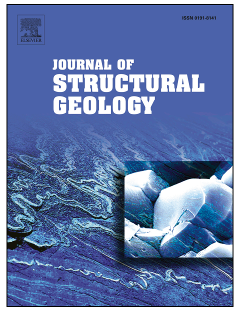
Accepted Manuscript



Smoothing and re-roughening processes: The geometric evolution of a single fault zone

Katherine A.H. Shervais, James D. Kirkpatrick

PII: S0191-8141(16)30134-1

DOI: 10.1016/j.jsg.2016.09.004

Reference: SG 3384

To appear in: *Journal of Structural Geology*

Received Date: 11 February 2016

Revised Date: 2 September 2016

Accepted Date: 5 September 2016

Please cite this article as: Shervais, K.A.H., Kirkpatrick, J.D., Smoothing and re-roughening processes: The geometric evolution of a single fault zone, *Journal of Structural Geology* (2016), doi: 10.1016/j.jsg.2016.09.004.

Smoothing and re-roughening processes: the geometric evolution of a single fault zone

Katherine A.H. Shervais*[1] and James D. Kirkpatrick[2]
1.Department of Geoscience, Colorado State University, 1482 Campus Delivery, Fort Collins, CO 80524
2. Department of Earth and Planetary Sciences, 3450 University St., Montréal, QC H3A 0E8, Canada.
* Corresponding author (email: shervais@rams.colostate.edu)

keywords: fault roughness, fault core, fault geometry evolution, fault, low angle normal fault, principal slip zone

Abstract

The geometry of a fault zone exerts a major control on earthquake rupture processes and source parameters. Observations previously compiled from multiple faults suggest that fault surface shape evolves with displacement, but the specific processes driving the evolution of fault geometry within a single fault zone are not well understood. Here, we characterize the deformation history and geometry of an extraordinarily well-exposed fault using maps of cross-sectional exposures constructed with the Structure from Motion photogrammetric method. The La Quinta Fault, located in southern California, experienced at least three phases of deformation. Multiple layers of ultracataclasite formed during the most recent phase. Crosscutting relations between the layers define the evolution of the structures and demonstrate that new layers formed successively during the deformation history. Wear processes such as grain plucking from one layer into a younger layer and truncation of asperities at layer edges indicate that the layers were slip zones and the contacts between them slip surfaces. Slip surfaces that were not reactivated or modified after they were abandoned exhibit self-affine geometry, preserving the fault roughness from different stages of faulting. Roughness varies little between surfaces, except the last slip zone to form in the fault, which is the smoothest. This layer contains a