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Interacting faults

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ABSTRACT

The way that faults interact with each other controls fault geometries, displacements and strains. Faults rarely occur individually but as sets or networks, with the arrangement of these faults producing a variety of different fault interactions. Fault interactions are characterised in terms of the following: **1) Geometry** – the spatial arrangement of the faults. Interacting faults may or may not be *geometrically linked* (i.e. physically connected), when fault planes share an intersection line. **2) Kinematics** – the displacement distributions of the interacting faults and whether the displacement directions are parallel, perpendicular or oblique to the intersection line. Interacting faults may or may not be *kinematically linked*, where the displacements, stresses and strains of one fault influences those of the other. **3) Displacement and strain in the interaction zone** – whether the faults have the same or opposite displacement directions, and if extension or contraction dominates in the acute bisector between the faults. **4) Chronology** – the relative ages of the faults. This characterisation scheme is used to suggest a classification for interacting faults. Different types of interaction are illustrated using metre-scale faults from the Mesozoic rocks of Somerset and examples from the literature.

1. Introduction

Faults commonly develop as a network, within which the constituent faults can display a range of lengths, sizes, and orientations. A number of different interactions can occur within a network as the faults form geometric and kinematic relationships with each other (e.g., Fossen et al., 2005; Frankowicz and McClay, 2010; Nixon et al., 2014a; Duffy et al., 2015).

What, however, is the best way to interpret interacting faults and how does one differentiate between different types of fault interaction? To address these questions, we investigate the geometry, kinematics and age relationships of different fault interactions. We produce a scheme for identifying, interpreting, describing and ultimately classifying the ways in which any two faults may interact.

There has been considerable interest in the interaction and linkage of stepping, sub-parallel, synchronously active faults, especially normal (e.g., Larsen, 1988; Morley et al., 1990; Peacock and Sanderson, 1991; Leeder and Jackson, 1993; Walsh et al., 1999) and strike-slip faults (e.g., Wilcox et al., 1973; Rodgers, 1980; Biddle and Christie-Blick, 1985; Woodcock and Fischer, 1986; Aydin and Schultz, 1990). Peacock and Sanderson (1991), for example, show stages in the interaction and linkage of stepping normal faults (Fig. 1). There has been much less interest, however, in the interaction and linkage of non-parallel faults, which may or may not be synchronous (e.g., Fig. 2).

A fault network can form within a single stress field, producing interactions between coeval faults (Fig. 3a), including linkage of sub-parallel faults (e.g., Peacock and Sanderson, 1991; Cartwright et al., 1995; Gawthorpe et al., 2003; Fossen et al., 2005; Bull et al., 2006; Nixon et al., 2014a; Fossen and Rotevatn, 2016). A fault network can also form by the mutual abutting and cross-cutting relationships of conjugate faults (e.g., Odonne and Massonnat, 1992; Nicol et al., 1995; Kelly et al., 1998; Ferrill et al., 2009; Nixon et al., 2011). In contrast, some fault networks form by the overprinting or superposition of two or more stress fields, producing interactions between faults of different ages or type (Fig. 3b), resulting in abutting and cross-cutting relationships between the non-coeval fault sets (e.g., Fossen et al., 2005; Maerten et al., 2001; Bailey et al., 2005; Nixon et al., 2014a). Some fault networks form also by the reactivation of pre-existing faults (e.g., Maerten et al., 2001; Giba et al., 2012; Nixon et al., 2014a; Duffy et al., 2015). Such interacting faults may be:

