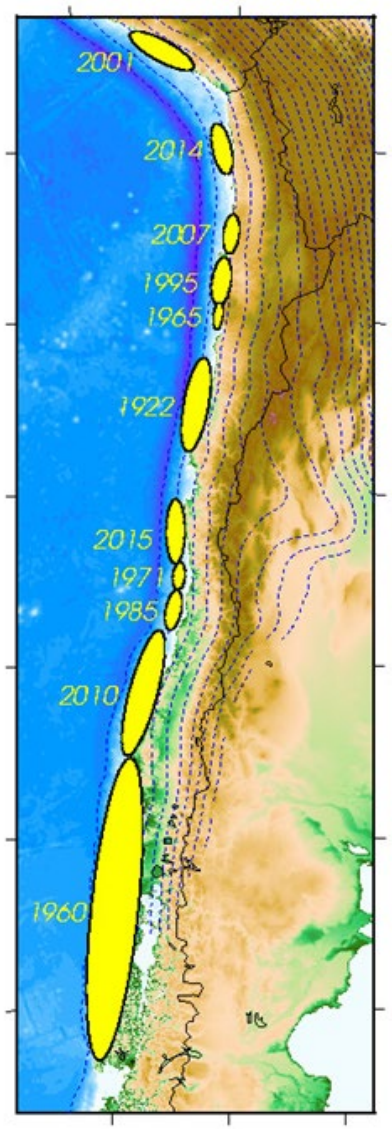
Tsunami Sources and Hazards in Southern Peru and Northern Chile

Seismicity in Northern Chile



Universidad de Tarapacá
Arica, Chile
22-25 August 2023

S. Barrientos
Centro Sismológico Nacional
Universidad de Chile

Seismicity of Chile

- *High seismic productivity rates*
  - *A large number of events per unit of time*
  - *Last 450 years: an average of one M> 8 every 12 yr.*
- *Giant earthquakes*
- *Different types of faulting*

Civil Protection Agency

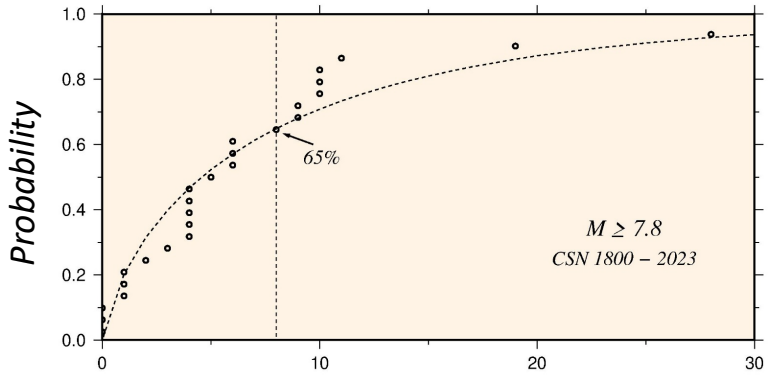
SENAPRED

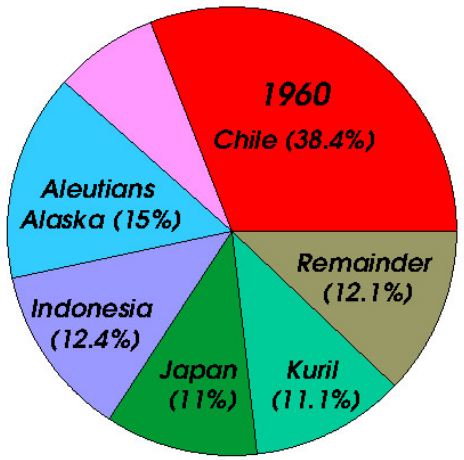
CSN ⟺ SHOA

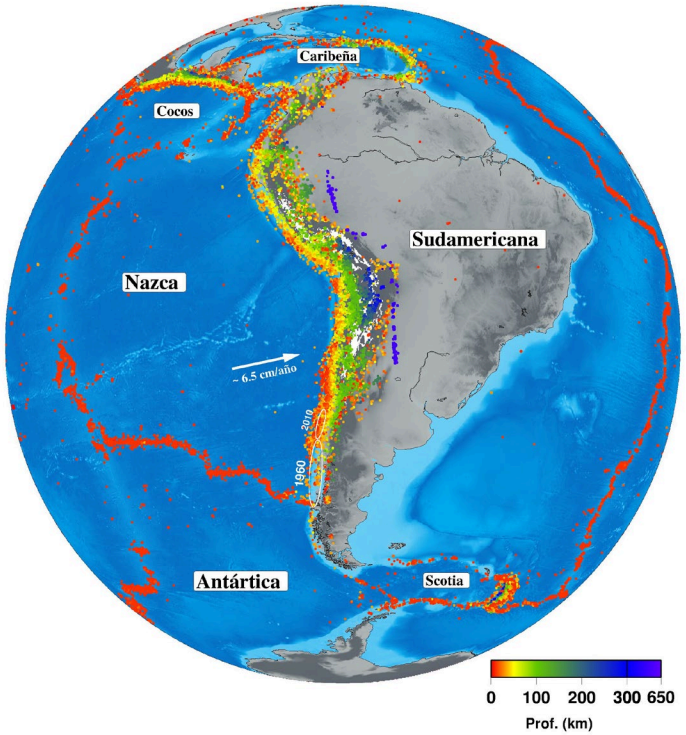
Tsunami Warning Agency

In Chile, since 1900, in terms of disasters of natural origin earthquakes and tsunamis are responsible of:

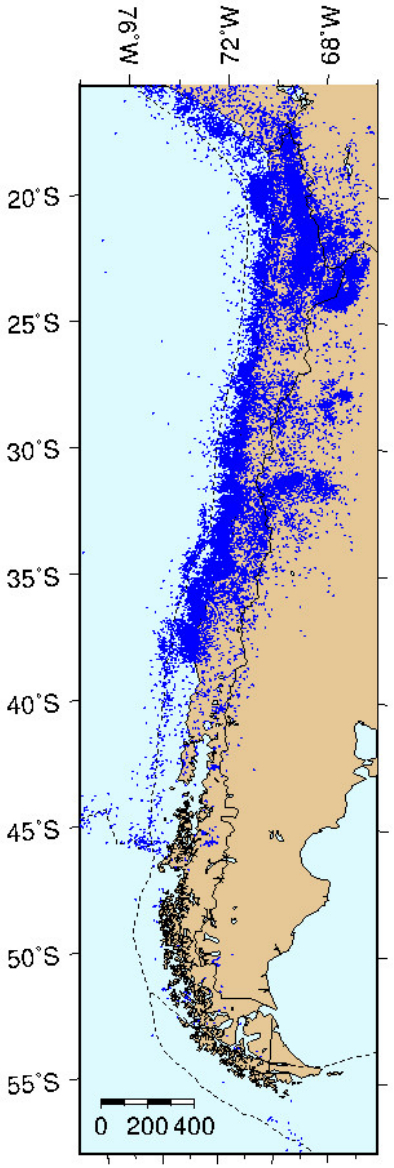
- *99% of fatalities*
- *98% of economic losses*



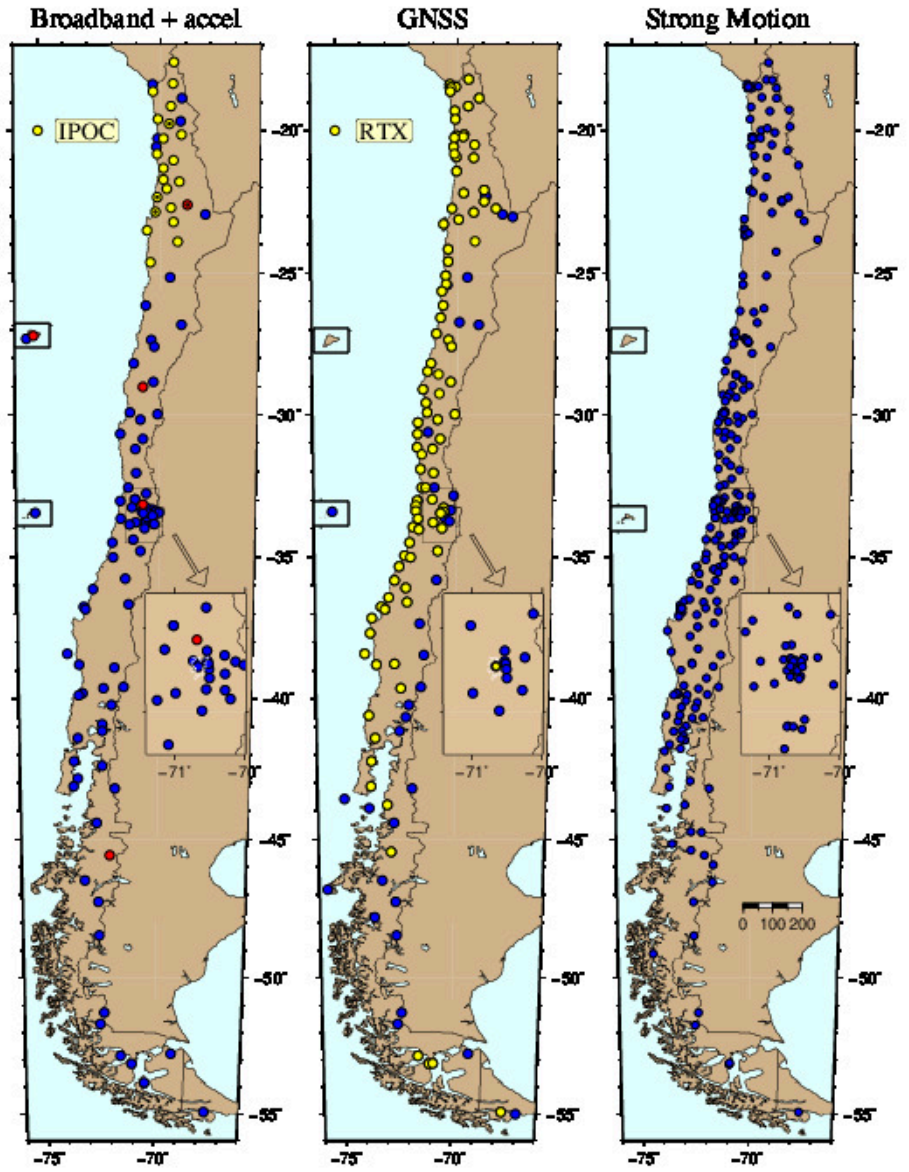




Worldwide seismic energy released 1900 → Presente



Observation System

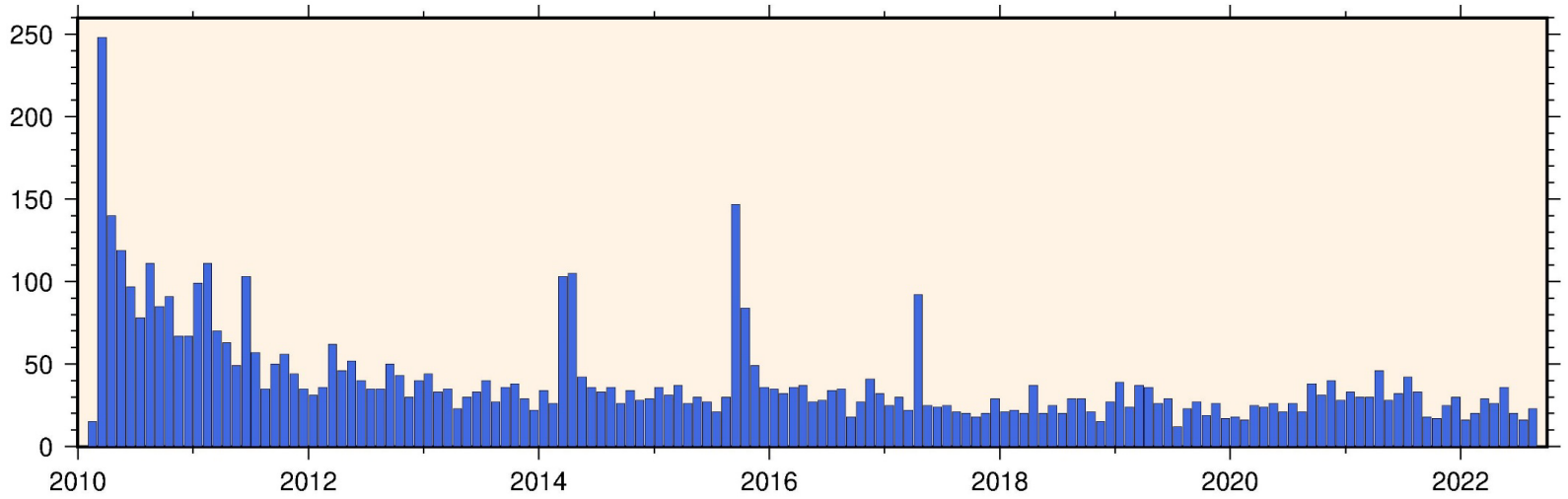


110 Full stations *(6-component)*
BB + accelerometers
25 academic colaboration
128 GNSS
Rapid displacement estimation
293 *accelerometers Engineering purposes (Minvu-Onemi)*

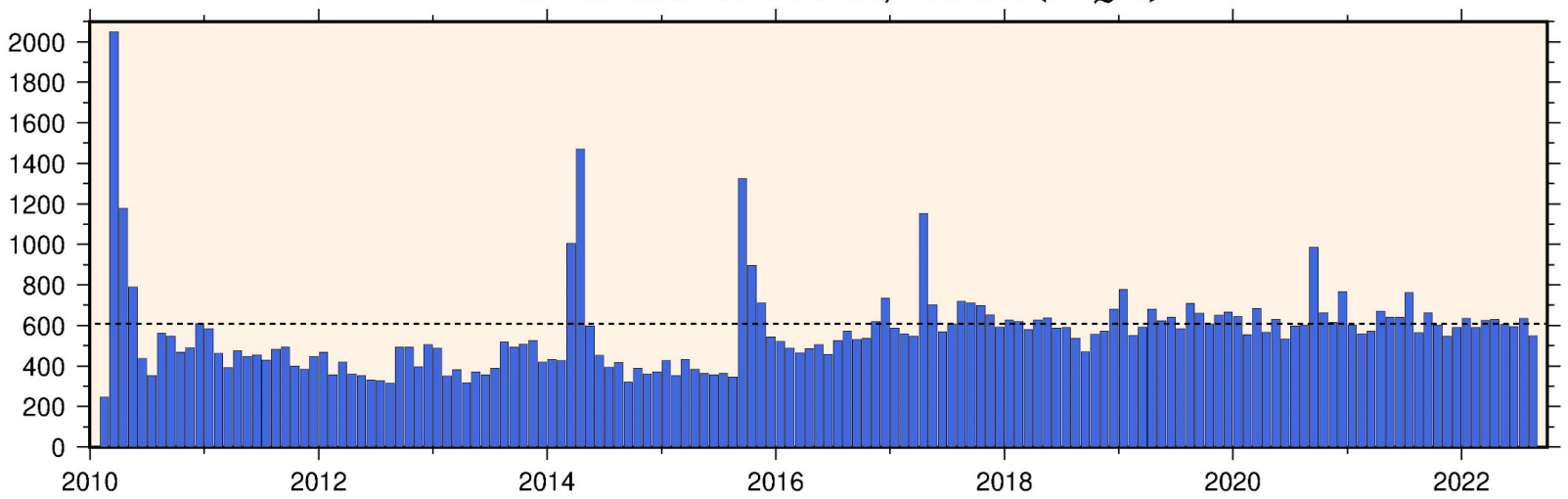
Seismicity of Chile

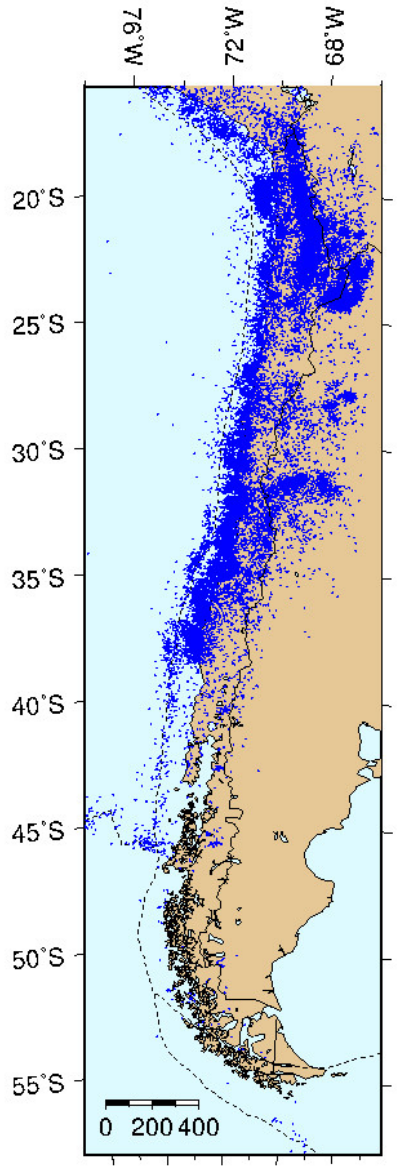
CSN
CENTRO SISMOLÓGICO NACIONAL
UNIVERSIDAD DE CHILE

Number of felt earthquakes/month



Total number of events/month ($M \gtrsim 3$)





Rapid Response

Origin time

Intrum. Intensity

M accel, BB

Preliminary epicentral Loc.

