

## Geodynamic mechanisms for building Earth's first continents

### Supervisory Team

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### Key Words

Metamorphism, tectonics, Archean, fieldwork, petrological modelling

### Overview

Today, continental crust forms at convergent plate margins, driven by the subduction of oceanic lithosphere (Hawkesworth et al., 2015); however, much petrological, geochemical, isotopic, and field evidence suggests that voluminous continent formation during the Archean (4–2.5 Ga) occurred in intraplate geodynamic environments instead (Palin et al., 2016; Piccolo et al., 2019). This research project will test the validity of two competing hypotheses for continent formation on the early Earth: mobile-lid (plate tectonic) vs. stagnant-lid (non-plate tectonic) regimes.

Fieldwork, mapping, and sample collection will be performed in parts of the Lewisian Complex, northwest Scotland, which contain a wide variety of well-preserved metamorphic and magmatic rock types that are of prime importance for addressing this question (e.g. Feisel et al., 2017).

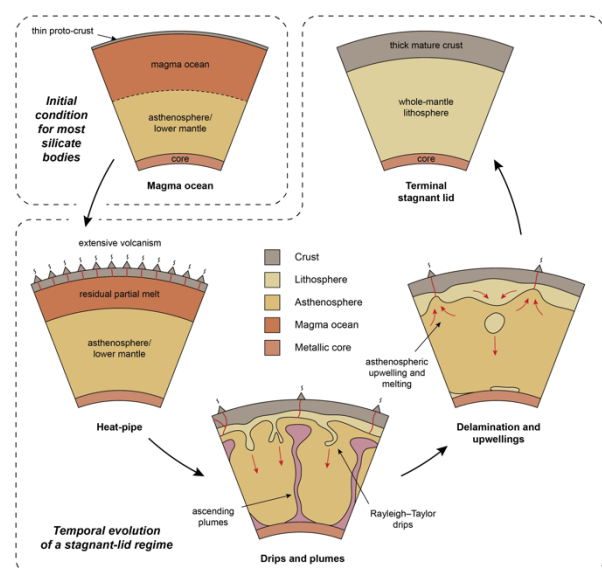


Figure: the temporal evolution of a stagnant-lid tectonic regime on a large rocky planet, such as Earth. The viability of each geodynamic environment for producing voluminous continental crust on the early Earth is strongly debated.

Prior geochronology performed on rocks from this region show that metamorphism and deformation occurred between c. 3.0 Ga and c. 2.7 Ga, which represents a critical time period in Earth evolution. This research will thus identify the geological processes responsible for forming Archean continental crust and help to evaluate when and how plate tectonics began on Earth. Such results have wide-ranging implications for the geological evolution of other rocky bodies in our solar system (e.g. Venus, Mars, the Moon) and for the potential habitability of exoplanets.

### Methodology

Fieldwork will involve geological mapping and collection of a variety of metamorphic and magmatic rocks. Subsequent laboratory work will involve bulk-rock and mineral chemical analysis, with these data used to perform thermobarometry and petrological modelling. Isotope geochronology will be used to constrain the absolute ages and rates of metamorphism, for example using *in-situ* U–Pb analyses of zircon and monazite.

A student working on this project will gain direct experience in the following tools and techniques:

- X-ray fluorescence (XRF)
- Scanning-electron microscopy (SEM)
- Electron probe micro-analysis (EPMA)
- Laser ablation inductively coupled mass spectrometry (LA-ICP-MS)
- Petrological modelling software (e.g. THERMOCALC, Theriak-Domino)

### Timeline

**Year 1:** Doctoral training courses, literature review, fieldwork planning, fieldwork and sample collection, sample characterisation, and laboratory training.

**Years 2 and 3:** Microanalytical work (XRF, SEM, EPMA), isotope geochronology (LA-ICP-MS), and petrological modelling. Data compilation and interpretation. Presentation of results at the Geological Society of London 'Metamorphic Studies Group' and 'Tectonics Studies Group' annual meetings.

**Year 4:** Data integration, thesis completion, write papers for international journals, presentation of results at an international conference.

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## Training & Skills

An ideal student for this project would enjoy conducting fieldwork, laboratory analysis, and petrological modelling in equal measure. They will learn how to plan and carry out a field sampling campaign, how to process and analyse samples in the laboratory, and be trained on a range of micro-analytical equipment. They will be trained how to apply phase equilibria calculations to natural samples and how to interpret the results within the framework of an initial hypothesis posed. The student will also be mentored on how to prepare scientific results for presentation at international conferences and how to write papers for publication in high-profile, international journals.

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## References & Further Reading

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## Further Information

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