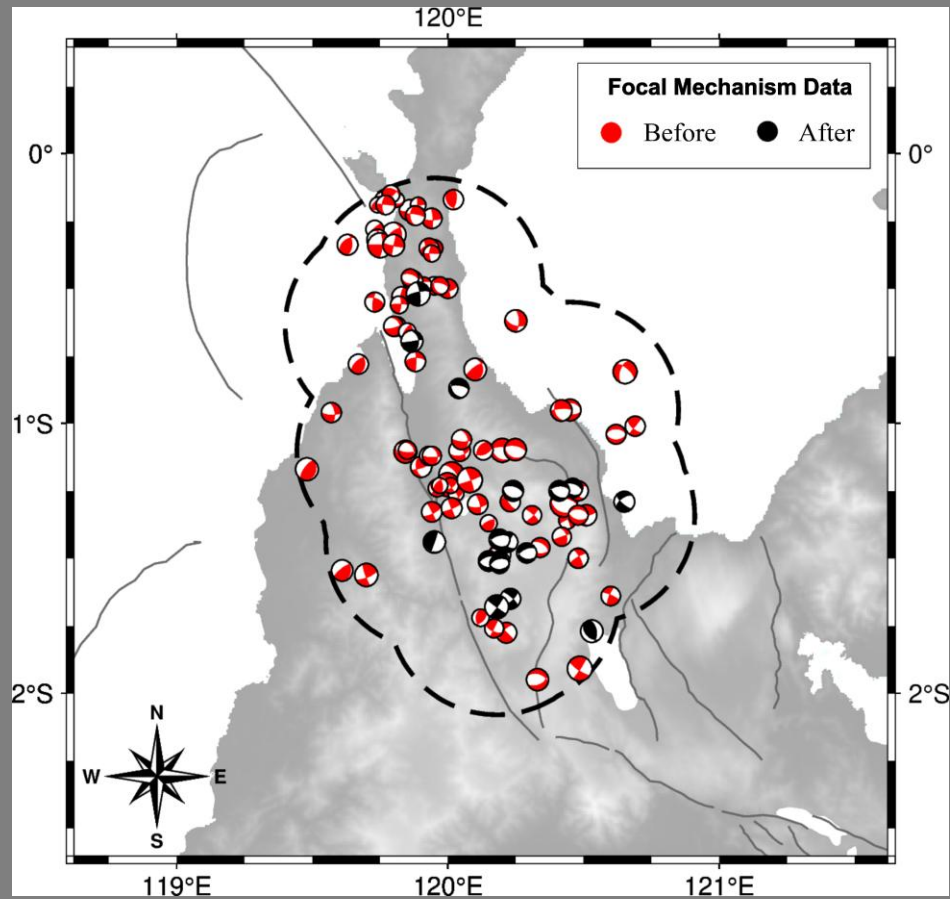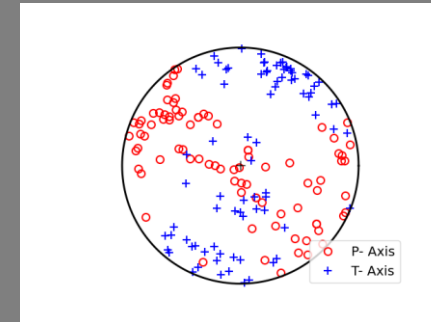# Stress Orientation Rotation
of the 2018 Mw 7.5 Palu Earthquake

