Polish Geological Society
Faculty of Geology, University of Warsaw
Institute of Palaeobiology, Polish Academy of Sciences
Polish Geological Institute-National Research Institute

10th Baltic Stratigraphic Conference

Chęciny 12–14 September 2017

Abstracts and Field Guide

Edited by Anna Żylińska

Faculty of Geology, University of Warsaw
Warszawa 2017

Chitinozoan response to a gigantic Late Ordovician volcanic ash fall recorded in northern Estonia

Olle Hints[1], Garmen Bauert[1], Irina Grigorjeva[1], Jaak Nõlvak[1], Tõnu Meidla[2] and Vincent Perrier[3]

[1]*Department of Geology, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia; olle.hints@ttu.ee; gbauert@yahoo.com; ira.grigorjeva@gmail.com; jaak.nolvak@ttu.ee*
[2]*Department of Geology, University of Tartu, Ravila 14a, 50411 Tartu, Estonia; tonu.meidla@ut.ee;*
[3]*Laboratoire de Géologie de Lyon: Terre, Planète, Environnement, UMR CNRS 5276, Ecole Normale Supérieure de Lyon, 69364 Lyon cedex 07, France; vincent.perrier@univ-lyon1.fr*

The Ordovician period witnessed many volcanic eruptions that are now recorded as bentonites within marine successions in different continents and regions. The Late Ordovician Kinnekulle bentonite is the thickest and most widespread volcanic ash layer in Baltoscandia, representing one of the largest known eruptions in the entire Phanerozoic (Huff *et al.* 1992; Bergström *et al.* 1995). The Kinnekulle Bed is also an important chronostratigraphic horizon, marking the base of the Keila Regional Stage in Baltic stratigraphy, and has been recently dated as 454.52 ± 0.50 Ma (Svensen *et al.* 2015).

The biotic effects of the Kinnekulle ash fall have generally been considered negligible (Huff *et al*. 1992). However, Hints *et al.* (2003) and Perrier *et al.* (2012) have documented its influence on benthic communities, particularly ostracods and polychaete worms, which show re-organization of communities and extinction of some species following the ash fall. The effect of the event on planktonic groups has remained poorly known. When studying the distribution of organic-walled microfossils across the Kinnekulle bentonite in the Männamaa core, western Estonia, Nõlvak (2008) concluded that the ash fall had no visible effects on prasinophycean algae and chitinozoans. In this study we examine the distribution of chitinozoans across the ash fall interval in further detail using quantitative data and higher resolution sampling. Our aim was to detect any patterns in abundance, diversity and assemblage structure that could indicate possible influence of the ash fall on planktonic groups and compare the chitinozoan data with previously studied benthic groups. This would allow for a better understanding of biotic effects of gigantic volcanic ash falls and might also provide new insights into chitinozoan palaeoecology.

Bed-by-bed sampling below and above the Kinnekulle bentonite was carried out in two outcrop sections, 64 km apart, in northern Estonia. The Põõsaspea cliff, NW Estonia, has previously been studied for ostracod response to the ash fall (Perrier *et al.* 2012). Here we utilize the same set of bulk samples for chitinozoans covering about 1.4 m of the limestone succession. The Laagri construction pit section, at the southern border of Tallinn, is close to the previously studied Pääsküla Hillock section of Hints *et al.* (1999, 2003) and covers *c.* 1.8 m of strata. A total of 50 samples, 10–50 g each, were dissolved using diluted hydrochloric acid to extract organic-walled microfossils. All chitinozoans and scolecodonts were hand-picked from the residue, identified and counted. Other groups such as prasinophycean algae abundant in the Haljala and Keila stages, foraminiferans, hydroids and graptolite fragments were picked selectively.

The recovered chitinozoan fauna consists of at least 23 species. A number of specimens could only be identified at generic level or as Chitinozoa indet. due to poor preservation in many samples. The abundance of chitinozoans varied from less than one to *c*. 22 vesicles per gram of rock. In the Põõsaspea section a clear trend in abundance was observed: the pre-event values continued in the first carbonate layers above the bentonite, followed by a gradual six-fold increase with a peak at *c*. 20 cm above the bentonite and then returned to 'normal values' of less than five vesicles per gram of rock. A similar pattern was observed in the Laagri section, but the post-event peak was less pronounced and the average abundance through the section was *c*. two times lower than in the Põõsaspea cliff section. Notably, the abundance peak in the Põõsaspea section coincides with the interval of lowest chitinozoan diversity, whether measured by simple species richness or diversity indices, such as the Shannon index.