M PGD GNSS

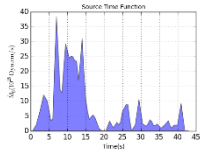
GNSS

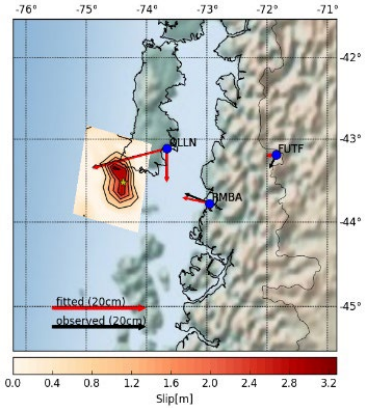
5 min

Acceleration records

10 min

Rupture Area M > 7.5



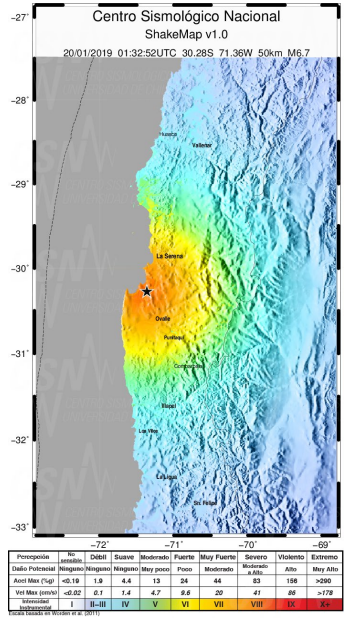


Body Waves

Surface Waves

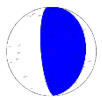
20 min

Shake maps



time

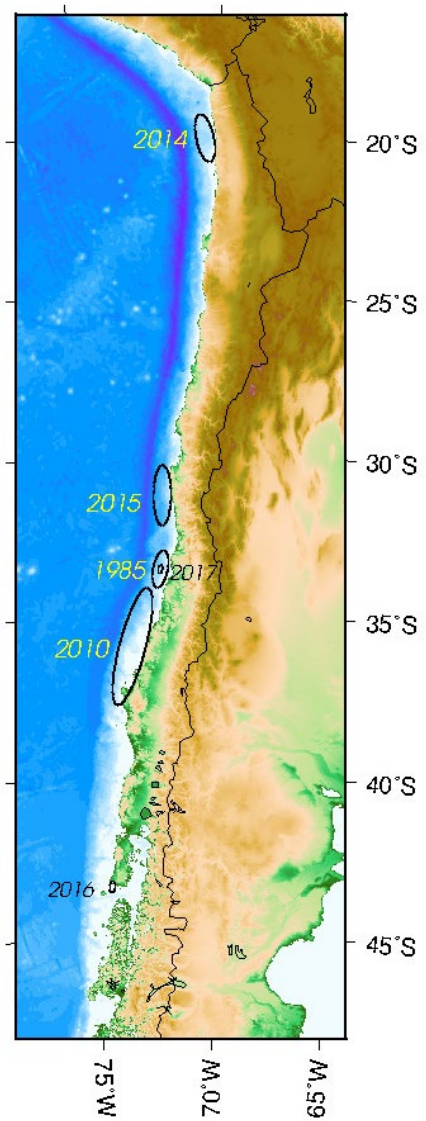
Preliminary loc and mag

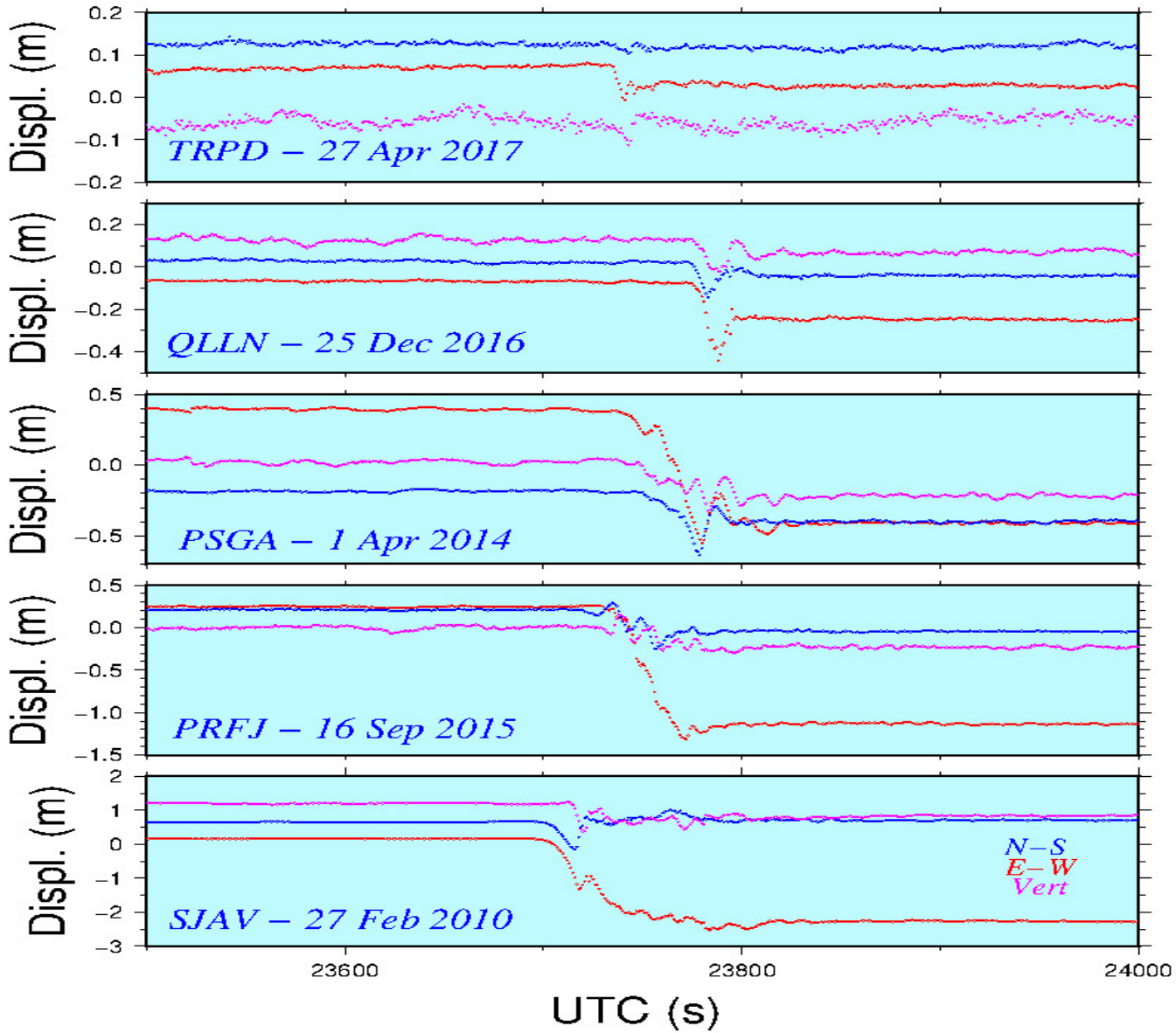


W-Phase M>5.0

Final location and magnitude

GNSS records





M=6.9

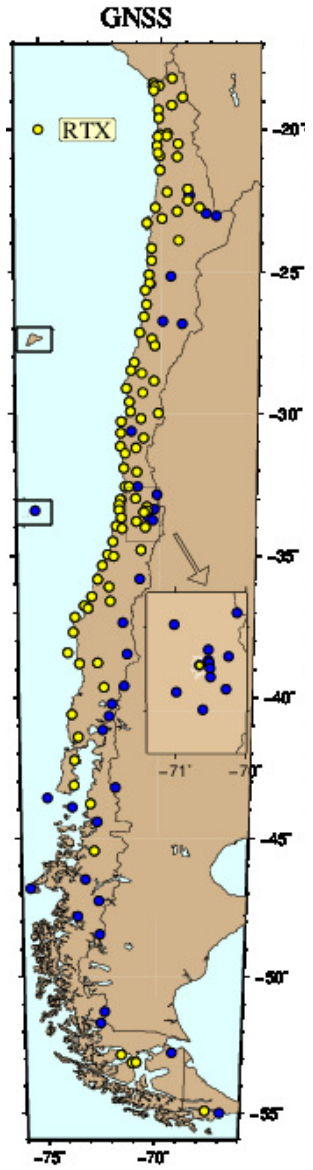
M=7.6

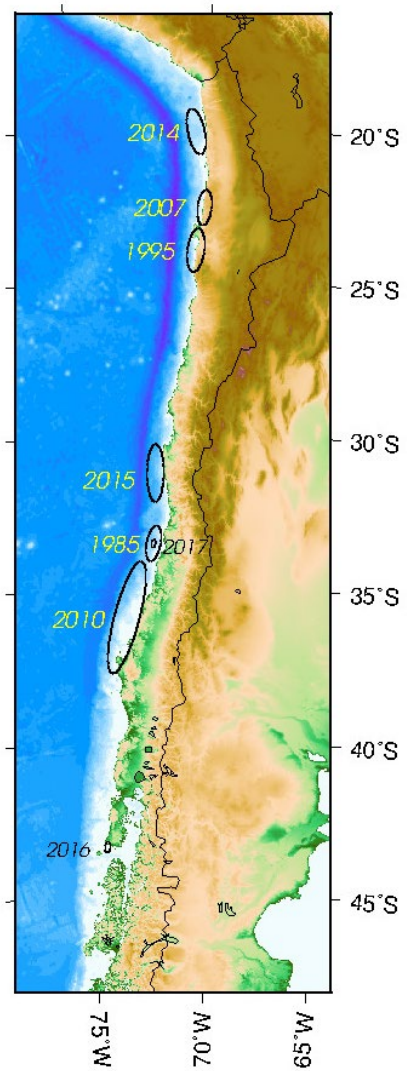
M=8.2

M=8.3

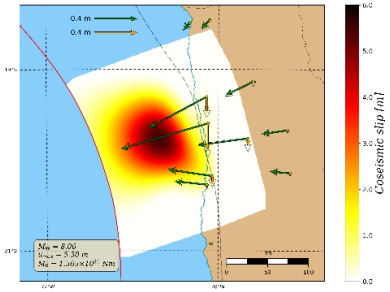
M=8.8

Grandes Terremotos recientes

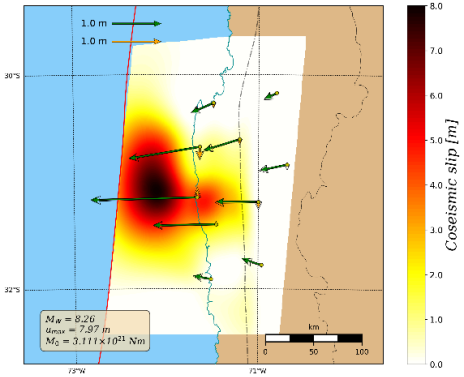




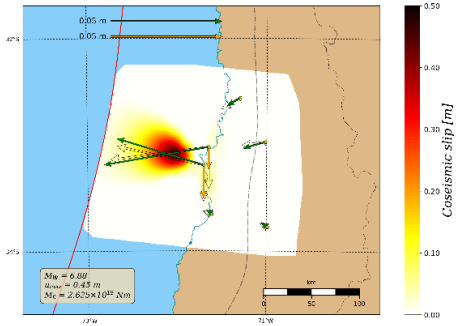
Iquique 2014



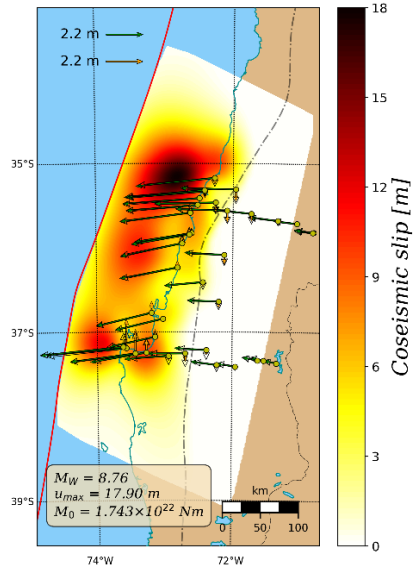
Illapel 2015



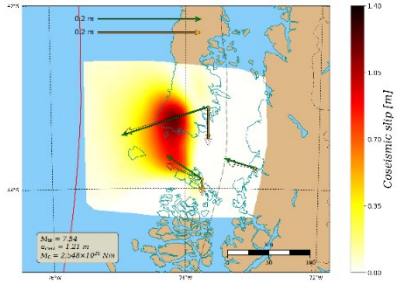
Valparaíso 2017



Maule 2010

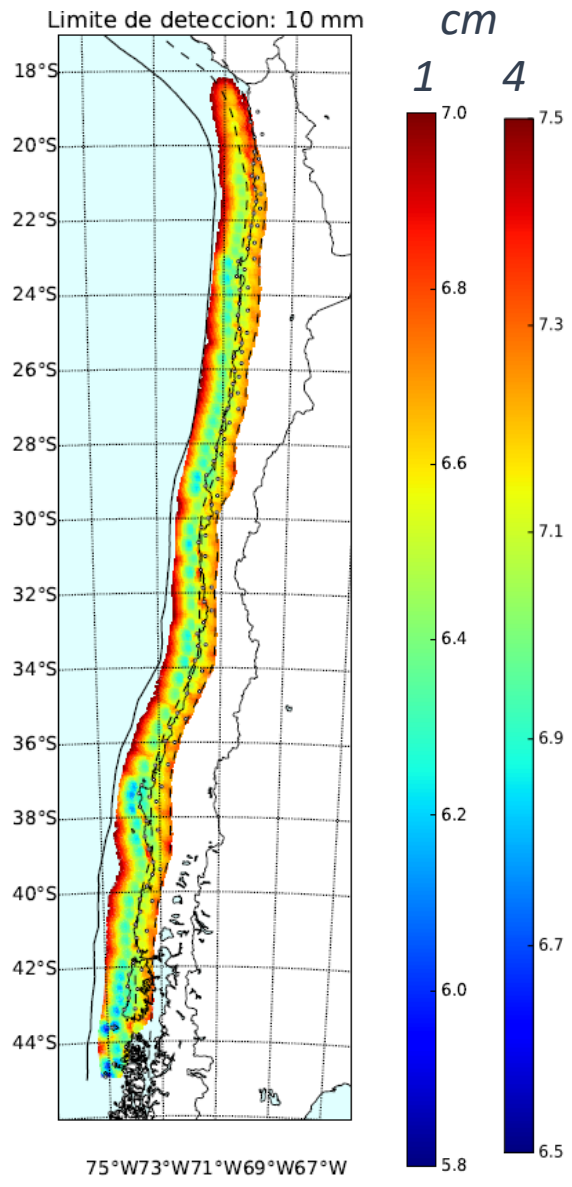


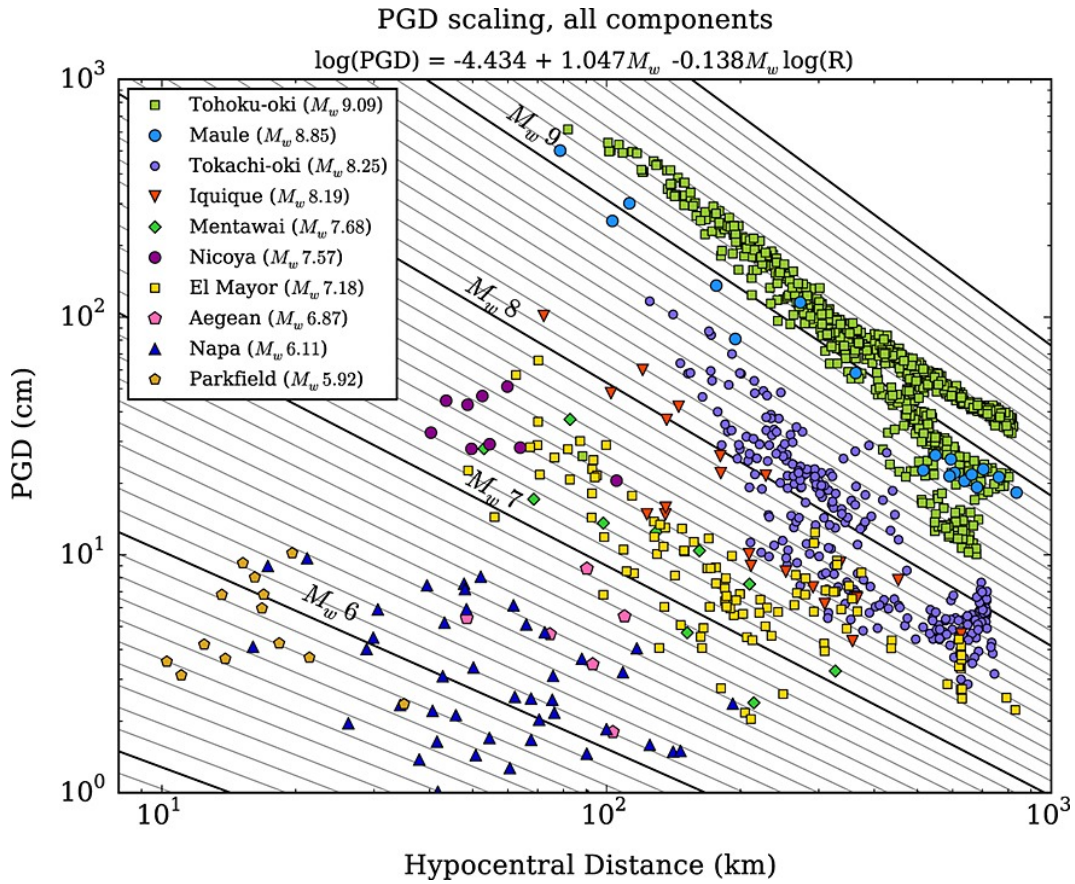
Chiloé 2016



Estimación de deslizamiento (F. del Campo)

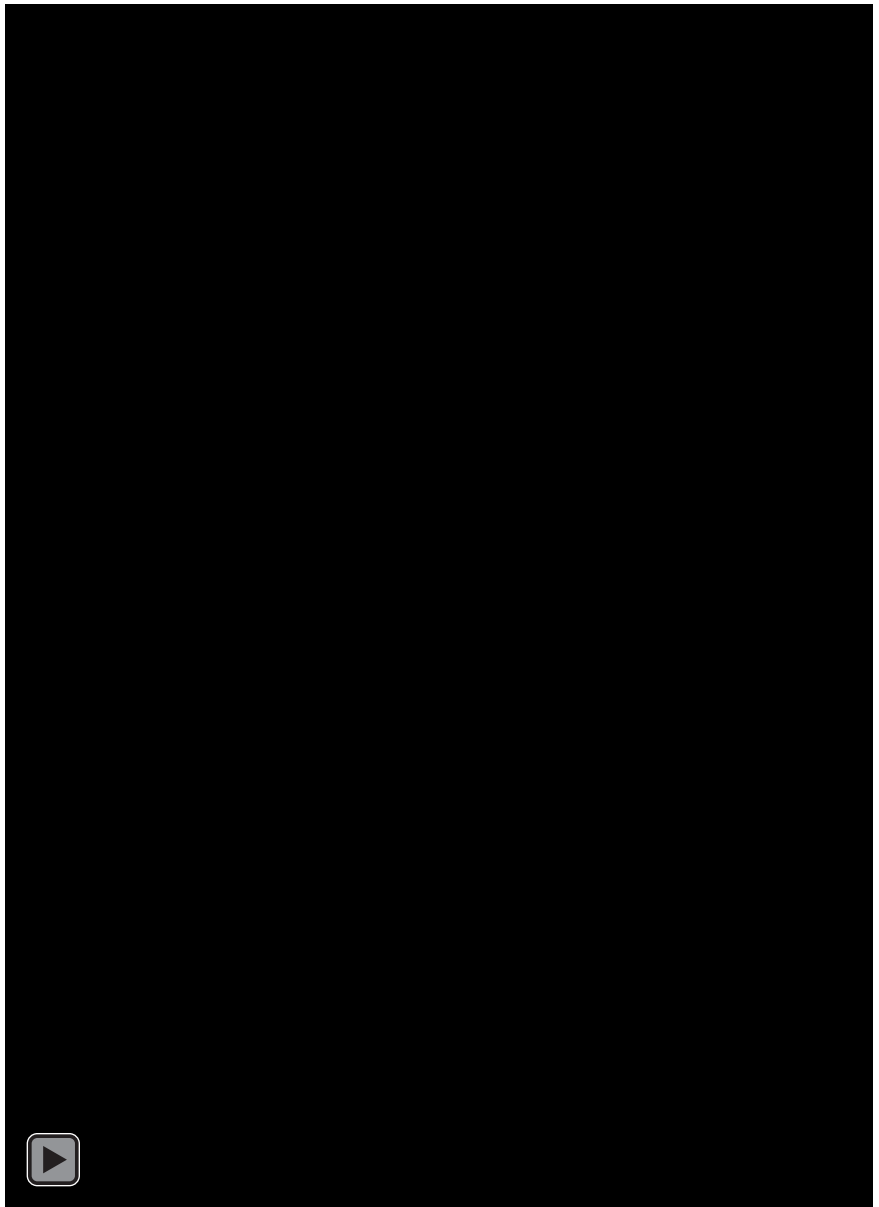
Detectability and PGD

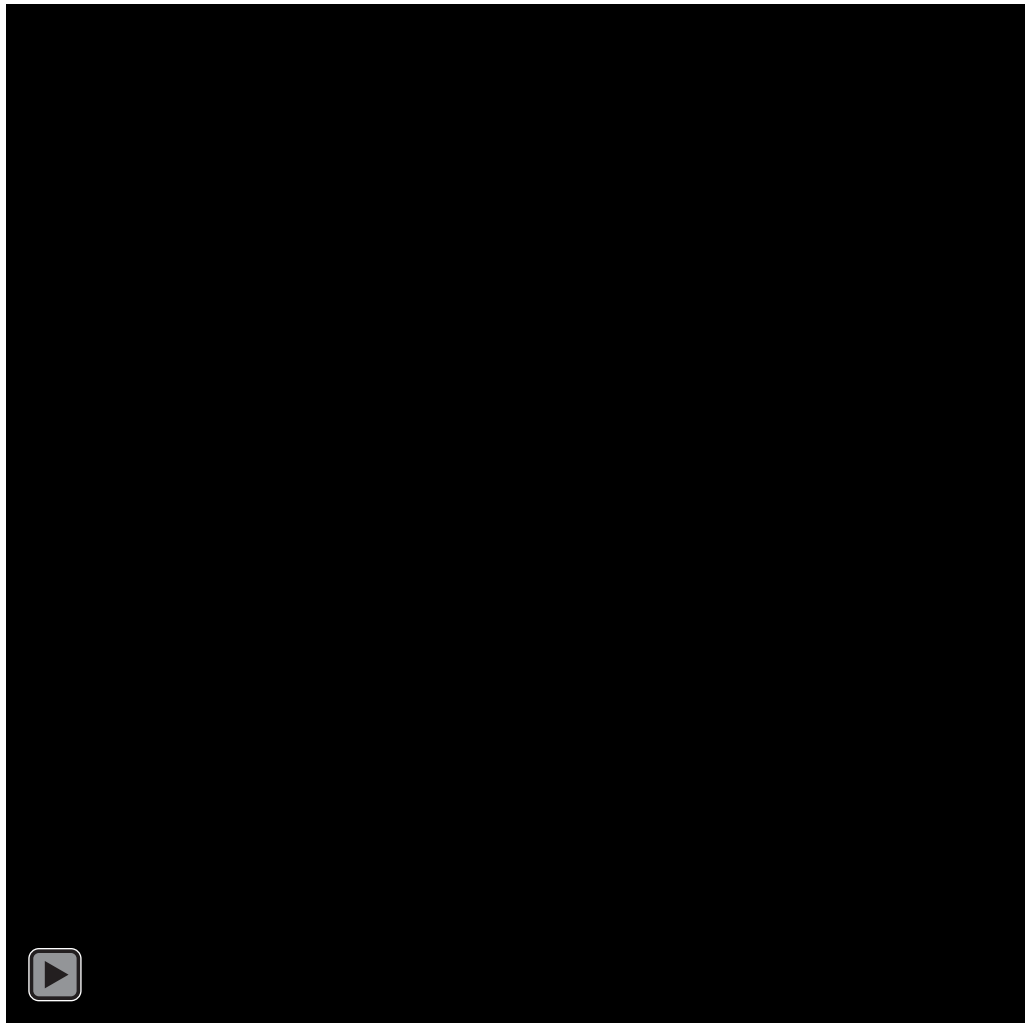




Melgar et al (2015)

