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Spatial variability of the Purbeck–Wight Fault Zone—a long-lived tectonic element in the southern UK

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ABSTRACT

New seamless onshore to offshore bedrock (1:10 k scale) mapping for the Lyme Bay area is used to resolve the westward termination of the Purbeck–Wight Fault Zone (PWFZ) structure, comprising one of the most prominent, long-lived (Variscan–Cimmerian–Alpine) structural lineaments in the southern UK. The study area lies south of the Variscan Frontal Thrust and overlays the basement Variscide Rhenohercynian Zone, in a region of dominant E-W tectonic fabric and a secondary conjugate NW-SE/NE-SW fabric. The PWFZ comprises one of the E-W major structures, with a typical history including Permian to early Cretaceous growth movement (relating to basement Variscan Thrust reactivation) followed by significant Alpine (Helvetic) inversion. Previous interpretations of the PWFZ have been limited by the low resolution (1:250 k scale) of the available offshore BGS mapping, and our study fills this gap. We describe a significant change in structural style of the fault zone from east to west. In the Weymouth Bay area, previous studies demonstrate the development of focussed strain associated with the PWFZ, accompanied by distributed strain, N-S fault development, and potential basement uplift in its hangingwall. In the Lyme Bay area to the west, faulting is dominantly E-W, with N-S faulting absent. Comparison of the newly mapped faulting networks to gravity data suggests a spatial relationship between this faulting variation and basement variability and uplift.

1. Introduction

Deformation in late Palaeozoic, Mesozoic and Cenozoic sequences in the southern UK is characterised by the development of major *en echelon* E-W orientated faults, which may be partially inherited from Variscan 'basement' structures, and which acted as growth faults controlling the deposition of Permian through to the late Cretaceous sequences, and furthermore provided the focus for Alpine inversion (Stoneley, 1982; Lake and Karner, 1987; Chadwick, 1986, 1993; Ziegler, 1987; Peacock and Sanderson, 1999; Smith and Hatton, 1998; Underhill and Stoneley, 1998; Underhill and Paterson, 1998; Blundell, 2002; Chadwick and Evans, 2005). The faults demonstrate significant structural variability along their length, relating for example to differing degrees of inversion in post-rift sequences and the development of overlapping major fault segments (e.g. Barton et al., 1998; Harvey and Stewart, 1998; Underhill and Paterson, 1998; Collier et al., 2006; Evans et al., 2011). Focussed inversion along these faults was accompanied by more distributed deformation and uplift of the intervening basins (Chadwick, 1993; Blundell, 2002; Sanderson et al., 2017).

The Purbeck–Wight Fault Zone (PWFZ) is one of the best-developed of these late Cretaceous–Cenozoic inversion lineaments, extending along strike for over 100 km from east of the Isle of Wight to Lyme Bay in the west (Fig. 1). It includes multiple overlapping fault segments, including, for instance, the Purbeck Fault extending across the south of the Isle of Purbeck, and the Abbotsbury–Ridgeway Fault extending westwards into Lyme Bay (Figs. 1 and 2; Stoneley, 1982; Hamblin et al., 1992; Chadwick and Evans, 2005; Evans et al., 2011). The history of study of the spectacular exposures of this World Heritage site 'Jurassic Coast', accompanied by detailed onshore and offshore mapping, and subsurface seismic interpretation, also make it one of the best understood examples of a major structure affecting both the

