Strain accumulation across the Aksay segment of Altyn Tagh fault: Investigation of the influence of laterally varying lithospheric properties

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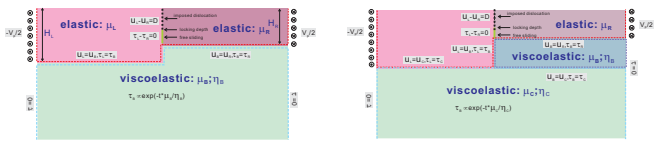
Introduction:

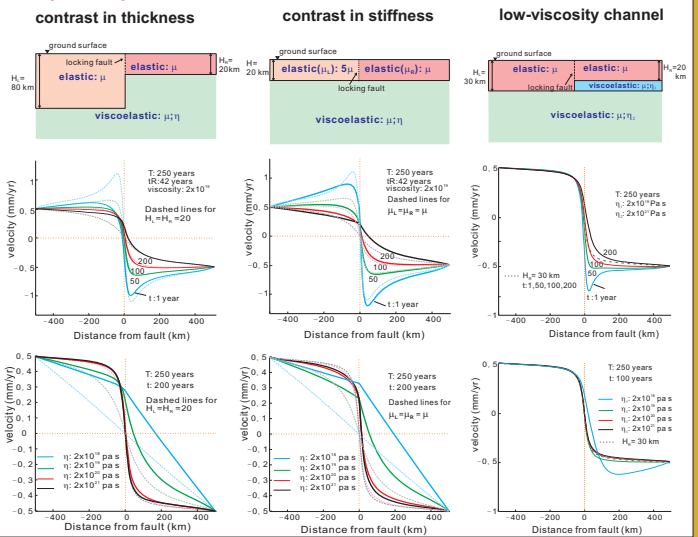
We use **boundary element methods** to develop **earthquake cycle models** consisting of faulting in an elastic plate with possibly **different thickness** and **rigidity** on either side of the fault overlying a viscoelastic substrate. We show that **isolate plate models** that neglect the coupling of the plate to the underlying substrate might **significantly overpredict the asymmetry** in deformation across the fault. We also show **a low-viscosity channel** that exists **within lower crust** could **significantly contribute to the asymmetry**.

model I for SAF &GSF **model II for ATF**



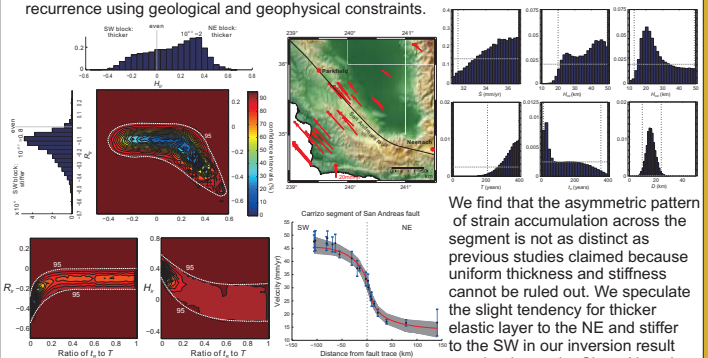
Asymmetry of Deformation

contrast in thickness **contrast in stiffness** **low-viscosity channel**



Carrizo Segment of San Andreas Fault (SAF)

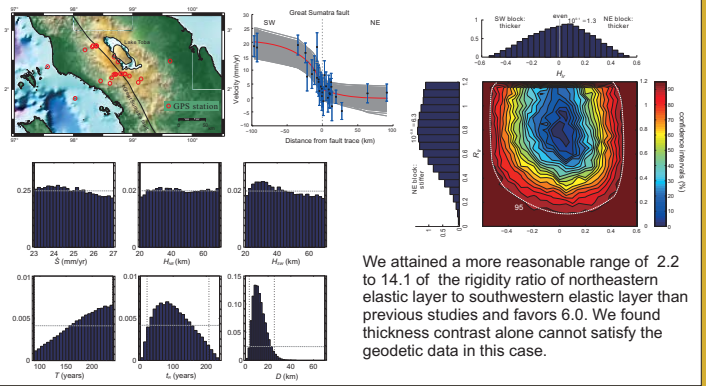
We invert 1994~2003 GPS data for the long-term slip rate, thicknesses of elastic layers, fault locked depth, rigidity ratio of the two elastic layers, stress relaxation time and earthquake recurrence using geological and geophysical constraints.