Future: Maule 2010 case



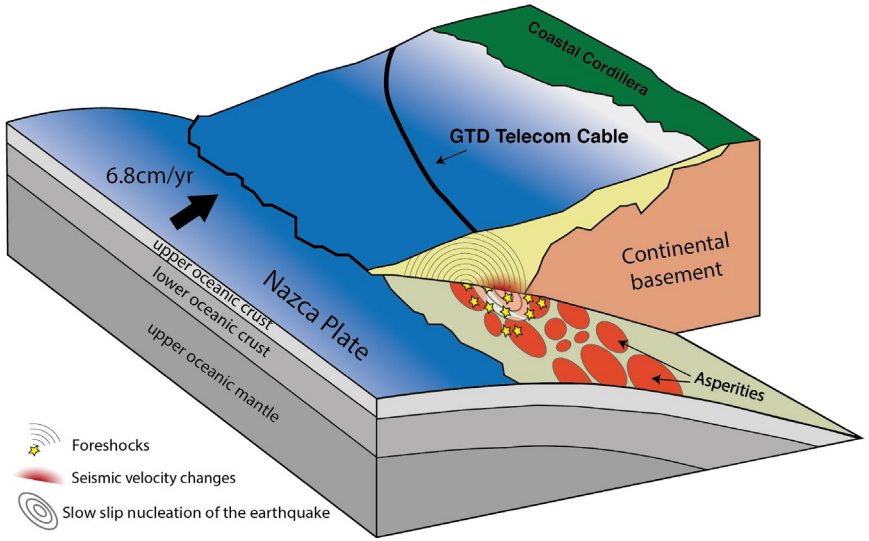


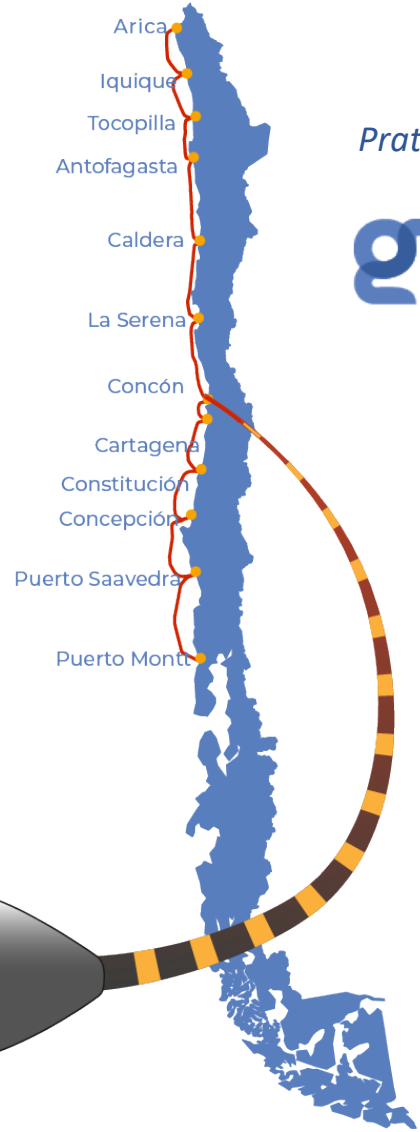
P. Koch

A look to the future: Distributed Acoustic Sensing

Unique Telecom Infrastructure
Telecom cables transformed into “seismi

- *3500 km long*
- *12 landing points*

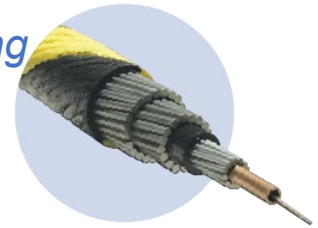


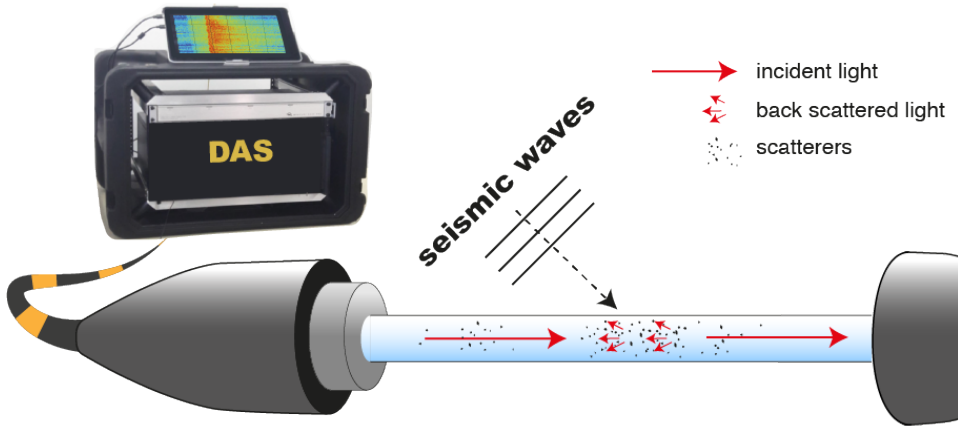


Prat Cable

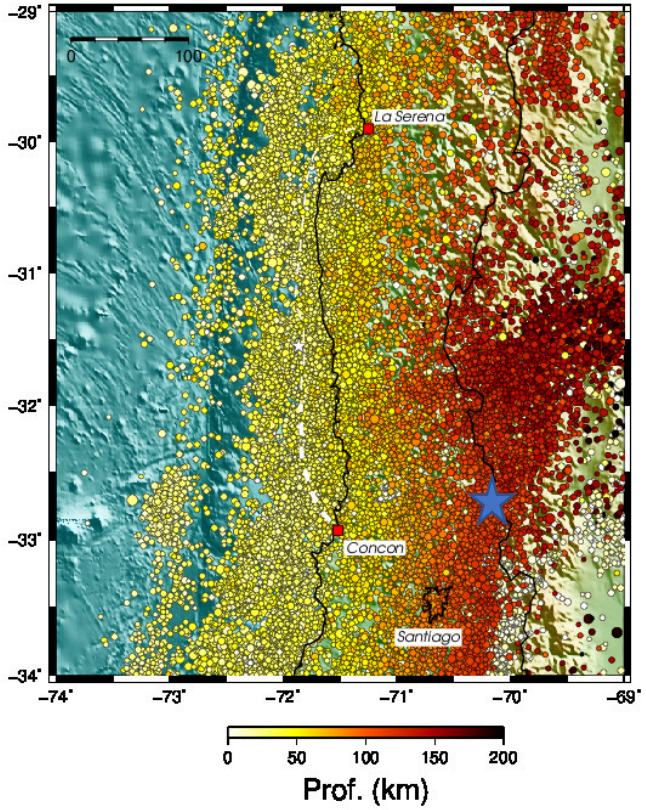
Project with D. Rivet (GeoAzur)

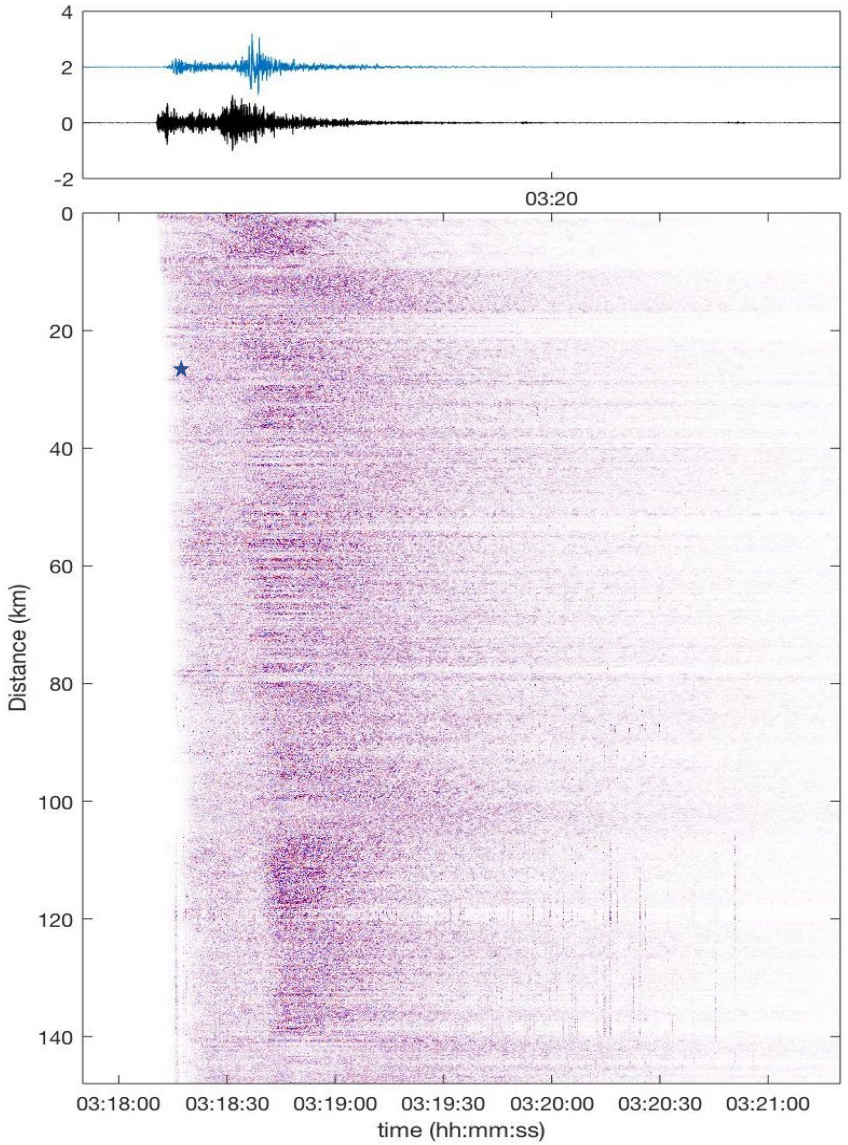
Optical Fiber
Dense network of sensors
150 km long
50 000 sensors
4 m sensor spacing





DAS *(P.I. Diane Rivet)*



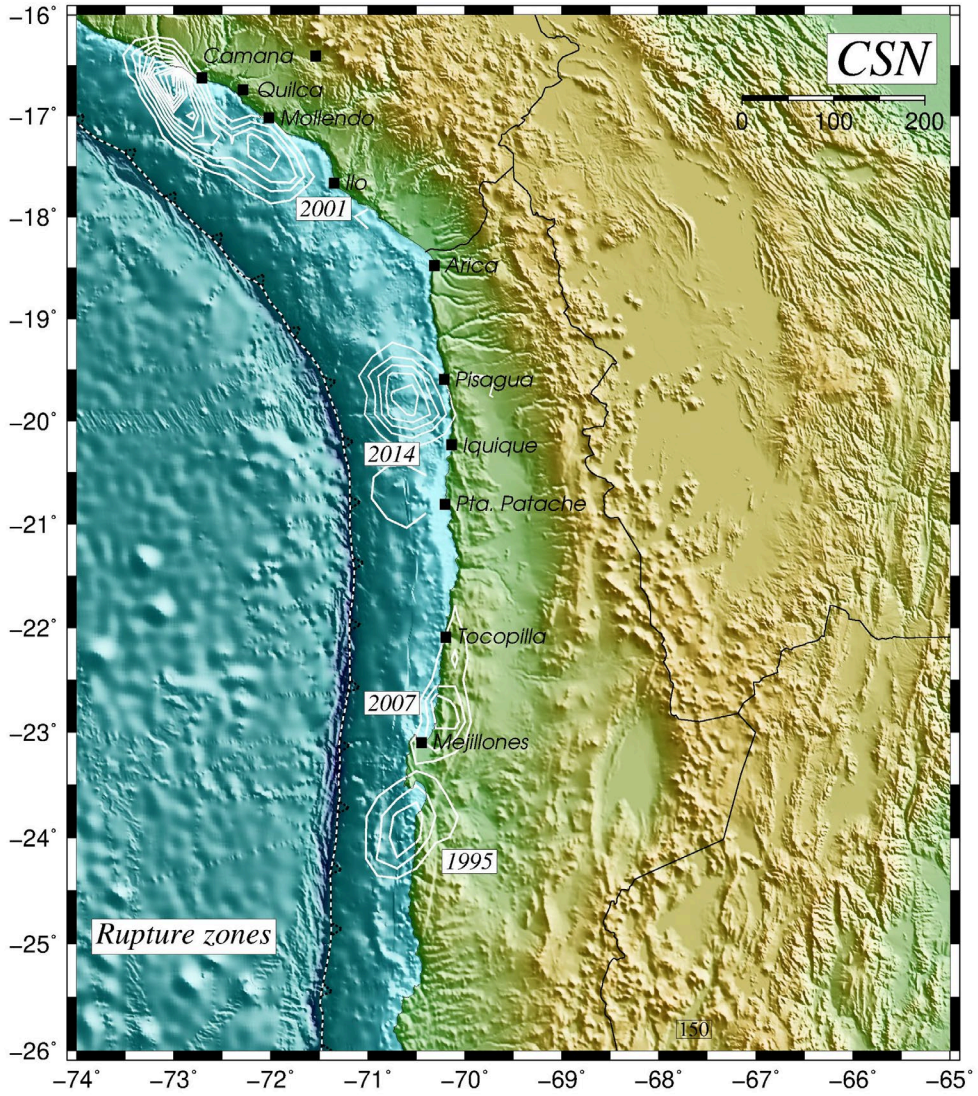


DAS recording of a M5.7 about 100 km away
4 m spacing between channels

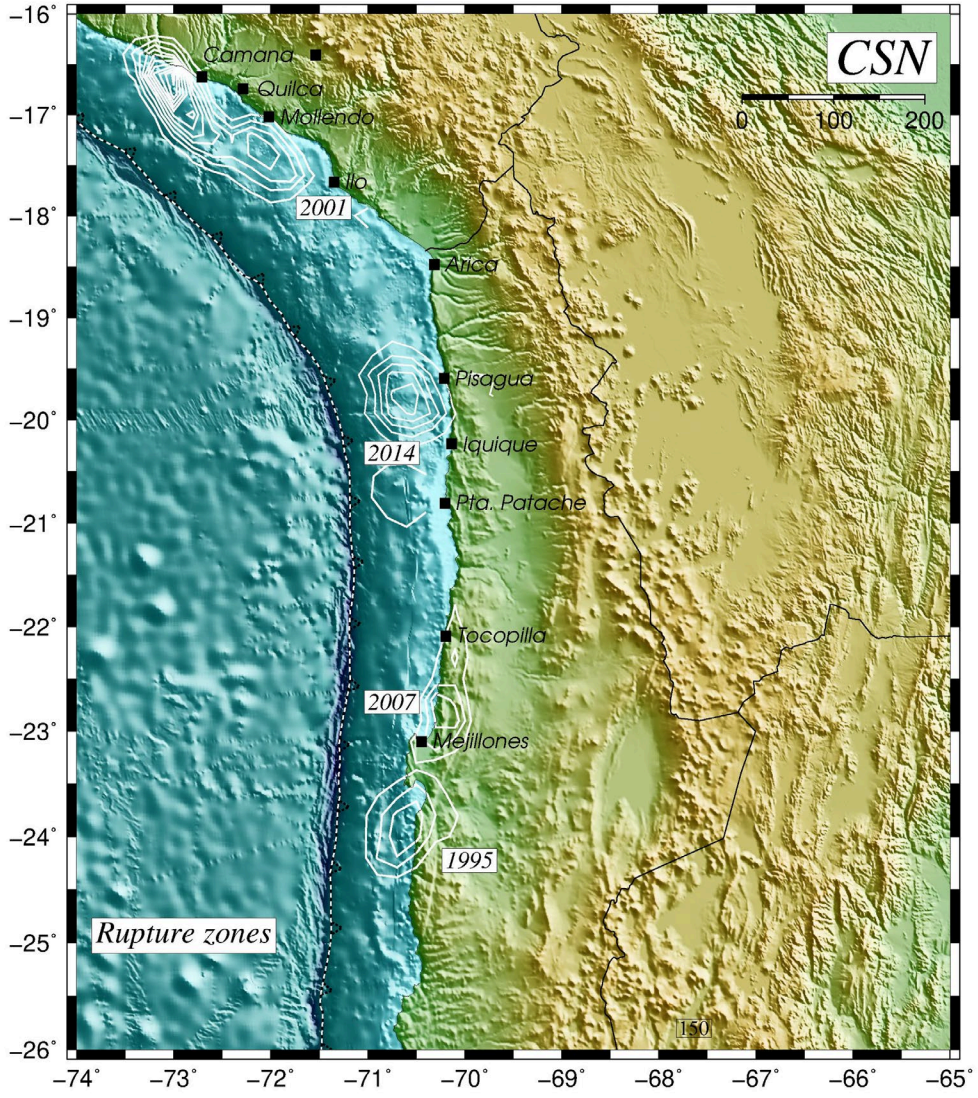
150 km long arrays
37000 sensors
4 m spacing between sensors
125 Hz temporal sampling

