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Review of the PhD thesis of B.Sc., M.Sc. Jinpeng Zhang
Diatoms in the Northwestern South China Sea continental margin
sediments: reconstruction of Late Pleistocene and Holocene
paleoenvironments

prepared under the scientific supervision
of Prof. Dr. hab. Andrzej Witkowski

I was asked to report on the Doctoral Dissertation, which was prepared in the Institute of Marine and Environmental Sciences, University of Szczecin, by M.Sc. Jinpeng Zhang. The Dissertation – *Diatoms in the Northwestern South China Sea continental margin sediments: reconstruction of Late Pleistocene and Holocene paleoenvironments* consists of four publications, was made under the supervision of Professor Dr. hab. Andrzej Witkowski (Institute of Marine and Environmental Sciences University of Szczecin, Szczecin, Poland). The Doctoral Dissertation presents a set of new and important results and it is up to the standards that one should uphold for a PhD thesis. The basis for issuing the opinion are the conditions set out in Article 13 of act. 1 of March 14, 2003 on Academic Degrees and Academic Title, and on Degrees and Title in the field of art (Dz. U. 2013, nr. 65 poz. 595 z póź. zm).

The Dissertation includes author statement of publications contribution, acknowledgements, and three, very precisely marked chapters – *Introduction, Regional Geographic and Geological Setting, Material and methods* and *Publications*. The additional bibliography (next to references cited in publications) comprises almost 90 publications. All

of them are English-language items. The Dissertation also includes four Appendixes (the first one contains submitted to PerJ manuscript) and a Polish and English-language summary.

The results obtained so far have seen publication articles (3) and was submitted to prestigious journals:

- 1) **Jinpeng Zhang**, Michał Tomczak, Andrzej Witkowski, Kai Liang, Jan Harff, Chao Li, Bing Wang. 2021. A diatom-based Holocene record of sedimentary and oceanographic environmental changes within the Beibu Gulf, NW South China Sea. *Marine Geology*, 432, 106395.
- 2) **Jinpeng Zhang**, Michał Tomczak, Chao Li, Andrzej Witkowski, Shun Li, Yang Zhou, Jakub Miluch. 2021. Paleo-ecological changes and sedimentary evolution of the Hainan Delta, NW South China Sea. *Journal of Asian Earth Sciences*, 209, 104685.
- 3) **Jinpeng Zhang**, Michał Tomczak, Andrzej Witkowski, Chao Li, Chixin Chen, Kevin McCartney. 2020. Marine diatom response to oceanographic and climatic changes in the NW South China Sea since the penultimate glacial interval. *Journal of Asian Earth Sciences*, 204, 104553.
- 4) **Jinpeng Zhang**, Andrzej Witkowski, Michał Tomczak, Chao Li, Kevin McCartney, Zhen Xia. The sub-fossil diatom distribution in the Beibu Gulf (NW South China Sea) and related environmental interpretation. (submitted to PeerJ, presented in Appendix 1).

MSc. Jinpeng Zhang is the first author of all of these publications, and his contribution to the work was estimated at 64-68% (sub-sample work, microscopy work, qualitative and quantitative analysis of cores, data collection and statistical analysis, preparation of figures and writing drafts of manuscripts). The entire Doctoral Dissertation covers the proper substantive part and complementary part on 188 pages. In accordance with the statutory requirements for Doctoral Dissertations, they should "constitute an original solution to the scientific problem (...) and demonstrate general theoretical knowledge of a candidate in a given discipline". With this in mind, when assessing the Dissertation the following criteria were adopted: relevance of the subject matter, correctness in formulating research goals, hypotheses and methodology of research.