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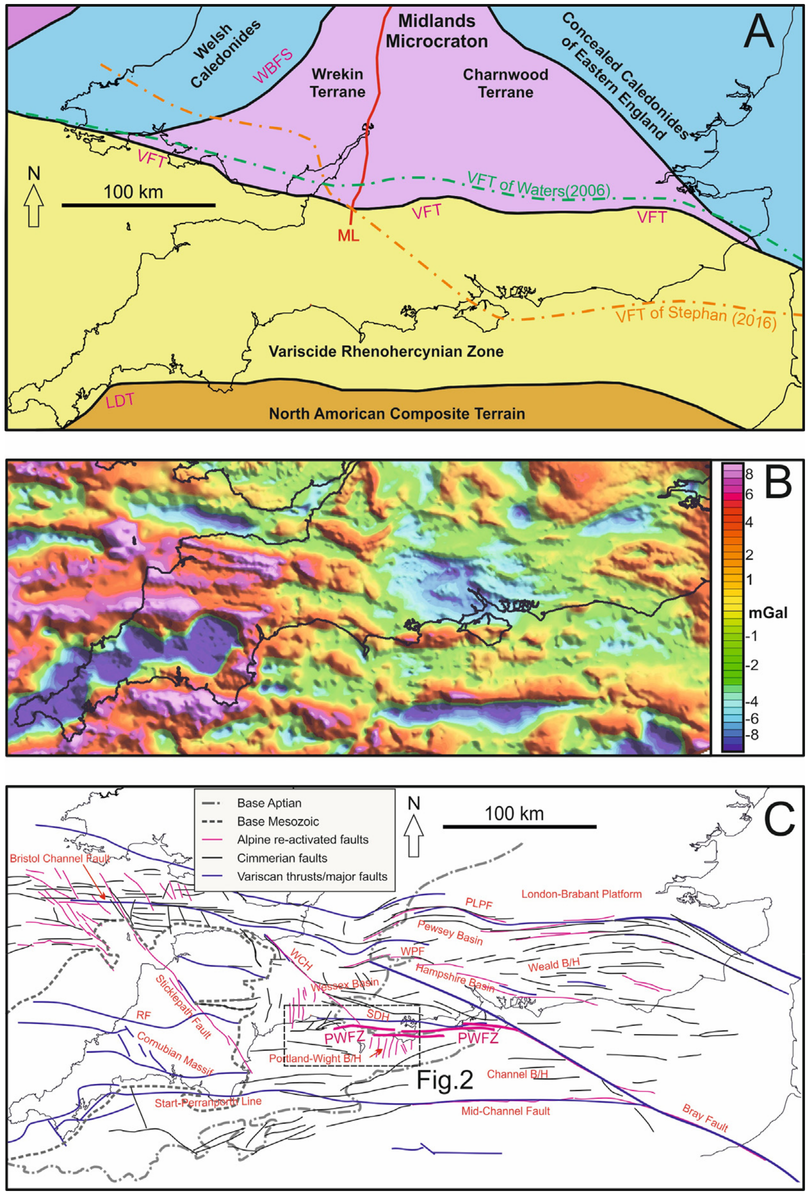

Fig. 1. Regional tectonic setting. A. Basement terranes of Southern Britain, after Chadwick and Evans (2005), including their proposed position of the Variscan Frontal Thrust (labelled VFT); differing positions proposed by other authors for the VFT are also shown; WBFS = Welsh Borderland Fault System; ML = Malverns Lineament.; B. BGS regional gravity compilation, with scale as shown (Bouguer onshore and free-air offshore; residual after subtraction of an upward-continued field); C. Compilation map of major fault lineaments in southern Britain, both concealed and cropping out. WCH = Watchet–Cothelstone–Hatch Fault; SDH = South Dorset High; WPF = Wardour–Portsdown Fault Zone; PLPF = Pewsey–London Platform Fault Zone; B/H = Basin/High; RF = Rusey Fault Zone. Base of Mesozoic cover and Base Aptian (Lower Cretaceous) shown. Compiled principally from Chadwick and Evans (2005), with additional information from the literature (including Stephan et al., 2016; Warr, 2012; Holdsworth, 2012; Waters and Davies, 2006; Leveridge and Hartley, 2006; Chadwick and Evans, 2005; Stoneley, 1982), plus additional lines from BGS digital mapping. Principal faults within the PWFZ emphasised in bold purple. Offshore faults in the study area (Fig. 2) taken from Sanderson et al. (2017) for Weymouth Bay, and from the present mapping in Lyme Bay.

deposition and deformation of cover sequences in the southern UK (e.g. Arkell, 1936, 1947; Chadwick, 1993; Underhill and Paterson, 1998; Barton et al., 2011). The topographical and tectonostratigraphical position of the PWFZ, extending west towards the margins of the exposed Cornubian basement massif in SW England, and to lower exposed (Permo–Triassic) stratigraphical levels than many of the other inversion fault zones in the southern UK, make it of particular interest.

Our current knowledge of the structures in southern England comes mainly from the interpretation of geological and geophysical data collected in the 1980s–2000s (summarised, for example, in Chadwick and Evans, 2005). Much of this work was implemented by the BGS as part of its mapping programme of the British Islands, together with commercial organisations principally driven by exploration for conventional hydrocarbons (Underhill and Stoneley, 1998). More recently, the onshore area has been evaluated for shale oil and shale gas potential (Greenhalgh, 2016). This exploration has resulted in a wealth of information including outcrop observations, borehole logs, seismic reflection profiles and potential field grids. Whilst these traditional datasets are still being expanded with new acquisition campaigns it is the application of new technologies that arguably offer the biggest potential to significantly advance our understanding of the structure of this well-known area. Recent examples of these new approaches include DInSAR onshore (Aldiss, 2013), and swath bathymetry offshore (Collier et al., 2006; Sanderson et al., 2017),

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