stratigraphy proved to be very valuable alternative for traditionally used biostratigraphic methods.

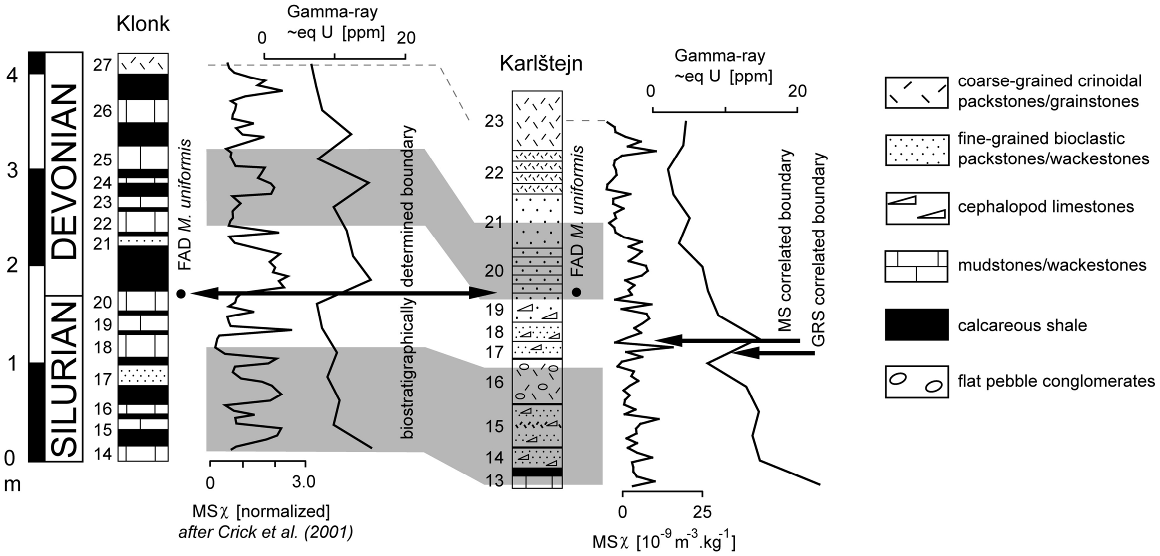


Fig.1. The MS and GRS stratigraphic correlation of the GSSP Klonk and parastratotype at Karlštejn. Note variable position of the S-D boundary at Karlštejn determined by biostratigraphic indicators and combined MS and GRS.

- CRICK, R.E., ELLWOOD, B.B., HLADIL, J., EL HASSANI, A., HROUDA, F. & CHLUPÁČ, I. 2001. Magnetostratigraphy susceptibility of the Přídolian-Lochkovian (Silurian-Devonian) GSSP (Klonk, Czech Republic) and a coeval sequence in Anti-Atlas Morroco. *Palaeogeography Palaeoclimatology Palaeoecology* 167: 73-100.

- VACEK, F., 2007. Carbonate microfacies and depositional environments of the Silurian-Devonian boundary strata in the Barrandian area (Czech Republic). *Geologica Carpathica* 58 (6): 497-510.

- VACEK, F., 2008. Evolution of depositional environment based on combined microfacies, magnetosusceptibility, and gamma-ray spectrometric study (Silurian-Devonian boundary, Barrandian, Czech Republic). *In* KIM, A.I., SALIMOVA, F.A. & MESHCHANKINA, N.A. (Eds) *Global alignments of Lower Devonian carbonate and clastic sequences (SDS/IGCP Project 499 joint field meeting), Kitab State Geological Reserve, Uzbekistan, Contribution* 113-114.