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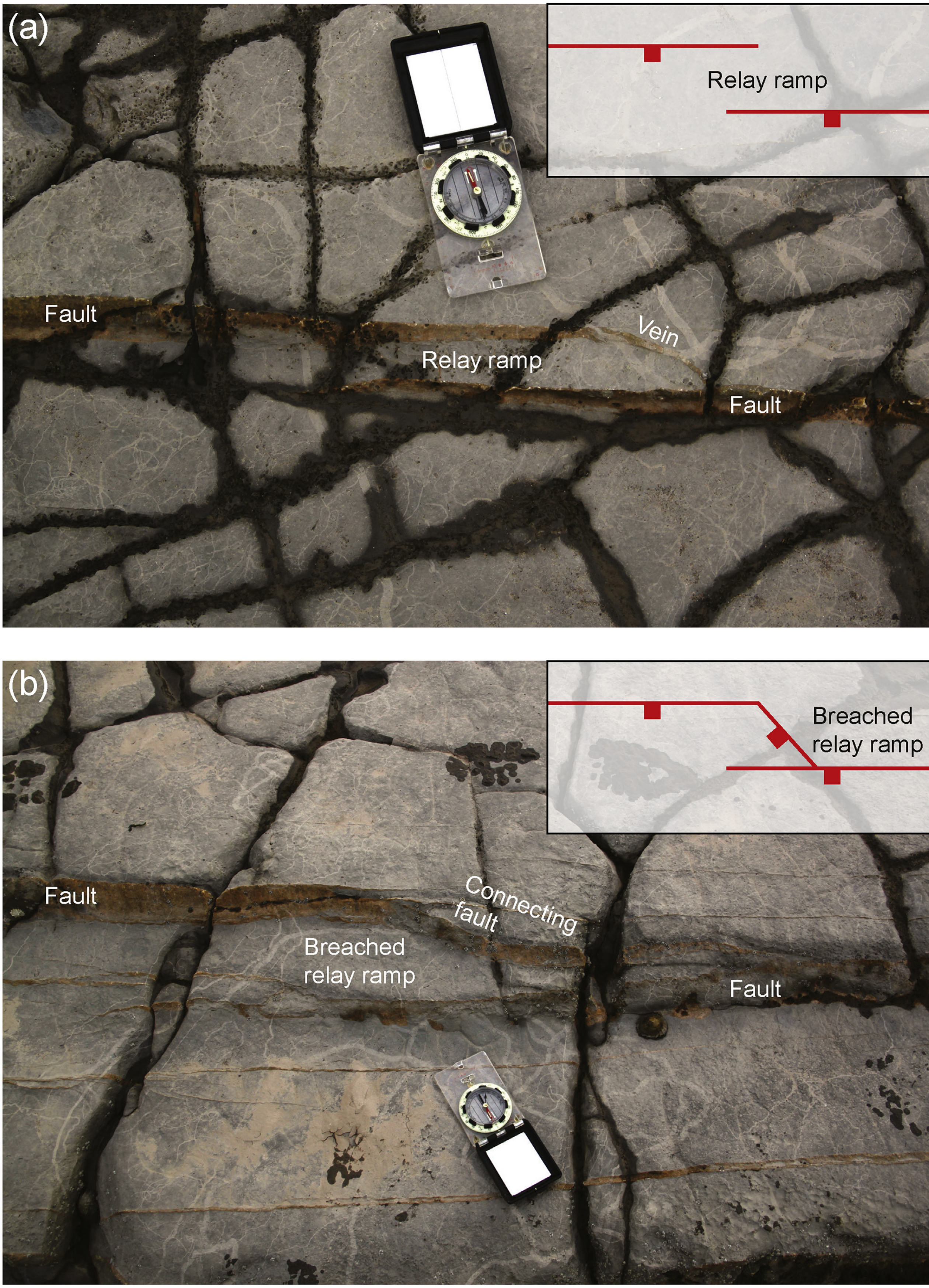

Fig. 1. Examples of interaction and linkage of sub-parallel, synchronous normal faults that step in map view across a relay ramp on Liassic limestone bedding planes, Somerset, UK. (a) The two faults step, with bedding rotated across a relay ramp. Veins cut across the relay ramp, these being precursors to breaching of the relay ramp. (b) The relay ramp is breached by a connecting fault.