U-Pb SIMS apatite dating using a common lead correction (examples from the Scottish Caledonides)

ELLA JEWISON[1] ETIENNE DELOULE[2] JOHAN VILLENEUVE[2] NICOLAS BELLAHSEN[1] LOIC LABROUSSE [1] CLAUDIO ROSENBERG [1] RAPHAEL PIK[2] DAVID CHEW[3]

[1] Institut des Sciences de la Terre de Paris, Université Pierre et Marie Curie, Sorbonne Universités, CNRS, Paris, France. Email: ella.jewison@upmc.fr

[2] Centre de Recherches Pétrographiques et Géochimiques (CRPG), UMR 7358 CNRS-Université de Lorraine, 15 rue Notre Dame des Pauvres, BP 20, F-54501 Vandœuvre-lès-Nancy Cedex, France

[3] Department of Geology, School of Natural Sciences, Trinity College Dublin, Dublin 2, Ireland

Apatite is a widely-used mineral in low-temperature thermochronology (U-Th/He and AFT). The use of apatite in U-Pb geochronology studies has great potential in unraveling the tectonothermal structure of orogens given its closure temperature of c. 450°C. However, since apatite can accommodate significant amounts of initial Pb in its structure, its requires a common Pb correction. Two approaches are commonly used: either plotting (co-genetic) data on Tera-Wasserburg and estimating the lower intercept age, or if the initial Pb composition is known, measuring ^{204}Pb and using its abundance to correct for common Pb. In this U-Pb apatite SIMS geochronology study, we compare Tera-Wasserburg lower intercept ages with ^{204}Pb corrected ages to examine the cooling history of the Northern Highlands of Scotland.

The Northern Highlands are an extensively studied Caledonian collisional wedge which resulted from the closure of the Iapetus Ocean during the Ordovician to Silurian. In Northern Scotland, two orogenic events are associated with Iapetus closure, the Grampian event (480-460 Ma) and the Scandian event (435-415 Ma), resulting in a complex and poorly understood Caledonian thermal history. Our U-Pb apatite and zircon data provide new constraints on the formation and cooling of this Caledonian ductile wedge.

Here, we present accurate ^{204}Pb-corrected apatite ages from five samples from different units. ^{204}Pb-corrected ages yield equivalent errors and mean ages compared to lower intercept Tera-Wasserburg ages. This approach also enables the possibility of detrital apatite dating with the ^{204}Pb method.

Our data also suggest Caledonian cooling is younger than previously thought, and does not represent a simple monotonic cooling sequence. We thus present a refined thermal history path and a new model for the evolution of the Caledonian ductile wedge in Northern Scotland.