We find that the asymmetric pattern of strain accumulation across the segment is not as distinct as previous studies claimed because uniform thickness and stiffness cannot be ruled out. We speculate the slight tendency for thicker elastic layer to the NE and stiffer to the SW in our inversion result may be due to the Sierra Nevada.

Renun Segment of the Great Sumatra Fault (GSF)

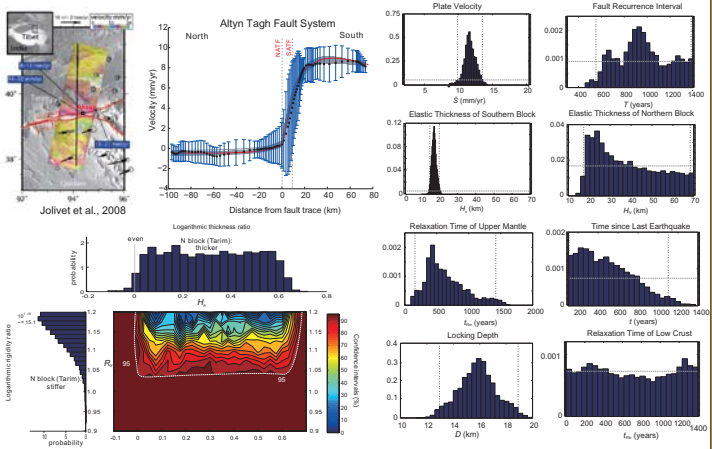
We also investigate the Renun segment of the Great Sumatra fault where the 1989-1996 GPS velocity profile across the fault is distinctly asymmetric.



We attained a more reasonable range of 2.2 to 14.1 of the rigidity ratio of northeastern elastic layer to southwestern elastic layer than previous studies and favors 6.0. We found thickness contrast alone cannot satisfy the geodetic data in this case.

Altyn Tagh Fault (ATF)

We also investigate the segment of Altyn Tagh fault, the northern border of the Tibetan plateau between the Tarim and the Qaidam basins, where surface velocity (projected to fault-parallel direction) obtained from a stack of 15 interferograms using ERS and ENVISAT radar data covering the 1995–2006 period is distinctly asymmetric. We examine the possibility of the existence of low-viscosity lower crust (a channel) in the Tibetan plateau which has been debated.



Inversion Result without Varying Fault Zone Position

Parameter	A Priori Bounds	95% Confidence	Most Probable
$\dot{S}$, mm/yr	2–20.4	9.8–13.4	11.6
H_{1L}, km	10–70	17.9–68.1	23.5
H_{2L}, km	10–70	14.8–19.8	17.0
R_L (R_1)	-1.2–1.2	1.06–1.2	1.18
T, years	300–1400	572–1376	925
t_{1st}, years	none	167–1418	430
D, km	0–70	13.0–18.7	15.9
t_e years	>100	119–1106	225
t_{1Lt}, years	0–1400	32–1369	None (almost uniform)

Note: d: distance of the central fault zone south of NATF

Inversion Result with Varying Fault Zone Position

Parameter	A Priori bounds	95% Confidence	Most Probable
$\dot{S}$, mm/yr	2–20.4	9.1–10.8	10.1
H_{1L}, km	10–70	14.3–63.0	23.8
H_{2L} km	10–70	10.1–13.0	10.3
R_L	-1.2–1.2	0.45–1.07	0.87
T, years	300–1400	914–1388	1378
t_{1st}, years	none	153–1181	262
D, km	0–70	4.9–11.3	10.2
t_e years	>100	115–638	118
t_{1Lt}, years	0–1400	72–1334	None (almost uniform)
d, km	0–10	3.3–7.1	4.6
H_L	-0.85–0.85	0.14–0.68	0.68

The asymmetric pattern of strain accumulation across Altyn Tagh fault near Aksay (at latitute of 94°) are attributed mainly stiffness contrast (stiffer Tarim) and partially thickness contrast (thicker Tarim). The existence of low-viscosity lower crust (a channel) in the Tibetan plateau is likely; however, the viscosity of this mid-crustal Tibetan channel in not resolvable. The NATF and SATF are likely an expression of a flower structure of the Altyn Tagh fault at shallow depth. The Altyn Tagh fault zone roughly centers on surface traces of NATF and SAFT at depth.