

## COMPETITION FUNDED

# Imaging the multi-scale landscape of Earth's core-mantle boundary

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### Project background

Similar as on the Earth's surface, intriguing **landscapes** are present deep inside our planet. To image these landscapes and gain critical insights into the dynamic processes that have shaped the evolution of our planet, surface recordings of seismic waves generated by earthquakes are typically used. Particularly, it is crucial to image the landscape of the core-mantle boundary (CMB). At this boundary, dynamic processes interact that are vital for life on Earth – with mantle flow driving plate tectonics and outer core flow sustaining our protective magnetic field. Despite many studies over the last 50 years, no consensus exists on the amplitude or pattern of CMB topography. In addition, there is a discrepancy between models based on observations of high-frequency travelling waves or long-period standing waves (Koelemeijer, 2020), which provide information on different scale lengths. Besides, it was recently recognised that robust estimates of CMB topography can help solve the debate regarding the origin of large structures in Earth's lowermost mantle (Deschamps et al., 2017).

#### **Research methodology**

This PhD project aims to image the dynamic topography of the CMB by using high-resolution data combined with novel seismic data processing methods. By using a new inverse method (Zaroli, 2016), the developed CMB topography models will have amplitudes that truly reflect real Earth structure and be accompanied by full uncertainty information. Crucially, new and existing observations of both travelling and standing seismic waves will be incorporated. Combining insights from both data types within one framework is vital for building a consistent CMB topography model (Koelemeijer, 2020). The student will compare the resulting models to predictions based on geodynamic simulations of mantle flow, with the aim to constrain the characteristics of lower mantle structure and to further our understanding of this enigmatic region inside the Earth.

#### Training

The PhD student will receive training in data analysis, computational and inverse methods as well as general research and communication skills. The student will benefit from being part of the DEEPSCAPE group at Royal Holloway and interaction with collaborators abroad.

#### Person specification

This project is suited for students with strong quantitative skills, notably in mathematical analyses and programming (e.g. geophysics or physics background).

## Key references

**Koelemeijer, P. (2020).** Towards consistent seismological models of the core-mantle boundary landscape. *Review chapter in press in: Mantle upwellings and Surface expressions, AGU Books.* <u>https://doi.org/10.1002/essoar.10502426.1</u>

Deschamps, F., Y. Rogister & P. Tackley (2017). Constraints on core-mantle boundary topography from models of thermal and thermochemical convection. *Geophys. J. Int.*, Vol. 212(1), 164–188, https://doi.org/10.1093/gji/ggx402

*Zaroli, C.,* P. Koelemeijer & *S. Lambotte* (2017). Toward seeing the Earth's interior through unbiased tomographic lenses. *Geophys. Res. Lett.*, Vol. 44, https://doi.org/10.1002/2017GL074996

*Zaroli, C.* (2016). Global seismic tomography using Backus–Gilbert inversion. *Geophys. J. Int.*, Vol. 207(2), 876–888, <u>https://doi.org/10.1093/gji/ggw315</u>

Soldati, G., **P.J. Koelemeijer,** L. Boschi & A. Deuss (2013). Constraints on core-mantle boundary topography from normal mode splitting. *Geochemistry, Geophysics, Geosystems*, Vol. 14(5), 1333-1342, <u>https://doi.org/10.1002/ggge.20115</u>

#### Application details

This project has been shortlisted for funding by the ARIES NERC DTP and will start on 1st October 2021. The closing date for applications is 23:59 on 12th January 2021.

Successful candidates who meet UKRI's eligibility criteria will be awarded a NERC studentship, which covers fees, stipend (£15,285 p.a. for 2020-21) and research funding. For the first time in 2021/22 international applicants (EU and non-EU) will be eligible for fully-funded UKRI studentships. Please note ARIES funding does not cover visa costs (including immigration health surcharge) or other additional costs associated with relocation to the UK.

ARIES students benefit from bespoke graduate training and ARIES provides £2,500 to every student for access to external training, travel and conferences. Excellent applicants from quantitative disciplines with limited experience in environmental sciences may be considered for an additional 3-month stipend to take advanced-level courses in the subject area.

ARIES is committed to equality, diversity, widening participation and inclusion in all areas of its operation. We encourage enquiries and applications from all sections of the community regardless of gender, ethnicity, disability, age, sexual orientation and transgender status. Academic qualifications are considered alongside significant relevant non-academic experience.

All ARIES studentships may be undertaken on a part-time or full-time basis, visa requirements notwithstanding

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