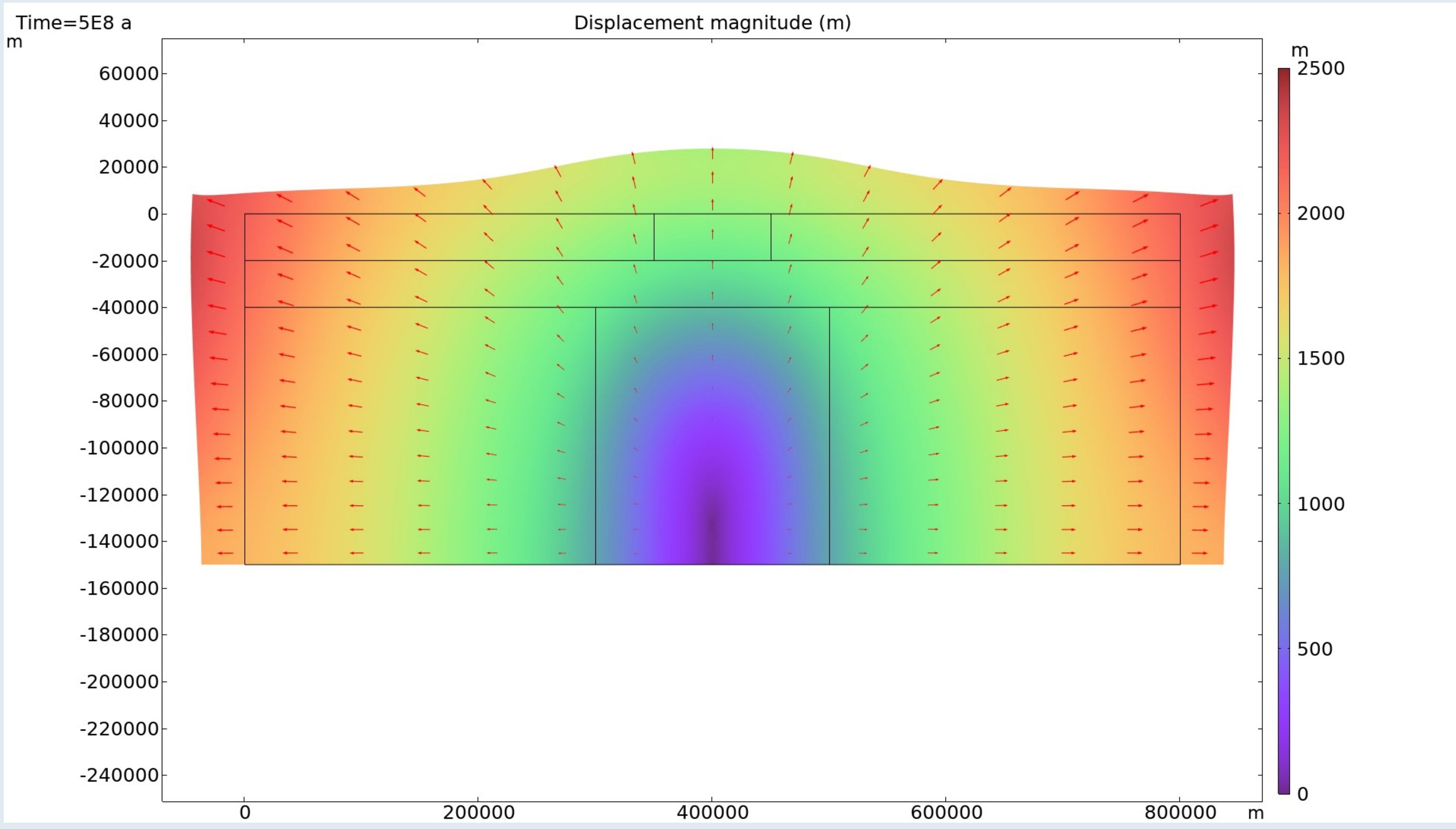


# Modelling of Intracontinental Rift Initiation

In this study, I examine how the increased content of radioactive elements within the post-orogenic continental mantle lithosphere affects the thermal and mechanical state of the lithosphere, particularly in the context of intracontinental rifting.

Y.P. Maystrenko
Geological Survey of Norway (NGU), Trondheim, Norway.