The dissertation by M.Sc. Jinpeng Zhang covers a hot topic in marine geosciences area of contemporary research in paleoecological studies – diatoms and their importance in the reconstruction of Late Pleistocene and Holocene palaeo-environments in the Northwestern

South China Sea sediments. The marine diatoms as palaeo-microfossils are poorly recognised in South China Sea. They can provide reliable and effective information on a marginal sea basin model for modern and past environmental studies. Diatoms have a large potential of application as powerful and reliable environmental bioindicators. The climate variation allows a view of palaeo-landscape reformation related to changes of the Earth's general water resources. The climate and sea-level fluctuations play an important role as drivers of diatoms growth and their survival on the continental margin habitats. Intensive research of marine diatoms has indicated the high level of diversity of brackish-, tropical water forms and coastal species. But, on the other hand, the identification of marine diatoms due to the huge number of taxa is still burdensome. This problem is related to the necessity of accurate and consistent identification of diatoms in order to be able to conclude about their autecological features.

The importance of the thesis are clearly presented in the *Introduction* of the work. The main goal was to analyze the fossil diatom assemblages and the diatom distribution patterns in the surficial sediments (sixty-six samples) and in the core sediment profiles (three separate cores) recovered from the shelf and adjacent slope sediments of the northwest South China Sea. The use of diatom identification results and their counts for the ecological interpretation of the assessed environmental features was made in relation to the current environmental conditions. Selected, dominant diatoms have demonstrated a high potential for reconstructing past environmental conditions. In the chapters 2 and 3 (Regional Geographic and Geological Setting and Material and methods) the geographic, geological and oceanographic settings, materials, methods used and data analysis were precisely described and illustrated. For the results of diatom studies such examinations were used: statistically constrained cluster analysis software package PC-ORD version 5.0 (Q-mode and R-mode hierarchical analyses), component analyses and redundancy analysis (RDA) (Canoco 5.1). Moreover, grain size and geochemical data statistics are given.

The data included in the first publication by Zhang et al. 2021 (Marine Geology) come from one 32 m long sediment core (ZK4BH), taken from the northwestern South China Sea. 116 samples taken from a depth of 0–15 m. were used in the diatom analysis. It is worth mentioning the laboriousness of identifying and counting up to 300 individuals in five slides of each sample (if the target count was 1500 valves). The results of diatom analysis cover the period from the early Holocene (10,000–7,800 cal. yr. BP) to the present. The Asian pattern of monsoon circulation was clearly reflected in an increase in the diatom abundance in the early and late Holocene. The anthropogenic impact has been noted particularly apparent over

the past 800 years. This publication contributed to the detailed recognition of changes caused by palaeoclimate change and anthropogenic impact in the Beibu Gulf area by diatom analysis.

The second paper, published in *Journal of Asian Earth Sciences* (2021) was based on microfossils: dinoflagellate cysts and diatom analyses of 101 m. long ZBW core (taken from the northwestern South China Sea). For dinoflagellate cysts 120 samples were analysed. For diatoms, the number of analysed samples is not given (120?). Moreover, I have not found any information concerning a) How many slides were analysed for the sample? b) How many valves were identified and counted per sample? This is important because the low diversity and total number of diatoms was low in the entire analyzed part of the core (page 6). The sentence concerning the general characteristics of the identified taxa includes the most numerous was also freshwater *Cyclotella striata* (see AlgaeBase). The lack of diatoms in the core could be an effect of a strong terrigenous sediment dilution and lateral transport (to the continental slope outside the Beibu Gulf).

The third publication, in *Journal of Asian Earth Sciences* (2020) is based on the 858 cm long core (111PC). Diatom analysis was based on 85 samples and its aim was to reconstruct the palaeoenvironment over the last glacial-interglacial cycle and Holocene. Identification and counts were done up to 200 individuals (?) of each sample. Out of the total number of 73 identified diatoms, 23 species with over 3% relative abundance were found. In addition to taxa classified as neritic, tropical open-sea species have also been found (*Alveus marinus*, *Azpeitia africana*, *A. nodulifera*, *Rhizosolenia bergonii*). The species fluctuations responded to the glacial-interglacial climate instability. According to the diatom abundance distribution six zones were distinguished. Looking at Table 6, the first place in absolute/relative (page 2) abundance belongs again to *Cyclotella striata*. The diatom assemblage zones correspond well to the glacial-interglacial climate temperature changes. Their distribution reflects changes to a terrigenous input from the surrounding drainage system. Moreover, the dynamic of geographic changes of the monsoon system is clear.