Comparison of MS and other proxies from the Middle-Late Frasnian: Implications for paleoclimatic analyses

Whalen, M.T.[1], Sliwinski, M.G.[1], Day, J.[2]

[1] Department of Geology and Geophysics, University of Alaska Fairbanks, Fairbanks, AK 99775
[2] Dept. of Geography-Geology, Illinois State University, Normal, IL 61790

A suite of data including major and trace elements, C, O, and N stable isotopes and magnetic susceptibility (MS) were acquired from samples collected in the Canadian Rocky Mountains that span a portion of the Middle-Late Frasnian including the punctata zone event. Proxies for paleoredox conditions, productivity, detrital input, and MS display similar trends indicating that these proxies and MS are inherently linked. Evaluation of the data within a sequence stratigraphic perspective implies that trends are likely influenced by eustatic sea level change. Clastic input proxies like Al, Ti, and Zr and the ratio Ti/Al display similar trends to the MS signature, corroborating hypotheses about MS and detrital input. Most proxies display an initial increase during lowstand and early transgression and eventually return to background levels during sea level highstand. Bioproductivity proxies δ13C, δ15N, Cu, Ni, and Ba also display similar trends implying that primary production was driven largely by detrital input. Similar overall trends in paleoredox proxies and TOC indicate that low oxygen conditions were responsible for preservation of organic matter produced during detrital-driven high productivity. Comparison of the MS signature with δ18O data from carbonate mud display remarkable similarity indicating the intimate interconnection between paleoclimate, weathering, detrital input, and bioproductivity events in the world ocean. Recent paleoclimate data based on interpretation of δ18O from conodont apatites indicates that the Givetian and early Frasnian were relatively cool and that the punctata zone event coincides with a warming trend that persisted until the first pulse, or lower Kellwasser event (LKE), of the F-F extinction (Joachimski et al., 2009). Coeval evolutionary development of terrestrial vegetation and soils and the concomitant influence of those processes on weathering and detrital input are commonly invoked as drivers of the Frasnian-Famennian mass extinction event. The *punctata* event appears to be a precursor to the Frasnian-Famennian without a significant perturbation of the biota. The lack of a major bioevent within the *punctata* zone may relate to this paleoclimatic trend. Whereas the *punctata* warming event follows the long-term cooling of the Middle Devonian, the LKE records a rapid warming/cooling event following the long-term warming of the Frasnian. As our MS data for the *punctata* interval closely follow the δ18O data, this similarity indicates the potential of MS as quick and inexpensive paleoclimate proxy.

- JOACHIMSKI, M.M., BREISIG, S., BUGGISCH, W., TALENT, J.A., MAWSON, R., M., GEREKE, M., MORROW, J.R., DAY, J. & WEDDIGE, K., 2009. Devonian climate and reef evolution: Insights from oxygen isotopes in apatite. *Earth and Planetary Science Letters* 284: 599-609.

Facies Sedimentology and cyclostratigraphy of Coniacian-Santonian transition. Northern Tunisia

Yaich, C.[1], Boulvain, F.[2], Kacem, A.[1], Trabelsi, M.[1] & Ben Youssef, M.[3]

[1] Laboratoire Dynamique Sédimentaire & Environnement ENIS. B.P.W 3038 Sfax. Tunisie. [2] Laboratoire Pétrologie Sédimentaire, B20, Université de Liège, Sart Tilman, B-4000 Liège. Belgique. [3] Laboratoire Géoressources. CRTE - Technopôle de Borj Cedria. Tunisie.

Tunisia offers a privileged location to understand the geological events of the southern Tethys during the upper Cretaceous. For the Coniacian-Santonian interval time, excepted some biostratigraphic works, few studies were focused on the boundary between the two periods.

The Santonian was recognized by Pervinquière (1903) due to the presence of an ammonite macrofauna (Texanites). Robaszynski et al. (2000) refined the stratigraphy of the Coniacian and Santonian through biostratigraphic analysis (planktonic foraminifera and macrofauna).

It was only from 1995 (Brussels congress) that this boundary led to more interest by researchers. Precisions on the Coniacian Santonian transition were brought by the study of the macrofauna, calcareous nannofossils, stable isotopes and planktonic foraminifera.

