TM R. Thomas BECKER and the Münster Group

Research in 2014 and early 2015 concentrated on the completion of the joint DFG-CNRST Maroc research programme, with Sarah and Ahmed EL HASSANI as co-leaders, on "Eovariscan evolution of the southern and northern Prototethys: high-resolution stratigraphy, facies developments, biogeography, and geodynamic interpretation". In the past four years it also involved on the German side Stephan EICHHOLT, Stephan HELLING, Sven HARTENFELS, Heiko HÜNEKE and Christoph HARTKOPF-FRÖDER, on the Moroccan side also Lahcen BAIDER, Mustafa BENFRIKA, Fouad EL KAMEL, and Abdelfatah TAHIRI. Denice BRICE kindly identified brachiopods for us. In total, more than 400 conodont samples were taken from 52 localities in 30 regions of the Meseta and Atlas realm (Fig. 1), which cover the Lochkovian to Tournaisian. Accidently also the top Viséan, since one supposed Givetian reef locality south of Marrakesch turned out to contain advanced *Mestognathus* (and no reef organisms at all).

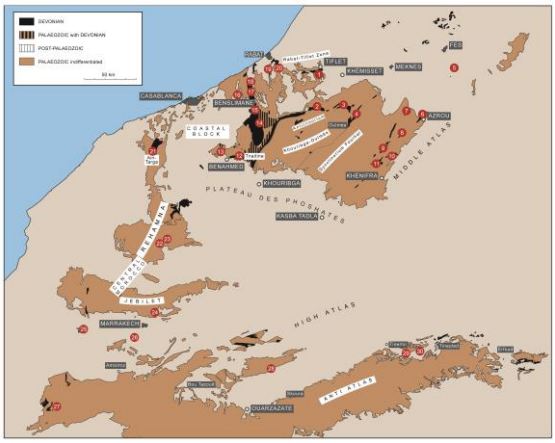

Fig. 1. Position of the more than 30 Devonian regions sampled in the frame of the joint DFG-CNRST Maroc programme in 2011-2015 (red dots).

We have started to write summary papers on the timing and extinction of Meseta Devonian reefs, on the age of Eovariscan reworking and re-deposition phases, and on the palaeogeographical evolution of the region in the context of plate tectonics across the Gondwana-Laurussia transition (western Prototethys). However, the wealth of new data on regional stratigraphy, structural geology, conodont and ammonoid faunas is too vast to be incorporated. Therefore, there are plans for a special issue of the "Notes et Memoires" series of the Geological Survey of Maroc. This certainly will take some time. The best or most interesting new ammonoid faunas of the Meseta are from the Oued Aricha (Famennian IV), Boudouda N of Benahmed (upper Frasnian), and from the isolated Immouzer-du-Kandar south of Fes (upper Emsian, upper Givetian, upper Frasnian, basal Famennian).

For the comparison of the external southern and northern Variscides, varied detailed work also continued in the Rhenish Massive. There was a focus on the Aachen Devonian, on the Bergisches Land, and on the eastern Sauerland (Nehden, Drewer, Beringhausener Tunnel, Martenberg, Winsenberg Road Section, Schmidt Quarry). Many new and partly preliminary results will be presented during the planned post-symposium excursion in conjunction with the IGCP 596-SDS meeting in Brussels. At the Wülfrath and Hofermühle Reef Complexes (Velbert Anticline) we enjoyed the good cooperation with the Rheinkalk GmbH, Dierk JUCH, Günter DROZDZEWSKI (both formerly from the Krefeld Survey), and with various amateur collectors, such as Thomas MAGIERA and Carlo HERD.

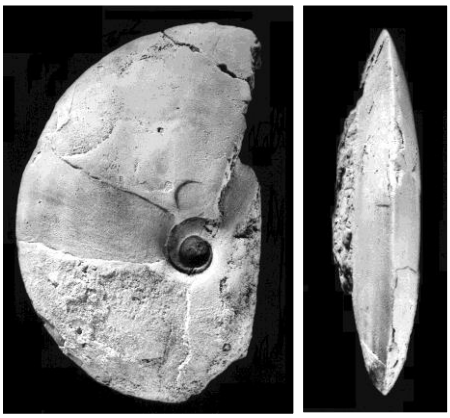

Fig. 2. *Petteroceras* n. sp. from Ouidane Chebbi.

