



Fluvial style in the Lower Old Red Sandstone: examples from southwest Wales, UK



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ABSTRACT

Studies of the behaviour of different types of present-day river channels with regard to sediment transport and depositional processes enable interpretation of fluvial deposits throughout the stratigraphic record. Early studies concentrated on the deposits of meandering and braided rivers by examining the depositional style and architecture of the sandbodies. The Lower Old Red Sandstone of southwest Wales is however a mud-dominated succession and, while there is variety in the architecture of the sandstones, up to 80% of some formations is composed of mudrocks. Detailed analysis of the Late Silurian and Early Devonian successions in southwest Wales has enabled recognition of three different styles of sandbody architecture (decimetre- to metre-thick sheets, multi-storey amalgamations and ribbon geometries), two different types of conglomerate (extraformational and intraformational), three different mudrock facies (pedogenically modified, burrowed and massive) and two types of heterolithic deposits (inclined and non-inclined). Characteristics of these units throw more light on the fluvial styles, allowing inferences that ephemeral, mud-dominated river systems were also present. Detailed study of the alluvial deposits also indicates aspects of Siluro-Devonian climate and palaeogeography.

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1. Introduction

The Old Red Sandstone was deposited during and after the convergence of Laurentia, Baltica and Avalonia, during the Caledonian orogeny (Woodcock and Soper, 2006); the resulting mountain belt producing the sediment that supplied the fluvial systems. Soper and Woodcock (2003) suggested that regional transtension affected southern Britain between the Late Silurian and the Emsian/Eifelian (Acadian transpression), when basins controlled by N–S normal faults subsided providing accommodation space for Lower Old Red Sandstone (LORS) sediment. Subsidence analysis by James (1987) and King (1994) indicated that load-generated flexural subsidence was linked to the development of a foreland basin to the south of the Laurentian mountain front during the Late Silurian–Early Devonian. From the Pridoli into the Early Devonian (Lochkovian) former Lower Palaeozoic basins bordering the Irish Sea were inverted, forming an upland area and sedimentation gradually changed from marine to non-marine facies. The upland was later subject to erosion thus

providing detritus to fill the Anglo-Welsh Basin (Soper and Woodcock, 1990; Hillier and Williams, 2004).

Simon and Bluck (1982) and Allen and Crowley (1983) used provenance studies of signature minerals and lithic clasts to identify source areas for the LORS in Scotland, Northern Ireland, SW Ireland, Isle of Man and the Anglo-Welsh Basin. In the early part of the LORS (Ludlow) Simon and Bluck (1982) envisaged that coalescing alluvial fan systems developed along the active Highland Boundary Fault and Southern Uplands Fault zones either side of the Midland Valley of Scotland with a major river system active through the Irish Sea and draining to the Rheic Ocean to the south of the British Isles (Fig. 1). With further convergence, separate sedimentary basins developed across Eastern Scotland and Central England, Wales and Ireland during the latest Silurian (Pridoli) (Allen and Crowley, 1983) fed by rivers draining from the Caledonian mountains (Fig. 2a). By the end of the Early Devonian the Caledonian Basin had extended further to the south-west and the large basin across England, Wales and Ireland had partially filled and uplifted to separate into the Dingle-Shannon and Anglo-Welsh Basins (Fig. 2b). The northern basins continued to receive sediment from the Caledonian mountains and material was supplied to the Anglo-Welsh Basin and south-western areas of the Dingle-Shannon Basin from erosion of sedimentary and volcanic rocks that comprised the uplifted area separating the basins.

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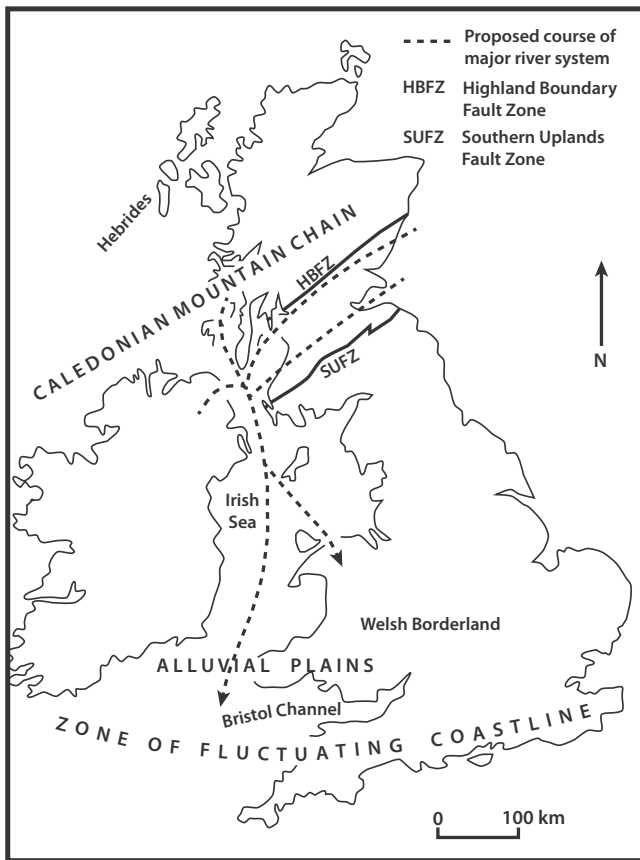


Fig. 1. Proposed major river system of the early Lower Old Red Sandstone (after Simon and Bluck, 1982).

