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Heavy mineral and zircon age constraints on provenance of the Sherwood Sandstone Group (Triassic) in the eastern Wessex Basin, UK

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ABSTRACT

Heavy mineral and zircon age data demonstrate that in the Sherwood Sandstone Group of the Marchwood-1 and Southampton-1 boreholes, on the eastern margin of the Wessex Basin, sediment was supplied from both the south (Variscan highlands) and the east (recycled Old Red Sandstone). Interplay of these two sources led to a well-defined heavy mineral stratigraphy in the area. However, the Sherwood Sandstone Group in the Wytch Farm oilfield, towards the centre of the Wessex Basin, contains only sandstones derived from the Variscan highlands to the south and lacks significant amounts of recycled Old Red Sandstone detritus. The equivalent sandstones (Otter Sandstone Formation) on the western margin of the Wessex Basin have a different provenance to both the central and eastern parts of the basin, since they almost entirely lack input from Variscan granitoids. Heavy mineral and zircon provenance data therefore demonstrate sediment input from a number of discrete source areas into the Wessex Basin during the Early and Middle Triassic, and that the 'Budleighensis River' system may not have been a single river, at least in the southern Wessex Basin area. It is also evident that provenance-based correlation schemes such as heavy mineral analysis or whole-rock geochemistry should be used with caution over long distances and require careful evaluation of lateral changes in provenance.

1. Introduction

The Triassic Sherwood Sandstone Group of the Wessex Basin plays a critical role in the understanding of provenance patterns in the Early to Middle Triassic of southern Britain. The Wessex Basin is the most southerly of a series of linked basins oriented approximately south to north, comprising the Worcester, Knowle, Stafford, Needwood, Cheshire and East Irish Sea basins, together with the East Midlands Shelf (Fig. 1). A large axial fluvial drainage system, termed the 'Budleighensis River', is believed to have dominated deposition in these linked basins (Wills, 1956). On the basis of a variety of data, including clast compositions (Audley-Charles, 1970; Campbell-Smith, 1963; Cocks, 1993), paleocurrents (Jones and Ambrose, 1994; Smith and Edwards, 1991; Steel and Thompson, 1983; Thompson, 1970), detrital mica ages (Fitch et al., 1966), and Pb isotope compositions in feldspar (Tyrrell et al., 2012), this river is believed to have flowed from south to north, with the sourceland lying within the Variscan mountains of northern France, possibly extending as far south as the Massif Central.

In view of the importance of the Wessex Basin as a key area in evaluating the role of the 'Budleighensis River' system, an integrated heavy mineral study, including determination of provenance-sensitive heavy mineral ratios and detrital U–Pb zircon ages, was undertaken on the well-exposed outcrop section of the Otter Sandstone Formation at Budleigh Salterton (Fig. 2), on the western margin of the basin (Morton et al., 2013). This work showed distinct differences in heavy mineral characteristics between the Otter Sandstone Formation at Budleigh Salterton and the Sherwood Sandstone Group in the Wytch Farm oilfield, indicating that during the Early-Middle Triassic, the Wessex Basin was fed by more than one river system.

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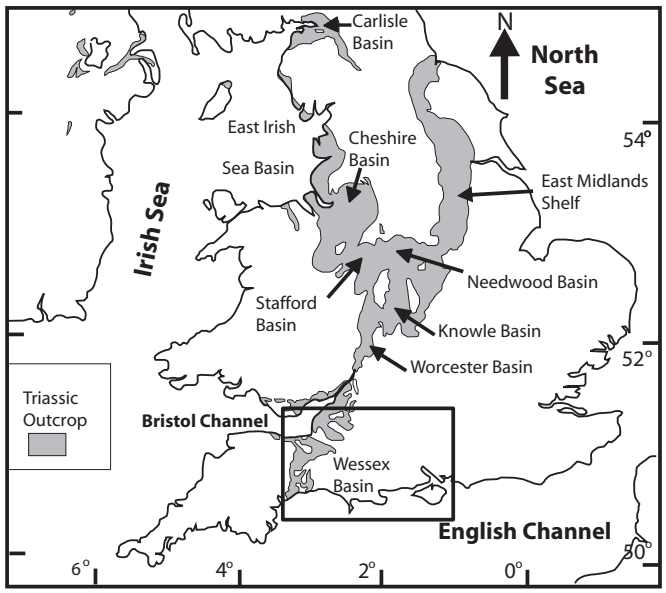

Fig. 1. Triassic outcrops and basins of the southern UK. Box is the area of the detailed Wessex Basin map in Fig. 2.

