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**Opinion on the PhD dissertation of Nguyen Van Kieu, M.Sc.**

***Depositional architecture of the Quaternary succession in the southern Song Hong-Yingehai Basin, offshore Vietnam: a seismographic and sequence stratigraphic approach***

The dissertation is 156 pages long and is composed of 8 chapters (with inner, 1-3 step hierarchic subdivision, the chapter 8 *Conclusions* excluded) and terminated with a list of references. The text is preceded by the *Table of contents* (3 pages) and *Acknowledgements* (1 page), *Abstract* (2 pages), *Streszczenie* (2 pages), *List of tables* (1 page) and *List of figures* (6 pages). It contains 9 tables and 67 figures. The dissertation is written in English, with summary in Polish (it would need linguistic verification).

Comments to the chapters of the dissertation and detailed comments

- Chapter 1 (*Introduction*) presents rationale, research aims and objectives and dissertation structure.
- Chapter 2 *Physiographic and geological settings* presents location of the study area (Song Hong-Yingehai Basin), its geological setting, recent tectonics and diapir intrusions. Fig. 2.1 is predominated by a topography of the area but the described Gulf of Tonkin is not indicated and the faults are hardly visible.

- Chapter 3 *Database and methodology* presents the database (well and seismic data) and methodology (core description, petrographic and biostratigraphic analyses, accompanied by correlation of well sections and depositional environments, seismic interpretation, mapping, sequence stratigraphy and clinofolds/clinothem interpretation). In general, the stratal terminations are not sufficiently explained, neither in the captions of the figures nor in the text. In Fig. 3.2, the headings in the column *Lithology...* are too small. In Fig. 3.5, the stratal termination ‘*apparent top lap*’ is mentioned in the table but it is missing in the scheme. In Fig. 3.7, the colours are not explained.
- Chapter 4 *Sedimentological and biostratigraphical analyses* presents results of lithofacies, foraminiferal and palynological analyses, as well as a description of biozones and palaeoenvironments. The title of the main chapter 4.2 *Microfauna and biostratigraphy* is incorrect, because a microflora is described in the subchapters 4.2.2 *Palynology* and 4.2.3 *Biozones based on calcareous nanofossils*.
- Chapter 5 *Seismic stratigraphy and clinofolds/clinothem* presents seismic facies and key horizons are described, as well as classification and arrangement of clinofolds/clinothem.
- Chapter 6 *Sequence stratigraphy* presents a sequence model and boundaries, maximum regression and flooding surfaces, supplemented with basal regression surface, systems’ tracts, depositional sequences and their palaeogeography. Detailed explanation is missing in the captions of Figs 6.3-5. The third example in Fig. 6.3 is not commented in the text. Figs 6.4-5 are neither cited nor commented in the text – it concerns especially different interpretations of the presented examples. The text in the lower right corner of Fig. 6.6 is completely illegible.
- Chapter 7 *Discussion* presents the shelf-margin clinofolds and gravity flow deposits against a role played by the embayed coast topography. In the chapter 7.2, the word *Quarterly* should be replaced by *Quaternary*.

- Chapter 8 *Conclusions* recapitulates the most important achievements of the applicant's research. The word *Quarterly* in the text should be replaced by *Quaternary*.
- A list of references contains 235 publications. They represent generally the updated, selected achievements in sedimentology, biostratigraphy, seismic and sequence stratigraphy that were selected for the needs of the study area and topic of the dissertation. The only exception is the chronostratigraphy: it is mentioned several times in text, but it is not represented in the list of references and the most important publications on the global formal stratigraphic subdivision are missing.

#### General comments

The aim of the dissertation is the identification of seismostratigraphy and sequence stratigraphy, based on integrated sediment and wireline logs in the shelf deposits of the southern Song Hong-Yinggehai Basin, offshore Vietnam. This aim was supposed to be achieved by recognition of seismic-scale depositional elements, lithofacies and depositional environments whereas their spatial and temporary relationship were established, based on the chronostratigraphic setting interpreted from the biostratigraphic data and interplay between tectonic subsidence, eustatic oscillations and sediment flux.

The used database contains sediment samples collected from 25 wells, drilled by the PetroVietnam and other international oil companies, supplied with seismic data from a set of seismic profiles that cover a continental shelf to its slope and basin floor. The methodology comprised a lithologic description of the cores and biostratigraphic analysis of the sediment samples. However, it is not univocally stated what part of this basic work was done by the PhD applicant. A fundamental role in the applicant's correlation of the facies and basin-fill architecture was played by wireline log records (including gamma-ray, sonic, density and

porosity logs) that were found to reflect lithology and enabled to recognize sequence boundaries, systems' tracts and depositional environments.