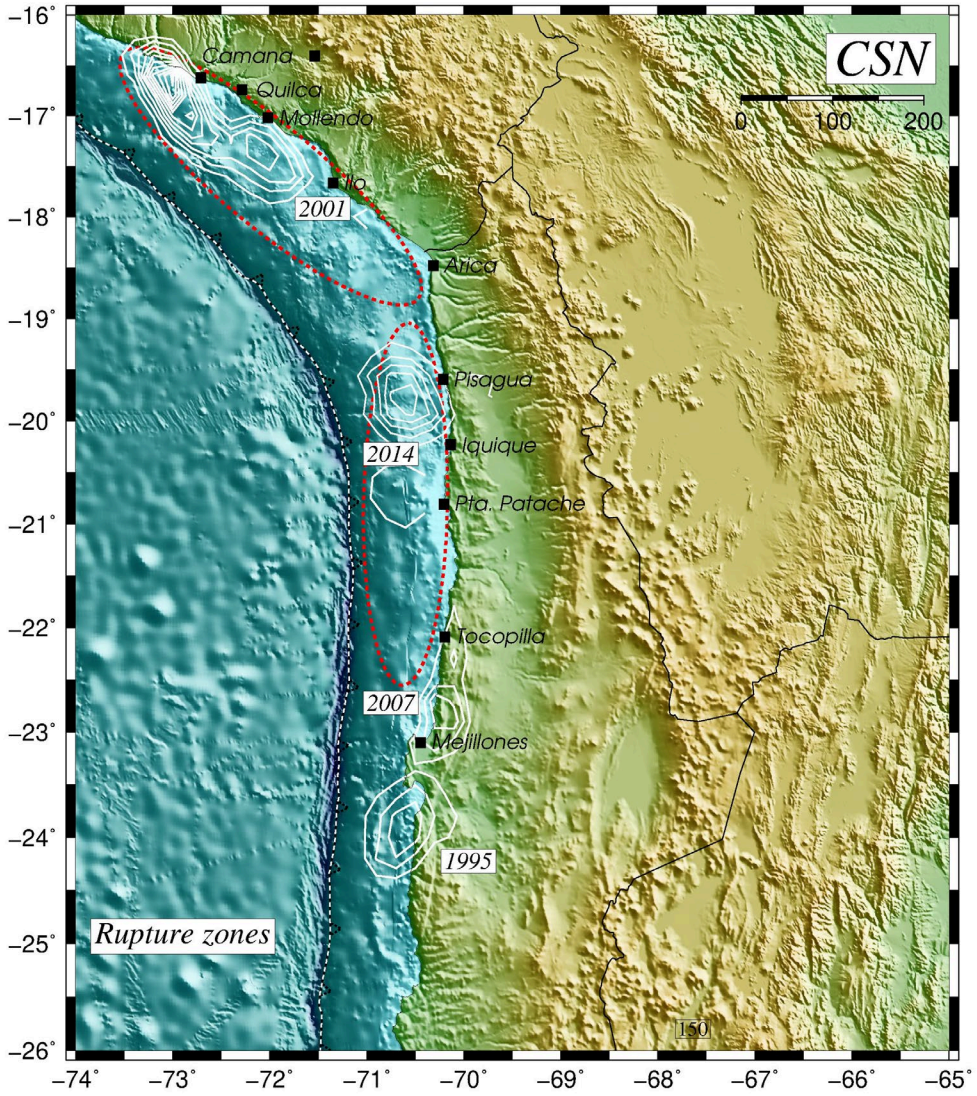
D.Rivet (2022)

Recent shallow rupture zones

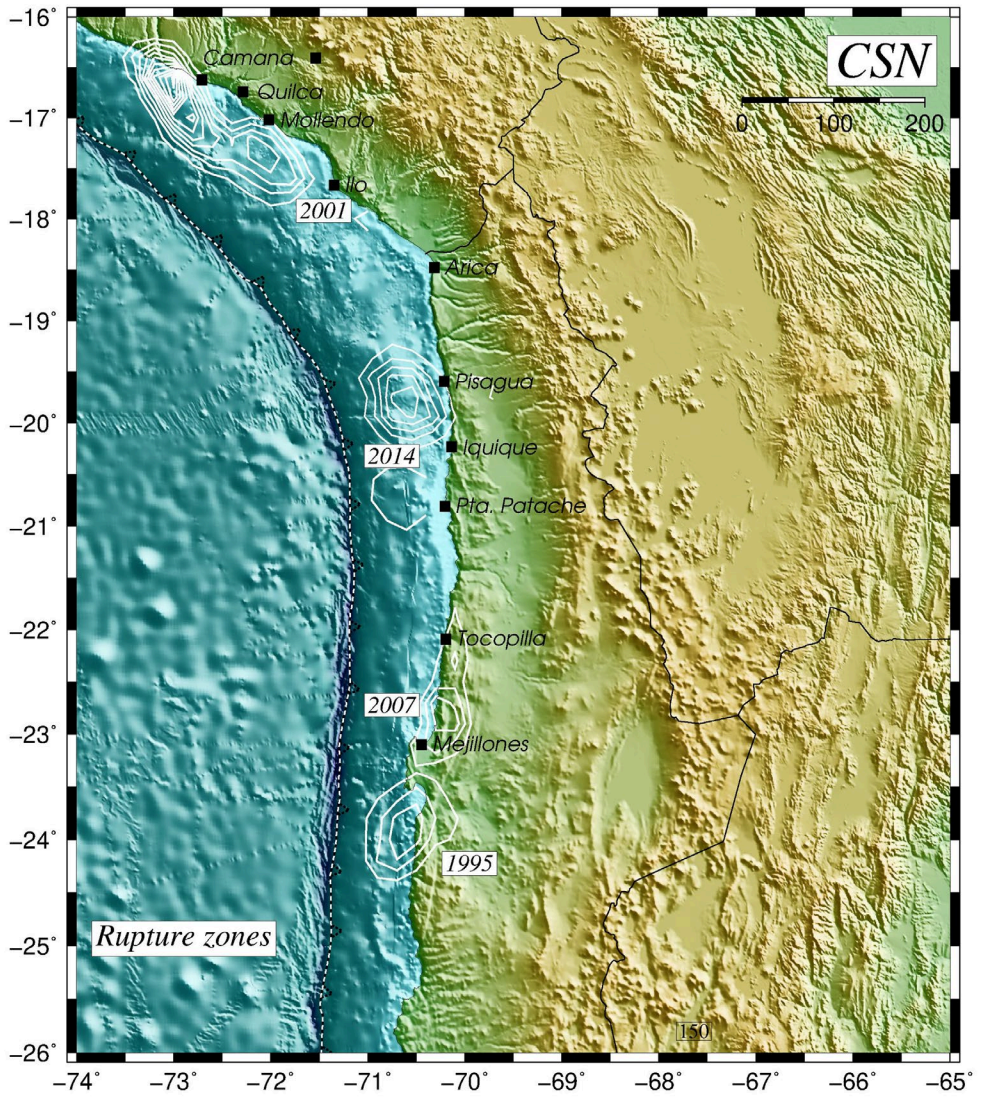


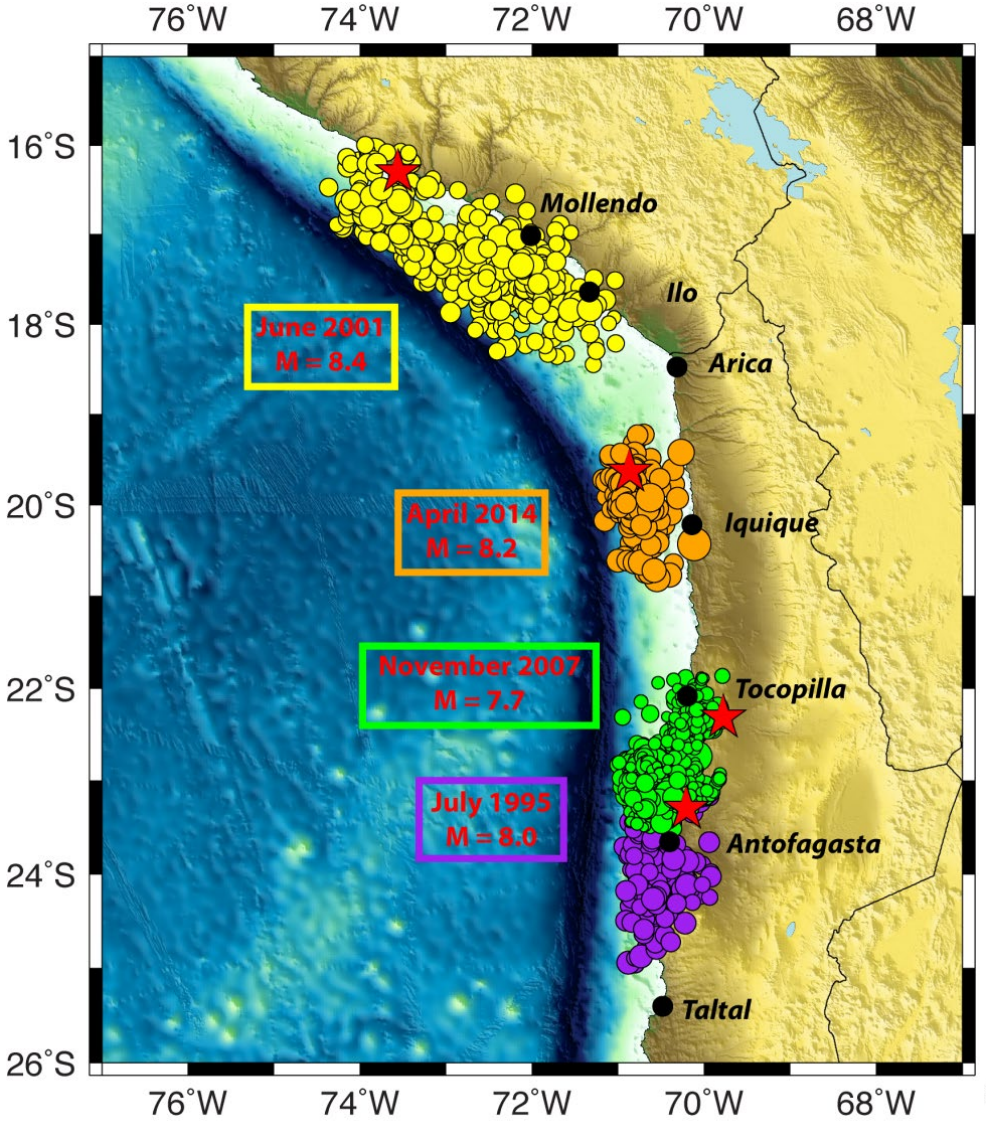
Recent shallow rupture zones





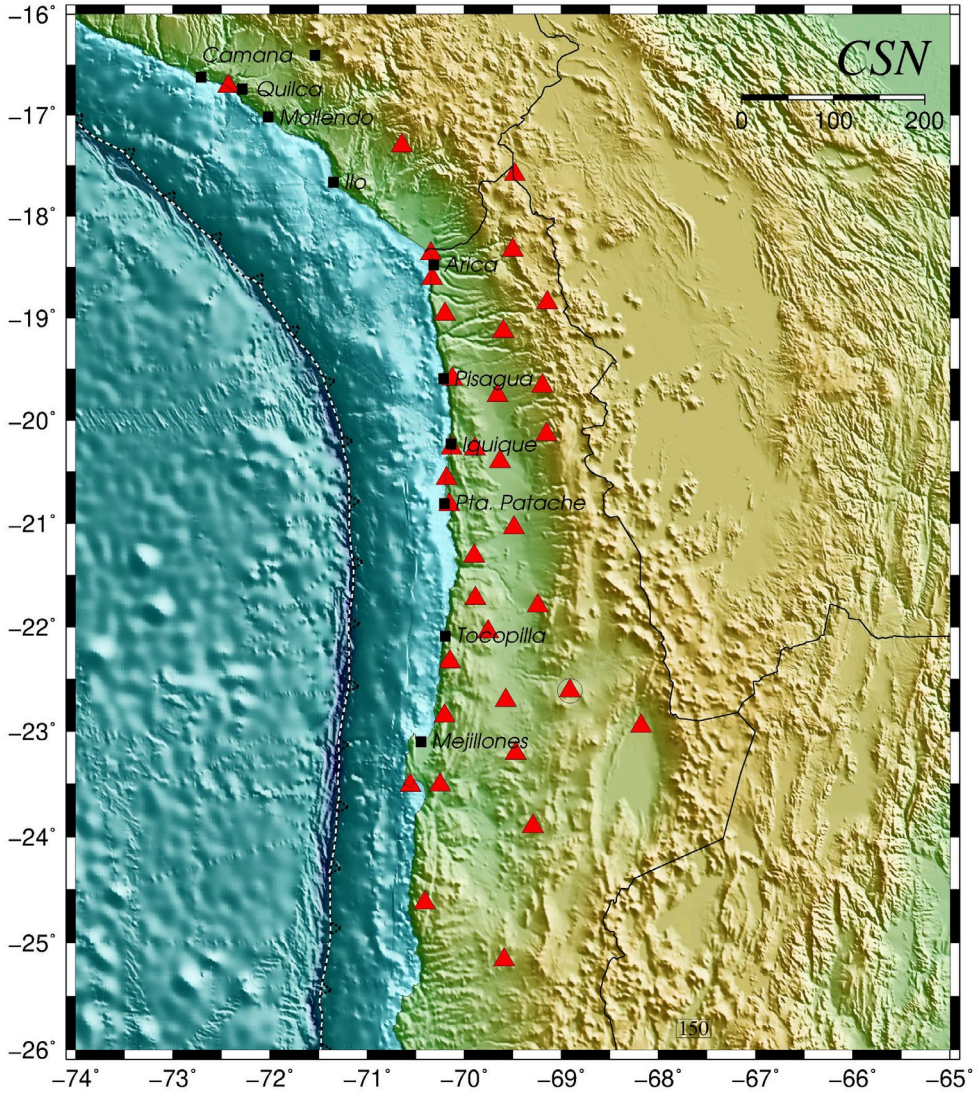
Recent shallow rupture zones



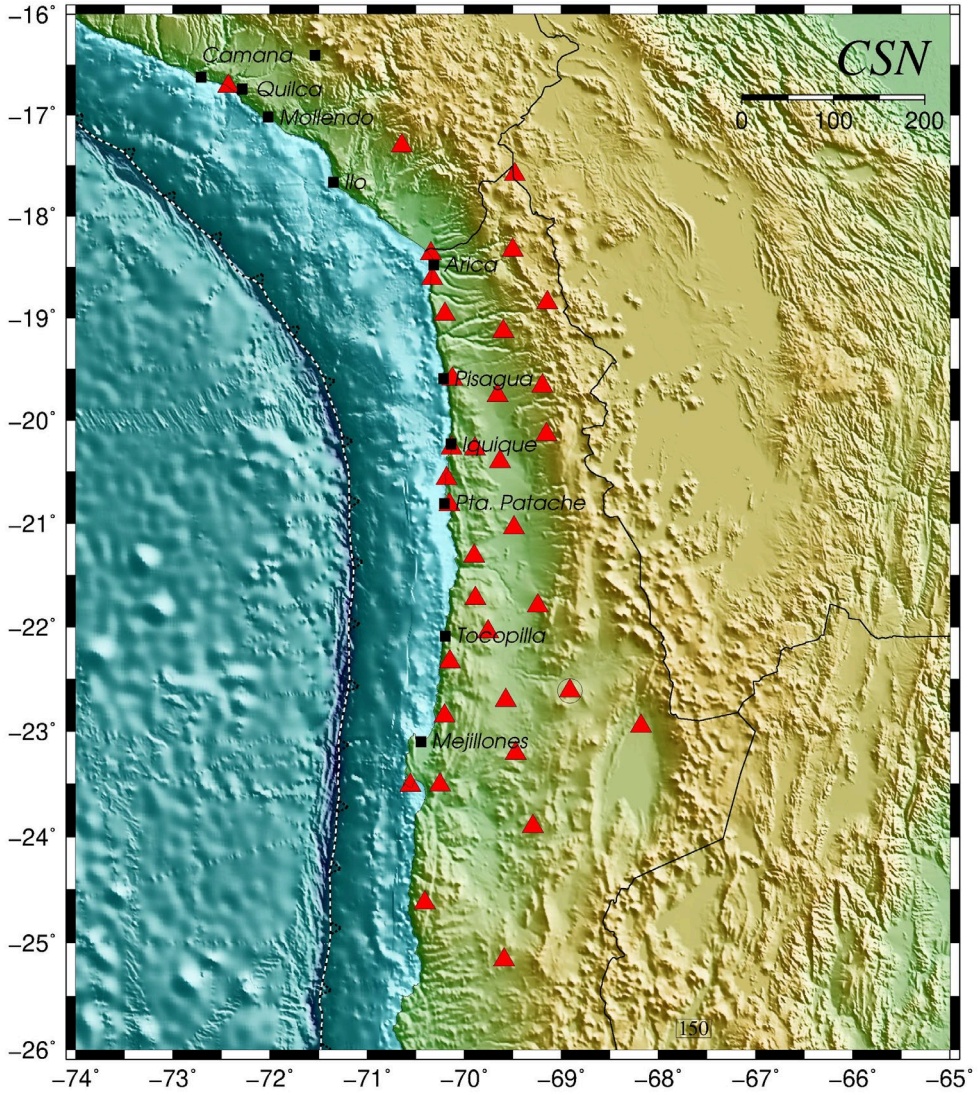


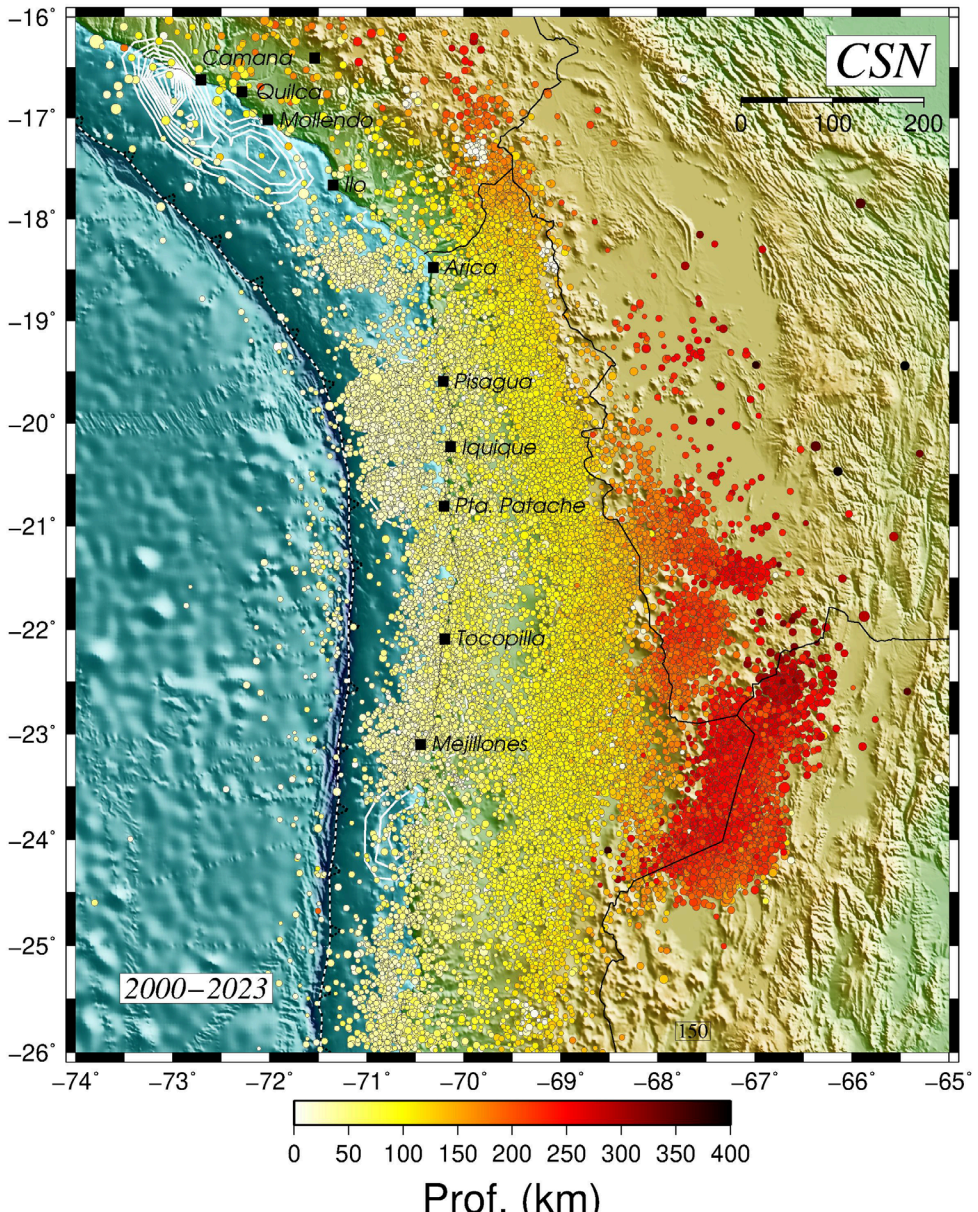
Beck et al. (2015)

Seismic stations (IPOC + CSN)