Together with Jürgen BOCKWINKEL studies of the rich upper Givetian goniatite faunas of the Anti-Atlas were continued. A third pharciceratid contribution dealt with the mixed pelagic-neritic assemblages of the northern Maider (Ait-ou-Amar, BOCKWINKEL et al. 2015). This enabled a comparison with the previously described faunas of roughly the same age of the deeper Tafilalt Basin (Hassi Nebech). It is possible to identify taxa that are more generalists (tornoceratids) and forms that preferred a deeper habitat (e.g., *Synpharcicera*). Subsequently, we started to work on the rich pelagic platform assemblages of Ouidane Chebbi at the eastern margin of the Tafilalt (Fig. 2). Jürgen is also leading joint investigations of new middle Famennian ammonoid faunas from a previously unknown shale unit between lower Famennian crinoidal limestones and the overlying, famous, shallow-water Velbert Formation (Hofermühle region, new motorway building site).

A further important topic are our studies around the Devonian-Carboniferous boundary. The publication of our Lalla Mimouna faunas from the northern Maider is delayed because Harald TRAGELEHN, after his stroke, still could not finish his monograph on the "siphonodelloids" of Franconia and Thuringia. We found many representatives of this group in the latest

Famennian (*Kalloclymenia* Limestone) of the Tafilalt (HARTENFELS & BECKER in prep.). But we were unsuccesfull to find new relevant D-C sections in the Moroccan Meseta. In the Rhenish Massive, together with the Cologne group around Hans-Georg HERBIG, we started to revise the type section of the Wocklum Limestone at the Borkewehr near Wocklum, where the weathered Hangenberg Blackshale has a very sharp base. Together with Tomás KUMPAN, Jirí KALVODA, Ondrey BÁBEK, JIRÍ FRYDA, and Tomás GRYGAR, classical Rhenish D/C boundary sections where re-studied using modern techniques, such as magneto-susceptibility, gamm ray spectroscopy, and element geochemistry (KUMPAN et al. 2015). Thomas joint Sandra KAISER and Markus ARETZ to write a detailed review of the global Hangenberg Crisis, which will be published in the IGCP 596-SDS volume (KAISER et al. in press). Based on a review of all published D-C sections, it will include a new model for this sixth 1st order Phanerozoic mass extinction that combines all available evidence. But it will also highlighten the many still open questions and future research directions. The review of D-C litho- and biostratigraphy has been extracted and will be published as a separate chapter in the same volume (BECKER et al. in press). This summary evaluates the proposed possible future D/C GSSP levels, with the conclusion that the main extinction at the onset of the global black shale event, the "natural boundary" of O.H. WALLISER, has still/currently the best practical potential.

Fig. 3. The re-sampled top of the Wocklum Limestone and overlying Hangenberg Blackshale at Oberrödinghausen.

Other work will have new data on the Drewer (BECKER et al. in prep.) and Oberrödinghausen sections (Fig. 3, M.Sc. M. SACHER). Jointly with MA Xueping a new Hangenberg Blackshale locality in South China will be published.

In addition there are various smaller projects, such as the first documentation of Upper Devonian global events in Bulgaria (BONCHEVA et al. 2015), new Emsian ammonoids from Victoria (with Clem EARP), stratigraphical data for Emsian ostracod faunas from southern Morocco (DOJEN et al. in prep), and, still not finished, new upper Givetian to basal Frasnian ammonoids from the Rudnyi Altai. At the International Cephalopod Symposium in Zürich, new data on prionoceratids (FISCHER & BECKER 2014) and on the origin and phylogeny of the Gephuroceratina were presented (BECKER 2014).

