Creep motion along the Chaman fault as detected by InSAR data using ERS and Envisat

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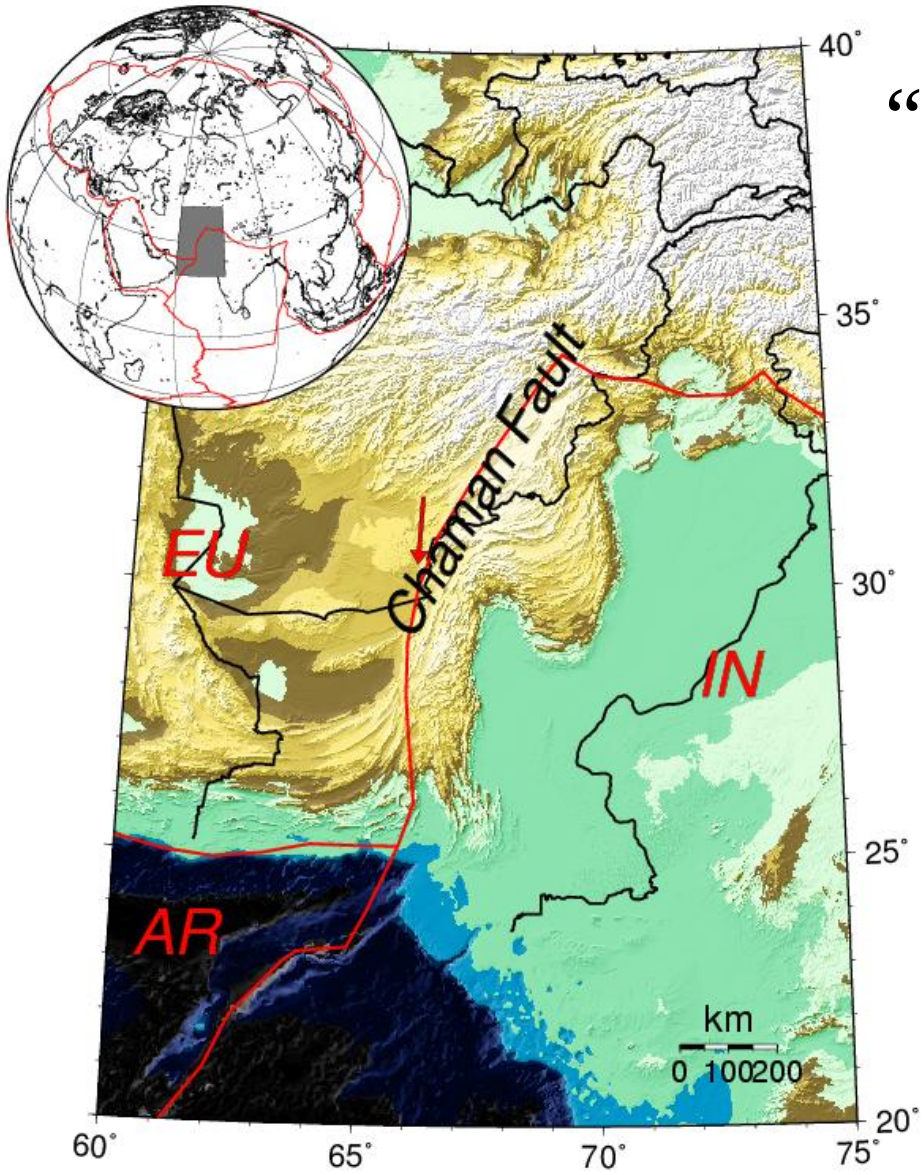
Where is the Chaman fault?