## Introduction

The lithospheric mantle often undergoes enrichment in incompatible chemical elements during ocean closure and collisional orogeny. This enrichment is most pronounced during the subduction of sedimentary rocks and crystalline crust derived from continents. Uranium and thorium are radioactive isotopes that belong to the group of high-field-strength elements (HFSE), whereas the radioactive isotope of Potassium is part of Large-Ion Lithophile Elements (LILE). All three radioactive isotopes are incompatible elements and can exhibit increased concentrations in the post-orogenic lithospheric mantle. The increased content of uranium, thorium and potassium in the post-orogenic mantle is well reflected in the composition of potassic and ultrapotassic magmas, which can be extremely rich in these elements. This enrichment is well-documented by geochemical studies and, therefore, must be considered during the numerical modelling of rifting processes.

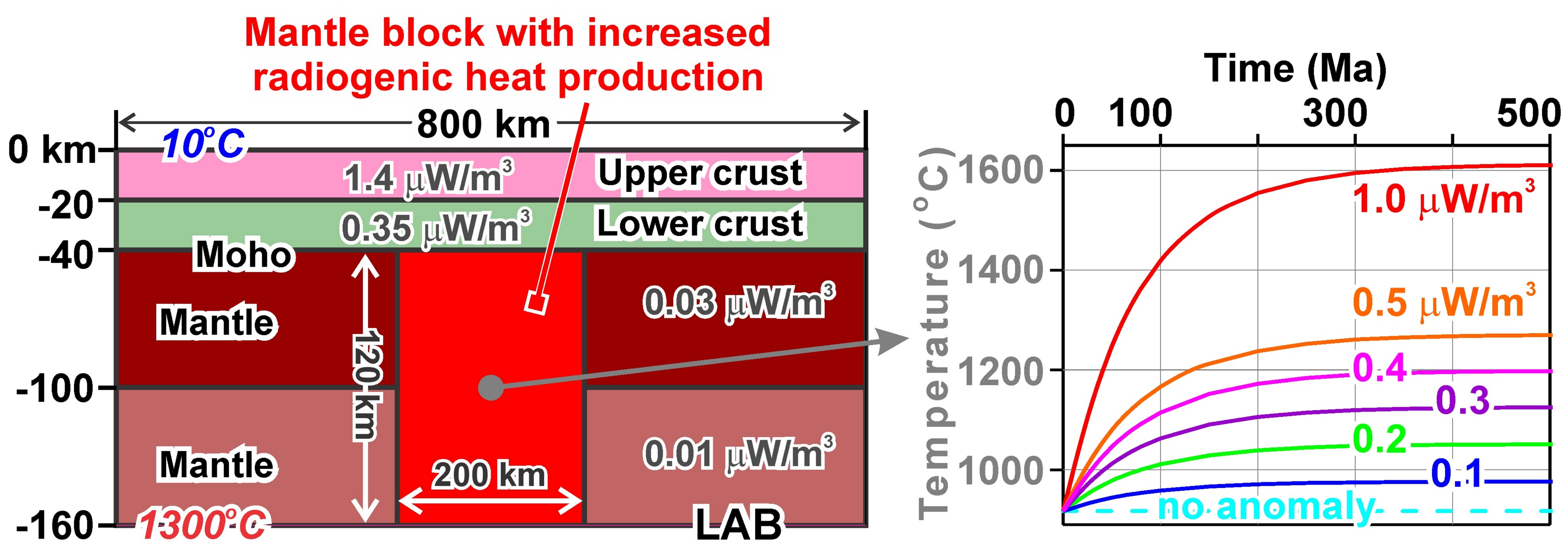


FIGURE 1 (Ref. 1). Left: Configuration and parameters of the purely conductive model. Right: Modelled time-dependent temperatures within the middle of the anomalous mantle block for varying radiogenic heat production.

## Methodology

To understand the mechanism of rifting, lithosphere-scale 2D models were used during the 2D conductive thermal modelling and 2D modelling of coupled heat transfer and elastic deformations of the lithosphere. In the purely conductive 2D thermal modelling, the "Heat Transfer in Solids" interface of COMSOL® was only used to simulate stationary and time-dependent heat transfer by conduction, which is presumed to be the dominant heat transfer mechanism at the regional scale within the solid lithosphere. Additionally, two COMSOL® interfaces, "Heat Transfer in Solids" and "Solid Mechanics" (Linear Elastic), were used to conduct a fully coupled thermal modelling that takes into account the thermal expansion of the lithosphere due to the decay of radioactive elements.

## Results

According to the purely conductive 2D thermal modelling (Figure 1), the anomalously high content of radioactive elements in the post-orogenic lithospheric mantle leads to a time-dependent temperature increase, creating favorable conditions for rifting after the orogeny. The time gap between the orogeny and the temperature increase within the lithosphere is governed by two main factors: (1) the quantity of the radioactive isotopes and (2) the size of the hosting lithospheric mantle (Ref. 1). According to the 2D thermo-mechanic modelling (Figure 2), the post-orogenic temperature rise induces thermal expansion of the lithosphere, which is sufficient to trigger the initial stage of intracontinental rifting without the need for external, regional-scale, extensional, tectonic forces.

