

## Constraining the timing of orogenesis in Shetland using garnet and mica geochronology

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The archipelago of Shetland is uniquely placed within the Caledonides of the North Atlantic due to its central location between the East Greenland, Norwegian, and Scottish sectors of the orogen<sup>1</sup>.

Here we present Lu-Hf and Sm-Nd garnet ages, and Rb-Sr mica ages for metamorphic lithologies from a wide geographic and tectonostratigraphic area of Shetland. Lu-Hf and Sm-Nd ages are broadly interpreted to represent the timing of peak metamorphic conditions in garnets where prograde zoning is observed in trace-element LA-ICPMS profiles. Conversely, Rb-Sr mica ages are interpreted to relate to deformation-induced recrystallization, and typically yield similar ages to Sm-Nd garnet ages.

Ordovician-Silurian garnets are prevalent throughout Shetland and span the entire collisional orogenic: from the initiation of tectonism by obduction of the Shetland ophiolite at  $489 \pm 7$  Ma, to the oblique collision of Laurentia and Baltica at c. 427 Ma. The majority of garnets grew during the Grampian phases of the Orogen. In the northern Isles of Unst and Fetlar, peak metamorphism appears to have been reached up to 10 Ma earlier than in mainland Scotland, with several Lu-Hf and Sm-Nd ages of c. 480 Ma, between only 9-4 Ma after the obduction of the Shetland ophiolite<sup>2</sup>. Throughout all of Shetland, ages of c.450 Ma provide further evidence for the Grampian II accretionary event recorded in the Moine nappe of mainland Scotland<sup>3</sup>.

Only two samples yield garnet ages that relate to the Silurian Scandian phase of orogenesis that is widespread in both the East Greenland and Norwegian Caledonides. This may indicate that Shetland had been uplifted to higher in the nappe pile than these areas during the later phases of the orogenic cycle. However, Devonian Rb-Sr mica ages in westernmost Shetland are consistent with the diachronous northward-younging of the thrust belts that define the western Laurentian margin, suggesting a late orogenic evolution that has more in common with East Greenland and Norway than with northern Scotland<sup>4</sup>, where movement on the foreland propagating nappe systems had essentially ceased by 429 Ma<sup>5</sup>.

<sup>1</sup>Fossen 2010. *GSLSP* 335

<sup>2</sup>Crowley & Strachan 2015. *JGSL* 172

<sup>3</sup>Bird et al 2013. *JGSL* 170

<sup>4</sup>Walker et al 2016. *JGSL* 173

<sup>5</sup>Goodenough et al 2011. *JGSL* 168