It is well known that continuum deformation of media with strain weakening rheology causes deformation zones to progressively decrease in width and structural complexity as shear strain is localized (Ben-Zion and Sammis, 2003). Strain localization occurs on faults at seismogenic depth (e.g., Chester and Chester, 1998; Boulton et al., 2012) and at the surface, as evidenced from detailed mapping of surface ruptures and analogue experiments in granular media (Tchalenko, 1970). In Geology, Zinke et al. (2015) hypothesize that large differences in accumulated strike-slip displacement on the Wairau (~460 km) and Awatere (~20 km) faults in New Zealand have resulted in narrower and less complex offset deformation zones (OFD) along the Wairau fault despite similar slip rates, lithologies, and tectonic settings. Their hypothesis is not supported by the data they present because (1) the compared sites are structurally and topographically dissimilar, and these differences may independently account for the observed rupture patterns, (2) large along-strike variations in the width and complexity of surface rupture zones occur along other nearby analogous faults with uniform structural maturity, (3) wide and structurally complex OFD zones are common features along faults with more accumulated slip and greater structural maturity, and (4) strain localization in granular media with simple boundary conditions occurs at low shear strain, implying that a factor other than structural maturity may be responsible for variations in OFD width and complexity.

The Saxton River site (SR) is located at a restraining bend along the Awatere Fault, where the fault stroke averaged over a distance of 15 km along the surface trace in both directions changes ~12° from 64°±1° NE of SR to 76.5±0.5° SW of SR. The trace of the Wairau Fault either side of the Branch River (BR) site is comparably straight (NE=67±0.5°, SW = 61±0.5°) with the possibility of a slight (~6°) releasing divergence in fault strike. On the nearby Hope Fault, Khajavi et al. (2014) showed increases in OFD width and complexity correspond with deviations in fault strike of ~10–20°. Restraining bends on strike slip faults are commonly associated with an increase in the width and complexity of surface ruptures (e.g., Duffy et al., 2014).

The SR and BR sites are also topographically distinct. Topographic relief on the Awatere fault trace exceeds 250 m within 6 km of the SR site whereas the Wairau Fault trace is largely confined to the Wairau River valley with < 50 m of relief within 10 km of BR. Along strike changes in near-fault topography can perturb shallow stress fields and consequently influence OFD width and structural complexity (Barth et al., 2012; Eusden et al., 2005; Khajavi et al., 2014). Furthermore, the bulged deformation zone at SR occurs on a bedrock spur, suggesting that subsurface topography associated with the spur may have an influence on the surface rupture morphology. Zinke et al. (2015) do not carefully consider macro-structural variations, topographically-influenced stress perturbations or sedimentary thickness variations in their comparison of the SR and BR sites despite the structural and topographic justifications to do so.

The Hope Fault OFD zone width varies from < 10 m, where is confined to a single discrete fault trace, to > 400 m, where it is manifested as a structurally complex mosaic of faults and folds, along strike lengths of < 3 km. Structural continuity along the principal slip zone suggests uniform structural maturity despite these OFD variances. Surface rupture patterns on the Alpine Fault, which has incurred > 400 km of lateral displacement (Sutherland, 1999) and is one of Earth’s most structurally mature active faults, are kinematically partitioned and notoriously complex, with surface rupture zones commonly exceeding 300 m (Barth et al., 2012). Clearly, structural maturity is not a primary control of OFD complexity and width variations along these faults.

Strain localization onto structurally simple, continuous strike-slip faults at the surface occurs at low finite shear strains in quasi-homogeneous granular materials with simple boundary conditions (e.g., steep underlying fault, low topographic relief). Shear localization occurred after lateral surface displacements of ~3 m in the Dash-e Bayaz earthquake (Tchalenko and Ambraseys, 1970) and ~2–3 m in the Darfield earthquake (Van Dissen et al., 2013). Perhaps other controls on surface rupture morphology, including near-surface strain localization (independent of fault maturity) and variations in material properties of faulted media, depth-to-basement, near-fault topography, and fault strike need to be more carefully considered in future analyses.

REFERENCES CITED

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