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Fractal fault zone geometry and scale-dependent static stress drop

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I have shown that fault zone geometries, composed of fault segments and jog, are hierarchically selfsimilar (Fig.1a). This inhomogeneous structure breaks down the wellknown relations among fault length, averaged seismic slip and seismic moment. The distribution of seismic slip also is pinned hierarchically by jogs, showing a spectral distribution (Fig.1b). Based on the high quality data of fault traces and slip distributions from 21 surface earthquake strike-slip faults, here I show that average static stress drop $\triangle\sigma$ decreases as L_0.

Key Point 1
If $D_{av}$of a fault (L, D_{max}) is $\pi D_{max}/4$, $\triangle\sigma = C\pi D_{max}/4L$.
For a fault composed of linked n faults with (L/n, D_{max}) also $D_{av} = \pi D_{max}/4$, while $\triangle\sigma = nC\pi D_{max}/4L$.
[Symbol fault length:L, maximum slip:D_{max} and averaged slip:D_{av}, static stress drop:$\triangle\sigma$, proportional constant:C]

Key Point 2
Slip distributions D_x on fault segments are approximated by two simple cases below.
Cases of homogeneous frictional resistance $D_x = 2(1 - \nu)/G \times ({\sigma_{yx}}^r - {\sigma_{yx}}^c) \times (a^2 - x^2)^{0.5}$.
Cases of frictional resistance with a linear gradient $D_x = (1 - \nu)/G \times (2{\sigma_{yx}}^r - {\sigma_{yx}}^c(x/a)) \times (a^2 - x^2)^{0.5}$.
[Symbol half length of fault segments:a, Poisson's ratio:ν, remote stress:${\sigma_{xy}}^r$, frictional resistance:${\sigma_{xy}}^c$]

Key Point 3
When $L_s(i,j) < W_s$, $\triangle\sigma_{av}(i,j) = (7\pi G/8)(D_{av}(i,j)/L_s(i,j)$.
When $Ls(i,j) > W_s$, $\triangle\sigma_{av}(i,j) = (2G/\pi)(D_{av}(i,j)/W_s$.
The static stress drops averaged over the whole fault length L_0 is $\triangle\sigma = (\sum\triangle\sigma_{av}(i,j)L_s(i,j)/L_0$.
[Symbol for j-th segment of hierarchical rank i, segment length:$L_s(i,j)$, averaged slip:$D_{av}(i,j)$, static stress drop:$\triangle\sigma_{av}(i,j)$, thickness of seismogenic crustal layer:W_s, rigidity:G]

Analytical Results
17 among 21 data are approximated to the equation below (Fig.1c).
$\triangle\sigma = 79.0\ {L_0}^{-0.519}$ (units km and MPa)

Keywords: static stress drop, scale dependence, fault zone geometry, hierarchically selfsimilar

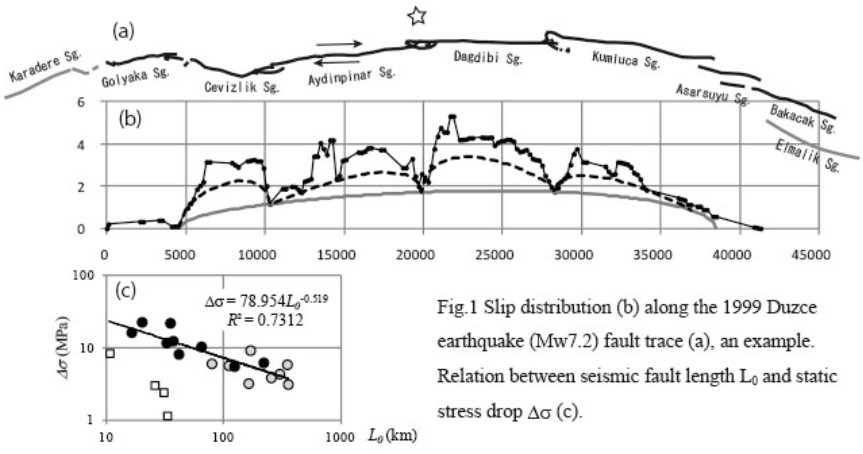

Fig.1 Slip distribution (b) along the 1999 Duzce earthquake (Mw7.2) fault trace (a), an example. Relation between seismic fault length L_0 and static stress drop $\Delta\sigma$ (c).