M U N I

COMMENTARY TO HABILITATION THESIS[1]

Time control and reconstruction of paleoenvironmental changes in Paleozoic carbonate record

Mgr. Tomáš Kumpan, Ph.D.

This Habilitation thesis presents a synthesis of candidate research conducted between 2016 and 2026, focused on multidisciplinary stratigraphy and paleoenvironmental reconstruction from Paleozoic carbonate rocks. The thesis is a commentary on fifteen selected publications, organised into two thematic parts. My research combines methods of conodont biostratigraphy, carbon isotope chemostratigraphy, and element geochemistry to address both stratigraphic and paleoenvironmental questions, applied to Paleozoic carbonate deposits. The habilitation thesis is based on 15 publications selected from work conducted subsequent to my doctoral studies, and is structured into two thematic parts:

In **the first part *Advances in Devonian and Carboniferous Stratigraphy*** [papers 1–7], I address stratigraphic problems related to redefinition of Devonian-Carboniferous boundary and stratigraphic subdivision of the lower Tournaisian. Results of testing two criteria proposed for the redefinition of the Devonian-Carboniferous boundary are commented in **Topic A *Redefinition of the Devonian-Carboniferous System Boundary***: the evolutionary lineage of *Protognathodus collinsoni–kockeli* as a biostratigraphic tool [papers 1–2], and element chemostratigraphy proxy to identify the major regression associated with the Hangenberg Crisis across various depositional settings [papers 2–4]. **Topic B *Revised lower Tournaisian conodont taxonomy and biostratigraphy*** provides commentary to my work on refinement of the lower Tournaisian stratigraphy by study of conodont taxonomy and biostratigraphy [papers 5 and 6] and carbon isotope chemostratigraphy [paper 7].

In the **second part *Element geochemistry in Paleoenvironmental reconstruction: from black to red deposits*** [papers 8–15], I synthesize several case studies on palaeoenvironmental reconstruction based on trace and REE element analysis of Ordovician, Devonian, and Carboniferous limestones. I have used element geochemistry to investigate various paleoenvironmental signals and diagenetic processes in contrasting sedimentary settings: organic-rich black deposits of the Hangenberg Crisis **(Topic C; *Hangenberg Crisis and its anoxic black deposits*;** papers 8-10) and iron-rich red carbonates of the selected Ordovician and Devonian stratigraphic intervals (**Topic D**; **Geochemistry of Paleozoic Red Iron-rich Marine Sediments;** Papers 11 to 15). The selected papers show development of my methodological approach from study of bulk geochemical information across stratigraphic sections to combination with *in-situ* microgeochemistry. The higher resolution of microgeochemistry provide view on the record of processes related to microenvironments or high-frequency paleoenvironmental changes, which are mixed in bulk samples, and allow more robust reconstructions. On the other hand, multivariate datasets show, that the geochemical record is highly complex, and combination with paleontological and sedimentological approaches are necessary.

My specific contributions to each publication are detailed in the tables accompanying each paper.

[1] KAISER, I, **Tomas KUMPAN** and Michael W. RASSER. High-resolution conodont biostratigraphy in two key sections from the Carnic Alps (Grune Schneid) and Graz Paleozoic (Trolp) - implications for the biozonation concept at the Devonian-Carboniferous boundary.

[1] The commentary must correspond to standard expectations in the field and must include a brief characteristic of the investigated matter, objectives of the work, employed methodologies, obtained results and, in case of co-authored works, a passage characterising the applicant's contribution in terms of both quality and content.

Newsletters on Stratigraphy [online]. 2020, **53**(3), 249–274. ISSN 0078-0421. Available at: doi:10.1127/nos/2019/0520

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: I participated in the analysis of part of the conodont material and in the development of the research design, and contributed to manuscript writing.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
0	0	40	40

[2] KUMPAN, Tomas*(corresponding author)*, Jiri KALVODA, Ondrej BABEK, Tomas Matys GRYGAR and Jiri FRYDA. The Devonian-Carboniferous boundary in the Moravian Karst (Czech Republic). *Palaeobiodiversity and Palaeoenvironments* [online]. 2021, **101**(2), 473–485. ISSN 1867-1608. Available at: doi:10.1007/s12549-019-00409-z

According to AIS PALEONTOLOGY – SCIE Q3

Author's contribution to the publication: I led the author collective in preparation of this review paper, which includes new data, for a special volume on the global Devonian–Carboniferous boundary; my responsibilities comprised data mining, manuscript design and writing.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
50	100	80	90

[3] BABEK, Ondrej, **Tomas KUMPAN**, Jiri KALVODA and Tomas Matys GRYGAR. Devonian/Carboniferous boundary glacioeustatic fluctuations in a platform-to-basin direction: A geochemical approach of sequence stratigraphy in pelagic settings. *Sedimentary Geology* [online]. 2016, **337**, 81–99. ISSN 1879-0968. Available at: doi:10.1016/j.sedgeo.2016.03.009

