



## **An abrupt extinction in the Middle Permian (Capitanian) of the Boreal Realm with a causal link to anoxia, acidification and mercury poisoning**

David Bond (1), Paul Wignall (2), Michael Joachimski (3), Yadong Sun (3,4), Ivan Savov (2), Stephen Grasby (5,6), Benoit Beauchamp (6), and Dierk Blomeier (7)

(1) Department of Geography, Environment and Earth Sciences, University of Hull, Hull, HU6 7RX, United Kingdom (d.bond@hull.ac.uk), (2) School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, United Kingdom, (3) Geozentrum Nordbayern, Universität Erlangen-Nürnberg, Schlossgarten 5, 91054 Erlangen, Germany, (4) State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, 388 Lumo Road, Wuhan, 470073, Hubei Province, P.R. China, (5) Geological Survey of Canada, 3303 33rd Street N.W., Calgary, Alberta, T2L 2A7, Canada, (6) Department of Geoscience, University of Calgary, 2500 University Dr. N.W., Calgary Alberta, T2N 1N4, Canada, (7) Millennia Stratigraphic Consultants, 35 Swansfield, Lechlade-on-Thames, Gloucestershire, GL7 3SF, United Kingdom

The controversial Capitanian (Middle Permian, 262 Ma) extinction event is mostly known from equatorial latitudes and consequently its global extent is poorly resolved. We demonstrate that there were two, severe extinctions amongst brachiopods in northern Boreal latitudes (Spitsbergen), in the Middle to Late Permian, separated by a recovery phase. New age dating of the Kapp Starostin Formation of Spitsbergen using strontium and carbon isotopic trends suggests that the first crisis occurred in the Capitanian. This age assignment indicates that this Middle Permian extinction is manifest at higher latitudes. Redox proxies (pyrite framboids and trace metals) show that the Boreal crisis coincided with an intensification of oxygen depletion, implicating anoxia in the extinction scenario. The highly toxic metal mercury becomes enriched in strata at the Middle Permian extinction level implicating death-by-toxicity (and a possible link to volcanism). Finally, the near-total loss of carbonates across the Boreal Realm in the Middle to Late Permian also suggests a role for acidification. New in prep. data from Ellesmere Island, Arctic Canada (samples collected July 2015) tentatively suggests that this potent “three strikes and you’re out” extinction mechanism was a Boreal-wide phenomenon. The Late Permian recovery interval saw the appearance of new brachiopod and bivalve taxa alongside survivors, and an increased mollusk dominance, resulting in an assemblage reminiscent of younger Mesozoic assemblages. The subsequent end-Permian mass extinction terminated this Late Permian radiation.