2. The Lower Old Red Sandstone in Pembrokeshire

Palaeogeographic reconstructions show that the Anglo-Welsh Basin, in a distal position relative to the Caledonian Mountain chain, lay in sub-tropical latitudes between 12–22° S (Channel et al., 1992; Scotese, 2002). The climate has been interpreted as semi-arid with well-defined wet and dry seasons (Allen, 1974a; Marriott and Wright, 2004), though it is also apparent, from detailed study of sedimentology and palaeosols, that more humid climate sometimes prevailed and wetlands developed (Hillier et al., 2007, 2011a,b). The Lower Old Red Sandstone outcrop in southern Wales extends from the Welsh Borderlands to Pembrokeshire (Fig. 3), covering about 20,000 km². It is dominated by a coarsening upwards sequence of alluvial sediments deposited between the Late Silurian (Ludlow) to late Early Devonian (Emsian). The thickness of the preserved deposits are c. 2.4 km in the eastern part of the outcrop to 3.4–4.4 km in the south-west (Friend et al., 2000) and comprise mainly alluvial fan, fluvial channel and floodplain sediments, with debris flow and minor ephemeral lake deposits. The sequence is dominated by mudrocks, many of which have been modified by pedogenesis (Allen, 1974a, 1986; Marriott and Wright, 1993; Love and Williams, 2000) and bioturbation (Marriott and Wright, 2004; Morrissey and Braddy, 2004). There are several conspicuous tuff beds throughout the succession, some forming important marker horizons (Allen and Williams, 1981, 1982) and revealing evidence of a diverse ichnofauna (Morrissey and Braddy, 2004; Marriott et al., 2009).

Due to the excellent exposure of LORS along the coast of Pembrokeshire (Fig. 3), this area has attracted considerable attention and study. Dixon (1921) carried out the first detailed description of the LORS succession, but it was not until over 40 years later that major studies of the fluvial sedimentology and stratigraphy were carried out by Allen (1963, 1964, 1974b,c) and

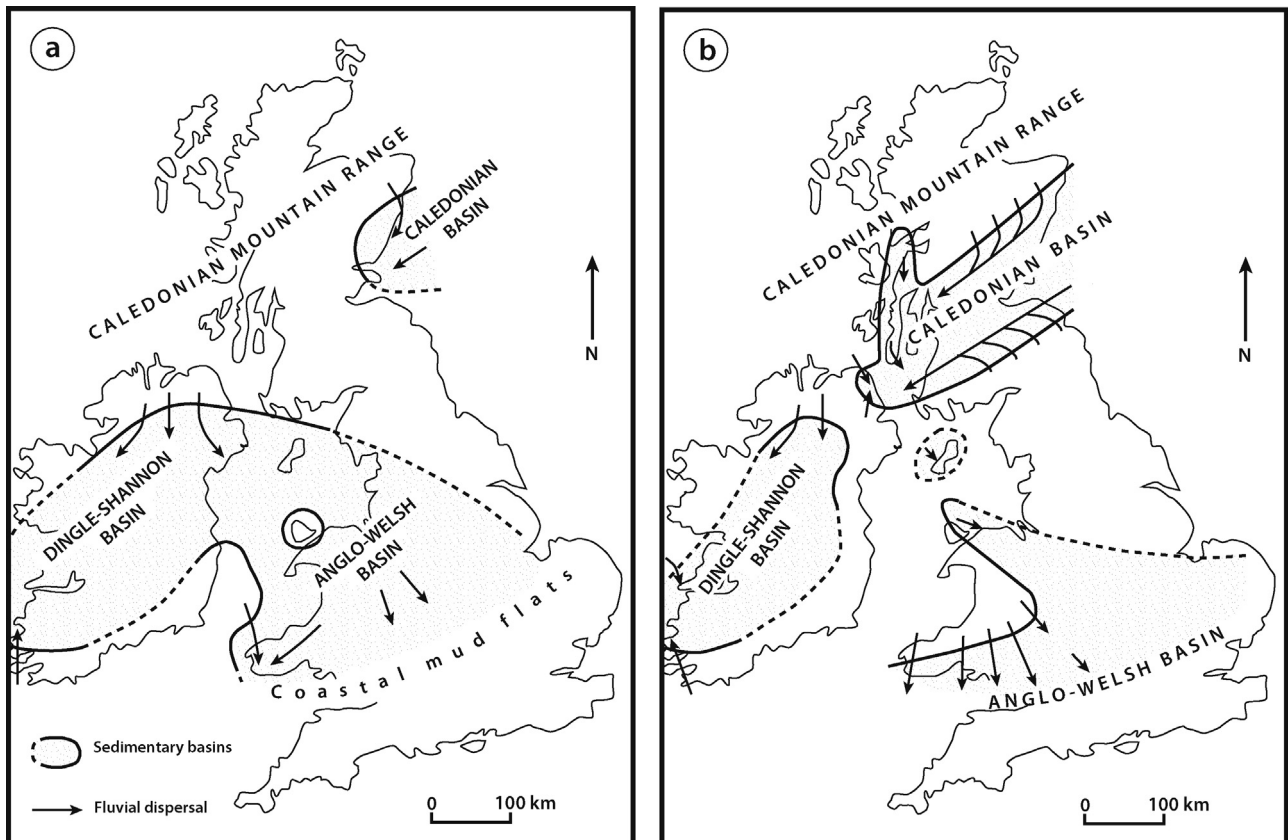


Fig. 2. Likely position of sedimentary basins and direction of fluvial dispersal in: (a) Mid-Pridoli, (b) Mid to Late Lochkovian (after Allen and Crowley, 1983).

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