Deep crustal xenoliths document the Early Palaeozoic transition from active margin to intracontinental setting of the Scottish Midland Valley

E. BADENSZKI[1*], J. S. DALY[1], M. J WHITEHOUSE[2], M. S. A. HORSTWOOD[3], A. KRONZ[4], P. J. LANCASTER[5] AND B. G. J. UPTON[6]

[1]UCD School of Geological Sciences, University College Dublin, IRL; (*correspondence:eszter.badenszki@ucd.ie)
[2]Swedish Museum of Natural History, Stockholm, SWE
[3]NERC Isotope Geosciences Laboratory, Nottingham, UK
[4]Georg-August-Universität Göttingen, GER
[5]University of Portsmouth, UK
[6]University of Edinburgh, UK

Deep crustal xenoliths (metadiorites, metatonalites and metasediments), hosted by Lower Carboniferous magmatism, provide unique insight into Early Palaeozoic (Caledonian) tectonics of the Scottish Midland Valley (SMV) and its transition from an active plate margin to an intracontinental setting.

Metatonalite xenoliths have a protolith age of 454±8 Ma ($\varepsilon Hf_{t=454}$ from +7.4 to +9.0) and originated from a juvenile magmatic arc not currently exposed. Metasedimentary xenolith protoliths accumulated in a fore-arc setting, on the southern margin of the SMV after c. 450 Ma, during the final stage of subduction of the Iapetus Ocean. Two detrital zircon populations are present: the older is interpreted to have a Laurentian provenance whereas the younger originates from the Late Ordovician Midland Valley arc. Metadiorite xenoliths (c. 416 Ma, $\varepsilon Hf_{t=416}$ from -0.6 to +7.8) represent unexposed "Newer Granite" plutons, an extensive granitic suite intruded after closure of the Iapetus Ocean, previously considered as rarities within the SMV.

An early metamorphic phase affected the metatonalites and metasedimentary xenoliths at c. 420-400 Ma, likely due to tectonic burial of the southern margin of the SMV, and also marking the minimum depositional age of the metasediments. The metasedimentary xenoliths record PT conditions of c. 5-7 kbar and c. 620-780°C, although these cannot be unambiguously assigned in time since all xenolith types were affected by later metamorphism at c. 395 Ma (corresponding to the Acadian Orogeny). Because of their younger protolith age, the metadiorites experienced only this younger metamorphic event, and hence the PT conditions derived from them (c. 5-11 kbar and c. 825-858 ºC) are confidently dated at 395 Ma.