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: I participated in data collection, analysis and interpretation of detrital proxies, and contributed to publication design, synthesis and manuscript writing.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
50	0	50	50

[4] HARTENFELS, Sven, Ralph Thomas BECKER, Hans-Georg HERBIG, Wenkun QIE, **Tomas KUMPAN**, David DE VLEESCHOUWER, Dieter WEYER and Jiri KALVODA. The Devonian-Carboniferous transition at Borkewehr near Wocklum (northern Rhenish Massif, Germany) - a potential GSSP section. *Palaeobiodiversity and Palaeoenvir*onments [online]. 2022, **102**(3), 763–829. ISSN 1867-1608. Available at: doi:10.1007/s12549-022-00531-5

According to AIS PALEONTOLOGY – SCIE Q3

Author's contribution to the publication: I contributed to this multidisciplinary paper (biostratigraphy, sedimentology, geochemistry, cyclostratigraphy) proposing a GSSP candidate, with responsibility for the design and writing of the element geochemistry section.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
10	0	10	10

[5] KAISER, Sandra I., **Tomas KUMPAN** and Vojtech CIGLER. New unornamented siphonodellids (Conodonta) of the lower Tournaisian from the Rhenish Massif and Moravian Karst (Germany and Czech Republic). *Neues Jahrbuch fur Geologie und Palaontologie-Abhandlungen* [online]. 2017, **286**(1), 1–33. ISSN 0077-7749. Available at: doi:10.1127/njgpa/2017/0684

According to AIS PALEONTOLOGY – SCIE Q4

Author's contribution to the publication: I participated in the analysis of conodont material from the Moravian Karst, and was responsible for the development of the research and publication design and manuscript writing, with special focus on biostratigraphy and new species determination.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
50	30	50	50

[6] ZHURAVLEV, V, Artem N. PLOTITSYN, Vojtech CIGLER and **Tomas KUMPAN**. Taxonomic notes on some advanced Tournaisian (Mississippian) siphonodellids (Conodonta). *Geobios* [online]. 2021, **64**, 93–101. ISSN 1777-5728. Available at: doi:10.1016/j.geobios.2020.12.001

According to AIS PALEONTOLOGY – SCIE Q2

Author's contribution to the publication: I participated in the analysis of conodont material from the Moravian Karst, and was responsible for the development of the research and manuscript writing, with special focus on biostratigraphy.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
30	40	30	40

[7] CIGLER, Vojtech, **Tomas KUMPAN*(corresponding author)***, Jiri FRYDA, Jiri KALVODA and Stepan DAMBORSKY. Refinement of the lower Tournaisian (Mississippian) conodont, foraminiferal and carbon isotope stratigraphy of the Moravosilesian Basin (Czech Republic) and implications for global correlation. *Newsletters on Stratigraphy* [online]. 2025, **58**(1), 71–98. ISSN 0078-0421. Available at: doi:10.1127/nos/2024/0830

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: I designed and led the research, supervising my PhD student in conodont biostratigraphy and taxonomy, and was responsible for the analysis, interpretation and manuscript writing of the carbon isotope dataset.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
50	100	60	90

[8] KALVODA, Jiri, **Tomas KUMPAN*(corresponding author)***, Marketa HOLA, Ondrej BABEK, Viktor KANICKY and Radek SKODA. Fine-scale LA-ICP-MS study of redox

oscillations and REEY cycling during the latest Devonian Hangenberg Crisis (Moravian Karst, Czech Republic). *Palaeogeography Palaeoclimatology Palaeoecology* [online]. 2018, **493**, 30–43. ISSN 1872-616X. Available at: doi:10.1016/j.palaeo.2017.12.034

According to AIS PALEONTOLOGY – SCIE Q1

Author's contribution to the publication: As the corresponding author, I was responsible for coordinating the author group, integrating and analysing results, and preparing the manuscript, with special focus on redox-sensitive trace elements.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
60	40	50	60

[9] KUMPAN, Tomas*(corresponding author)*, Jiri KALVODA, Ondrej BABEK, Marketa HOLA and Viktor KANICKY. Tracing paleoredox conditions across the Devonian-Carboniferous boundary event: A case study from carbonate-dominated settings of Belgium, the Czech Republic, and northern France. *Sedimentary Geology* [online]. 2019, **380**, 143–157. ISSN 1879-0968. Available at: doi:10.1016/j.sedgeo.2018.12.003

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: As the leading author, I designed the study, collected and analysed the dataset, and was responsible for manuscript preparation, including the formulation of conclusions and the overall structure of the text.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
80	70	60	60