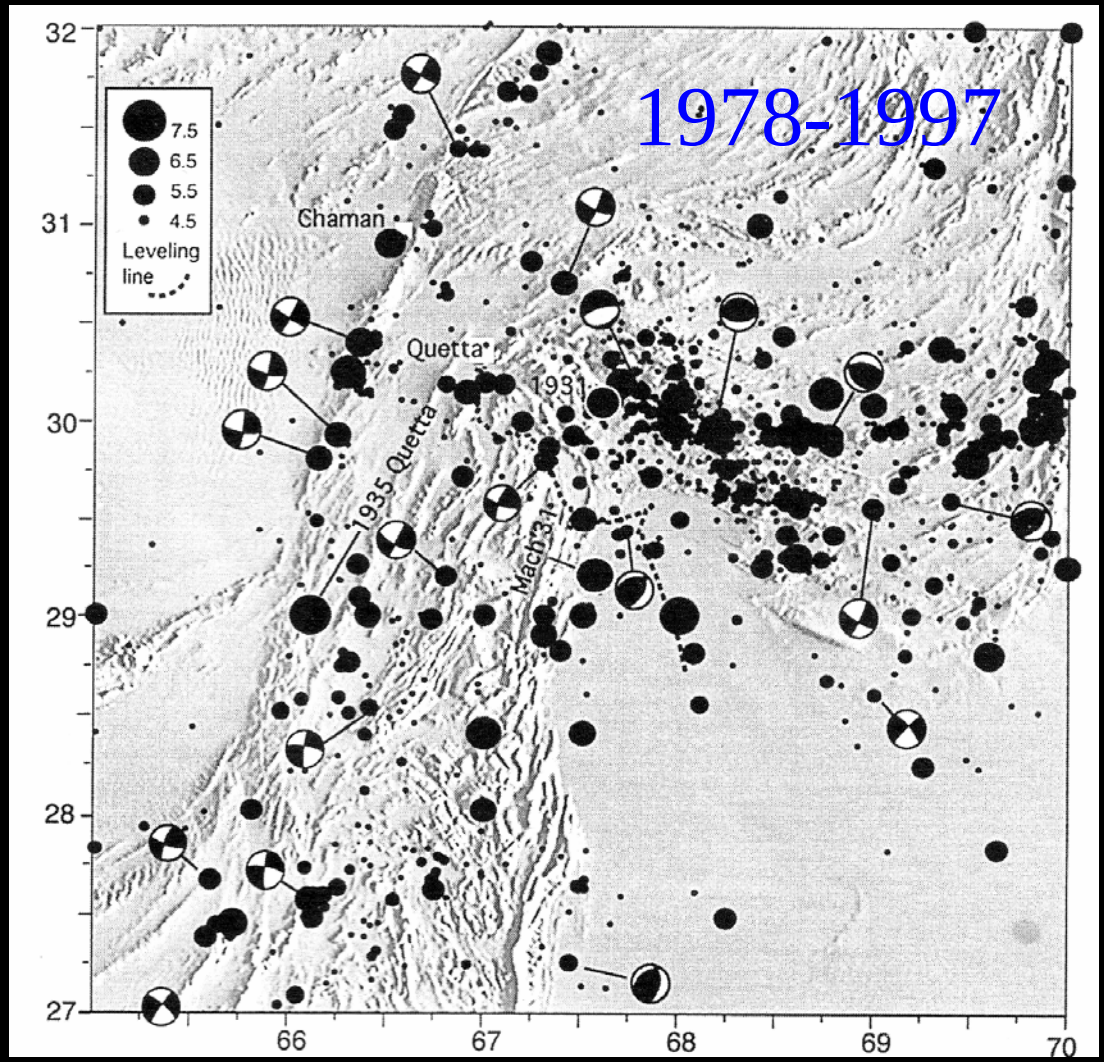


"Transform plate boundary"
Between EU and IN plates

Afghanistan to Pakistan
~900km

Left lateral plate motion
~40mm/yr w.r.t. IN
(NUVEL-1)

Past Seismicity



1892 Chaman

1931 Mach

1935 Quetta

Ambraseys and Bilham (2003, BSSA)

