Did methane generated by igneous sills drive the Paleocene-Eocene Thermal Maximum?

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Background The Paleocene-Eocene Thermal Maximum (PETM) was a rapid, extreme, global warming event that provides a natural analogue for modern anthropogenic climate change. PETM warming was forced by an unusually high concentration of the greenhouse gas methane in the atmosphere. A leading hypothesis is that this methane was generated by thermal maturation when igneous sills of the North Atlantic Igneous Province (NAIP) intruded organic-rich sedimentary rock. The methane escaped to the atmosphere through hydrothermal vents that have been observed on seismic reflection data and in drill core. This cross-disciplinary studentship offers the chance to model both generation of methane in the solid earth and also the climatic consequences of methane in the atmosphere, in order to test the hypothesis that NAIP sills caused the PETM global warming.

Aims and Objectives The project will begin by assembling databases of North Atlantic sill, vent and host-rock locations, ages and dimensions. This information will be used to drive numerical models of methane generation and expulsion to the atmosphere. Atmospheric chemistry simulations will then be performed to test whether the North Atlantic Igneous Province generated methane fast enough to explain the PETM global warming.

Methods The data collection phase will be based on our own extensive collection of seismic images and borehole data. Methane generation and expulsion rates will be calculated using in-house software that combines a thermal model of an intruding and cooling igneous sill, an organic maturation model from the oil industry and a hydrothermal vent model developed by the diamond industry. Atmospheric chemistry modelling tools include simple box models for methane and carbon dioxide, two-dimensional full chemistry and circulation models, and radiative forcing models. Full training will be provided in all aspects of data interpretation, solid earth and atmospheric modelling, as appropriate to the student's background.

Birmingham is an ideal location for a project spanning solid earth and atmospheric science. Our Geosystems research group has excellent links with the oil industry, who supply most of the data used to measure the igneous sills, and we have internationally recognized expertise in the Paleocene-Eocene Thermal Maximum and the North Atlantic Igneous Province, as well as seismic data processing and interpretation, emplacement of igneous sills and numerical modelling of solid earth processes. Birmingham also has a strong research track record in Atmospheric Science, including members of the UK National Centre for Atmospheric Science, and specific expertise in tropospheric oxidation chemistry.

References

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Applicants with BSc or MSci in Geoscience or Atmospheric Science are invited to contact Stephen Jones (s.jones.4@bham.ac.uk) to discuss the project