# Low-temperature thermochronology of the Mesozoic uplift history in the Hardangerfjord area, SW Norway

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The geology of the Hardangerfjord area is dominated by the Hardangerfjord Shear Zone (HSZ), a major crustal-scale structure that formed during Devonian extension shortly following the Caledonian orogeny. The HSZ might be part of an even larger zone of crustal deformation stretching across the North Sea into the Highland Boundary Fault in Scotland. The Hardangerfjord itself follows the trend of the shear zone and acted as one of the largest sediment pathways in the area. The amount of inland erosion and the corresponding depositional patterns are strongly affected by onshore tectonics.

The present project aims to constrain the amount and timing of post-Caledonian uplift in this area by fission track, (U-Th)/He and K/Ar dating. In particular the apparent absence of Mesozoic brittle reactivation of the HSZ in this area is targeted by sampling of detailed profiles parallel and across the HSZ. Furthermore, vertical profiles on steep flanks of the Hardangerfjord are analysed in order to obtain more precise uplift and erosion rates. This study will improve our understanding of onshore tectonic processes and their effect on offshore sedimentation cycles in the North Sea.

# Subducted oceanic crust exhumed from the lower mantle

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Over the last 25 years diamonds from several continents have yielded inclusions that have been interpreted as sub-lithospheric in origin. The mineralogy and compositions of the inclusions have been interpreted in terms of both peridotitic and basaltic protoliths and a range of pressures. There is now an abundance of samples of basaltic inclusions that record transition zone and lower asthenospheric pressures [1], but until now there has been no convincing evidence for diamonds that crystallised in the lower mantle from a basaltic protolith.

In this study we report on a suite of mineral inclusions in diamonds from Juina, Brazil, which have exactly the mineralogy and chemistry expected for a basaltic composition at depths of 700-1200 km. Syngenetic, composite mineral inclusions in diamonds from a single kimberlite pipe (Juina 5) are found to have the bulk chemistries of the ‘calcium ferrite’ phase (CF-phase), ‘New Aluminium Silicate’ phase (NAL-phase), Al- and Fe-rich Mg-perovskite, and Ti-rich Ca perovskite. CF- and NAL-phases have previously been observed only in high pressure and temperature experiments on basaltic bulk compositions. The inclusions therefore indicate an origin of the diamonds and inclusions in oceanic crust subducted into the lower mantle.

The relatively high density of subducted basalt, especially if it is cooler than the surrounding peridotitic mantle, means that the mechanism for exhumation of basaltic crust from the lower mantle is puzzling. Available time constraints from other sub-lithospheric diamonds from the Juina region [2] indicate uplift rates of buoyant plumes of subducted material of ~ 1 – 50 cm/yr. Various subduction-exhumation cycles that can explain all the data will be discussed.

[1] Harte (2010) *Min Mag.* **74** 189–215. [2] Bulanova *et al.* (2010) *Contrib. Min. Pet.* **160** 489–510.