Focal Mechanisms Data
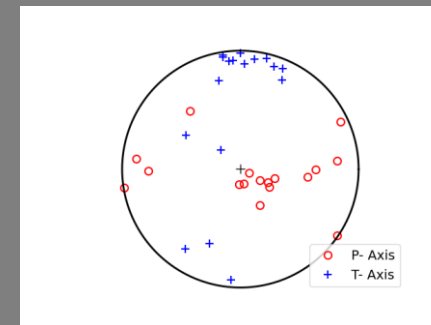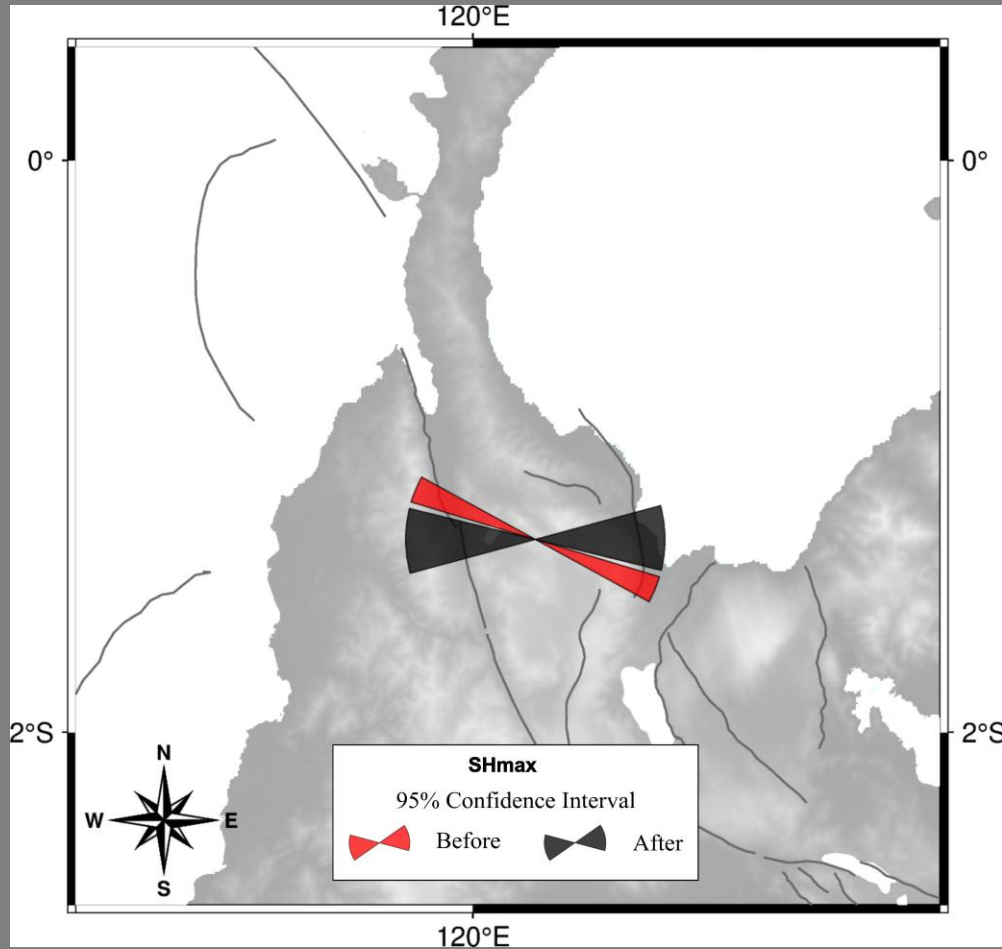

Before 2018 Mw7.5 Palu

85 events
May 1977 – Sep 2018
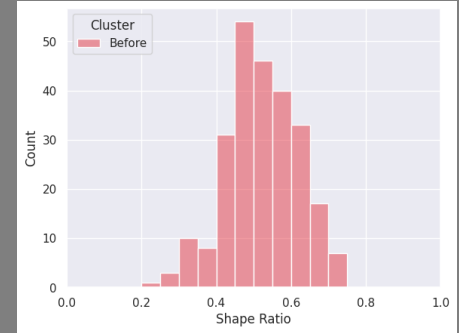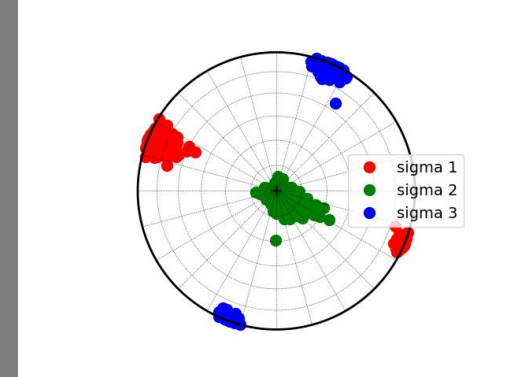
After 2018 Mw7.5 Palu

