Early metazoan evolution: Neoproterozoic Snowball Earth, Cambrian Explosion and the Great Ordovician Biodiversification

Place:
North and Northeast Greenland, Svalbard.

Disciplines:
The project will involve multi- and interdisciplinary work. The multi- and interdisciplinary approaches involve geology, geophysics, geochemistry, palaeontology, molecular evolution and developmental biology. Scientists from several institutes in Denmark and elsewhere will be involved in the work.

Motivation:
The aim of the project is to investigate late Precambrian to early Palaeozoic palaeoclimatic and biological changes using biotic, isotopic and sedimentological signals thus providing data to test and frame hypotheses regarding, for example, the early colonization of land by fungi and plants. These data are a necessity for 1) Palaeoclimatic studies associated with Snowball Earth, when the Earth was completely covered by ice, and 2) palaeontological studies of the Cambrian explosion and the following Ordovician radiation.

Research:
The approach is in the first instance field based. Collections from a series of incomparable exposures in eastern North Greenland, Northeast Greenland and Svalbard form the basis of this multidisciplinary project.

Scientific background
Major advances in the knowledge of Earth and biotic history in the late Precambrian and early Palaeozoic, especially during the Neoproterozoic (1000ˆ545 Ma), have driven a variety of new research areas during the last ten years. According to these discoveries the Earth may have passed through several cycles of global glaciations during the period 750ˆ580 Ma, each of them possibly characterized by the complete freezing of all of the planet,s oceans for 10 myr or longer. At the same time molecular clocks have suggested that major groups of complex multicellular organisms such as plant, animals and fungi were present during, if not before, these global glaciations. Moreover, fossils of complex organisms, metazoan embryos and trace fossils have been found considerably earlier than expected. Nevertheless the main explosion of body plans occurred during the early to mid Cambrian whereas the main expansion of numbers of animals occurred during the early Ordovician. Key exposures in the Arctic region provide unequalled opportunities to chart these events and tie them to climatic and environmental changes over an interval of several hundred million years. The Arctic regions provide some of the best-exposed and accessible sections through these critical intervals in earth history. These areas provide an unique opportunity to develop models for early metazoan evolution and to train younger scientists in field, laboratory and numerical methods. Field work is planned on Spitsbergen, in Northeastern and eastern North Greenland. The project requires logistic support for a base camp with a convenient location in the Arctic region. Fixed winged aircrafts and helicopters are needed. The work will be carried
out with groups in lightweight camps.

The team
The basic working group is composed of staff members from the Geological Museum in Copenhagen, University of Copenhagen (within the Natural History Museum of Denmark and Geocenter Copenhagen) and the University of Oxford; but the group has a large international network of relevant expertise. The group of participants is planned to be expanded to comprise a number Ph.D. students and Post. Docs. These will be recruited from Denmark and abroad. This young group of researchers will target specific problems, with a training aspect, in the field and the laboratories and within the scope of the large umbrella of the proposed project.

Implications of the project
Determining the biological and environmental background for the glacial events followed by the Cambrian explosion and Ordovician diversity are currently areas of high profile research. The proposed research project will give results that greatly improve the understanding of palaeoclimatical, biological and palaeontological changes from greenhouse to icehouse and back to greenhouse environments in deep time.