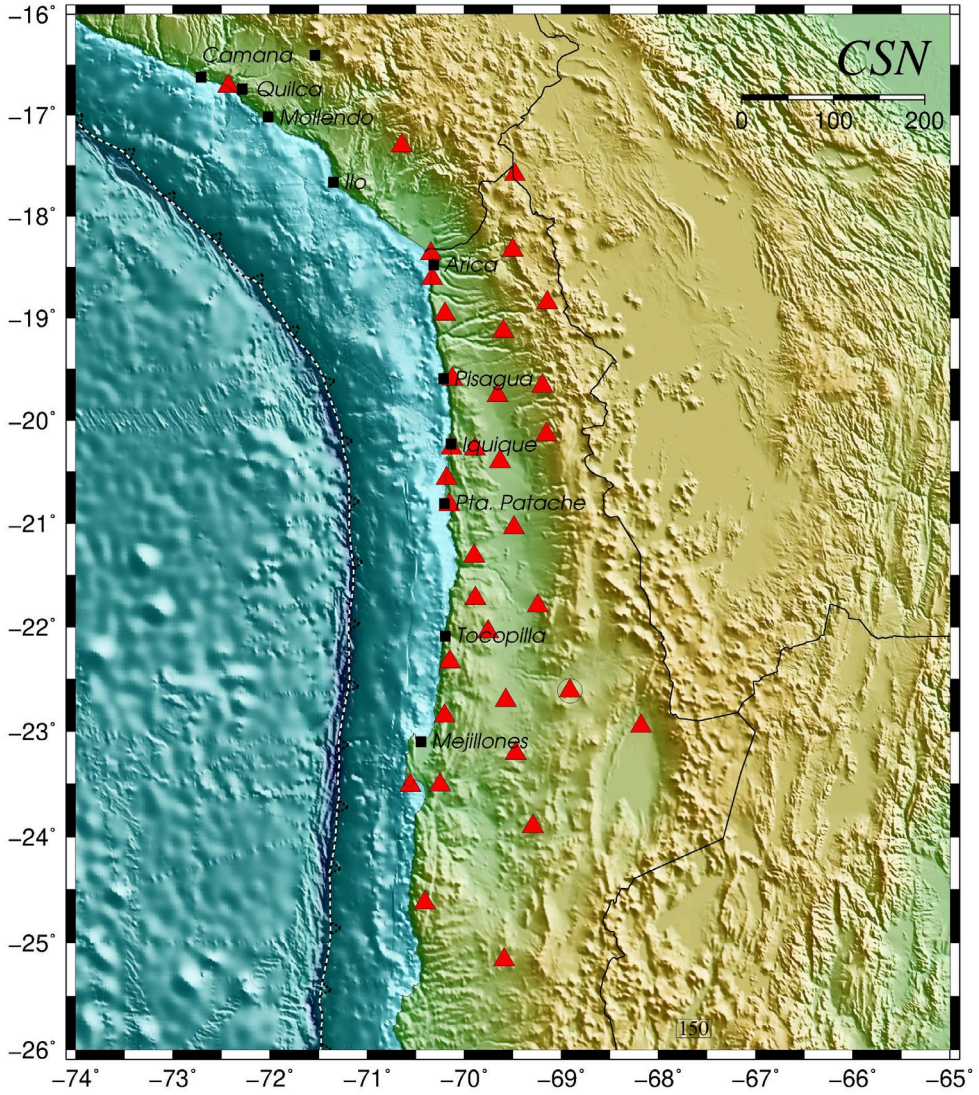


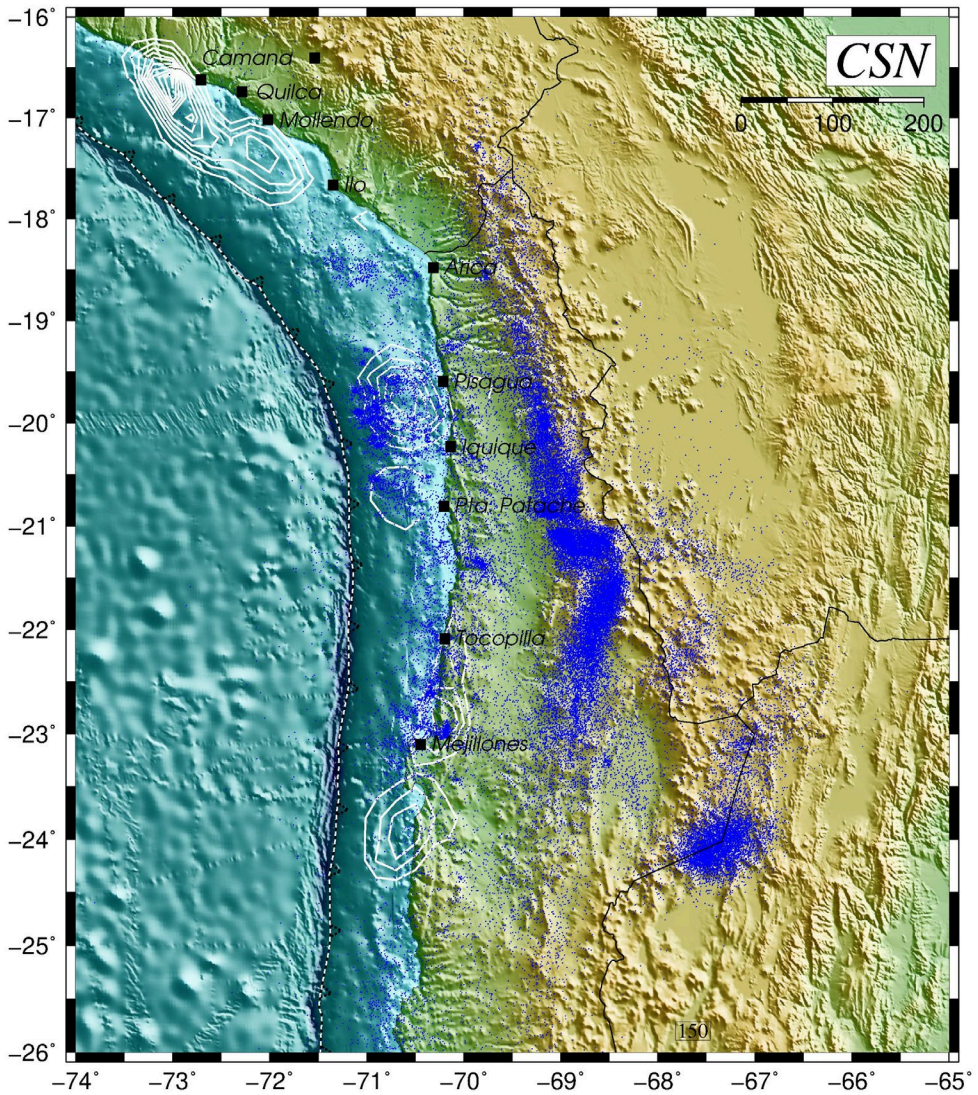
Seismic stations



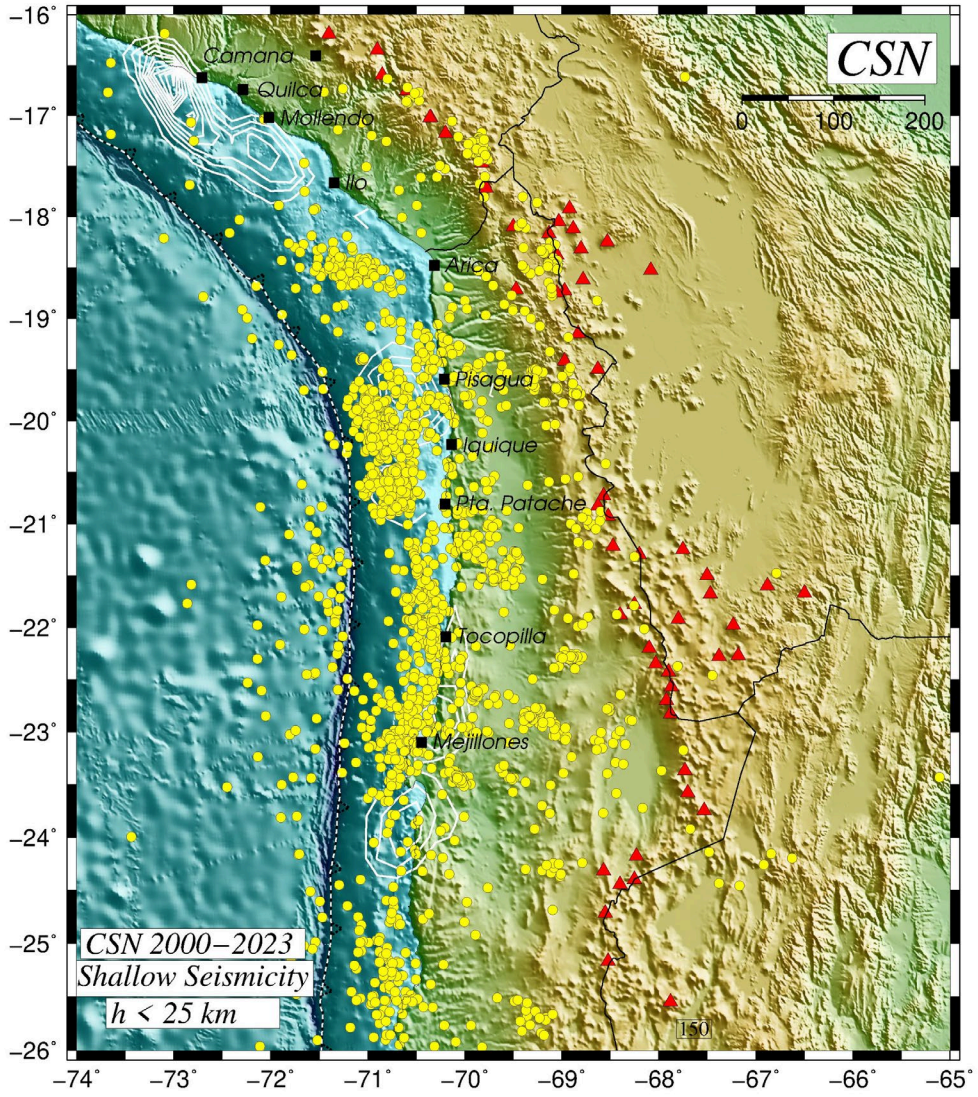


Seismic stations

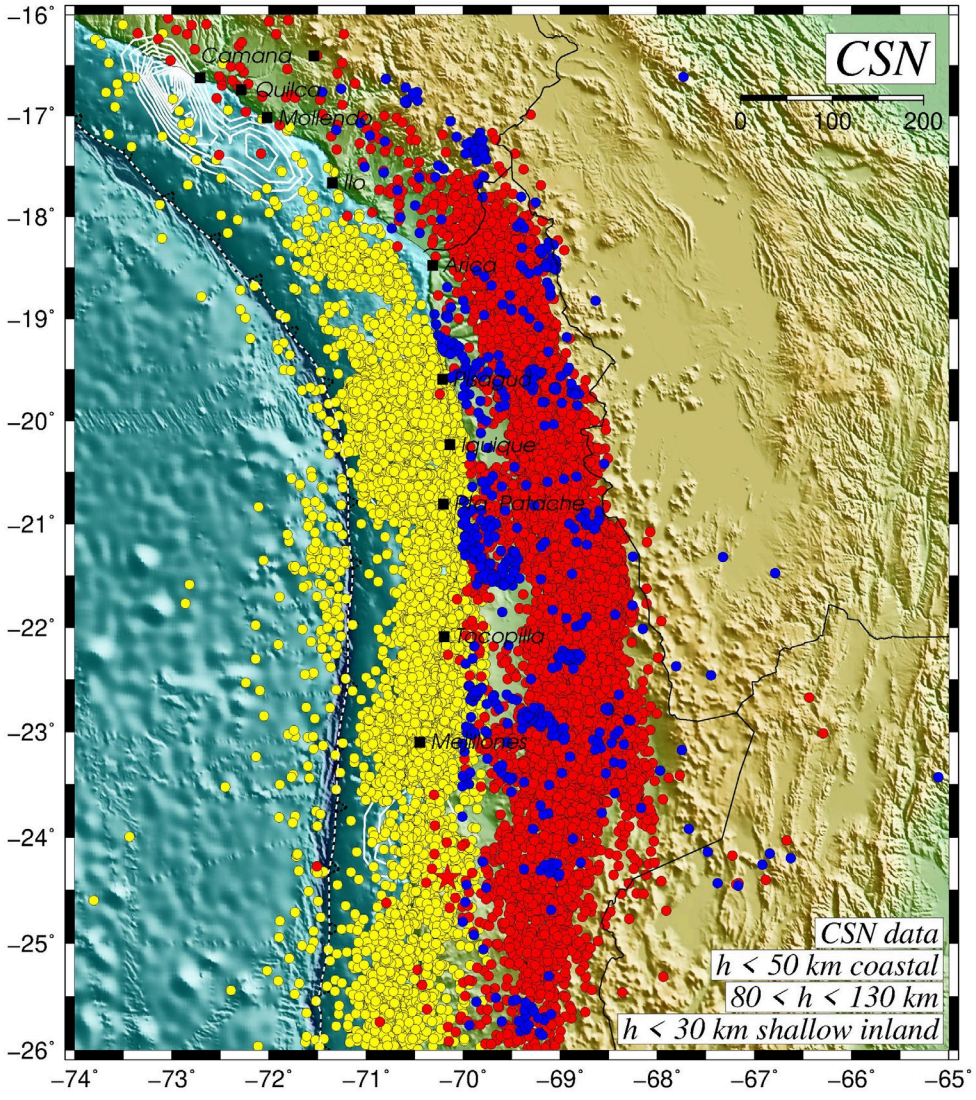


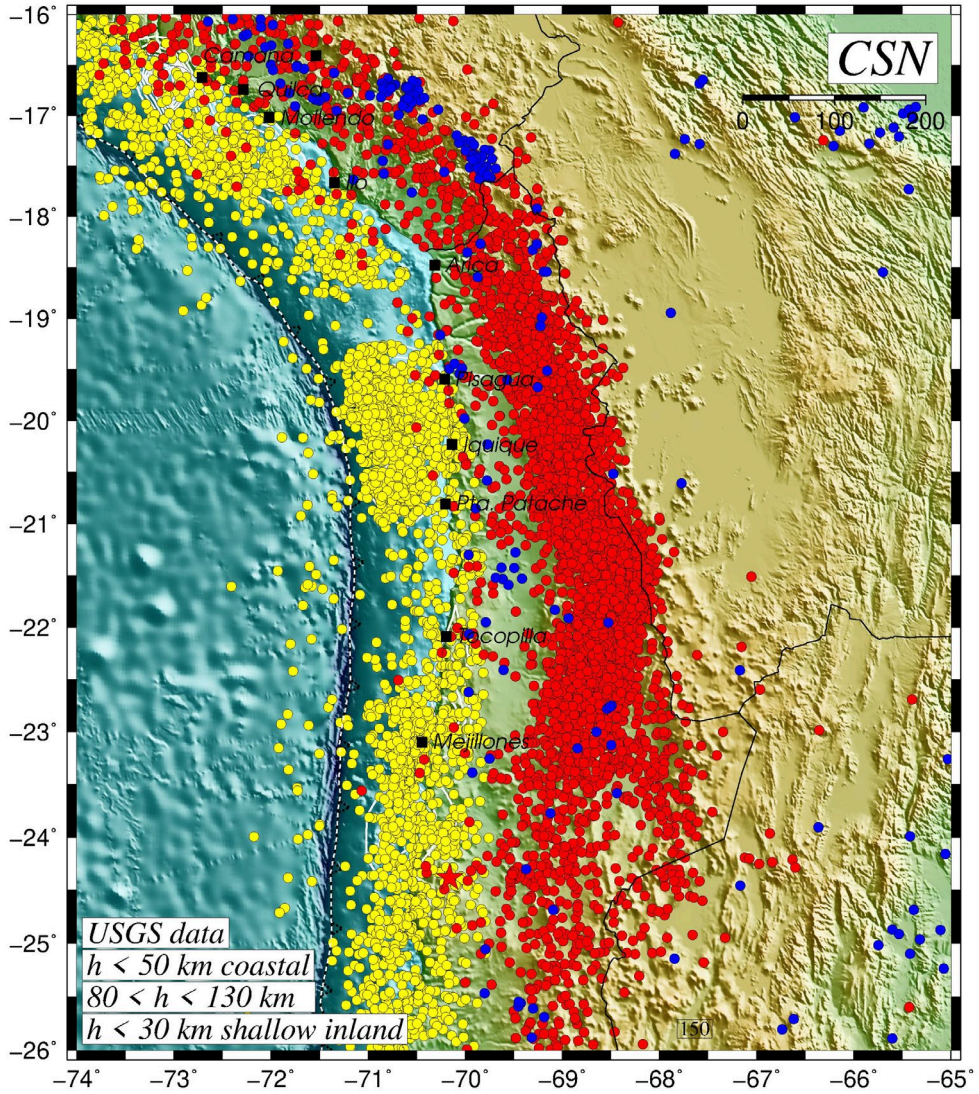


Shallow events CSN catalog

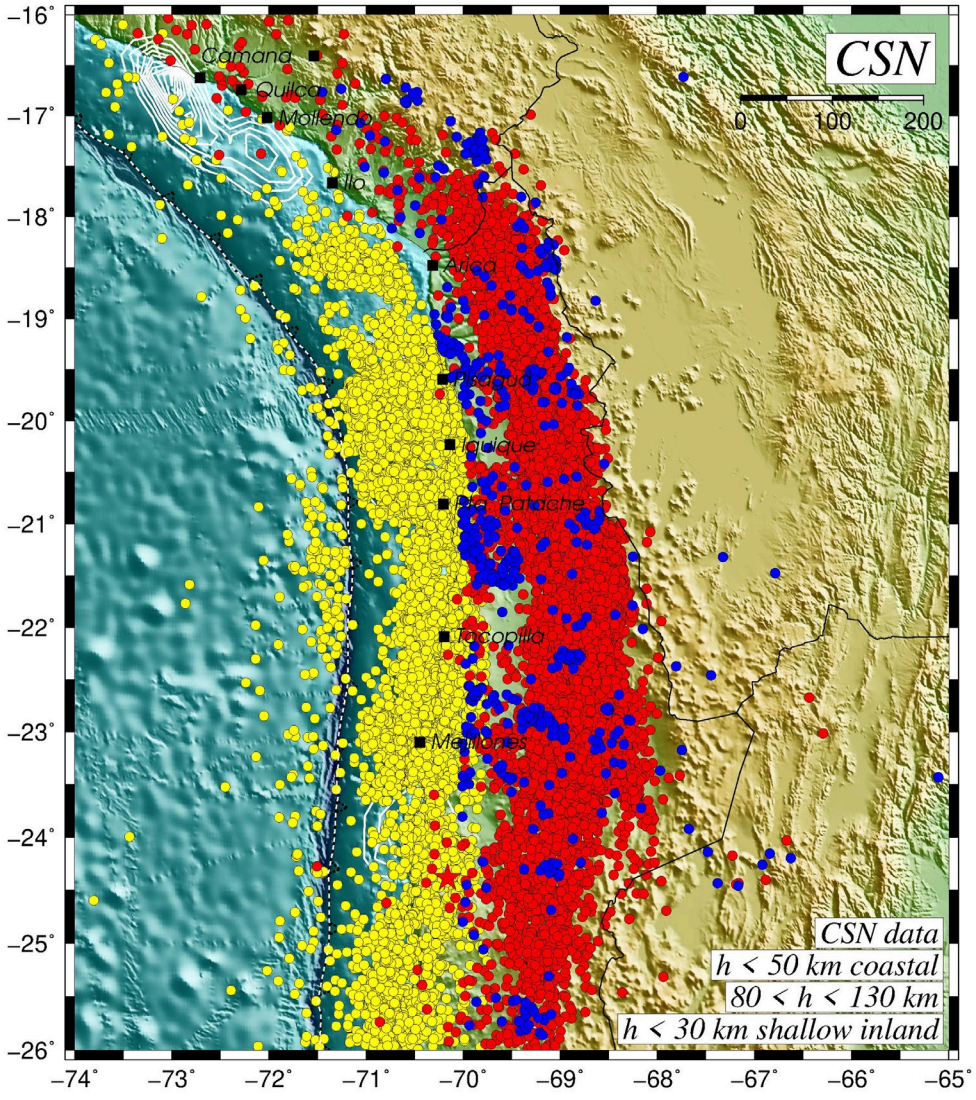


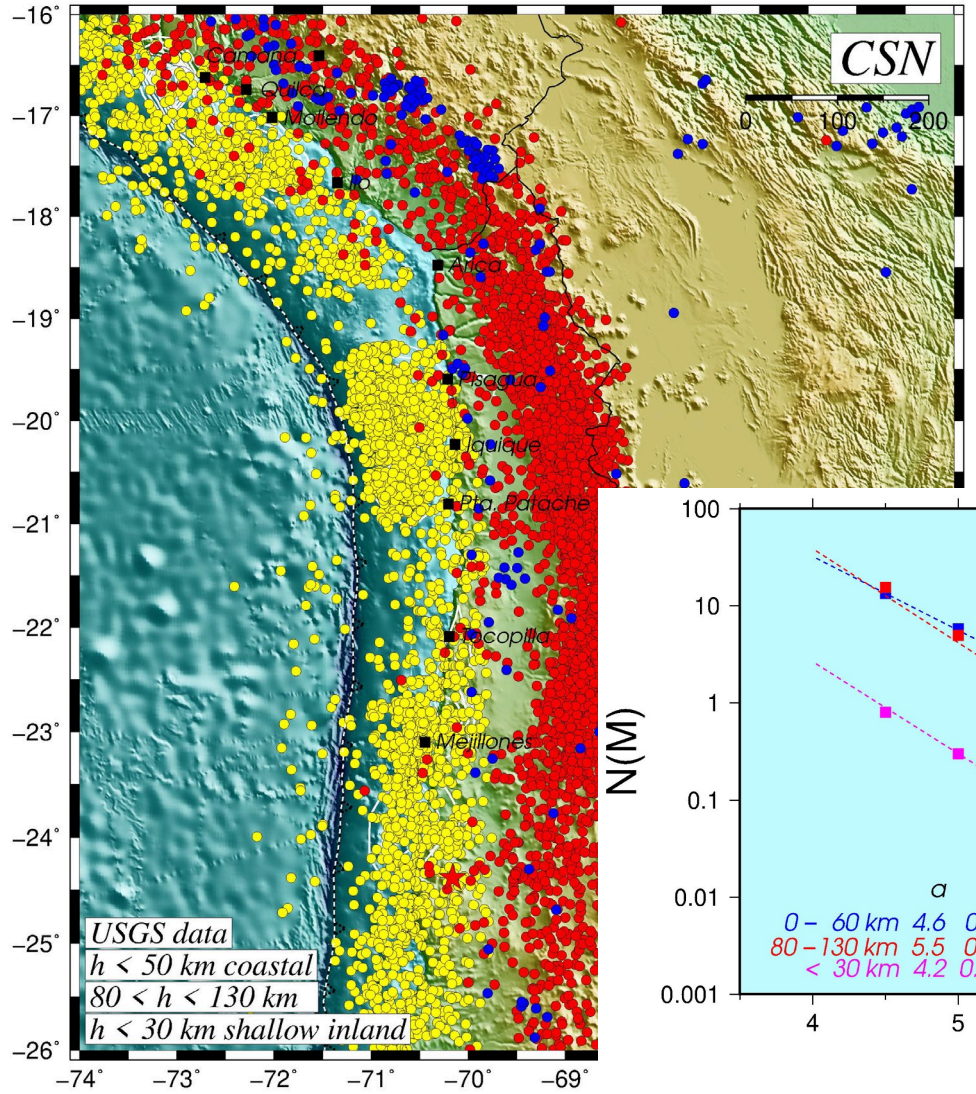
Seismicity rates

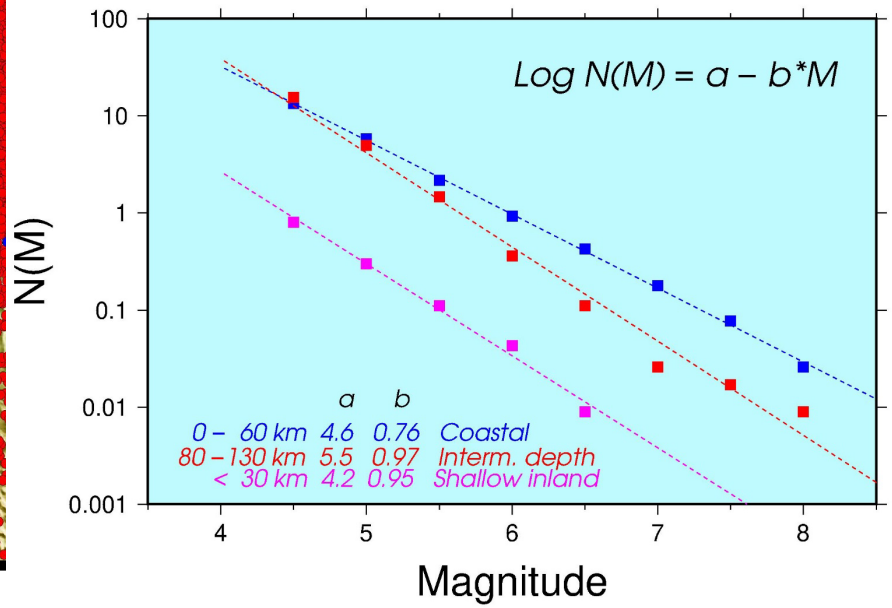




