

Christian-Albrechts-Universität zu Kiel, 24098 Kiel

-- To whom it may concern --
St. Petersburg State University

Prof. Dr. Astrid Holzheid
Experimental and Theoretical Petrology

Institute of Geosciences
Christian-Albrechts-Universität zu Kiel

Ludewig-Meyn-Straße 10, 24118 Kiel
F. R. of Germany

www.petrologie-mineralogie.ifg.uni-kiel.de/en

Authorized Person

Astrid Holzheid

Mail, Phone, Fax

astrid.holzheid@ifg.uni-kiel.de

phone +49(0)431-880-1451

fax +49(0)431-880-4376

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Review of the member of the dissertation council

for the dissertation of Ruiqi Chen

on the topic

**“Natural and synthetic oxides with f-elements: recrystallization, crystal chemistry,
thermal and magnetic properties”**

submitted

for the degree of candidate of geological and mineralogical sciences of

St. Petersburg State University

Scientific specialty 1.6.4.

Mineralogy, Crystallography, Geochemistry, Geochemical Methods of Mineral Exploration

It is a pleasure to write this recommendation letter for acceptance of the degree of candidate of geological and mineralogical sciences submitted by Ruiqi Chen.

At first, I would like to clarify that I do not know Ms. Chen in person and will thus be able to only judge her written performance.

Ms. Chen's thesis consists of four main chapters as well as the thesis summary and conclusion chapter.

The first part of the **thesis summary** serves as introduction. Especially the first 3.5 pages provide needed information about the rationale of the study, including a justification of the study, the state of the art regarding potential minerals that might serve as host materials for radioactive waste as well as the need to add knowledge to magnetic properties of the potential host materials. Without the first 3.5 pages of the chapter “thesis summary” the readers would be lost why Ms. Chen is interested in the

minerals that are described in detail in the first chapter “Literature review”. The chapter “thesis summary” includes the above-mentioned well-structured short introduction which highlights the relevance of the study, summarizes e.g., envisaged aims, individual tasks, used methods, key results, presentations at conferences and publications, respectively, and concludes with statements regarding scientific novelty, thesis statements to be defended and brief introduction of main results (as last subchapter of the chapter “thesis summary”). Ms. Chen refers to her four scientific articles in Web of Science indexed journals, four to be submitted to articles, and her presentations at Russian and international conferences. I believe that this information is a requirement by the doctoral degree regulations of St. Petersburg State University, otherwise they would be out of place in a chapter that starts with an introduction to the field of the conducted research. However, it might have been more appropriate to have a separate introduction chapter and not having the scientific introduction and rationale, respectively, to the project’s topic hidden in the chapter named “thesis summary”.

Chapter 1 “Literature review” is a potpourri as it provides an overview about the minerals selected to get further studied within the scope of the PhD thesis as well as very general information about thermal expansion and magnetic properties. Unfortunately, Ms. Chen missed to provide information why she has chosen the six minerals brannerite, thorite and huttonite, respectively, fergusonite-(Y), samarskite, zirconolite and “minerals of the crichtonite group”. The title “geological fingerprints and crystallographic structure of the studied minerals” is a bit misleading. Information about geological fingerprints is missing, but the structures are described well. Ms. Chen does not provide a literature review about thermal expansion and magnetic properties, it is more repeated text book knowledge. However, this information is for sure needed to follow Ms. Chen’s explanations regarding her findings in the later chapters.

Chapter 2 “Research methodology and experimental conditions” provides brief information about the used analytical methodologies, in some parts already combined with the first results.

Chapter 3 “Evolution of metamict minerals with increasing temperature” descriptively provides – as it says in the title – the various changes within metamict minerals with temperature. The referee is aware of the fact that the chapter summarizes a lot of various observations that are the result of time-consuming measurements and processing of the gained data. Information about the heat treatment, i.e. how the heat treatment was performed and with the aid of which devices seem to be missing. The overwhelming information of all 6 minerals / mineral groups is a bit difficult to digest. I believe Ms. Chen was aware of this and smartly added brief summaries that conclude the findings for each mineral and she placed all her findings in relation to the scientific rationale of the PhD project.

Chapter 4 “New synthetic compounds related to minerals of the crichtonite group” focuses on the synthesis of minerals in the crichtonite structure with some rare earth elements (La^{3+} , Ce^{3+} , Nd^{3+}) as well as divalent cations like Ca^{2+} , Sr^{2+} or Ba^{2+} added in the crystal structure and consecutive determination of the magnetic properties as minerals of the crichtonite group might be well-suited archetypes for new minerals following the strategy “from minerals to materials”. Subsections summaries provide highlights of the findings, but they are not put in direct context to the scientific rationale of the PhD project that was still followed in chapter 3.

The final chapter of the thesis is the **conclusion chapter**. Ms. Chen was not only able to study in detail the changes in crystal structure and properties of metamict minerals as function of temperature but also to synthesize new compounds and fully characterize the crystal structures of all synthesized

compounds, including magnetic properties. Unfortunately, some kind of an evaluation is missing in respect to the "most ideal" crystal structure and resulting properties needed for minerals to be used as storage and protecting minerals, respectively, as well as an outlook to future needed work, including the information which potential storage minerals might be useful to studied next.

All chapters are reasoned in themselves. As the thesis project was multifold regarding the various aspects, logic flow unfortunately does only partly exist for the consecutive chapters.

However, it is beyond doubt that the submitted thesis of Ms. Chen is a 'solid piece of work' and the high level of the PhD is out of question.

Some comments of mine related to the individual chapters should not be counted or judged as criticism of Ms. Chen's work and her findings.

Ms. Chen should be granted the award of candidate of geological and mineralogical sciences at St. Petersburg State University - scientific specialty 1.6.4.: Mineralogy, Crystallography, Geochemistry, Geochemical Methods of Mineral Exploration.

The dissertation is a scientific qualification work that resolves a scientific problem important for the development of the relevant field of science or provides new science-based technical, technological or other solutions and developments vital for the national development.

No violations of paragraphs 9 and 11 of the Order No.11181/1 as of November 19, 2021 "On the Procedure for Awarding Academic Degrees at St. Petersburg State University" have been detected.

The dissertation meets the criteria of dissertations for the academic degree of candidate of sciences, established by the specified Order. The dissertation is recommended for the defense at St. Petersburg State University.

Member of the dissertation council
Full Professor, Head of Petrology and Mineralogy, Kiel University, Kiel – Germany



Prof. Dr. Astrid Holzheid

Institut für Geowissenschaften
der Universität Kiel
-Petrologie-
Olshausenstr. 40 • D-24098 Kiel