The Rise and Demise of the North China Craton (Ref IAP2-18-165)

Durham, Department of Earth Sciences
In partnership with Glasgow University

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Key Words
North China Craton, Geodynamics, Metasomatism, Numerical modelling, Subduction

Overview
The North China Craton (NCC, Figure 1) has been extensively studied in recent years, partly because it demonstrates the processes involved in the formation of continental crust in the Archaean, but also because it is an unusual example of cratonic destruction. The mantle root to the craton was destroyed in Mesozoic-Cenozoic times, over two billion years after it formed, while the crust was deformed in a series of tectonic and magmatic events, connected in some way to marginal collisions and subduction zones.

This project will explore possible scenarios for the destruction of the craton (Figure 2), using state-of-the-art modelling techniques to understand i) the control of different parameters on the evolution and potential removal of mantle lithosphere from beneath the NCC ii) the consequences of different models for the tectonic and magmatic evolution of the region.

The project builds on extensive research into continental evolution conducted at Durham, in collaboration with geochemical expertise at Glasgow University.

Methodology
The destruction of the North China craton potentially involve a range of processes on different length- and timescales, and a number of processes have been suggested to be responsible for the destruction of this craton, including subduction, suture re-activation, melt- and fluid metasomatism, and small-scale convective instabilities. Combined geodynamical and petrological modelling in this project will be done with the state-of-the-art community-supported code ASPECT (https://aspect.geodynamics.org) coupled to the widely used software Perple-X (http://www.perplex.ethz.ch/).

ASPECT has been designed for a range of different geodynamical problems (e.g. Figure 3; Dannberg and Heister, 2016), uses cutting-edge numerical techniques for optimal performance, is very well documented, and is extensible to tailor for individual needs. Further examples of the ASPECT code in action can be found here. By combining these geodynamical-petrological models with observational data sets (including seismic tomography, kimberlite xenolith data, tectonic activity, as well as timing, distribution, and composition of intraplate volcanism), we aim to further our understanding of the thinning of...
the North China cratonic lithosphere and destruction of its lithospheric keel.

![Figure 2) Illustration of the different models proposed for the destruction of cratonic lithosphere (Lee et al., 2011).](image)

The project builds on from previous work by the supervisors on craton formation and destruction (Wang et al., 2014; 2016) as well as structural and geochemical analyses of the region (Wang et al., 2018). The project will furthermore benefit from project partners in Canada (Graham Pearson, University of Alberta) and France (Pierre Bouilhol, CRPG, Nancy).

**Timeline**

**Year 1)** Gaining familiarity with the project through literature review, introduction and training in numerical modelling and the software package ASPECT, IAPETUS DTP training, and attendance of a first conference; 9-month progress report.

**Years 2)** Further development of numerical models and parameter sensitivity analyses; compilation and qualitative comparison of model results to observables; 21-month progress report; preparation for publication of first key results in a peer-reviewed journal.

**Years 3)** Finalizing numerical modelling results by full integration of geodynamical models with observables, such as seismic tomography, kimberlite xenolith data, tectonic activity, and magmatism; 33-month progress report; first publication and preparation for publications of further research.

**Final 6 months)** Finalizing further publications of research outcomes; thesis completion and submission.

**Training & Skills**

The student will become part of a vibrant research culture in the department of Earth Sciences, in which ~80 PhD students work on a wide range of Earth

Science research projects. In particular, the student will closely collaborate with the academic staff, postdoctoral researchers and fellows, and postgraduate students in the geodynamics research group.

![Figure 3) Numerical simulation of lithospheric destabilization using ASPECT. Figure from the ASPECT user manual at https://aspect.geodynamics.org, after Dannberg and Heister (2016).](image)

The student will become part of the IAPETUS DTP, which offers a multidisciplinary package of training focused around meeting the specific needs and requirements of each of our students who benefit from the combined strengths and expertise that is available across our partner organisations.
Further training will be provided in geodynamical modelling (programming, code development, model setup, and usage) as well as data management of high-performance computing systems. The project is an opportunity for the student to become proficient in computer programming and large dataset analysis, with support from an enthusiastic modelling community. ASPECT is open source with an importance placed on member participation in development (which is done in the open at https://github.com/geodynamics/aspect), allowing for worldwide collaboration and education (e.g., through Hackathons and public meetings).

The student is expected to attend national and international conferences to disseminate research results and to spend time away from Durham to integrate project partners at the partner institutes.

References & Further Reading


Further Information

For any information on the project, the geodynamics group, the department of Earth Sciences or, more generally, matters related to doing a PhD in Durham, please feel free to contact Jeroen van Hunen (jeroen.van-hunen@durham.ac.uk).