17 events
Sep 2018 – Nov 2021

Stress Inversion Result

Before 2018 Mw7.5 Palu

After 2018 Mw7.5 Palu
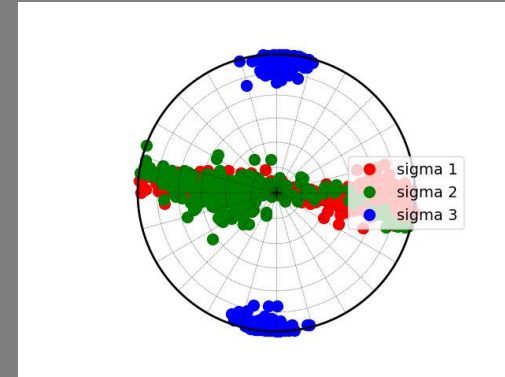
	σ1 Azimuth	σ1 Plunge	σ2 Azimuth	σ2 Plunge	σ3 Azimuth	σ3 Plunge	SHmax
Before	112.4 ± 5.9	11.3 ± 10.8	77.7 ± 87.0	76.7 ± 10.9	23.0 ± 6.2	5.1 ± 4.8	112.8 ± 6.0
After	95.6 ± 20.5	42.5 ± 39.7	84.4 ± 42.3	45.5 ± 39.1	5.2 ± 11.8	9.1 ± 9.0	89.3 ± 14.5
Δ	-16.7 ± 20.3	32.7 ± 42.6	7.5 ± 99.6	-32.4 ± 42.0	-17.1 ± 14.6	2.9 ± 10.5	-22.8 ± 15.4

Stress Drop Ratio $\left(\dfrac{\Delta\tau}{\tau}\right)$ Calculation

To calculate the stress drop ratio, we use
equation (4) in Hardebeck 2001

$$\Delta\theta = \tan^{-1}\left(\frac{1 - \frac{\Delta\tau}{\tau}\sin 2\theta - \sqrt{\left(\frac{\Delta\tau}{\tau}\right)^2 + 1 - 2\frac{\Delta\tau}{\tau}\sin 2\theta}}{\frac{\Delta\tau}{\tau}\cos 2\theta}\right) \longrightarrow \frac{\Delta\tau}{\tau} = -\frac{\sin(2\Delta\theta)}{\cos(2\theta + 2\Delta\theta)}$$