In this study, we try to characterize in terms of facies sedimentology and cyclostratigraphy the Coniacian and Santonian boundary in northern Tunisia, in two different locations: Kalaat Senan and Jebel Oust.

Facies evolution in terms of energy and depositional environment, evolution of the magnetic susceptibility signal and manganese content show several variations of accommodation during the Coniacian-Santonian interval. More specifically, a minimum of accommodation is recorded near the boundary between Coniacian and Santonian, and is correlated between both sections. Above this discontinuity, the Santonian, parts of the sections show a general landward stepping compatible with a eustatic rise, known at the regional scale.

- PERVINQUIERE L., 1903. Etude géologique de la Tunisie centrale. *De Rudeval*, Paris, 360p.

- ROBASZYNSKI F. GONZALEZ DONOSO J.M., LINARES D., AMEDRO F., CARON M., DUPUIS CH., DHONDT A.V. & GARTNER S., 2000, Le Crétacé supérieur de la région de Kalaat Senan, Tunisie Centrale: Litho-biostratigraphie intégrée. Zones d'ammonites, de formainifères planctoniques et de nannofossiles du Turonien supérieur au Masastrichtien. *Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine* 22: 359-490

PAPER SUBMISSION

A special issue of Geologica Belgica (impact factor 0.522) will be published after the meeting on the application of magnetic susceptibility in paleoenvironmental studies. You are all welcome to submit a paper for this special issue. The deadline is 3 Decembre 2009 (at the meeting).

Full instructions for authors are found on:

http://www2.ulg.ac.be/geolsed/GB/page1.htm.

When submitting a manuscript the authors confirm that it is novel and not being introduced at other journals. While intellectual rights remain with the authors, copyright is transferred to Geologica Belgica.

Submitted papers should be concise, presenting material not previously published. Each paper will be reviewed by at least two reviewers from an international editorial board.

Instructions to authors: for your manuscript, imitate scrupulously the layout but do not try to reproduce the journal lay out. Use the style "normal" throughout the whole paper. Your paper should be submitted in English, use either American or British English.

The abstracts of this IGCP-580 conference will be published in this abstract book.

DEADLINES:

- 2 Decembre: deadline for paper sunbmission
- Early March: first review
- Early April: second submission after review.
- May: last check, layout, then the papers are send to the printer and publisher
- Summer 2010: publication of the special issue of Geologica Belgica on line
- Decembre 2010: distribution of the volumes of the special issue of Geologica Belgica.

IGCP-580 WEBSITE

The IGCP-580 website is a communication platform for all IGCP-580 participants. If you have any idea for its improvement, do not hesitate to contact me (ac.dasilva@ulg.ac.be).

One of the important goal of this platform will be to help all researcher interested in magnetic susceptibility studies to know what studies have already been done.
We will propose the creation of a database of the main Magnetic susceptibility research in paleoenvironmental study, including:

Author of the research
Location of the sections
Lithology
Stratigraphic interval
Publication references
Available on request (email address)
Still in progress

So if you are working for example on the Frasnian, the data base will told you which studies have already been done on this stage, where you can find the related publications and if they are available magnetic susceptibility curve that you could compare to your curve.