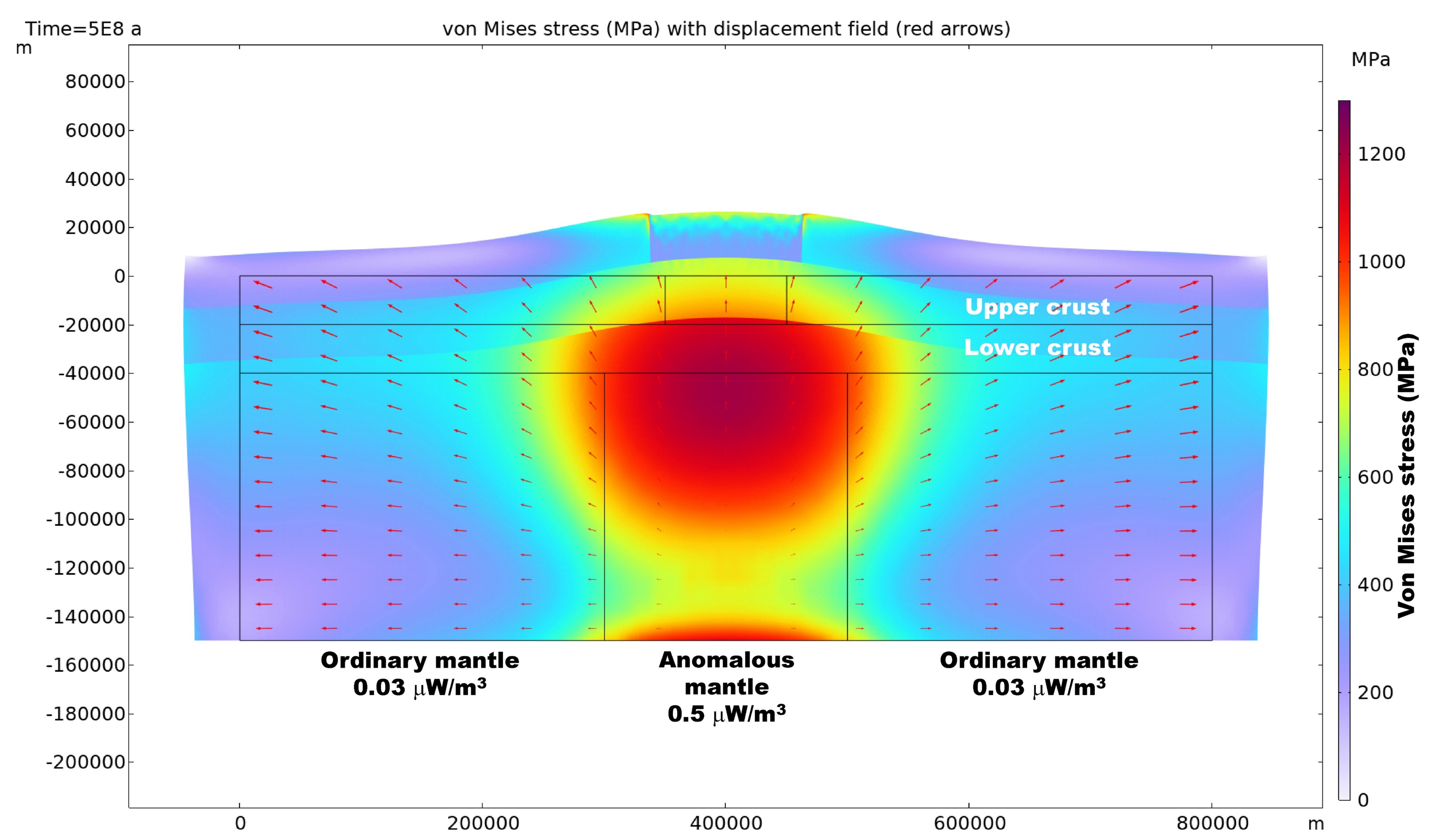


FIGURE 2. Modelled von Mises stress distribution (coefficient of thermal expansion is 0.000032 1/°C; visualization scale factor for thermal expansion is 20).

REFERENCES

1. Maystrenko, Y.P., Slagstad, T., 2020. Radiogenic trigger and driver for continental rifting and initial ocean spreading. Terra Nova, 32 (2), 159-165, doi: 10.1111/TER.12444

GEOLOGICAL SURVEY OF NORWAY
- NGU -