

**Review of the PhD thesis „Geochemical markers from foraminiferal tests as a tool for reconstruction of paleoceanological environments: a case study from the Miocene of the Central Paratethys” by Filip Scheiner**

First I would to express that it is honouring to take part in the PhD defense procedure at the Charles University. I have been in contact with the supervisor, Dr. Katarína Holcová and have already published two papers with her. Hence, it is my pleasure to review a PhD thesis supervised by Dr. Holcová. Since I deal mainly with stable isotope geochemistry, I'll make comments mainly to those parts.

The thesis is based on four main studies that have all been published in international journals.

Study I uses single foraminifer test  $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$  and Mg/Ca data to infer seawater temperatures, salinities, and water mass origin with the candidate as the senior author.

Study II focusses on a satellite basin and reconstructs seawater circulation patterns using new stable isotope data on different foraminifer species. The candidate is the last author of the paper.

Study III extends the analyses with organic geochemical data, determines the origin of organic matter and excludes the possibility of significant freshwater contribution from the continental areas. The candidate is again the first author of the paper, indicating his essential contribution.

Study IV presents a complex paleoenvironmental reconstruction of a more eastern part of the Paratethys, in the basis of the combined use of sedimentological, paleobiological and stable isotopic data. The candidate is the 6th of the 7 authors, indicating that he contributed, but did not lead this study.

Two papers appeared in Palaeogeography, Palaeoclimatology, Palaeoecology, one was published in Marine Micropaleontology and a fourth one was published in Facies. Thus, the studies have been appropriately published.

The referee is not in an easy situation with the thesis' evaluation as it describes the published results in a rather general way. I checked some of the available PhD thesis of the Institute of Geology and Palaeontology of the Charles University, and most of them contained more information and explanatory figures from which the thesis could be evaluated, and which is mainly missing here. At some places, the thesis contains spoken language (e.g., „could be tricky”) that should be generally avoided in a doctoral thesis. English is generally appropriate, there are only some typos or grammatical errors.

The Methods section contains only basic information that could have been better elaborated.

The foram preservation investigation is really excellent, the use of SEM for checking the tests' state is perfect. However, I missed some spectacular SEM photos that could have demonstrated the preservation convincingly. This is especially important as there are statements that would require definition. For example what is „well preserved”? Nice photos with well preserved and altered tests would greatly help.

The candidate mentions secondary mineral infillings. Mild acid treatment may dissolve or disintegrate the secondary carbonate. Was there any attempt to check such pre-treatment methods?

For me the major problem with the Methods section is that it is too short and non-informative. It is not clear how  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  accuracies were assessed, only the internal precision is mentioned, which is close to meaningless, only the performance of the mass spectrometer is indicated. I checked the cited paper, it contains more information, but only the expected isotopic compositions of the standards. The real external precision and the accuracy can be assessed from measured compositions of several standards in the course of the study. The same holds true for the  $\delta^{13}\text{C}_{\text{Org}}$  data, where a precision of  $\pm 0.1\text{‰}$  is given, which is excellent, but only the cited paper (study III) contains the description of applied standards. In general, accuracy can be assessed only from the measured values of standards and their standard deviations.

In section 2.2.3.2. the candidate describes how the Corg/Ccarb ratio is calculated. As a pure  $\text{CaCO}_3$  is used as a reference, this approach is valid only if the samples contain carbonate and

organic matter exclusively. If other minerals are present, the Corg/Ccarb ratio can be calculated if the carbonate content is known.

The Results section is painfully short, it is just a short list of data sources. The Results section usually contains description of major observations, data ranges, outliers, trends, relationships. The data are only available in the electronic version, and the Elsevier and Springer pages of Studies III and IV allow data downloading only for subscribers. It would have been informative to include the data in a supplementary table here.

I have several questions and comments concerning the section of Discussion.

- why is the single test analysis so unique? The Kiel device is designed for this.
- The Discussion starts as a Results description.
- The  $\delta^{18}\text{O}$  value of  $-11.2\text{‰}$  is not high, just the opposite, low.
- The meaning of „bulk” analysis is not clear. Generally „bulk” means total carbonate, i.e., a mixture of fossil and matrix carbonate. In the present work „bulk” seems to be used as word for several foram tests within one sample. This does not mean that outliers can not be identified, just the shifts of the outliers from the average value become smaller. If „bulk” is meant for total carbonate, then the author is right, the matrix carbonate generally contains diagenetic  $\text{CaCO}_3$ , but in this case the literature is full with such data and Scheiner et al. (2018) is not the primary citation.
- section 4.2., page 20, bottom: the author refers to Mg/Ca values as if they had been shown. This makes the discussion difficult to follow.
- page 21, middle: „Overall, all the isotopic values reflect the presumed habitats of the studied species well.” The entire section is full of general statements that are difficult to evaluate without looking at the data themselves, while the data are listed and shown in the cited papers.
- 4.3.: the section starts with the sentence „The calculated paleotemperatures are equivalent to modern subtropical regions” as if the data had been shown.
- section 4.4.:
- A figure showing the data of the present study as well as those from the literature would help the reader to understand the arguments.

- The section is a general description of other studies with a lot of information. The statements are too general and sometimes vague. For example in the middle of page 25 the author writes „whether the waters were isolated or they were unable to fully develop remains still unclear”, but it is not defined what „develop” means in this case. At the end the reader is referred to the cited study papers again for details.

Section 4.5.:

- Stable isotope compositions should generally be rounded to the first digit.

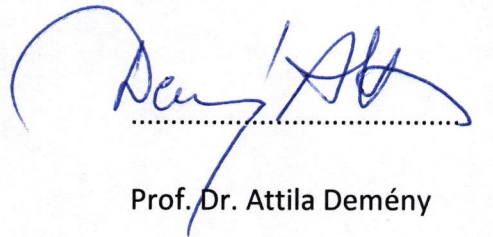
- Page 26, bottom: the rise of carbonate content may not only be related to the increase in carbonate production, but also to the decrease of terrigenous input (although the lack of freshwater influx would make this possibility unlikely).

- Section 5., Summary

- The author writes „this thesis discusses in detail the methodological aspects of the used proxies including new approaches that were specifically designed for the studied environment”, but actually the details are missing.

In summary, the studies are well designed, the data are of state-of-art, and the results and conclusions are valuable. The studies are published in leading international journals, and the candidate had essential contributions in them. The only problem I encountered is the presentation of the thesis that could have been elaborated in more details and better illustrated in order to convince the readers. Hence I would rate the thesis and the presented work at 90%, congratulating for the studies and suggesting to include nice figures in the defense presentation (e.g., SEM photos that may attract the audience’s attention). In conclusion, I highly recommend that the candidate obtain the PhD degree.

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