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Dating cleavage formation in the Irish Variscides: an *in situ* ^{40}Ar/^{39}Ar Ultra Violet Laser Ablation approach.

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Determining the absolute timing of deformation and metamorphic phases is a major problem encountered in the study of the peripheral zones of orogenic belts. In such low-grade settings the isotopic dating of fabric development may offer the best or in some cases the only opportunity to constrain individual deformation events. Previous geochronological studies of fabric development in rocks deformed at low temperature have generally been restricted to the K-Ar or ^{40}Ar/^{39}Ar analysis of cleavage seams in slate belts. In this study we present a method of cleavage dating by targeting mica beards which have developed in strain fringes using the in situ ^{40}Ar/^{39}Ar Ultra Violet Laser Ablation (UVLA) method. This approach allows small microstructures ($<$ 250μm), which are unequivocally syn-kinematic, to be targeted and provides a means to date cleavage in low-grade settings where sandstone, and not slate, is the dominant lithology. The use of in situ analysis also avoids the hazards of detrital contamination and ^{39}Ar recoil.

The current study focuses on the Upper Palaeozoic sedimentary sequences of the Munster Basin, southern Ireland, which lies within the Rhenohercynian Zone of the European Variscides. This is a peripheral tectonic region which experienced shortening during the Late Carboniferous. Deformation was accommodated by the development of kilometre-scale and lower-order folding, high-angle reverse faulting and regional fabric formation. This fabric developed as a pressure solution cleavage and has resulted in the formation of mica beards in low strain zones around detrital quartz grains. The

^{40}Ar/^{39}Ar UVLA analysis of these structures yielded cleavage ages in the range of 327 to 301 Ma; indicating a temporal range of $c.$ 20 Ma for cleavage formation in the Irish Variscides. The ages can be interpreted as dating the timing of cleavage and not cooling, as the peak metamorphic episode in the Munster Basin has been characterised as a syn-extensional, diastathermal event which occurred at $c.$ 365 $\pm$ 15 Ma. The temperatures associated with deformation were less than 325ºC; well below the closure temperature for Ar in white mica (350ºC). As neocrystallisation occurred below the closure temperature the ages produced record the absolute timing of Variscan cleavage development. This region has not experienced significant heating after Variscan deformation indicating that ^{40}Ar loss due to thermal rejuvenation has not occurred.

The new age dates suggest that cleavage initiated pre/syn-folding and continued to develop after folding had ceased producing an axial planar fabric. They also constrain the maximum age of deposition in the Munster Basin to the Namurian, as cleavage formation reflects crustal shortening, implying that relative uplift had occurred resulting in the end of deposition. The ages for cleavage formation in the Irish Variscides are broadly similar to the "younger ages" of Dodson and Rex (1971) which are interpreted to date cleavage formation in the Rhenohercynian Zone of southwest England. This may indicate that rates of upper crustal accretion were synchronous across the western region of the foreland Rhenohercynian Zone of the European Variscides.

Dodson, M.H. & Rex, D.C. 1971. Potassium-argon ages of slates and phyllites from southwest England. *Quarterly Journal of the Geological Society, London,* **126,** 465-499.