Research students: **Achim SCHWERMANN** finished his systematic screening of our hundreds of Moroccan conodont samples for shark teeth, in order to document their regional distribution patterns in time and space. Besides wide-spread *Phoebodus*, *Omalodus*, *Thrinacodus*, *Jalodus*, *Denea*, *Cladodus*, *Proacrodus*, and *Stethacanthus* species, he also found *Squatinactis*, *Orodus* and *Arduodens*. In addition, there are some rare and new teeth, including a new genus. To our surprise, there is not a single pre-Givetian shark tooth; the group did not populate main Gondwana in Lower Devonian to Eifelian times.

Sebastian POMMERERING continued previous studies of the Münster Group on the palaeopathology of mid-Palaeozoic ammonoids. Failed predation rates (healed shell fractures) reflect the palaeoecology of taxa and correlate with shell form types. This approach was extended for the first time to the Middle Devonian, based on our rich collections from the Dra Valley of the Anti-Atlas.

Two B.Sc. students, **Anna SAUPE** and **Nadine VERKERK**, analyzed the impact of the *Annulata* and Dasberg events on assemblages of agglutinating foraminifers from pelagic carbonate ramps. The studies were based on the Oese section in the Rhenish Massive and on the Kahlleite Quarry in Thuringia. Both separate regions show somewhat different foraminifer assemblages but comparable strong changes of foraminifere associations caused by hypoxic event phases, without any extinctions or long-lasting evolutionary change.

The B.Sc. project of **Till SÖTE** fell into our D/C boundary research. He studied the biostratigraphy and microfacies of the Reigern Quarry in the northern Sauerland. This is a famous clymeniid locality (type section for several species) but its succession has never been documented. There is a sudden hiatus at the D/C boundary but Til found for the first time evidence that there is not only the lower Wocklumian but also a thin development of the *Wocklumeria* Zone.

Stephan HELLING continued his Devonian trilobite studies in the frame of a cumulative Ph.D. programme. He tries to finish a paper on the Pragian trilobite limestone clasts in the Eovariscan breccia of Taourirt n´Khellil (SE of Tinerhir, Morocco), in order to clarify their palaeobiogeographic relationships across the "Southern Variscan Front" (the Meseta-stable

Gondwana margin). For this aim, a new Pragian fauna from Ain-al-Aliliga in the Cherrat Valley (south of Rabat) is important (HELLING & BECKER 2015b, Fig. 4). He also investigates the impact of the Chotec Event on phacopids in the northern/central Tafilalt and a new phacopid bed from within the thick Daleje Shale equivalents of the southern Tafilalt (HELLING & BECKER 2015a). Manuscripts on new Moroccan *Gerastos* (Proetidae) and on the middle Frasnian trilobites of the central Tafilalt are not yet finished because new material became available in 2015.

Fig. 4. *Metacanthina issimourensis* from the Pragian at Ain-al-Aliliga, Oued Cherrat, Meseta.

Stephan EICHHOLT is continuing his Ph.D. on the comparison of Givetian/Frasnian reefs of the southern (Moroccan Meseta) and northern (Rhenish Massive) external Variscides, across a significant palaeolatitudinal gradient in the southern hemisphere (across the at least 3000 km wide Prototethys, including the Armorican Terrain Assemblage and southern European plates). He is close to complete a first, long manuscript (for "Facies") on the reefs of the Oued Cherrat Valley and adjacent regions to the south (Al Attamna) and southeast (Khatouat Massive), including reworked reef clasts of Eovariscan breccias and olistrostromes. Some complication stemmed from Sarah´s conodont data since she proved that one of the largest supposed Givetian reef belt is in fact of lower Emsian age. It is intriguing how similar Meseta reefs are, in terms of microfacies, to Rhenish reefs, whilst there are clear differences to the mostly small Anti-Atlas bioherms and biostromes. Research will continue with a detailed study of the Oulmes region reefs and of isolated occurrences eastwards.