The latest work (Appendix 1) submitted to *PerJ* journal, concerns 66 core top samples from the eastern part of Beibu Bay. The main aims of the paper were “to provide a comprehensive view on the sub-fossil diatom biogeography, distribution pattern and oceanographic environmental controls ... based on Beibu Gulf core-top samples”. Particular diatoms provided ecological information that gave a picture of the environment and helped in reconstruction of the palaeoclimatic conditions in the South China Sea. Among identified diatoms were found freshwater (*Planolithidium hauckianum*), coastal (*Cyclotella striata*),

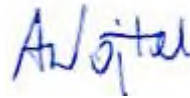
neritic, warm water (*Bacteriastrum hyalinum*) and tropical (*Asterolampra vanheurckii*) species. The results show that the species composition and percentage amount of dominants vary significantly at sites with similar environmental parameters (water depth, temperature, salinity, nutrient level – Chl. *a*). Surface salinity, chlorophyll *a* concentration and water depth influenced the distribution of diatoms, although they explained only 38.14% of the variability of canonical redundancy analysis. The R-mode cluster analysis separated two main groups of sub-fossil diatoms (with four subgroups B1, B2, B3, B4) and showed a complex distribution pattern of diatoms. The Q-mode cluster analysis showed clear distribution of diatoms divided into various areas. It is important to pay attention to the statement by M.Sc. Zhang and coauthors on the role of regional factors influencing the distribution of diatoms. The regional water cycle plays an important role in moving warmer and waters of higher salinity into south and the center of the Beibu Gulf. As a result of this process, the tropical diatoms are more numerous in these parts of the Gulf. The manuscript is illustrated by 9 figures and 4 tables.

In the context of the research problem and the objectives of the dissertation, the hypotheses were clear and right. The clearly defined direction and scope of the research enabled the PhD student to accomplish the assumed research goals. Research methodology is clearly described and illustrated. The diatom distribution patterns were assessed, and the most indicative taxa were applied in a regional reconstruction of environmental changes during the Quaternary. The results presented in the publications and manuscript are impressive, because of the breadth of topics covered and the range of problems addressed, from diatom taxonomy, autecology, biomonitoring and palaeo-reconstruction, each of which need an excellent knowledge of diatoms. Comparison between subfossil and fossil diatom assemblages as environmental reconstruction proxies was applied. The reviewed PhD provides a comprehensive view on marine environmental controls on fossil diatom distribution pattern in the Northwestern South China Sea. The publications by M.Sc. Zhang have made important contributions to our knowledge of an environment prevailing at a Quaternary in the North South China Sea, both as applied science for use in monitoring of marine waters of the world. Presentation of four publications as the doctoral dissertation is a big achievement. The publications *Paleo-ecological changes and sedimentary evolution of the Hainan Delta, NW South China Sea* (publication 2) and *Marine diatom response to oceanographic and climatic changes in the NW South China Sea since the penultimate glacial interval* (publication 3) deal with Pleistocene diatoms. *A diatom-based Holocene record of sedimentary and oceanographic environmental changes within the Beibu Gulf, NW South China Sea*

(publication 1) and *The sub-fossil diatom distribution in the Beibu Gulf (NW South China Sea) and related environmental interpretation* (publication 4) are focused on Holocene diatoms. In the Appendix 2 are 20 Plates with 90 well-done SEM photos of selected diatom taxa. Appendix 3 includes 1 plate with 12 light microscopic photos of diatoms from the core 111PC. Appendix 4 provides a complete systematic list of all diatoms (268 taxa) identified in the North South China Sea during a doctoral dissertation focused on Pleistocene and Holocene reconstruction of this part of the world. Due to the insight and multifaceted recognition issues, this work provides a lot of valuable information.

All of these considerations conspicuously point to the conclusion: M.Sc. Jinpeng Zhang has shown an ability for creative and interesting scientific work. The presented results are up to the standards that one should uphold for a PhD thesis.

Sincerely,



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