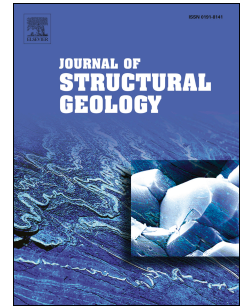


Accepted Manuscript

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

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PII: S0191-8141(16)30134-1

DOI: [10.1016/j.jsg.2016.09.004](https://doi.org/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.

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

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9
10 keywords: fault roughness, fault core, fault geometry evolution, fault, low angle normal
11 fault, principal slip zone

12
13 **Abstract**

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

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