Current data combined with previous knowledge on Baltoscandian chitinozoans suggests that none of the species became extinct at the level of the Kinnekulle bentonite. However, concerning the relative abundance of individual taxa, the same interesting pattern emerged from both sections studied. The pre-event faunas were dominated by *Belonechitina comma*, accounting for 40–60% of the assemblage. After the ash fall, the abundance of *B. comma* dropped abruptly and *Euconochitina primitiva* peaked in relative abundance in two successive samples, to be followed by the bloom of *Desmochitina* spp. in the next few samples. After the *Demochitina* peak, *c*. 30 cm above the bentonite, the assemblage structure, diversity and abundance returned to background values, similar to those in the pre-event samples. In higher strata the abundance of *B. comma* gradually increased in both sections.

We conclude that the observed abundance bloom, diversity decline and reorganization of the assemblages just above the Kinnekulle Bed most likely express direct biotic influence of the volcanic ash fall on chitinozoan parent animals. Changes in chitinozoan faunas were less severe than in the case of benthic ostracods and no chitinozoan taxa became extinct as a result of the ash fall. However, it seems that the effects persisted for approximately the same time period as for the ostracods, corresponding to *c*. 30 cm of the limestone succession above the top of the Kinnekulle Bed. The time equivalent of these beds must be less than *c*. 30 ky based on recent radiometric dates of multiple bentonites by Svensen *et al.* (2015), but perhaps only a few ky as estimated by Perrier *et al.* (2012), or even less.

Apart from documenting the effect of the ash fall on chitinozoans, our study revealed the zonal species *Angochitina multiplex* in both sections. This chitinozoan has one of the shortest ranges in the Baltic region, occurring, often abundantly, just above the Kinnekulle bentonite (Hints and Nõlvak 1999). Thus, it is a valuable criterion for the base of the Keila Regional Stage in places where the bentonite is missing or cannot be unambiguously identified. In the Põõsaspea and Laagri sections, *A. multiplex* occurs 0.68–0.76 m and 1.15–1.4 m above the top of the Kinnekulle Bed, respectively. This confirms the very short temporal range of the species, but poses a question if it is slightly diachronous or, alternatively, the post-ash fall interval below the FAD of *A. multiplex* is very condensed or missing in previously studied sections. This aspect should be examined further in other sections to provide insights into depositional patterns and patchiness within the Late Ordovician Baltoscandian Basin.

Acknowledgements. This study is a contribution to IGCP Project 653 "The onset of the Great Ordovician Biodiversification Event" and was supported by the Estonian Research Council.

Bergström, S.M., Huff, W.D., Kolata, D.R. and Bauert, H. 1995. Nomenclature, stratigraphy, chemical fingerprinting, and areal distribution of some Middle Ordovician K-bentonites in Baltoscandia. *GFF*, **117**, 1–13.

Hints, O., Hints, L., Meidla, T. and Sohar, K. 2003. Biotic effects of the Ordovician Kinnekulle ash-fall recorded in northern Estonia. *Bulletin of the Geological Society of Denmark*, **50**, 115–123.

Hints, O. and Nõlvak, J. 1999. Proposal for the lower boundary stratotype of the Keila Regional Stage (Upper Ordovician). *Proceedings of the Estonian Academy of Sciences. Geology*, **48**, 158−169.

Huff, W.D., Bergström, S.M. and Kolata, D.R. 1992. Gigantic Ordovician volcanic ash fall in North America and Europe: biological, tectonomagmatic, and event-stratigraphic significance. *Geology*, **20**, 875–878.

Nõlvak, J. 2008. Distribution of Ordovician chitinozoans. Männamaa (F-367) drill core. *Estonian Geological Sections*, **9**, 13–18.

Perrier, V., Meidla, T., Tinn, O. and Ainsaar, L. 2012. Biotic response to explosive volcanism: Ostracod recovery after Ordovician ash-falls. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, **365–366**, 166–183.

Svensen, H.H., Hammer, Ø. and Corfu, F. 2015. Astronomically forced cyclicity in the Upper Ordovician and U–Pb ages of interlayered tephra, Oslo Region, Norway. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, **418**, 150–159.