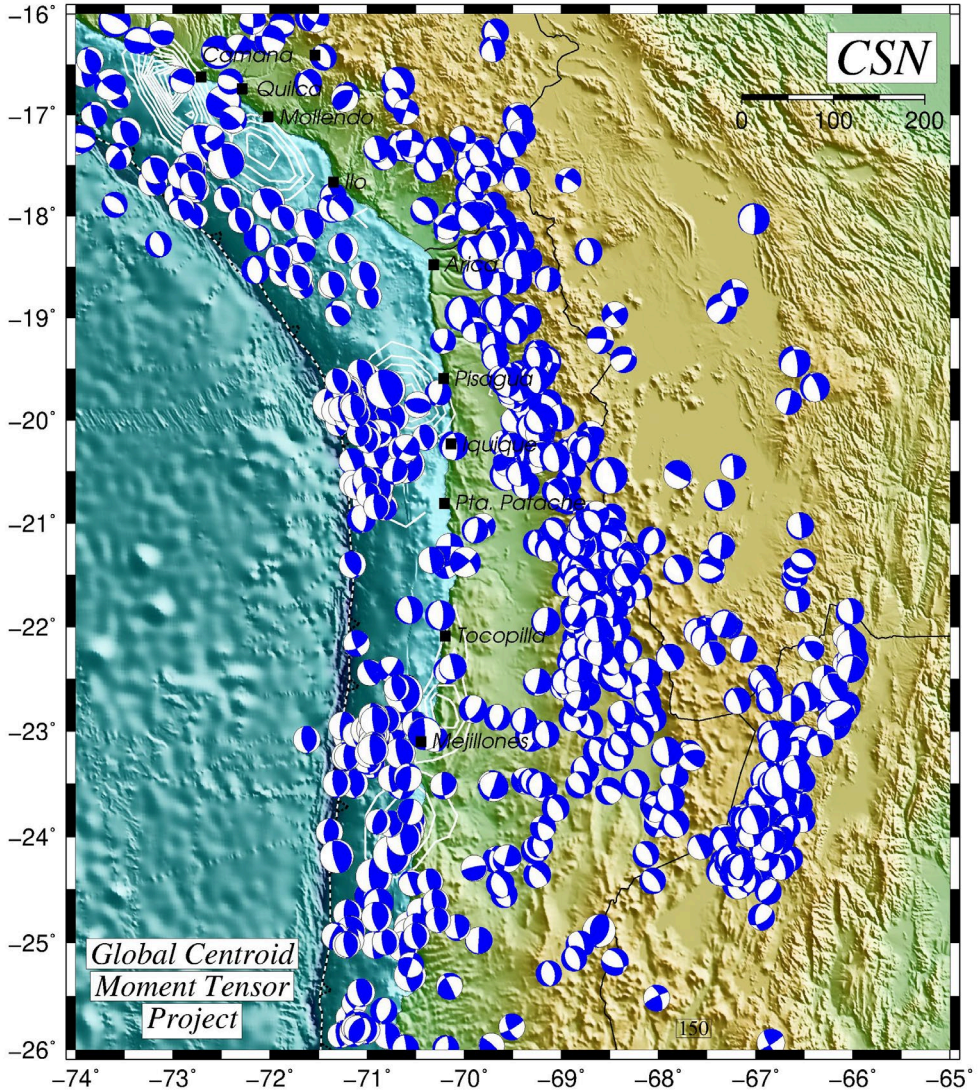
Seismicity rates



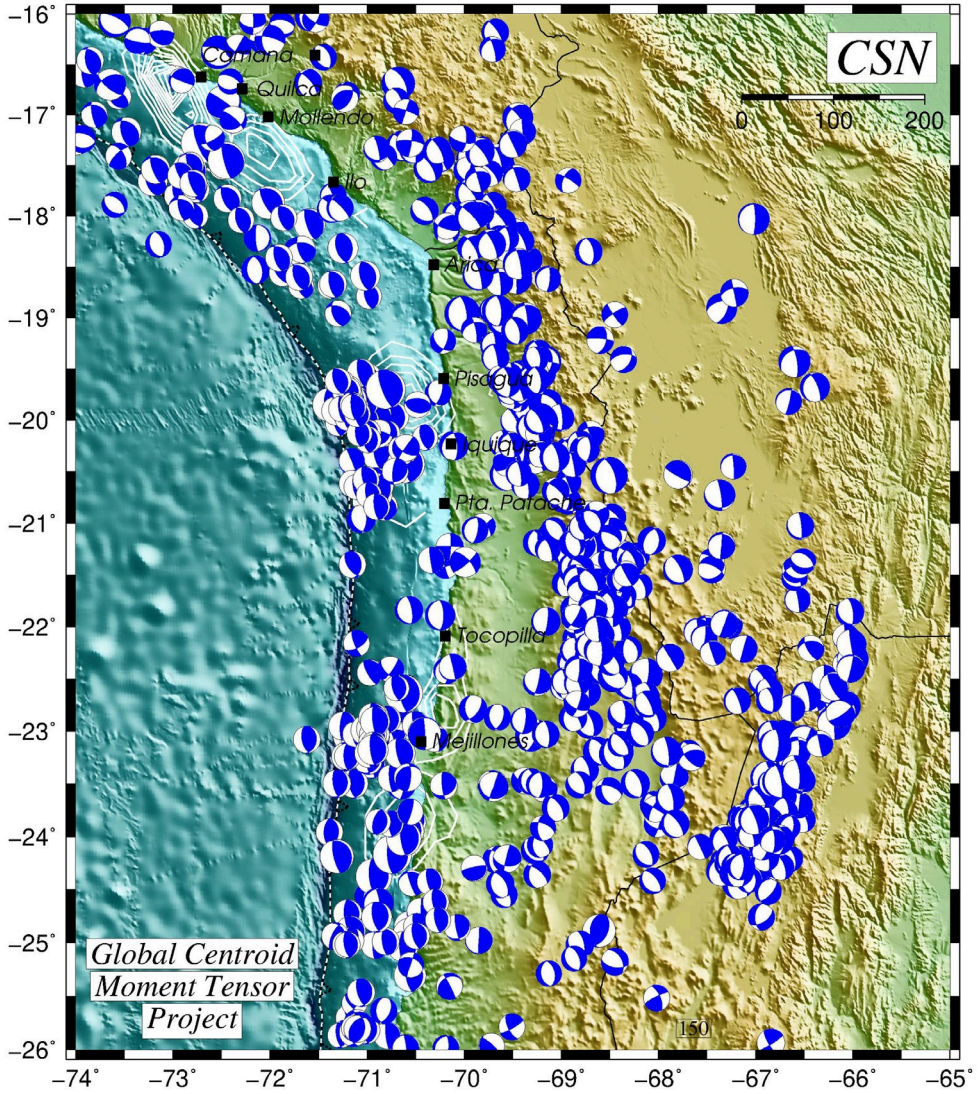




Global CMT Project

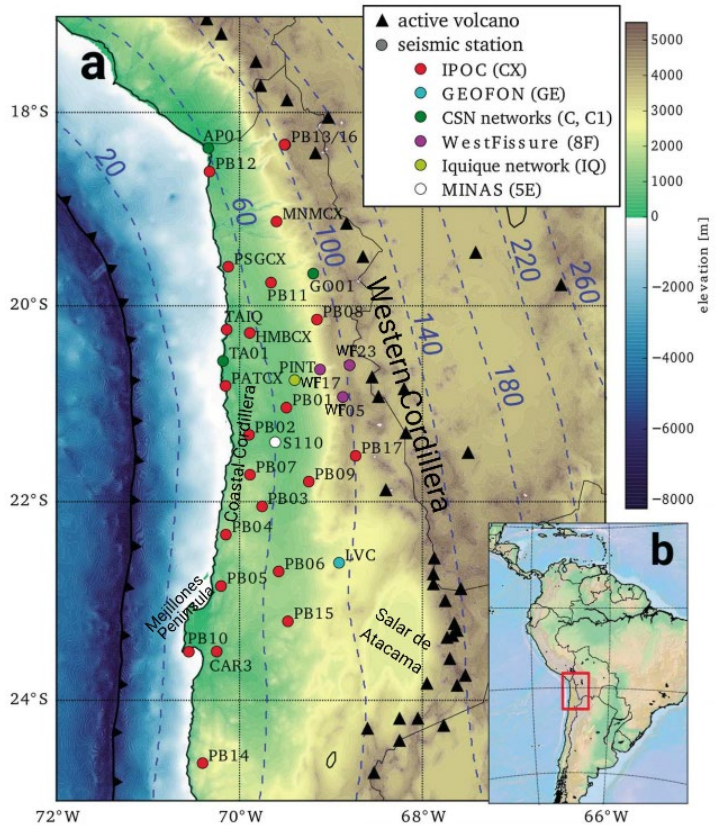


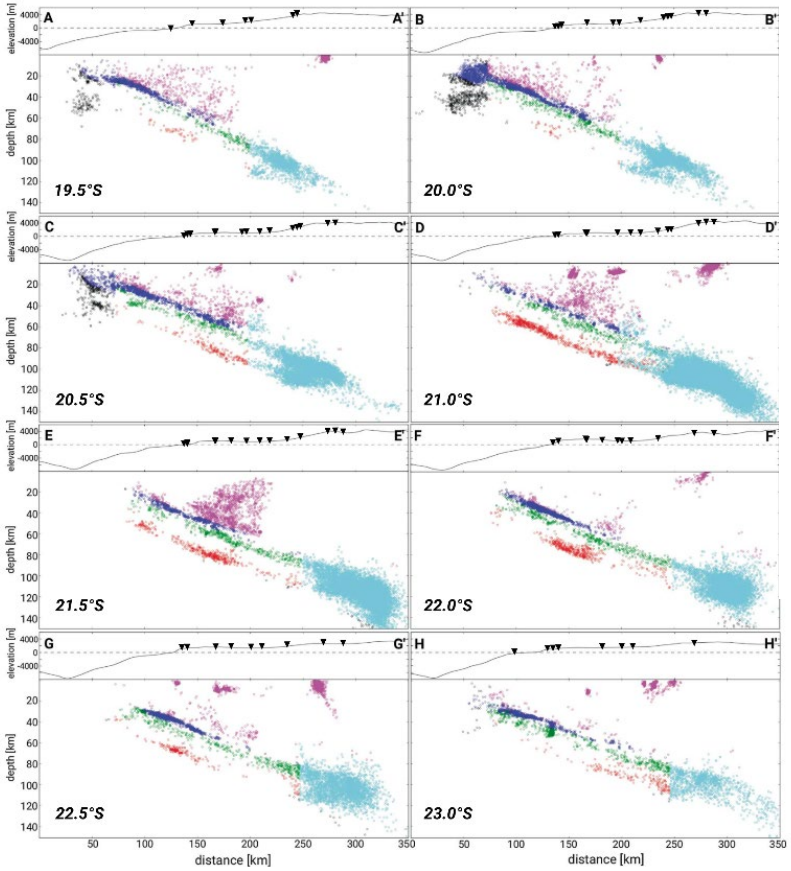
Global CMT Project

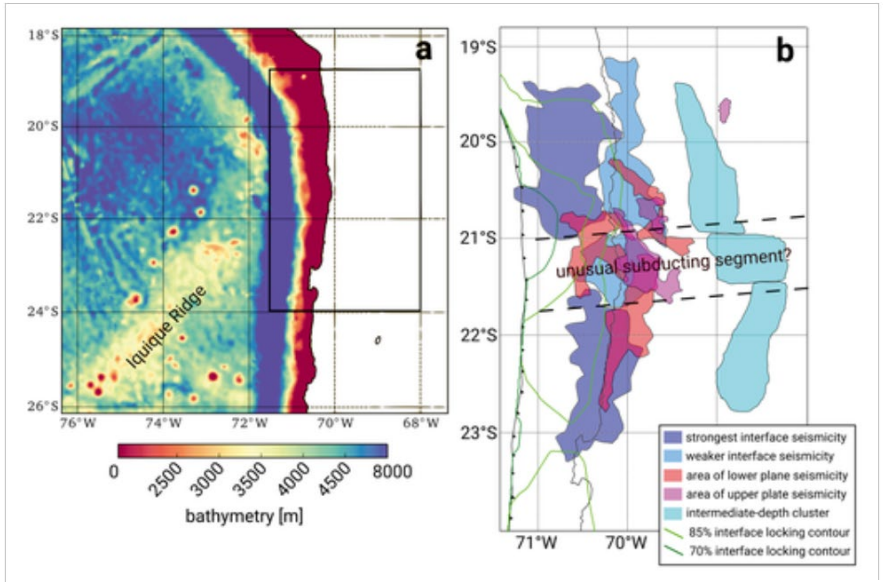


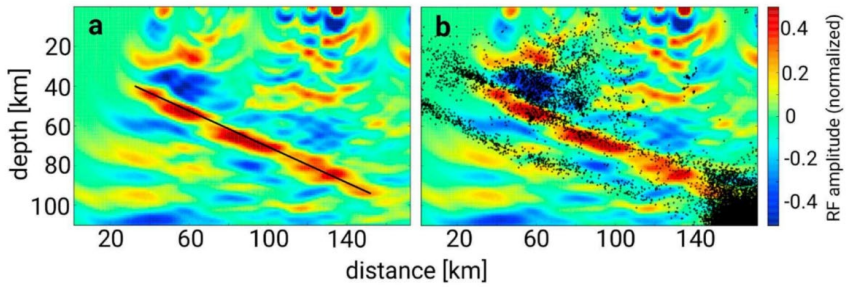
Role of outer rise events
e.g. Largets aftershock of 2010 Maule earthquake