Apart from a small amount of data from Wytch Farm (Morton and Hallsworth, 1994) and the Winterborne Kingston-1 borehole (Morton, 1982), there is no published information on the heavy mineral provenance characteristics of the Sherwood Sandstone Group in the subsurface of the Wessex Basin. However, a petrographic study of the Sherwood Sandstone Group in the Marchwood-1 borehole (Knox et al., 1984), located near to the eastern margin of the Wessex Basin (Fig. 2), revealed the presence of marked variations in composition. The Marchwood-1 succession can be subdivided into a lower unit and an upper unit on the basis of a change in gamma-ray values and the restriction of high porosity and permeability to the upper part of the sequence (Fig. 3). These changes in character coincide with a sharp upward increase in the proportion of feldspar, coupled with a decrease in the proportion of lithic grains (Fig. 4). Knox et al. (1984) also noted that the lower unit (comprising lithic sandstone and conglomerate) has a similar composition to the underlying Devonian Old Red Sandstone (ORS) and proposed that recycling of the ORS was responsible for generating the lower part of the succession. By contrast, the upper arkosic sandstone unit appears to have a similar composition to the Sherwood Sandstone Group in the Winterborne Kingston-1 borehole, towards the centre of the Wessex Basin (Lott and Strong, 1982).

This paper documents the results of a provenance study of the succession in the Marchwood-1 borehole and its neighbour Southampton-1 (Fig. 2), using conventional heavy mineral analysis and U–Pb dating of detrital zircon. The aim was to establish the origin of the Sherwood Sandstone Group at the eastern margin of the Wessex Basin, and to evaluate the relationships between the sandstones in the eastern, central (Wytch Farm) and western (Budleigh Salterton) areas, thereby characterising the 'Budleighensis River' system at the southern end of its influence in southern Britain.

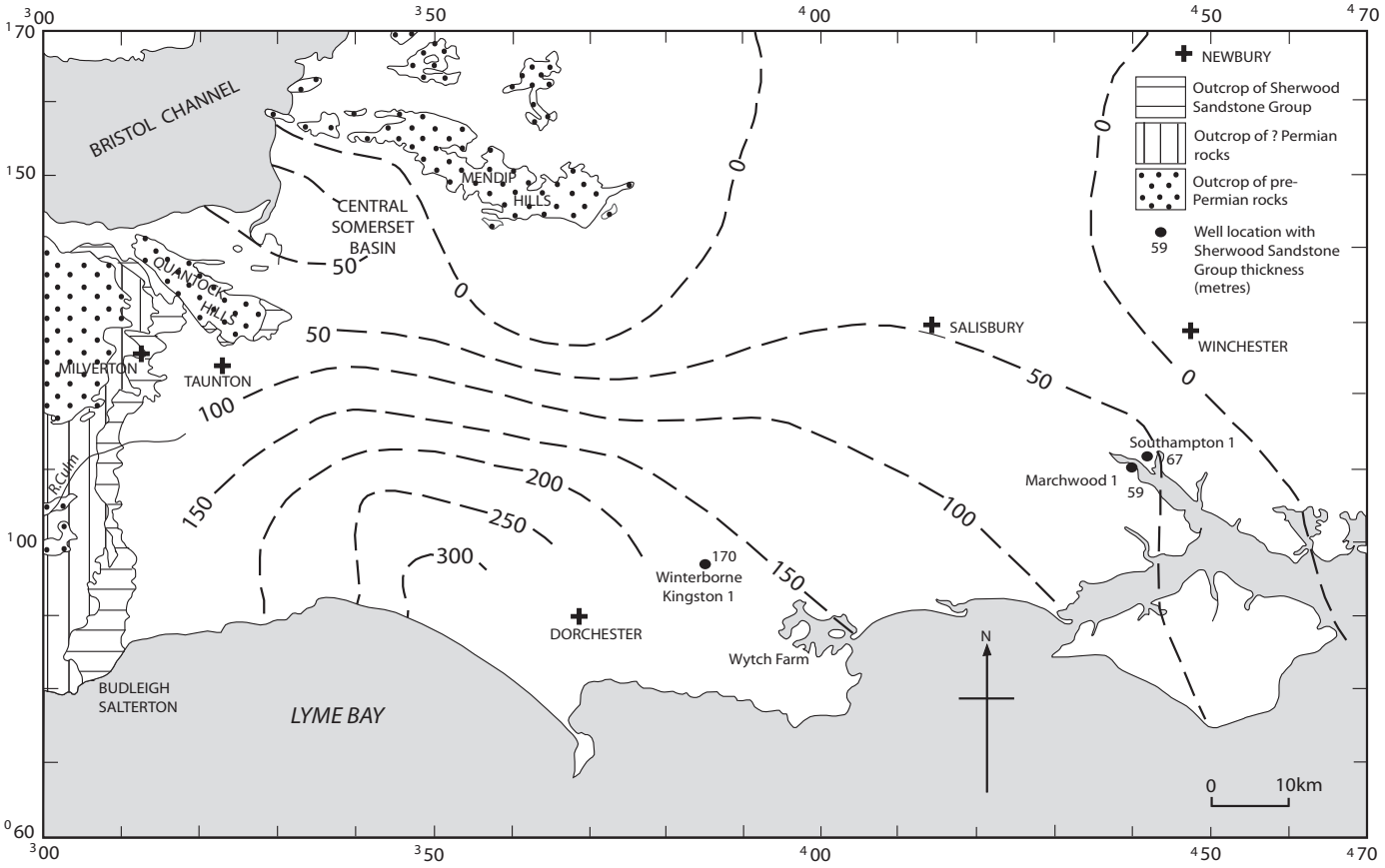

Fig. 2. Map of the Wessex Basin showing locations of sections discussed in this paper. Adapted from Holloway et al. (1989).