Lithology of the cores and intensity of bioturbations enabled to classify 6 lithofacies that were correlated with the gamma-ray spectrometric record. Assemblages of planktonic and benthonic foraminifers were used to establish the biostratigraphy but also to determine a palaeoecological environment, connected with a continental shelf (neritic environment) and a continental slope (batial environment). A biostratigraphic role of nannofossils and of palynofoms was not clearly described.

Seismic data were interpreted in terms of 9 seismic facies, distinguished in the Quaternary deposits of the southern Song Hong-Yinggehai Basin. This achievement was followed by interpretation of the seismic stratigraphy, based on depositional sequences reflected by unconformities-bounded units. The seismic stratigraphy led the foundations for the sequence stratigraphy that reflected several stages of sea regression and transgression, recorded by varied relationship between changing accumulation and sediment supply in the offshore area. Altogether, 25 key seismic horizons and the modern sea bed were distinguished and they were interpreted as the sequence boundaries. Some of them were biostratigraphically dated, the others could be partly evaluated from biostratigraphic age/depth curves for each well. Recapitulation of dating of the sequence boundaries enabled to calculate progradation and aggradation relations, and to show 5 stages of the shelf margin progradation throughout the Quaternary.

Results of the applicant's investigations can be used in further research connected with oil and gas exploration in the offshore area of Vietnam.

#### General abnormalities

In the dissertation, an incorrect age interval is used for the Quaternary as the age 1.93 Ma is generally accepted globally to indicate its lower boundary. Since 2009, the Quaternary is a formal chronostratigraphic unit and its formal lower boundary coincides with the Gelasian Global Stratotype Section and Point (GSSP) with the astronomically tuned age of 2.58 Ma (Gibbard et al., 2010). The question arises if the boundary 1.93 Ma, mentioned several times in the text of the dissertation, is a real base of the Quaternary in the study area or it is located somewhere within the Early Pleistocene, namely in the upper part of the Gelasian Stage. In the latter case, the contents of the dissertation would comprise only a part of the Quaternary, then it would not be reflected by dissertation title. The other possibility is that the age 1.93 Ma is not supported by a reliable absolute dating and it was accepted by the applicant based on previous publications – if it is the case, then it can be simply replaced by the correct age of 2.58 Ma.

Moreover, in the global chronostratigraphy the subseries of the Pleistocene and the Holocene are formal chronostratigraphic units (cf. Walker et al., 2018, 2019; Head et al., 2021), therefore they must start in English with the capital letters (e.g. Early/Lower Pleistocene, Late/Upper Holocene).

### Recapitulation

The dissertation presents a complex and profound study of the offshore shelf deposits in the southern Song Hong-Yinggehai Basin in northern Vietnam. Such work is undoubtedly original and touches many aspects of sedimentology, biostratigraphy, seismic and sequence stratigraphy. It is very well illustrated and the reference list is mostly updated. In general, this dissertation presents a very high level and can be treated as a model one. It proves a broad knowledge of the applicant in the discipline of the Earth and related environmental sciences. It proves that the applicant is ready to work independently.

The dissertation of Nguyen Van Kieu, M.Sc. is well written, the used geologic terminology is correct (except for the chronostratigraphic terms), a topic and successive steps of research and interpretation are clearly presented. The noted errors and shortcomings do not devalue the general, high standard of the thesis. The aim of the research is clearly defined and the interpretation is based on suitable source data and a reliable geologic evidence, supported by citation of correctly selected references. The illustrations are excellent and play a crucial role to understand the applicant's way of thinking. I make a conclusion to highlight the evaluated dissertation of Nguyen Van Kieu, M.Sc.

#### Final conclusion

The evaluated dissertation is an original and independent work of the applicant. I state that it fulfills criteria of the PhD dissertations, determined in the proper state law (art. 187 ustawy z dnia 20 lipca 2018 r. Prawo o szkolnictwie wyższym i nauce; Dz. U. z 2022 r., poz. 478, z późn. zm.), therefore **I make a conclusion to allow Nguyen Van Kieu, M.Sc. for further action in this PhD course.**

A handwritten signature in blue ink, appearing to read 'Alister', is positioned to the right of the text.

Warszawa, 2023-08-23