Calculation of θ and $\Delta\theta$

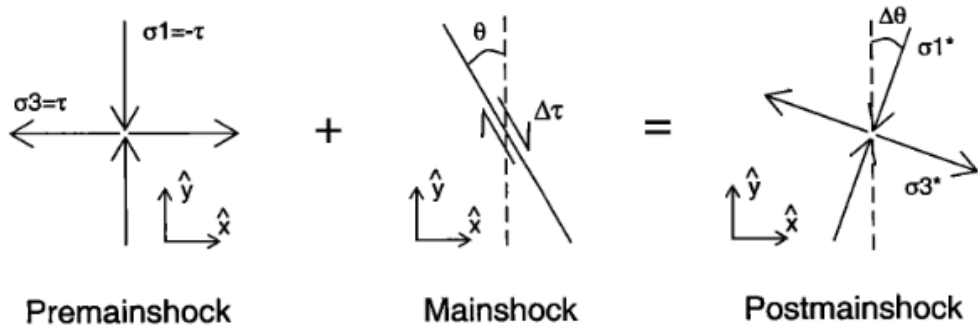21,874 HARDEBECK AND HAUKSSON: CRUSTAL STRESS FIELD IN CALIFORNIA

Figure 8. Assumed geometry of a stress rotation due to slip on a fault. The postmainshock stress state is equal to the premainshock stress state plus the stress change due to the earthquake. The problem is assumed to be two-dimensional, so it can be represented entirely in the σ_1-σ_3 plane. θ is the angle from the fault trend to the σ_1 axis, clockwise positive. $\Delta\theta$ is the rotation of the stress field, clockwise positive. The mainshock stress drop, $\Delta\tau$, is taken to be positive for the sense shown and negative for the opposite sense of slip.
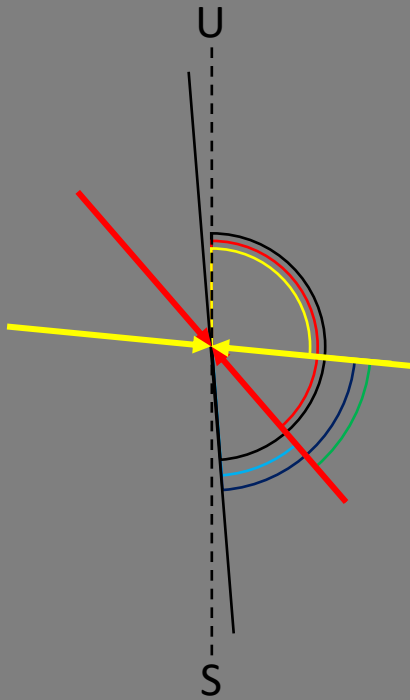
Hardebeck & Hauksson 2001 say that θ and $\Delta\theta$ are calculated on the $\sigma1 - \sigma3$ plane. Since the mechanism of the 2018 Mw7.5 Palu earthquake is strike-slip, the $\sigma1 - \sigma3$ plane is horizontal, so the angle used is SHmax with respect to the strike of fault.
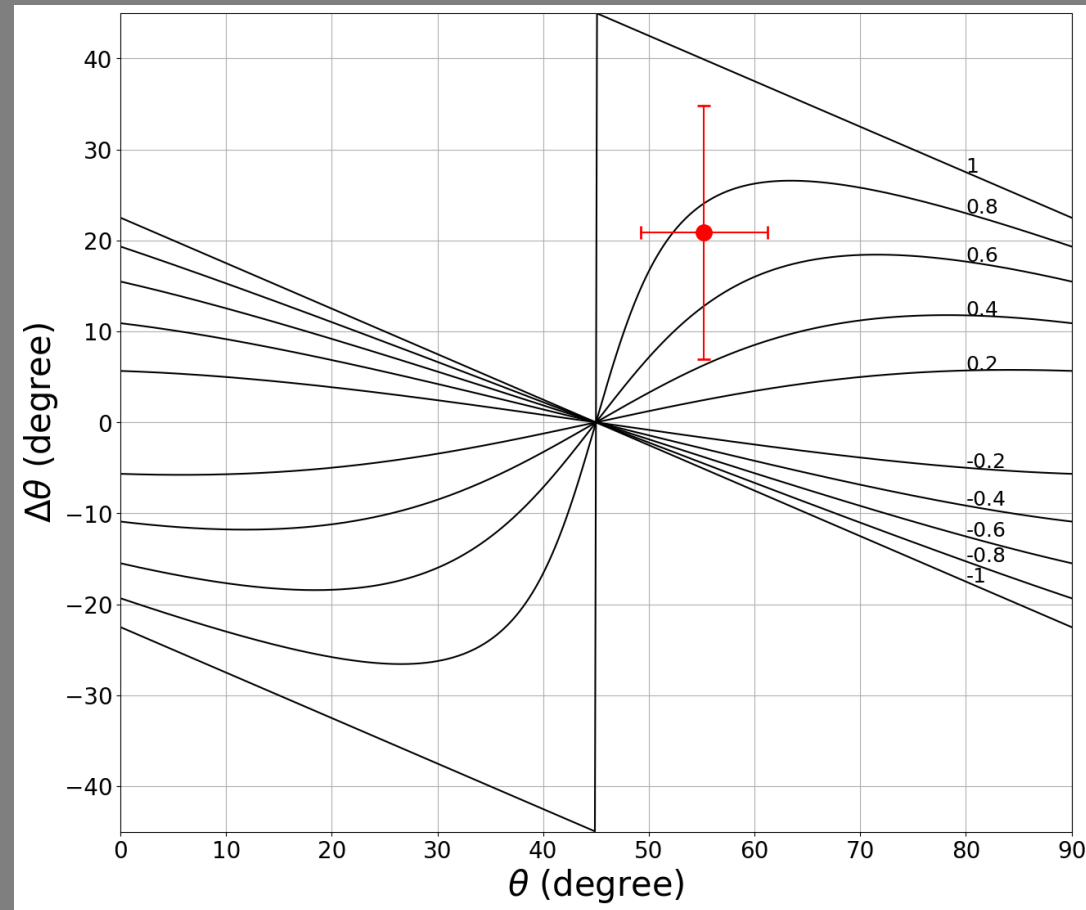
Nodal plane 2018 Mw 7.5 Palu
348 · 57 · -15   87 · 77 · -146

$$\theta = strike - before$$
$$\theta_a = strike - after$$
$$\Delta\theta = \theta_a - \theta$$

Fault | *Before* | *After* | $\theta + \Delta\theta$ | θ | $\Delta\theta$

Model Stress Drop 2018 Mw 7.5 Palu by SHmax

$\theta_b = 55.24 \pm 5.97\ (49.26{-}61.21)$

$\Delta\theta = 20.86 \pm 13.94\ (6.92{-}34.80)$

$\dfrac{\Delta\tau}{\tau} = 0.75 \pm 0.30\ (0.33{-}0.94)$