Sören STICHLING started a new Ph.D. programme financed by the Rheinkalk GmbH. The aim is to use microfacies, conodont- and cyclostratigraphy to reconstruct the palaeoecological and palaeogeographic development of the economically very important reef complex of the Hönne Valley through its almost 1000 m of thickness. The study is based on numerous boreholes (Fig. 5), which have never been available to science, and on the large active quarries.

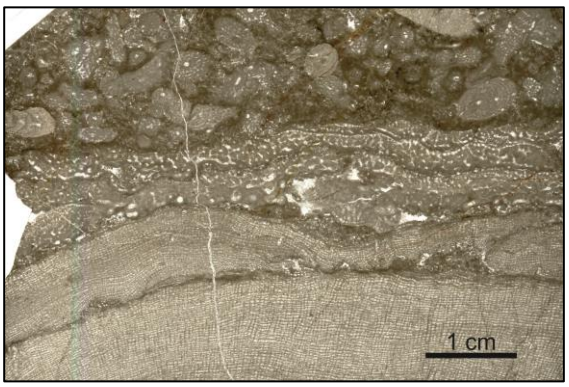

Fig. 5. Laminar stromotoporids overlain by *Stachyodes* Baffle-/Rudstone (reef core facies), subsurface at Beul, eastern Hönne Valley.

Sven, Sarah and Thomas assisted a visiting Ph.D. student from Wuhan, **WANG Zhihong**, in his study of the Upper Devonian (mostly Famennian) of the isolated Wulankeshun section in the western Junggar Basin. Conodont faunas are strongly endemic and require the establishment of new local zonations, separately for icriodids and polygnathids. There is a strange new group of "polygnathids" with "siphonodelloid" large basal cavity, which is better placed (in future) in a new genus. Zhihong moved on to Erlangen to work with Michael JOACHIMSKI on the isotope stratigraphy of his section. Results will be published in a special volume on Palaeozoic events in China, in "Palaeo x 3" (WANG et al. 2015).

CM Sven HARTENFELS

is deeply involved with the supervision of the named research students and took part in the 4th International Palaeontological Congress, hold in Mendoza, Argentina. Together with Thomas, he guided a field excursion for Master students in the Moroccan Meseta, Maider and Tafilalt in spring 2015. He continues his studies on the Famennian successions of Ziyyar (Moroccan Meseta) and El Khraouia (Tafilalt). New results of the *Annulata* Event(s) in the latter sequence were presented at the 2nd International Congress on Stratigraphy (Graz, Austria) in July 2015. Furthermore, he worked on the revision of the Ballberg section (Rhenish Massive, HARTENFELS & BECKER 2015). It becomes famous, because it was one, on which ZIEGLER (1962) based his standard conodont zonation for the middle to upper/uppermost Famennian. Currently, 54 of 82 carbonate layers were sampled for conodonts. First results will be presented at the final meeting of the IGCP 596 in Brussels, Belgium. Together with **Marius SACHER** (current M.Sc. thesis), he measured and re-sampled the Famennian to Tournaisian succession at Oberrödinghausen railway-cut (Fig. 6). First conodont data document that the section starts in the *Pa. marginifera marginifera* (= Lower

marginifera) Zone and ranges, as long known, into the Lower Tournaisian.

Fig. 6. The *Annulata* Blackshale units (upper left) in the Oberrödinghausen Railway Cut.

Together with Christoph HARTKOPF-FRÖDER (Krefeld), partly with Hans-Georg HERBIG and Sarah ESTEBAN LOPEZ (both Cologne), there is an ongoing revision of the Famennian to Lower Carboniferous Riescheid section of the Velbert Anticline. Furthermore, Sven continues his studies on Famennian conodont faunas from just above the last, micriobialithic limestones of the Wülfrath and Hofermühle reef complexes.

Finally, together with Thomas and Peter KÖNIGSHOF, he works on organizing and preparing the Brussels IGCP 596 post-conference fieldtrip to the Rhenish Massive and editing the associated field guide.