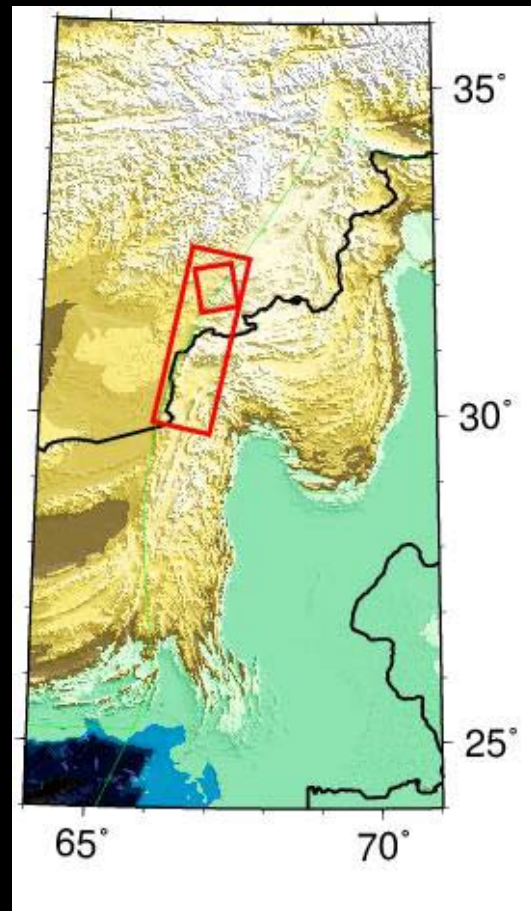
Motivation and Scope

- Few crustal deformation measurement.

  No InSAR observation (to our knowledge)
- How plate motions are accommodated in and around continental plate boundary?
- Locked? Freely slipping?
- Evaluate seismic coupling and earthquake hazard potential

Data and Processing

- ERS1/2: 1992~2003 (Track 134, Frame 2761-2779-2997 descending)
- Envisat:2004~2006 (Track 213, Frame 621 ascending, IS6, inc~41°)
- SRTM Digital Elevation Model
- TU Delft orbit data



Descending? Ascending?

How sensitive to the signal?

$$[\cos\theta\sin\lambda, -\sin\theta\sin\lambda, -\cos\lambda]\begin{bmatrix} Ue \\ Un \\ Uu \end{bmatrix} = \Delta LOS$$

θ : *heading angle* (*c.w. from North*), λ : *incidence angle, right looking*

If $Uu=0$ and fault azimuth =45deg., we see...

ERS1/2 Descending $\quad -0.21\Delta s = \Delta LOS$

Envisat Ascending IS6 $\quad +0.54\Delta s = \Delta LOS$

ERS1/2 Descending data

Nov 02, 1992 - Jun 03, 1999

(T=6.58yrs,Bp=48~29m)

East

South

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North

West

-1.0cm +1.0cm

+:toward satellite

Sep 13, 1993 - Oct 01, 1998

(T=5.05yrs, Bp=65~54m)

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-1.0cm +1.0cm

+:toward satellite

Detection of co-seismic signal

Observation (no-stack): Preliminary model:

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Fault parameters:

Depth(bottom)=5km, L=7km,W=4km

Dip=100deg., U(left lateral)=0.55m

∴ Mw~5.6 (ISC Nov 16 '93: M5.4, Depth=30km)

Average of the two

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LOS step~3mm/yr
(probably true..)

Are these true?
???

-2.5mm/yr +2.5mm/yr

Envisat Ascending data

T=70d, Bp=-24.5m T=35d, Bp=226m

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T=35d, Bp=60.3m T=70d, Bp=-80.6m

+: toward sensor, cyclic

-1.0cm +1.0cm

All acquisition dates are independent.

Short-term 4 stack: Low S/N

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T=140d, Bp=134.8m T=175d, Bp=-228.3m

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T=175d, Bp=-281.2m T=175d, Bp=-81.6m

All acquisition dates are independent.

Middle-term 4 stack

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T=560d, Bp=50.8m

T=315d, Bp=-38.2m

T=280d, Bp=46.6m

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T=350d, Bp=50.8m

T=385d, Bp=50.8m

+: toward sensor, cyclic

-1.0cm +1.0cm

All acquisition dates are independent.

Long-term 5 stack: Higher S/N

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Comparison to topography

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Summary

- Envisat ascending results: The longer the time span, the clearer the signal. We therefore (presumably) detected real deformation signals with “only” two-years long data.
- ERS descending results: consistent with left lateral motion, whereas we should keep in mind that the track is rather insentive to this particular fault.
- Need to analyze adjacent ascending track data of Envisat.
- Surely ALOS PALSAR data as well!!