Northern Chile



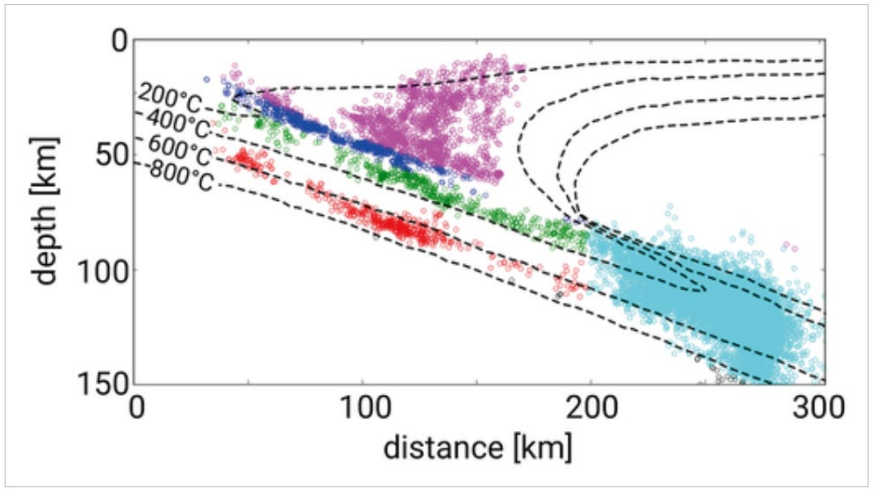




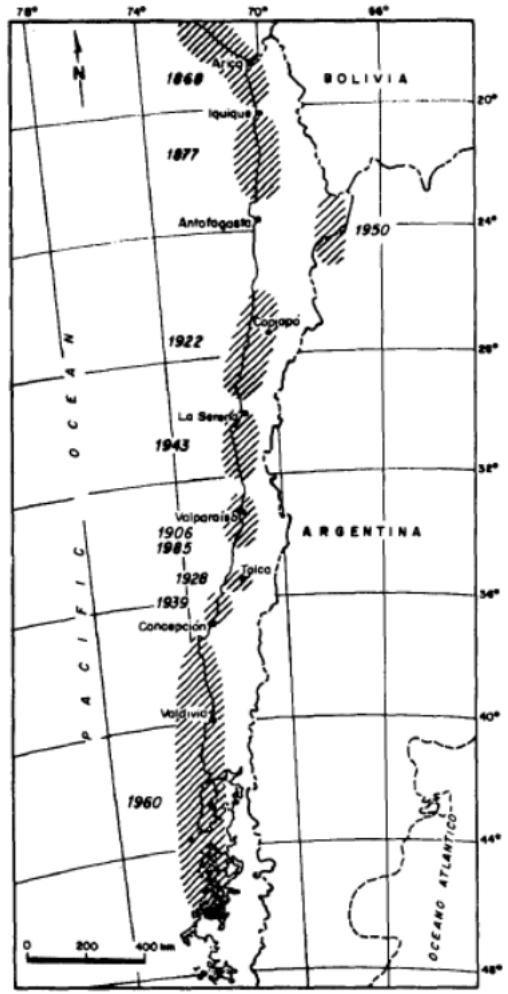


> 100.000 events

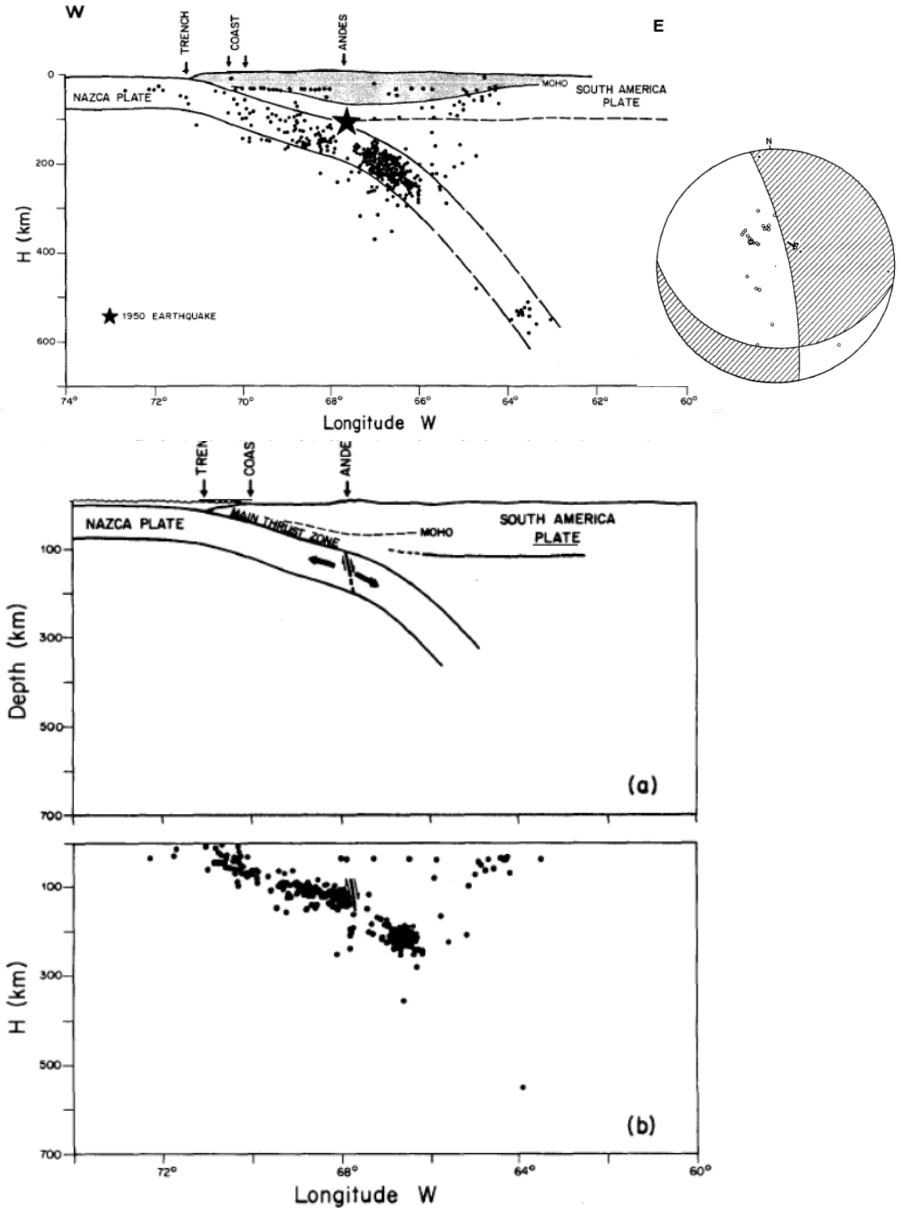
Sipple et al. (2018)

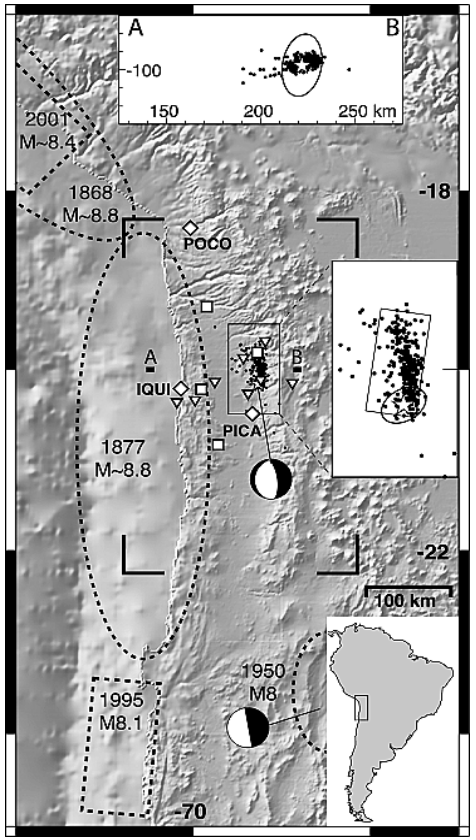


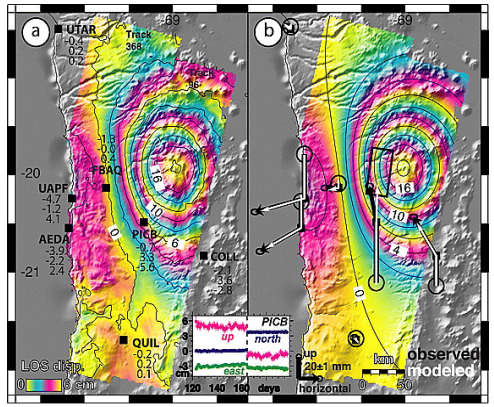
1950 M8.0 Calama and 2005 and M7.8 Tarapacá earthquakes

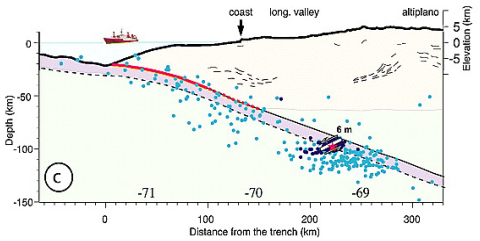


Kausel and Campos (1992)



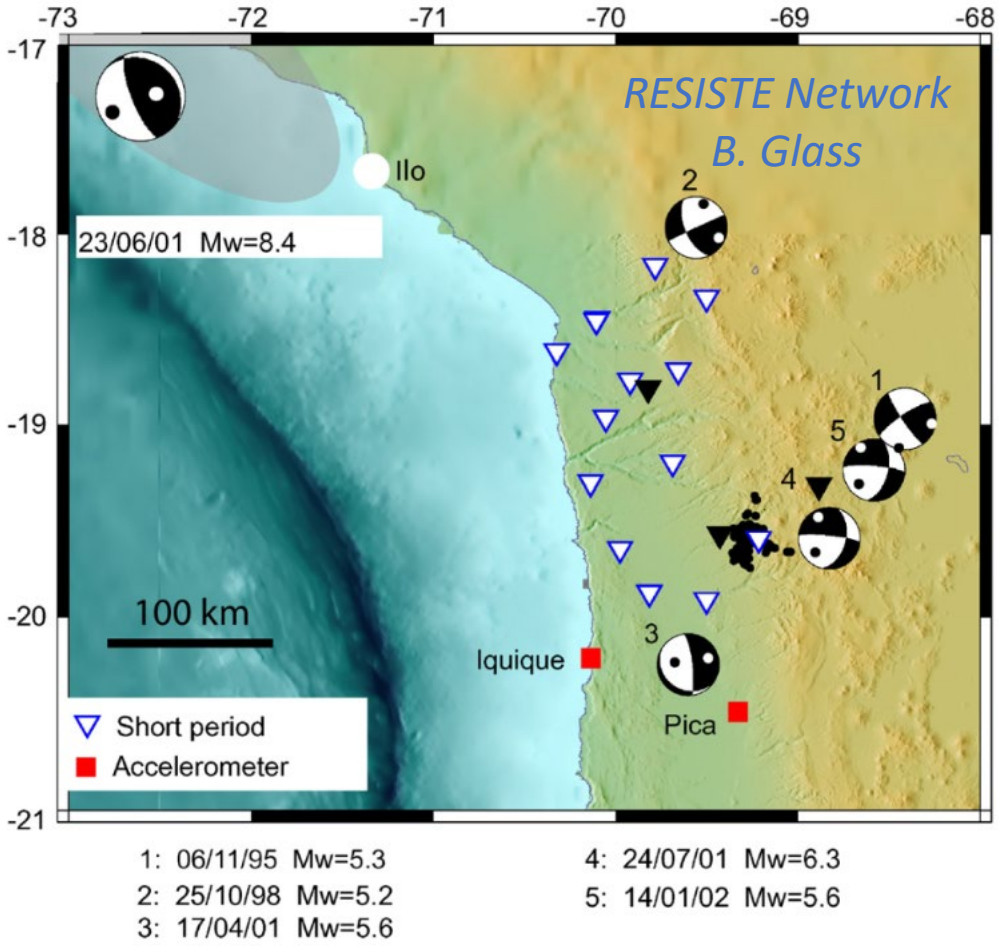


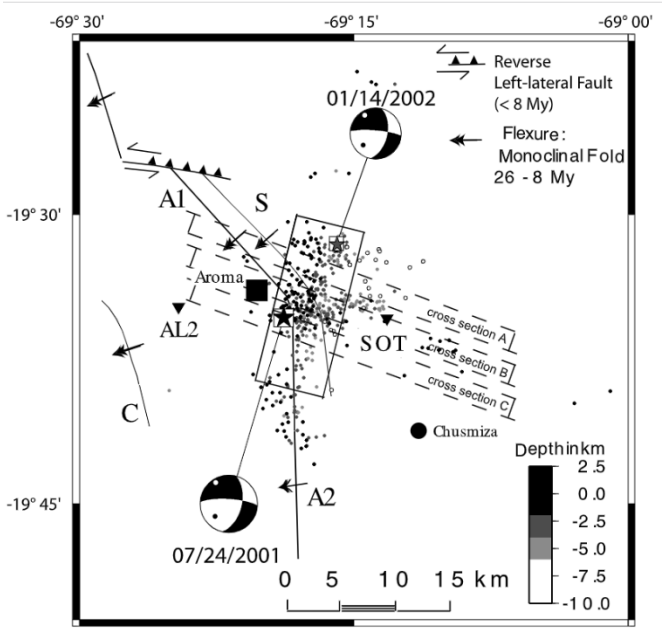




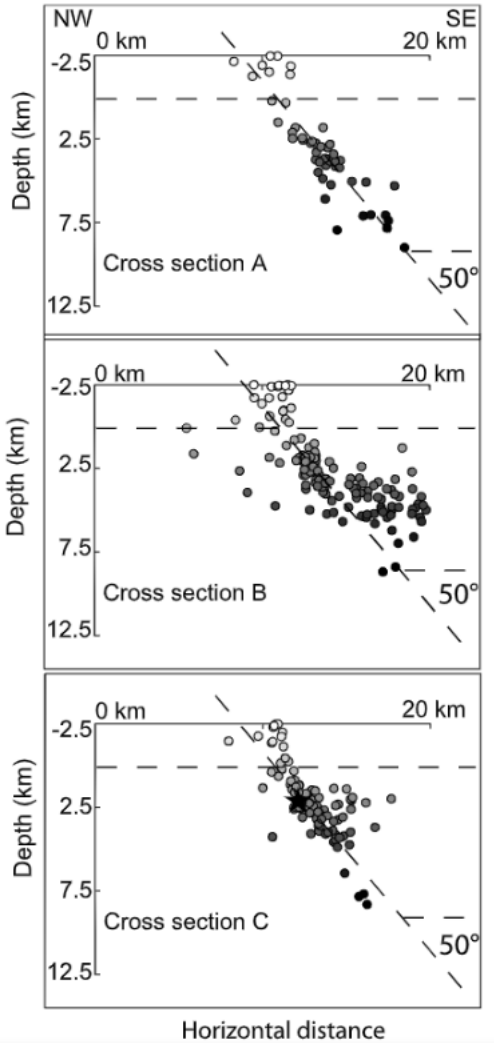
Peyrat et al. (2006)

Inland shallow seismicity



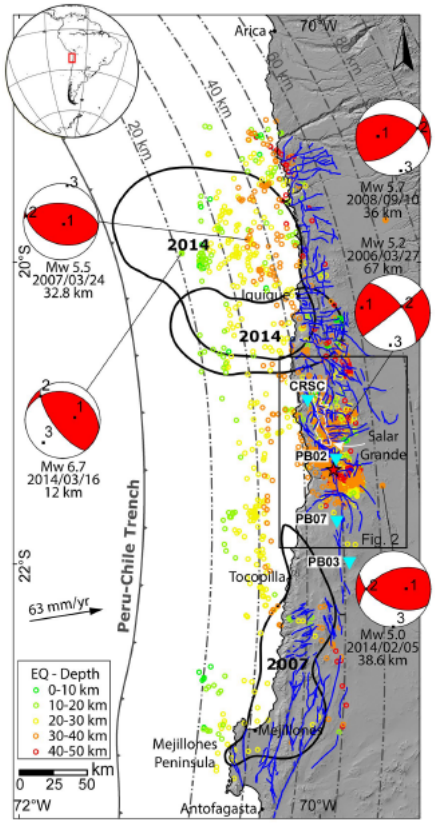


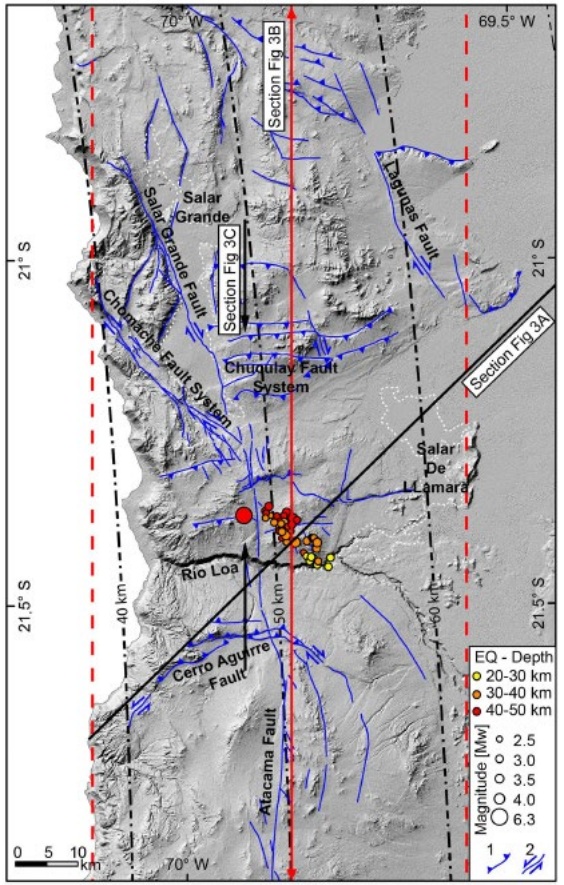
Legrand et al. (2007)

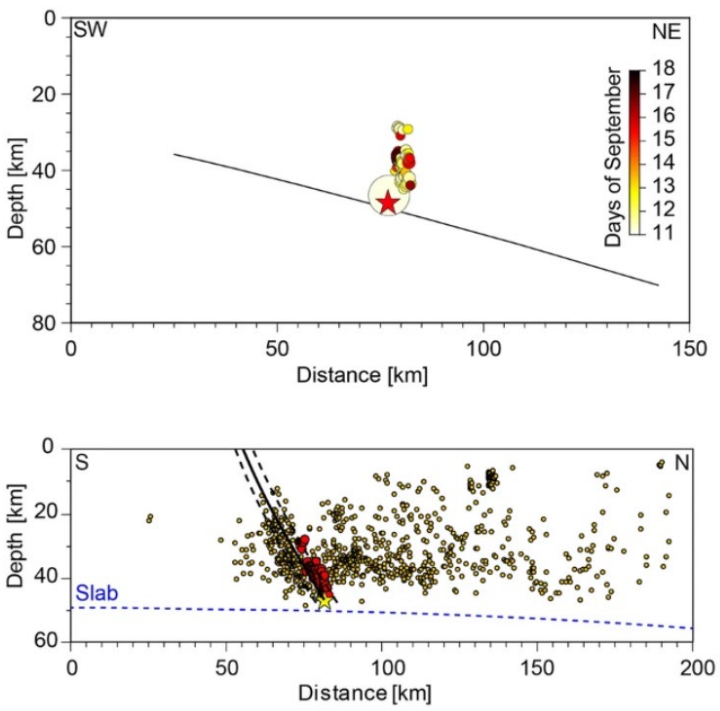


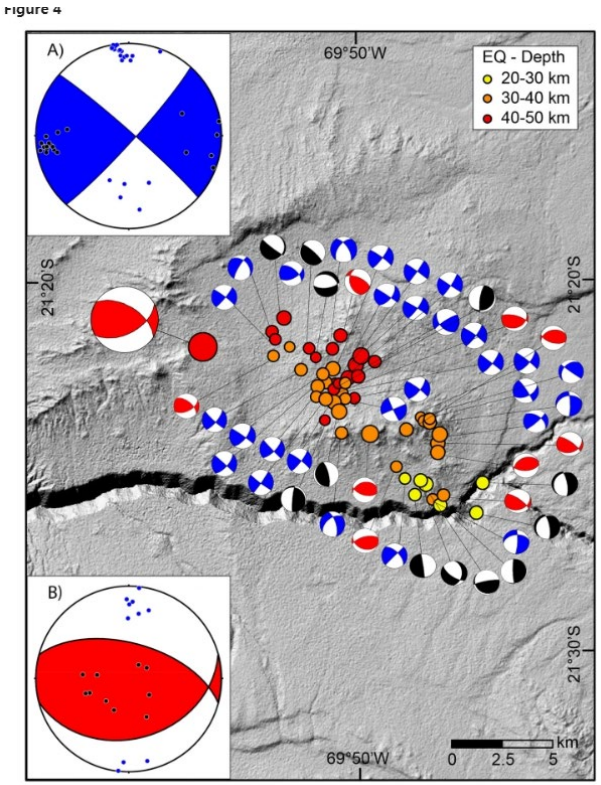
2001 M6.3 Aroma earthquake, h < 10 km

Inland shallow seismicity









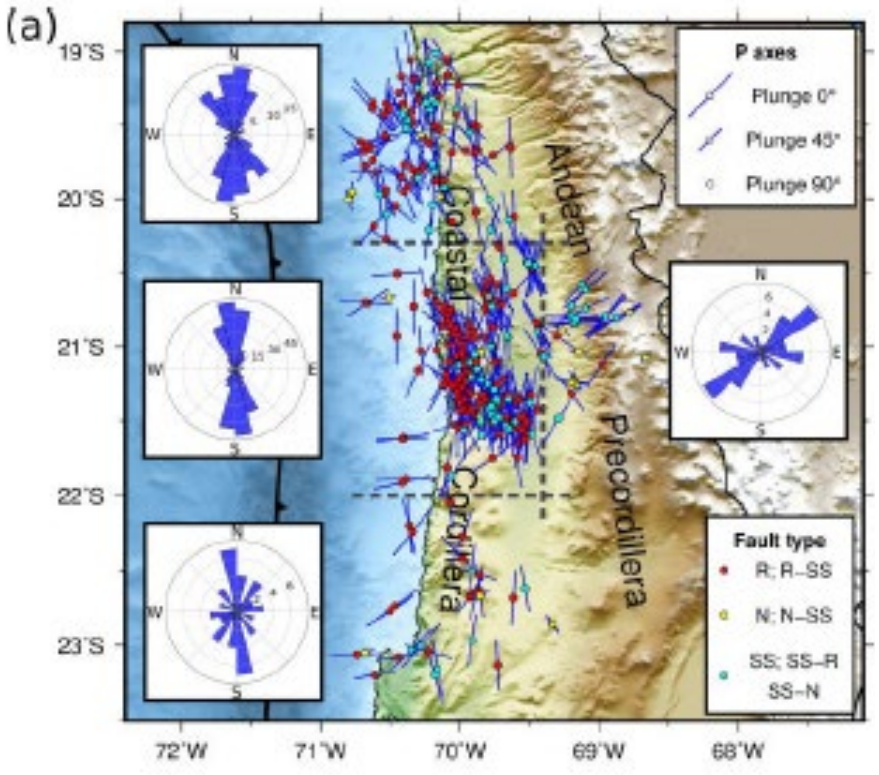
Sep 11, 2020 M6.3 earthquake

Gonzalez el al. (2021)

