



Post-Acadian sediment recycling in the Devonian Old Red Sandstone of Southern Ireland



Meg Ennis^a, Patrick A. Meere^{a,*}, Martin J. Timmerman^b, Masafumi Sudo^b

^a School of Biological, Earth & Environmental Science, University College, Cork, Ireland

^b Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Karl-Liebknecht-Str. 24-25, D-14476 Potsdam-Golm, Germany

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ABSTRACT

The Upper Devonian Munster Basin of southern Ireland has traditionally been viewed as a post-orogenic molasse deposit that was sourced from the Caledonides of central Ireland and subsequently deformed by the end Carboniferous Variscan orogenic event. The basin fill is composed of super-mature quartz arenite sandstone that clearly represents a second cycle of deposition. The source of this detritus is now recognized as Lower Devonian Dingle Basin red bed sequences to the north. This genetic link is based on the degree of similarity in the detrital mica chemistry in both of these units; micas plot in identical fields and define the same trends. In addition, the two sequences show increased textural and chemical maturity up-sequence and define indistinguishable $^{40}\text{Ar}/^{39}\text{Ar}$ age ranges for the detrital mica grains. Partial resetting of the Ar ages can be attributed to elevated heat flow in the region caused by Munster Basin extension and subsequent Variscan deformation. The combined evidence from southwest Ireland therefore points to a Caledonian or possibly Taconian primary source area that initially shed detritus into the Lower Devonian Dingle Basin which was subsequently recycled into the Upper Devonian Munster Basin following mid-Devonian Acadian basin inversion.

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1. Introduction

The late Paleozoic tectonostratigraphic history of southern Ireland is dominated by three distinct orogenic phases corresponding to the end-Silurian Caledonian, the mid-Devonian Acadian and the end-Carboniferous Variscan orogenies with two intervening periods of net crustal extension and associated basin development. The first of these extensional phases resulted in the development of the Upper Silurian to Lower Devonian Dingle Basin while the second phase corresponded with the development of the Upper Devonian/Carboniferous Munster/South Munster Basins (Fig. 1). The Upper Old Red Sandstone (UORS) fill of the Munster Basin has traditionally been viewed as a post-orogenic molasse deposit sourced from the Caledonide Belt to the north (Friend et al., 2000 & references therein), and subsequently deformed by the Variscan event c. 320 Ma (Quinn et al., 2005). However this model represents an oversimplification of both the tectonic and sedimentary histories of southern Ireland in that it ignores the potential impact of the mid-Devonian Acadian Orogeny. The Acadian, originally considered to be a late Caledonian event, is now recognized as a separate, transpressional episode that occurred after Iapetus Ocean closure and was preceded by a phase of transtension and Lower Devonian

basin formation (Soper and Woodcock, 2003; Woodcock et al., 2007; Kroner and Romer, 2013). Acadian deformation culminated in Mid-Emsian times (Sherlock et al., 2003) and led to the deformation and inversion of the Lower Old Red Sandstone (LORS) basins across the British Isles (Soper and Woodcock, 2003). Evidence of Acadian deformation of the Dingle Group prior to the deposition of the Upper Devonian Slieve Mish Group in the Dingle Peninsula was first deduced by Shackleton (1940) and elaborated by Todd (1989, 2000). Meere and Mulchrone (2006) have further argued that the high-strain, penetrative cleavage in the Dingle Group is Acadian in age, and not Variscan as held by previous authors (Shackleton, 1940; Parkin, 1976; Todd, 1989, 2000). Across Britain significant volumes of LORS are thought to have been recycled southwards both during and immediately following Acadian basin inversion (Soper and Woodcock, 2003). This study uses a multidisciplinary approach to establish a consanguineous relationship, by a similar sedimentary provenance, between the LORS and UORS sequences of southern Ireland. A combination of petrographic and microprobe analysis in conjunction with $^{40}\text{Ar}/^{39}\text{Ar}$ detrital mica dating suggests a shared common provenance between these two units (Ennis, 2008). This new information requires a revised model for the provenance of the UORS deposits in southern Ireland and Britain by highlighting the importance of the Acadian deformation event as a driver for sediment recycling. In addition the $^{40}\text{Ar}/^{39}\text{Ar}$ age data highlights the importance of the onset of a Late Devonian thermal event, which extended into Carboniferous

* Corresponding author.

times and has resulted in a reset of the Ar signature in the detrital mica population of both the LORS and UORS units in southern Ireland.

2. Regional geology

2.1. Dingle Peninsula paleozoic geology

The Paleozoic geology of the Dingle Peninsula contains a set of five unconformably bound litho-tectonostratigraphic units representing alternating phases of localized crustal extension and compression from the Late Silurian to Mid Devonian (Horne, 1974; Todd et al., 1988a; Todd, 1989) (Fig. 1B). The sedimentary studies of Todd et al. (1988a, 1988b) and Todd (1991) highlight the unconformable contacts between each stratigraphic unit and identify the impact of mid-Devonian