[10] KALVODA, Jiri, **Tomas KUMPAN*(corresponding author)***, Wenkun QIE, Jiri FRYDA and Ondrej BABEK. Mercury spikes at the Devonian-Carboniferous boundary in the eastern part of the Rhenohercynian Zone (central Europe) and in the South China Block. *Palaeogeography Palaeoclimatology Palaeoecology* [online]. 2019, **531**(Article 109221). ISSN 1872-616X. Available at: doi:10.1016/j.palaeo.2019.05.043

According to AIS PALEONTOLOGY – SCIE Q1

Author's contribution to the publication: As the corresponding author, I coordinated the author group, integrated and analysed the results, and led manuscript preparation, with special focus on redox-sensitive trace elements.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
70	60	40	60

[11] BABEK, Ondrej, Stanislava VODRAZKOVA, **Tomas KUMPAN**, Jiri KALVODA, Marketa HOLA and Lukas ACKERMAN. Geochemical record of the subsurface redox gradient in marine red beds: A case study from the Devonian Prague Basin, Czechia. *Sedimentology* [online]. 2021, **68**(7), 3523–3548. ISSN 1365-3091. Available at: doi:10.1111/sed.12910

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: I contributed to this multidisciplinary study (mineralogy, petrophysics, geochemistry) through in-situ LA-ICP-MS microgeochemical data acquisition and interpretation, and participated in the synthesis and formulation of the study conclusions.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
20	0	20	20

[12] BABEK, Ondrej, **Tomas KUMPAN**, Mikael CALNER, Daniel SIMICEK, Jiri FRYDA, Marketa HOLA, Lukas ACKERMAN and Katerina KOLKOVA. Redox geochemistry of the red `orthoceratite limestone' of Baltoscandia: Possible linkage to mid-Ordovician palaeoceanographic changes. *Sedimentary Geology* [online]. 2021, **420**(Article 105934). ISSN 1879-0968. Available at: doi:10.1016/j.sedgeo.2021.105934

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: My role in this multidisciplinary study (mineralogy, petrophysics, geochemistry) centred on in-situ LA-ICP-MS microgeochemistry, encompassing data acquisition, interpretation, and contribution to the synthesis and conclusions.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
30	0	30	30

[13] BABEK, Ondrej, **Tomas KUMPAN**, Wenjie LI, Marketa HOLA, Daniel SIMICEK and Jaroslav KAPUSTA. Incipient reddening of Ordovician carbonates: The origin and geochemistry of yellow and pink colouration in limestones. *Sedimentary Geology* [online]. 2022, **440**(Article 106262). ISSN 1879-0968. Available at: doi:10.1016/j.sedgeo.2022.106262

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: In this multidisciplinary study (mineralogy, petrophysics, geochemistry), I provided in-situ LA-ICP-MS microgeochemical data and the corresponding manuscript sections, contributing to the geochemical interpretation and overall synthesis of the conclusions.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
30	0	30	30

Author's contribution to the publication: I participated in this multidisciplinary study (mineralogy, petrophysics, geochemistry) by contribution of data and manuscript parts from in situ LA-ICP-MS microgeochemistry, providing intrepretation and synthesis for the study conclusions.

[14] BABEK, Ondrej, **Tomas KUMPAN**, Stanislava VODRAZKOVA and Catherine GIRARD. Fluctuating seafloor oxygenation before, during and after the Frasnian/Famennian crisis: Quantitative colour analysis and geochemistry of Upper Devonian marine red beds, Montagne

Noire, S. France. *Facies* [online]. 2026, **72**(1, Article 7). ISSN 1612-4820. Available at: doi:10.1007/s10347-025-00719-z

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: I was responsible for the in-situ LA-ICP-MS microgeochemical component of this multidisciplinary study (mineralogy, petrophysics, geochemistry), contributing data, manuscript sections, and geochemical interpretation to the overall synthesis and conclusions.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
30	0	30	30

[15] VODRAZKOVA, Stanislava, **Tomas KUMPAN**, Radek VODRAZKA, Jiri FRYDA, Renata COPJAKOVA, Magdalena KOUBOVA, Axel MUNNECKE, Jiri KALVODA and Marketa HOLA. Ferruginous coated grains of microbial origin from the Lower Devonian (Pragian) of the Prague Basin (Czech Republic) - Petrological and geochemical perspective. *Sedimentary Geol*ogy [online]. 2022, **438**(Article 106194). ISSN 1879-0968. Available at: doi:10.1016/j.sedgeo.2022.106194

According to AIS GEOLOGY – SCIE Q1

Author's contribution to the publication: My contribution to this multidisciplinary study (mineralogy, petrology, geochemistry) comprised in-situ LA-ICP-MS microgeochemical data acquisition, interpretation, and synthesis, with direct input into the formulation of the study conclusions.

Experimental work (%)	Supervision (%)	Manuscript (%)	Research direction (%)
30	0	40	40