Magnetic susceptibility data base

	Location	Lithology	Stratigr. interval	Completely published	Available on request	In progress
da Silva, AC	Belgium/Tailfer	Carbonates	Devonian-Frasnian	Facies/2002/46/p89-102	AC da Silva	PUBLISHED
	Aywaille/Belgium	Carbonates	Devonian-Frasnian	Paleo3/2006/240/p373-388	AC da Silva	PUBLISHED
	Barse/Belgium	Carbonates	Devonian-Frasnian		AC da Silva	PUBLISHED
	Villers/Belgium	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	Tilff/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Bolland/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Colonster/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Chaudfontaine/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Huccorgne/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Netinne/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Neuville/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Soumagne/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Prayon/Belgium	Carbonates	Devonian-Frasnian	-	AC da Silva	V
	Lot/France	Carbonates	Jurassic	-	AC da Silva	V
	Judy Creek/Canada	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	Golden Spike/Canada	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	Redwater reef/Canada	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	Door Jam Mnt/Canada	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	South Hull/Australia	Carbonates	Devonian-Frasnian	Sed. Geol in press	AC da Silva	PUBLISHED
	Guppy Hills/Australia	Carbonates	Devonian-Frasnian	-	AC da Silva	V
Boulvain, F.	La Boverie/Belgium	Carbonates	Devonian-Frasnian	-	F. Boulvain	PUBLISHED
	Le Lion/Belgium	Carbonates	Devonian-Frasnian	Sed. Geol in press	F. Boulvain	PUBLISHED
Mabille, C.	Baileux	Platform	Eifelian-Givetian	-	C. Mabille	PUBLISHED
	Marenne	Mixed	Givetian	-	C. Mabille	PUBLISHED
	La Couvinoise	Ramp mixed	Eifelian-Givetian	http://hdl.handle.net/2268/680	C. Mabille	PUBLISHED

This platform won't work without your participation. So please, download the excel form on the website and fill the form with your main data.

FORTHCOMING IGCP-580 MEETING

IGCP 580 Meeting 2010 China, Guilin

- IGCP 580 Meeting: 2010 China, Guilin (Organized by Daizhao Chen from the Chinese Academy of Science and the IGCP-580 committee).

The dates are not fixed yet but the best period (weather conditions) is in autumn (Golden October).

South China is the most important region for the Devonian researches in China in various aspects, including paleontology, biostratigraphy, lithostratigraphy and sedimentology. Various depositional facies are observed, including restricted carbonate platform interior, open platform-platform margin, and marginal slope-basinal facies. Therefore, Guilin is one of the potential areas suitable to test correlations techniques.
Guilin is one of the most beautiful touristic cities, with its unique karstic sceneries, with green hills, rocky cliffs, clear water, fantastic caverns and variable shapes of karstic tower hills. This area is also famous for the cormoran birds and rice terraces, as well as chilli souce rice noodles.

FORTHCOMING MEETING

The International Conference “MIDDLE-UPPER DEVONIAN AND LOWER CARBONIFEROUS BIOSTRATIGRAPHY OF SOUTH URALS AND KUZNETSK BASIN” (SDS joint field meeting) to be held in the Novosibirsk (Russia) during **20 July – 10 August, 2011** was approved during the Subcommission on Devonian Stratigraphy and IGCP 499 business meetings in the Kitab State Geological Reserve (Uzbekistan Republic) (September, 2008).

Pre-and Post-conference field excursion will be held in the South Urals and Kuznetsk Basin (south of West Siberia) for an examination of the complete Middle-Upper Devonian and Lower Carboniferous marine sequences in terrigenous, bedded and reef carbonate, as well as volcanic facies with abundant and diverse faunal remains.

Fig. 1. Frasnian-Famennian section, right bank of Ryauzyak River, South Urals.

Fig. 2. Frasnian-Famennian section, right bank of Tom’ River, Kusnetsk Basin (SW Siberia).

Organizers

Siberian Branch of Russian Academy of Sciences
Trofimuk Institute of Petroleum Geology and Geophysics (IPGG SB RAS, Novosibirsk)
Ufa Scientific Center of Russian Academy of Sciences (Ufa SC RAS)
Institute of Geology Ufa SC RAS (Ufa)
Siberian Research Institute of Geology, Geophysics and Mineral Resources (SNIIGGiMS, Novosibirsk)
International Subcommission on Devonian Stratigraphy (SDS)

For further information please visit **http://www.ipgg.nsc.ru**,
Secretary e-mail: devon@ipgg.nsc.ru

SOUVENIRS FROM LIEGE…