Acadian tectonics as further described by Meere and Mulchrone (2006). The Dingle Basin represents an elongate structure that lies within c. 40 km of the present day trace of the Iapetus Suture (Phillips et al., 1976; McKerrow and Soper, 1989; Boyd and Sloan, 2000) within the northern part of the Leinster Terrane (Murphy et al., 1991). It is oriented northeast–southwest following the Caledonian trend and has been described as a “fault-bounded, pull-apart structure” within the Iapetus Suture Zone (Todd et al., 1988a, 1988b). The exposed basin stretches 60 km along the axis of the Dingle Peninsula and varies in width from 40 km in the west to 22 km in the east (Vermeulen et al., 2000). The sedimentation style is dominated by continental LORS deposition in lakes, alluvial fans/aprons and rivers below the Acadian unconformity (Holland, 1987; Todd, 1989, 1991; Richmond and Williams, 2000), while above the unconformity are alluvial fan, fluvial and aeolian erg

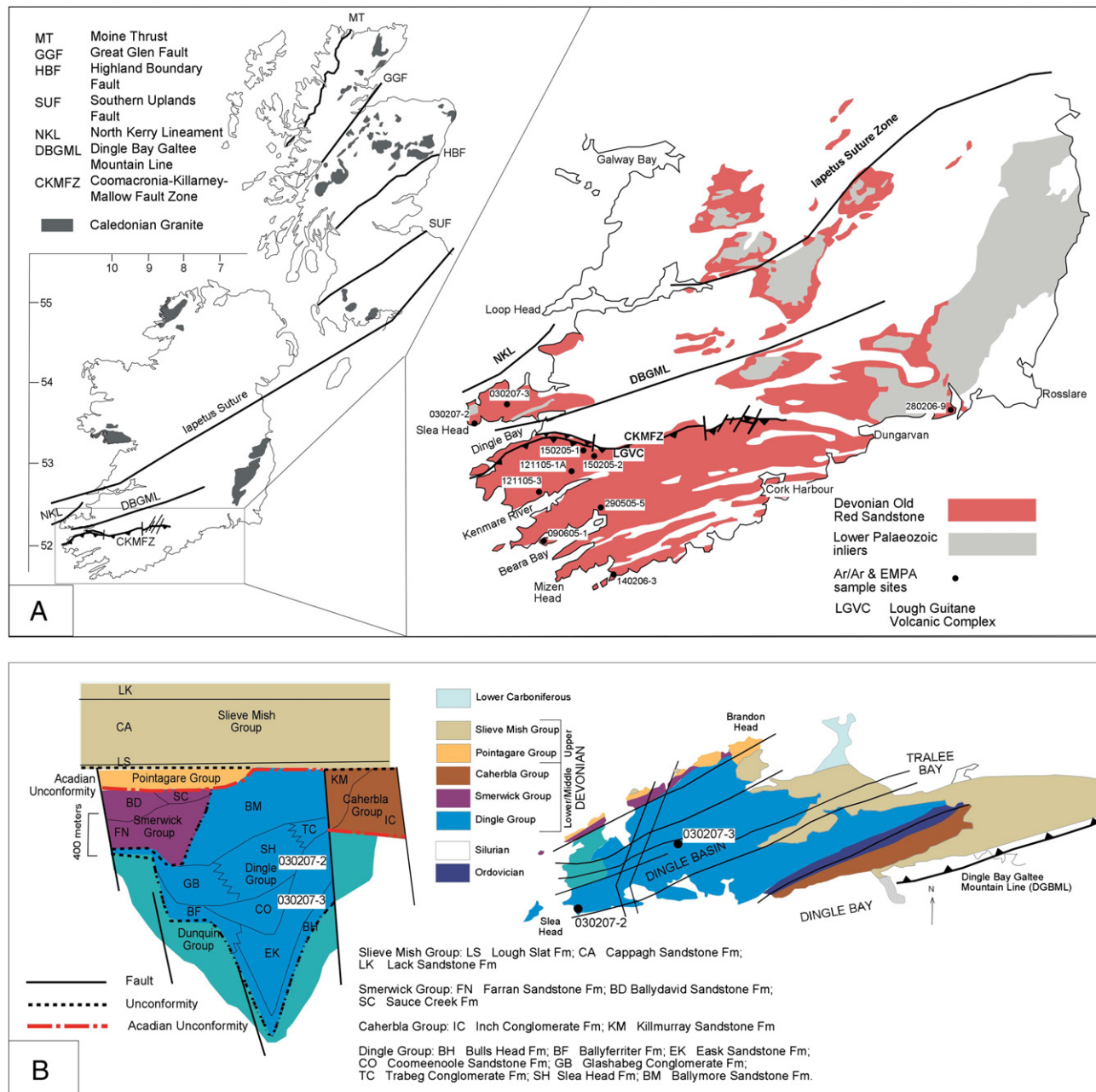


Fig. 1. A. Map showing the location of Caledonian granites and major fault structures in Ireland and Scotland. The study area and the extent of the ORS in southern Ireland, including the sample localities are highlighted. B. Lithostratigraphy of the Dingle Peninsula after Todd (1989), includes a generalized geology of the peninsula with sample site locations, the position of the Acadian unconformity follows Richmond and Williams (2000). C. Lithostratigraphy of the Upper Devonian sequences of the Munster Basin (after MacCarthy, 2004). Sample locations are included within the lithostratigraphy plot. Sample 280206-9 is not listed here as it is a basin margin sample and was collected from the Brownstone Member of the Templetown Formation in Dunmore East.

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