CM Z. Sarah ABOUSSALAM

Sarah struggled hard to deal with the huge piles of Meseta conodont samples. The identification and dating of often strongly mixed assemblages from Eovariscan breccia and conglomerate beds was a special challenge since homoemorphic icriodids and polygnathids of widely different age had to be recognized and distinguished. There are also surprisingly diverse assemblages from brecciated biostromes (Fig. 7). The results provide a completely new picture of the timing of synsedimentary block faulting and tilting of NW Gondwana. Some localities yielded odd forms that are probably new species. An isolated, large olistolite from between Tinerhir and Tinejdad, derived directly from the Southern Variscan front, produced very rich conodont faunas from non-black Kellwasser beds. The wealth of data led to joint presentation at the Mendoza IPC and Brussels meetings.

Equally demanding were the supervision of B.Sc./M.Sc. students and the identification of many Givetian-Frasnian samples of the Rhenish Massive, especially from the Hofermühle, Wülfrath, and Hagen-Balve reef complexes. Many new results will be in the IGCP 596-SDS Field Guide in September 2015. Together with Carl BRETT, Jay ZAMBITO and Thomas, there are also ongoing efforts to clarify the Givetian stratigraphy of Kentucky, with the hope to identify regionally the position of the Taghanic Events.

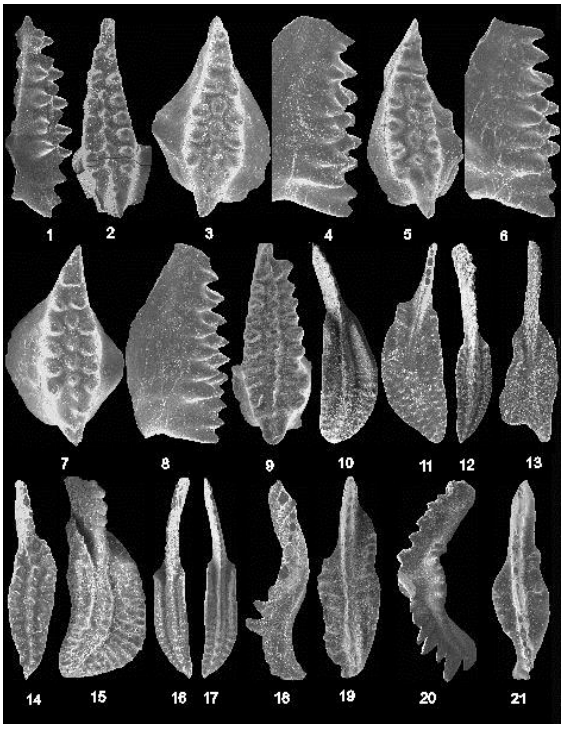

Fig. 7. Mixed Upper Givetian conodont assemblage from the brecciated reefal limestones at Ain-al-Aliliga (Oued Cherrat Valley, Moroccan Meseta).

The intense and rather long-running attempt to revise and refine the Emsian conodont stratigraphy of the Anti-Atlas, jointly with Pierre BULTYNCK and Thomas, is finally coming to an end (ABOUSSALAM et al. 2015). It involved the introduction of parallel regional icriodid and polygnathid zonations that are best correlated with the "conodont steps" of Celtiberia. It is impossible to recognize the "*kitabicus* boundary" in the study region since Pragian polygnathids were strongly restricted in their distribution, even in wide-spread dacryoconarid facies. *Eolinguipolygnathus excavatus* M114, the planned future basal Emsian index taxon, is very common in the region, and its variability and range is documented. There is one related new polygnathid (*Eol. radula* n. sp.) and Pierre found two new icriodids (*I. ovalis* and *I. praerectirostratus*) in the basal upper Emsian.

A joint attempt with G. RACKI and his colleagues to find the significant carbon isotope excursion associated with the Middlesex Event (lower/middle Frasnian transition) in the Rhenish Massive resulted in the re-sampling of the type locality of the Padberg Limestone in the eastern Sauerland. Locally the upper part of the lower Frasnian (MN Zones 3/4) is rather thick and the *punctata* Zone has not yet been identified.

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