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Geological Research through Integrated Neoproterozoic Drilling (GRIND): The Ediacaran-Cambrian Transition

Catherine Rose (1), Anthony Prave (1), Kristin Bergmann (2), Simone Kasemann (3), Francis Macdonald (4), Karl-Heinz Hoffmann (5), Ricardo Trindade (6), and Maoyan Zhu (7)

(1) University of St Andrews, School of Earth & Environmental Sciences, St Andrews, United Kingdom (cvr@st-andrews.ac.uk), (2) Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, (3) MARUM – Center for Marine Environmental Sciences and Faculty of Geosciences, University of Bremen, Germany, (4) Department of Earth Sciences, University of California Santa Barbara, CA 93106, USA, (5) Regional Geoscience Division, Geological Survey of Namibia, Windhoek, Namibia, (6) Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, 05508-900 São Paulo, Brazil, (7) Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences, Nanjing 210008, China

The Neoproterozoic Era (1000 - 541 Ma) is one of the most dramatic in Earth history: metazoans evolved, the supercontinent Rodinia formed and broke apart, the global carbon cycle underwent high-amplitude fluctuations, oxygen concentrations rose and climate experienced at least two episodes of worldwide glaciation. However, the discontinuous and fragmented nature of outcrop-based studies has hindered developing quantitative models of Earth system functioning during that Era. The Geological Research through Integrated Neoproterozoic Drilling (GRIND) project will begin to rectify this scientific shortcoming by obtaining 13 cores, each from 150 to 550 m, through the archetype successions that record the environmental and biogeochemical context during which animals evolved. The specific targets are the Ediacaran-Cambrian transition (ECT; c. 560-530 Ma) strata of west Brazil (Corumbá Group), south China (Doushantuo, Dengying and equivalent formations) and south Namibia (Nama Group). Our objective is to create a core network of correlative ECT strata that will enable constructing a highly resolved, temporally constrained geobiological, stratigraphic and geochemical database, as well as provide a legacy archive for future research. The goal is to understand the drivers of the Neoproterozoic Earth system revolution: it began with simple eukaryotes that populated Earth during the preceding billion years of the Mesoproterozoic, underwent multiple Snowball Earth events, and emerged with the oxygenated, diverse ecosystems of the Cambrian.

The three-nation drilling programme will be undertaken sequentially: drilling will commence in Brazil in 2019, with successive drilling in China and Namibia. The identified drill sites will sample shallow-to-deeper marine rocks across shelf-to-basin transects. The work aims to 1) construct a highly resolved temporal framework that will lead to the development of age models for the ECT; 2) refine the patterns of biotic evolution of organic-walled and mineralised microfossils, metazoans and trace fossils, and identify the links between and test hypotheses about biological evolution and environmental change, and 3) determine the palaeoenvironmental and biogeochemical conditions that led to the rise of oxygen and distinguish cause-and-effect relationships and basin-specific versus global-scale secular trends in geochemical and stable isotope patterns.

All cores will be split into halves with one-half being archived in repositories within each of the target nations and used for research purposes by GRIND-ECT scientists and for education and training for national capacity building and outreach activities. The other half of all cores will be shipped to the Federal Institute for Geosciences and Natural Resources in Berlin-Spandau, Germany, for permanent archiving. The cores at all the repositories will be available for future research and education activities and will mark the first step towards creating an on-shore continental scientific drilling archive that will match in stature that of the IODP.