FWF P 23775-B17 Late Eifelian climate perturbations: Effects on tropical coral communities

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Project FWF P 23775-B17 focused on late Eifelian climate perturbations and effects on climate sensitive organisms from low latitude shallow marine environments in central Europe. Results show that the so called Kačák crisis, which took place short before the Eifelian-Givetian boundary (numerical age: 387.7 million years ago), conforms to an interval of sea-level rise and fall contemporaneous with increasing and subsequently decreasing sea surface temperatures during the latest *kockelianus-ensensis* conodont biozones. This is confirmed by specific trends from the magnetic susceptibility of sedimentary rocks and by palaeotemperature calculations from the stable oxygen isotope composition of phosphatic microfossils (conodonts). An important issue of this project was the multidisciplinary study of sections from different bathymetric settings within a well-known platform to basin transect in low latitudes. Respectively, we worked out detailed profiles of five formations in the Carnic Alps, a mountain chain allocated at the Austrian/Italian border (Spinotti Formation, Kellergrat Formation, Freikofel Formation, Hoher Trieb Formation, Valentin Formation). We found out that sea surface temperature from shallow marine to pelagic deposits records increasing values across the event interval. Similar results are obtained for the neritic Middle Devonian sequence of the Prague Synform (Acanthopyge Limestone, Upper Dark Interval).

In order to establish a model on the cause of the Kačák crisis comprehensive geochemical analysis (stable carbon isotopy, XRF analysis and total organic carbon and sulfur contents) and gamma ray spectrometry together with information from microfacies were performed. Effects of the event on shallow marine communities are obvious. At least within carbonate platform deposits in the Carnic Alps, a change, for example in the composition of rugose coral taxa, from a low diversity fauna during and probably until short after the event interval to a rich and diverse fauna in the early Givetian is recognized. However, we could clarify that the rugose coral fauna preceding the Kačák Event is not late Eifelian in age, but older, which concludes that the disappearance of corals was not directly influenced by the Kačák Event, but probably a result of regionally changed palaeoenvironmental conditions. In order to display biodiversity patterns of climate sensitive organisms across the event interval we entered more than 1000 collections of published record on corals and conodonts into the Palaeobiology Database. This gives us the opportunity to model the response of rugose corals to late

Eifelian climate perturbations set in a global context. Because the Database is very complex it will take more time until we can conclude that issue.

For further comparison of results from the Carnic Alps and the Czech Republic, we started to investigate Middle Devonian deposits allocated in shallow marine settings of southern Laurussia (Eifel, Germany) and of an volcanic island arc complex in northern hemisphere low latitudes of the Palaeotethys (Baruunhuurai Terrane, Mongolia). Intense cooperation with two other international projects (IGCP 580 and 596) resulted in strong support of the community for dissemination of results.

Original project title

Late Eifelian climate perturbations: Effects on tropical coral communities.

Project leaders, funding agency, duration

Suttner, T.J., Austrian Science Fund (FWF), project budget: 271.050,86 EUR, 2011-2015.

Results

- The multidisciplinary investigation of Eifelian to Givetian sections especially in the Carnic Alps resulted in the most intensively studied area where the Kačák Event is evidenced. One of project related publications is cited under the Wikipedia entry for <Kačák Event>.
- Identification of conodont faunas from more than 300 rock samples led to a slightly changed age calibration of shallow marine and ramp deposits which previously was based on occurrence data of macrofossils or inferred by correlation of lithological features. Project results clarified age-related matters for sections in the Carnic Alps (Spinotti Formation, Kellergrat Formation, Freikofel Formation, Hoher Trieb Formation and Valentin Formation), the Graz Palaeozoic (Plabutsch Formation, Tyrnaueralm Formation), Prague Synform (upper limit of Acantophyge Limestone, Upper Dark Interval) and the Eifel (upper limit of the Junkerberg Formation).
- We addressed the question whether the Kačák Event represents a global extinction event or not. Whether sea-level change during the latest *kockelianus-ensensis* conodont biozones is related exclusively to climatically changed conditions or additionally forced by tectonic activity within the European Province accomplished by the closure of the Rheic Ocean will be tested by comparison of our results with studies from western Laurussia (Canada, Appalachian Basin), shelf deposits of eastern Laurussia (Holy Cross Mountains in Poland), Gondwana (e.g. the GSSP at Mech Irdane in Morocco) and from the Russian Craton (Altay and Ural mountains in Russia) with adjacent regions represented by volcanic island arcs (e.g. Baruunhuurai Terrane in western Mongolia).
- Effects of the Kačák Event on climate sensitive organisms such as rugose corals are obvious. In the Carnic Alps for example, we recognize a change in the coral community before and after the event interval. However, it turned out that coral-rich deposits of the Spinotti Formation, grown in nearshore environments of the carbonate platform before the Kačák Event, are older than proposed in literature (not latest Eifelian, but late Emsian to Eifelian) which documents that the decline/disappearance of coral taxa is not directly related to the Kačák Event in that specific case. However, in subsequently following deposits which are characterized by *Amphipora* limestone that persists until early Givetian

(and re-appears for several times until the Frasnian, for example in Moravia), significantly, only the rugose coral *Dendrostella* (at least two species) is present, e.g. at Mount Zermula (Cason di Lanza, Italy). Between the Marinelli hut and Plöcken Pass, *Amphipora* limestone interfingers with coral frame- and rudstone that had its onset in the earliest Givetian (*hemiansatus* conodont Biozone). With the onset of the coral reef species of *Dendrostella* disappeared. Based on palaeoenvironmental analysis, we conclude that the occurrence of *Dendrostella* in lagoonal deposits is linked with a change of specific environmental conditions on the carbonate platform during the Kačák transgression. In pelagic deposits of the same basin, corals from the platform are reworked and occur in distinct breccia levels below and above the Kačák Event interval. For biodiversity analysis about 200 oriented sections of rugose corals were produced. From the base of Spinotti Formation rugose coral genera such as *Acanthophyllum* sp. *Temnophyllum* sp., *Disphyllum* sp.?, *Phacellophyllum* sp., *Spinophyllum* sp., Ptenophyllidae were idenified. Within the Hoher Trieb Formation *Cyathophyllum* sp., *Grypophyllum* sp. and *Dendrostella* sp. are found among others.

- Stable oxygen isotope analysis of the PO_4-group of conodont apatite for calculation of palaeotemperatures (sea surface temperature = SST) in shallow marine, ramp and pelagic settings within the Palaeocarnic domain across the Late Eifelian Kačák Event gives implications not only on the palaeotemperature, but also addresses questions related to conodont ontogeny and salinity concentration of different bathymetric settings. Oxygen isotope values in shallow marine settings vary between 19.2-19.6 ‰ V-SMOW, while pelagic settings have values between 18.4-19.3 ‰ V-SMOW. Compared to that, conodont apatite from the highly condensed deeper marine Wolayer Glacier section shows values that range between 17.7-18.1 ‰ V-SMOW (measurements by Michael Joachimski and his team, Geozentrum Nordbayern, FAU). Interpretation of results from that study will help improving the quality of SST calculations based on conodont apatite.

Output:

Published papers

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