Reconstructing Ordovician climate changes and biotic turnovers using conodonts from Baltoscandia

Summary

Conodonts are extinct marine chordates that diversified during the Ordovician. Their fossil teeth, composed of bioapatite, constitute a unique archive of deep-time environments and climates. This project is focused on reconstructing Ordovician paleotemperature history within the Baltoscandian Palaeobasin using stable oxygen isotope records from conodont apatite. It involves the geochemical characterisation of conodonts and the application of in situ analytical techniques, notably SIMS. Combined with a taxonomic approach and improved palaeontological databases, the project aims to identify the transition from a greenhouse to an icehouse climate system and provide insights into its effects on conodont faunas in Baltica and worldwide.

Research field:	Earth sciences
Supervisors:	Prof. Dr. Olle Hints Dr. Peep Männik
Availability:	This position is available.
Offered by:	School of Science Department of Geology
Application deadline:	Applications are accepted between January 02, 2023 00:00 and January 22, 2023 23:59 (Europe/Zurich)

Description

Supervisors: Peep Männik and Olle Hints from the Department of Geology, School of Science, TalTech

Duration of the project: 4 years (2023–2027)

Conodont animals emerged in the latest Cambrian, diversified rapidly during the Ordovician Biodiversification and became extinct in the Triassic. The fossil record of conodonts is represented mainly by the teeth-like elements of their feeding apparatuses. The rapid evolution of conodonts and their abundant occurrence in marine sedimentary rocks make them useful biostratigraphic tools. Moreover, the stability of the mineral matter of conodont teeth (bio-apatite) constitutes an exceptional archive of sea-water composition. It allows for studying deep-time climate variations and environmental changes based on stable isotopes and other geochemical proxies.

Palaeozoic temperature estimates are almost exclusively based on oxygen isotope ($\delta^{18}O$) thermometry derived from various archives, notably phosphatic conodonts ($\delta^{18}O_{con}$) and calcitic brachiopods ($\delta^{18}O_{brach}$). These data suggest a global cooling trend during the Ordovician and a transition from a greenhouse to an icehouse climate system well before the Hirnantian glacial maximum and mass extinction. The oxygen isotope thermometry has its shortcomings related to possible diagenetic alteration of primary sea-water signals and uncertainties in Palaeozoic sea-water composition that influences temperature reconstructions. Moreover, in the case of the Baltica terrane that drifted towards progressively warmer climate regions during the Ordovician, the available oxygen isotope data contradict sedimentological and palaeontological evidence of climate change.

The PhD project will collect new data and evidence on $\delta^{18}O_{con}$ paleotemperature proxy from the latest Cambrian, through the Ordovician, and to the earliest Silurian, using existing and new samples from different parts of the Baltoscandian Paleobasin. The analytical techniques to be applied include in-situ SIMS (secondary ion mass spectrometry) work for measuring the $\delta^{18}O$ composition of individual conodont elements. The main outcome of the project will be a high-resolution time-constrained temperature reconstruction, with an improved understanding of individual and taxonomic variability and regional differentiation of $\delta^{18}O_{con}$ data across the palaeobasin. Possible effects of early marine diagenesis and late diagenetic overprints will also be assessed using other geochemical proxy indicators in conodonts and host rocks.

Additionally, the occurrence-level taxonomic database to be compiled allows the reconstruction of the turnover patterns and identifies possible links with climate change. This will allow assessing how the distribution of conodont

assemblages was affected by the changes in the environment in general and which factors might have played the controlling role in it. As a result, the project will give an idea of how the conodont faunas reacted to climatic perturbations occurring in the Ordovician and distinguish between the global and regional factors affecting the composition and distribution of conodont faunas.

The PhD student will work closely with other team members who work on oxygen and carbon isotope records from carbonates, sedimentary geochemistry and sedimentology, biostratigraphy and other microfossil groups.

Responsibilities

The project will include:

- Geological fieldwork for describing Ordovician sedimentary successions and collecting samples for micropaleontological, geochemical and sedimentological research;
- Laboratory work for microfossil extraction and preparation of conodont samples for analytical work;
- Identification of conodonts in existing and new collections;
- Running in-situ geochemical analyses of conodonts using SIMS, ICP-MS, SEM and other tools,
- contributing conodont data to an integrated database, combined with input from other team members;
- Presenting the results in seminars, workshops an conferences,
- Writing scientific publications (three papers in international peer-reviewed journals are required) together with other team members;
- Taking part in PhD courses and involvement in teaching undergraduates according to the specification of the doctoral study programme at TalTech.

Requirements and beneficial experiences

- MSc degree in palaeontology, geology, or a related subject
- a clear interest in the topic of the position
- proficiency in English
- strong and demonstrable writing skills
- capacity to work both as an independent researcher and as part of an international team

The successful candidate is expected to have a background in micropalaeontology and a good understanding of sedimentary geology and geochemistry. Prior knowledge of conodonts (taxonomy, biostratigraphy, sample processing), experiences with laboratory processing and analytical techniques, and a good understanding of Early Palaeozoic Earth history are beneficial for the position.

We offer

- Friendly community and modern working atmosphere within TalTech campus in Tallinn, capital of Estonia.
- Supervision by some of the best experts on Palaeozoic microfossils worldwide. Becoming a member of an Estonian national multi-institutional research project and team. Tight international collaboration and regular visits to other European research centres, participation in conferences and workshops annually for presenting the results and building a network of research contacts.
- Gross income starting from EUR 1600 per month (increase depending on performance).

TalTech Department of Geology

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