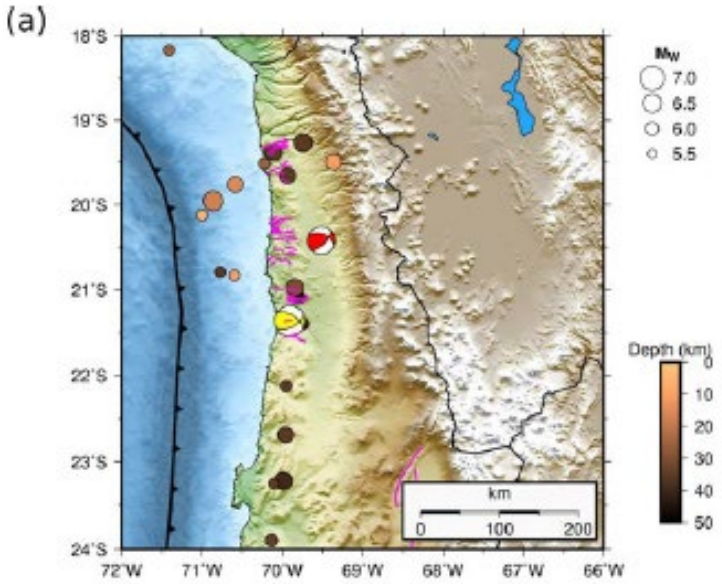
The role of interplate locking on the seismic reactivation of upper plate faults on the subduction margin of northern Chile

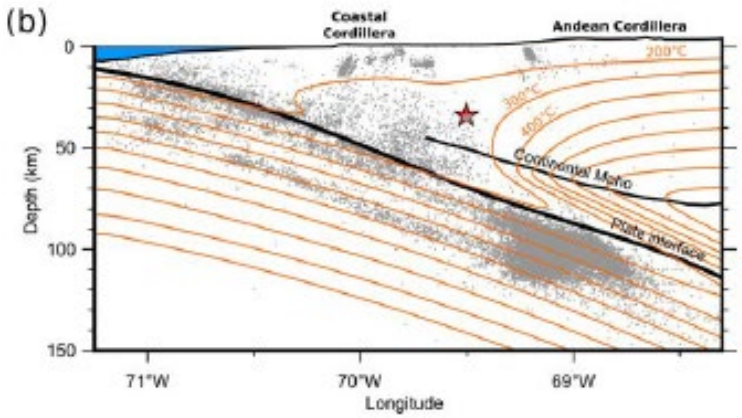
Stress field

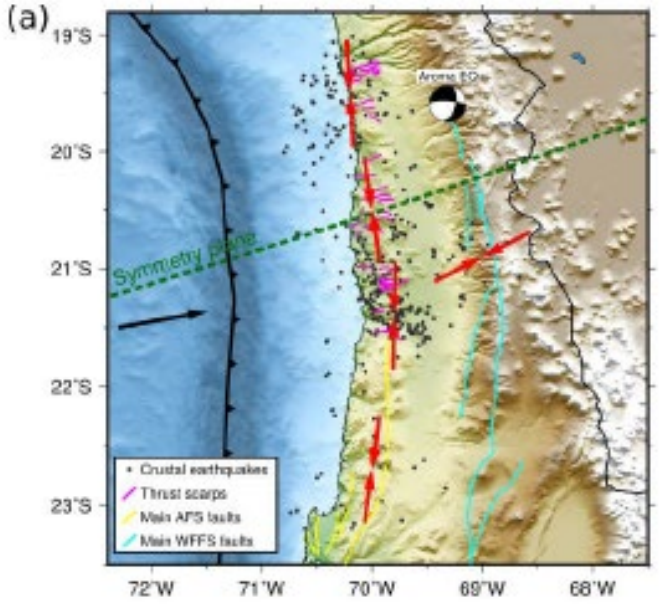
Pica earthquake
2008 M5.7 h~33 km

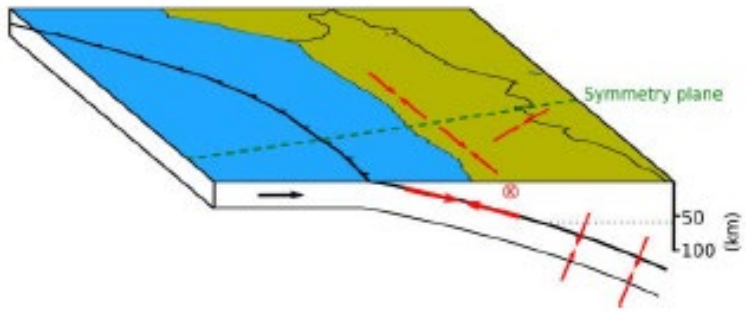


Herrera (2021)

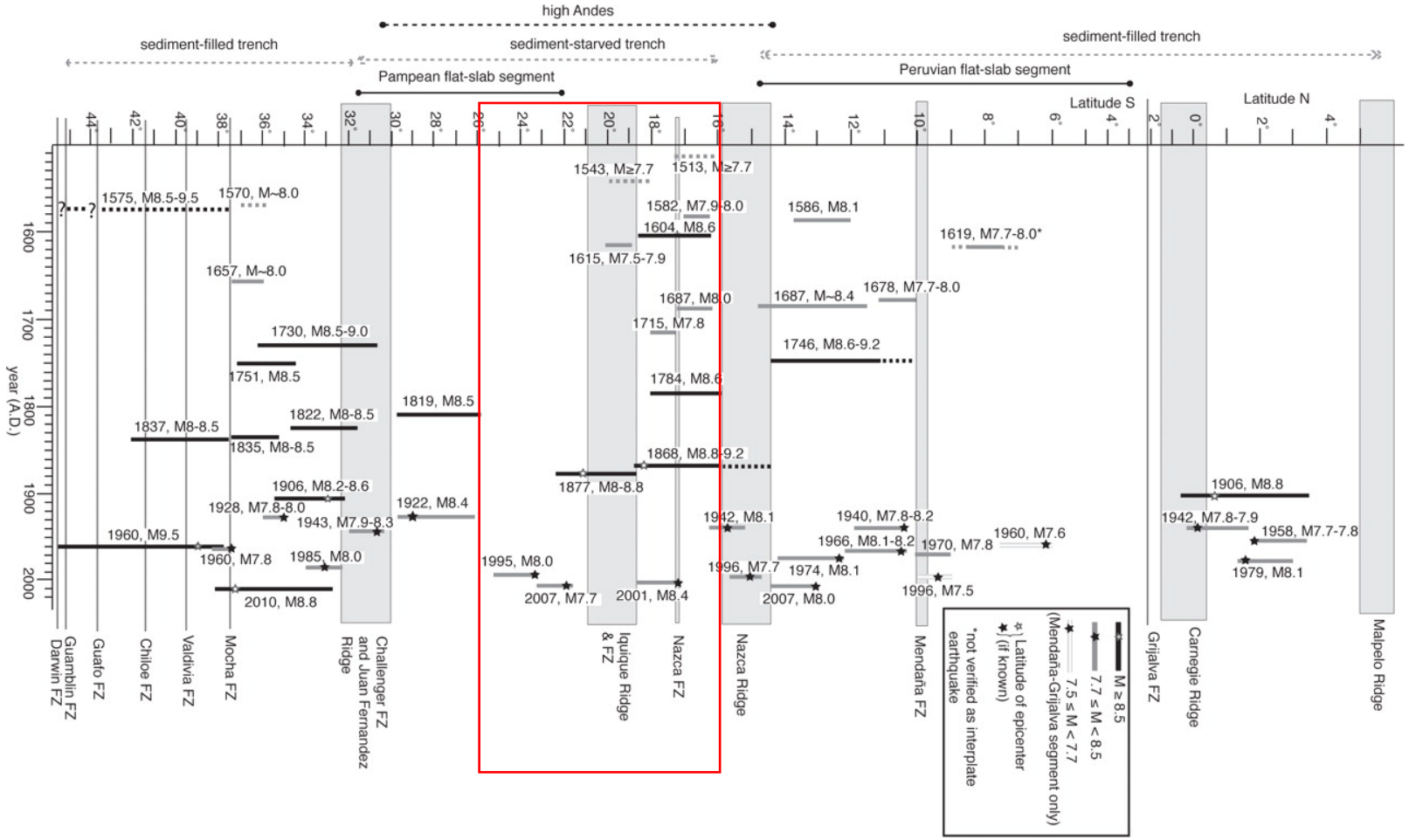




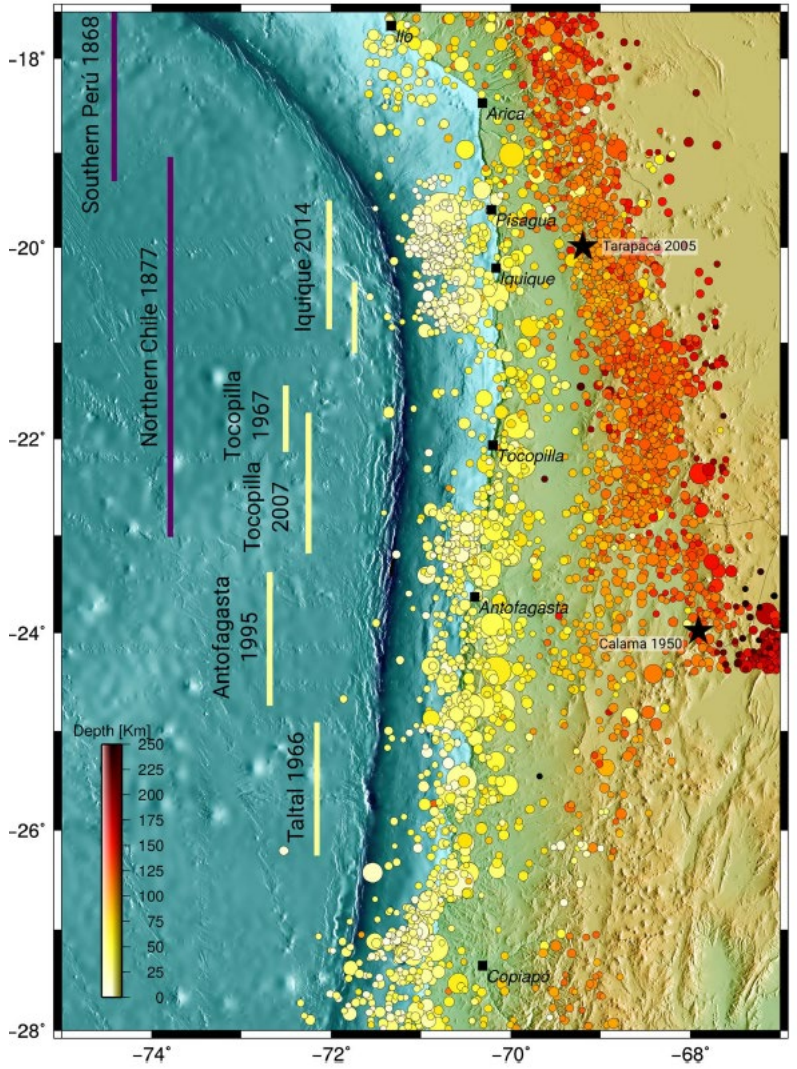




Historical Seismicity

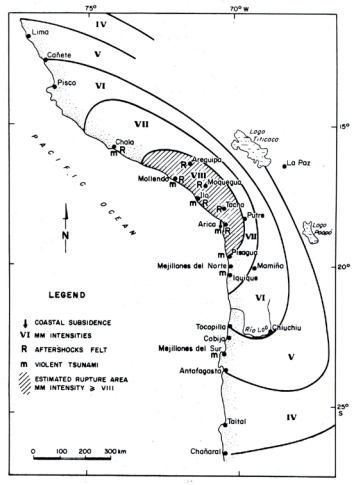


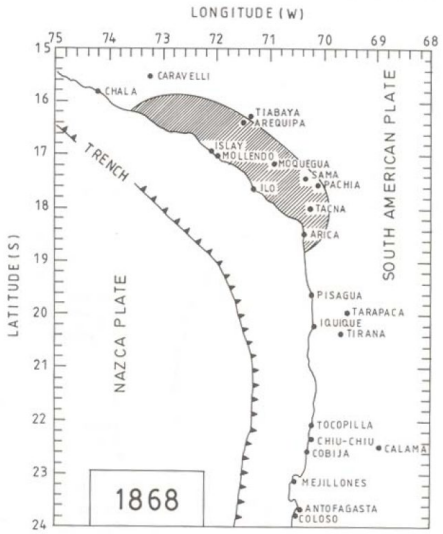
Carena (2011)

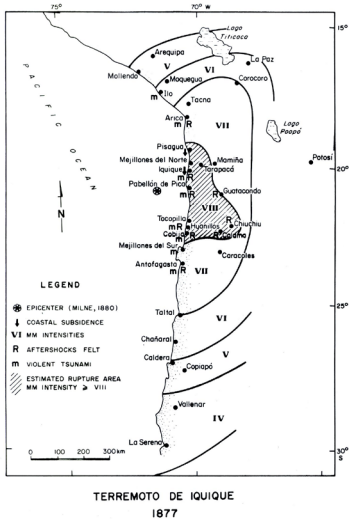


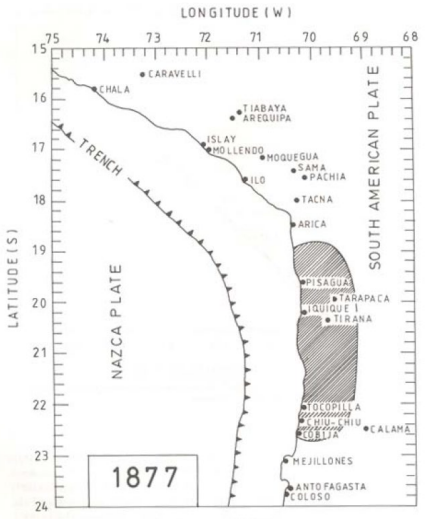
Ruiz y Madariaga (2018)

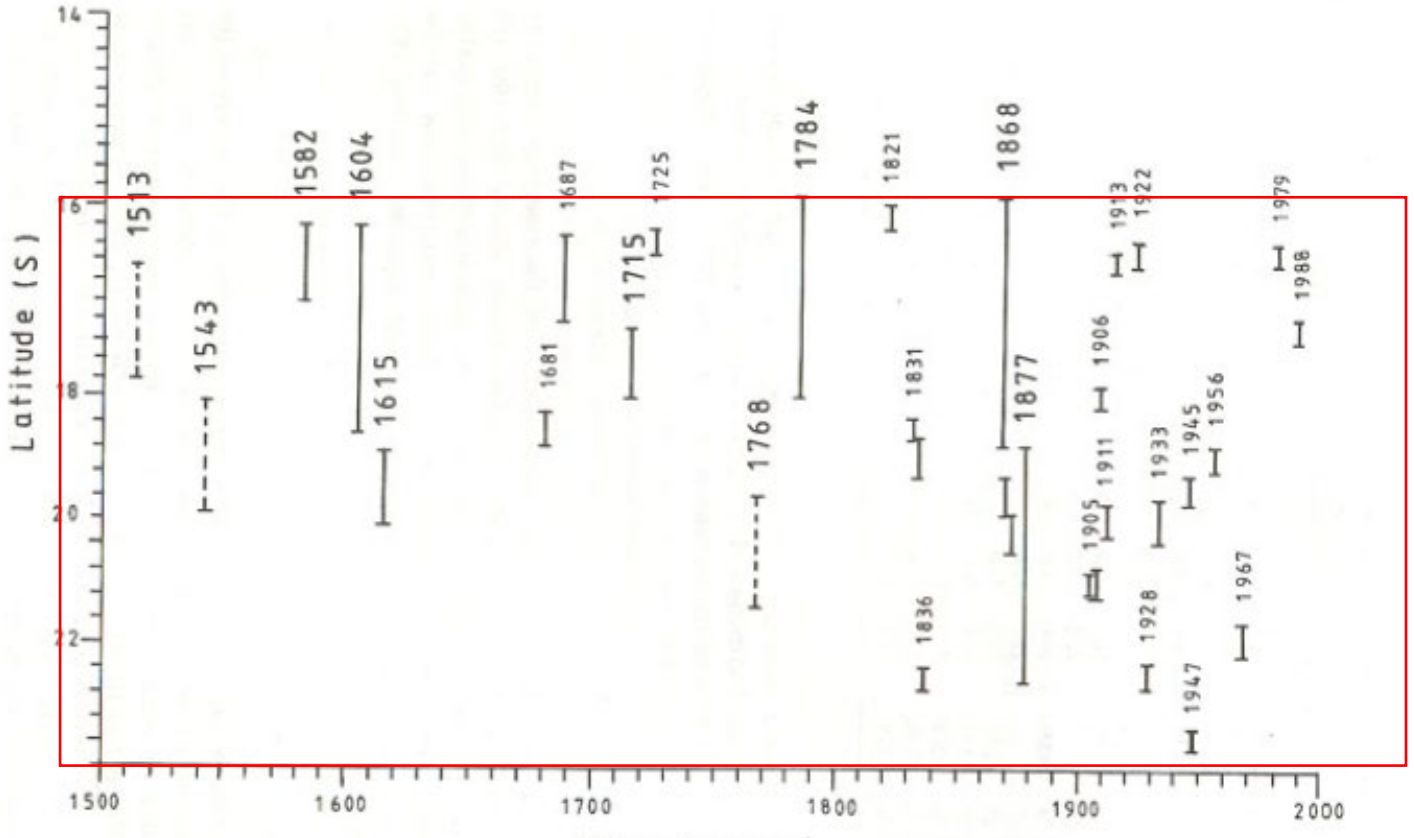
Historical Seismicity











Kausel (1986)

Comte and Pardo (1991)

Thanks

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UNIVERSIDAD DE CHILE