Aftershock Seismicity of the Mw 8.8 Maule Earthquake of 27 February 2010 Using a 2D Velocity Model

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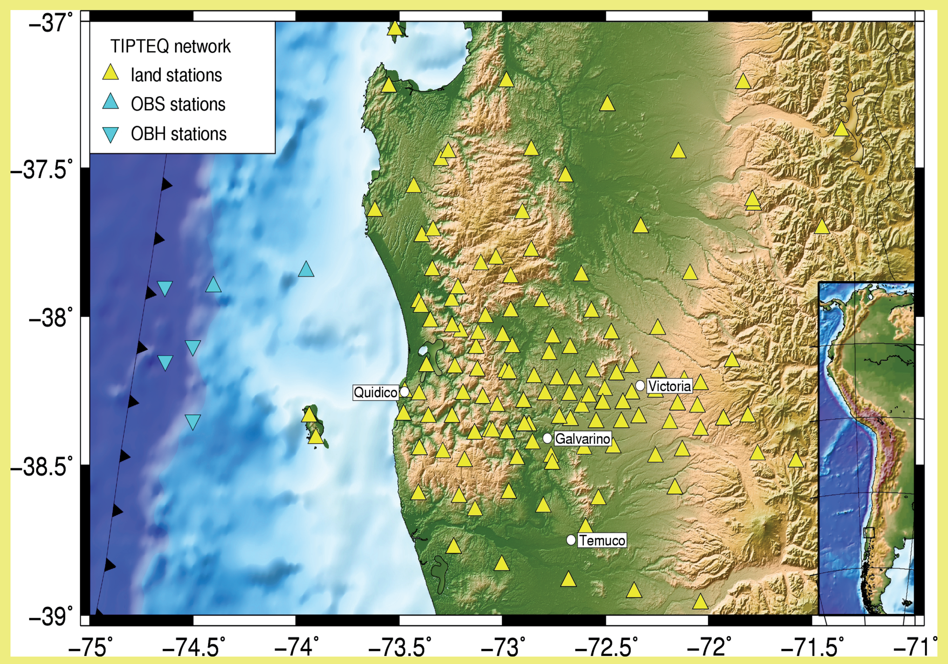
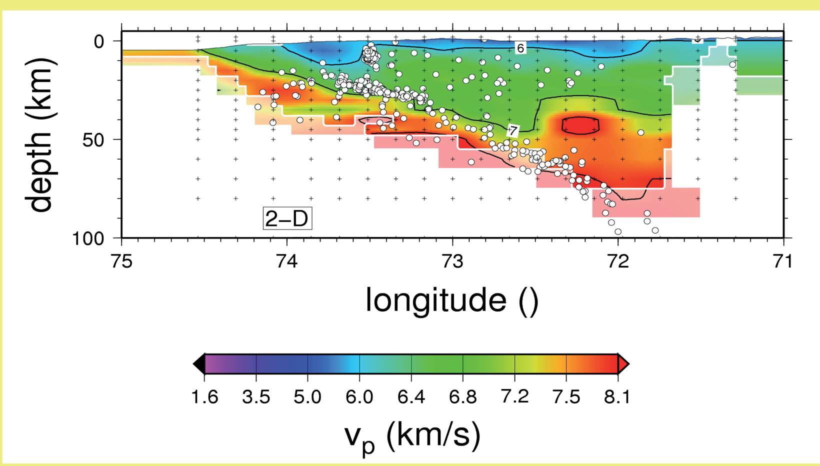
1) Introduction

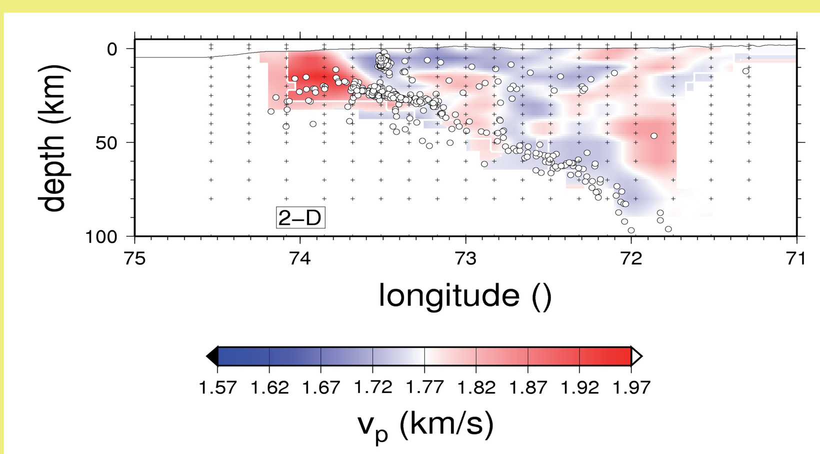
On 27 February 2010 a magnitude 8.8 earthquake occurred along the subduction zone in central Chile, rupturing a 350 km long section of the dipping fault interface. The southern part ruptured previously in 1835 during the M 8.5 Concepcion earthquake and the northern part ruptured in 1906 during the Mw 8.5 Valparaiso event. Immediately after the earthquake struck, a coordinated multinational effort took place to capture in great detail the aftershock activity. In total ~160 seismic stations were deployed by Chilean, French, USA, UK and German institutions, making this one of the best-observed aftershock sequences of a megathrust earthquake to date. Here we present earthquake locations based on STA/LTA triggering and a newly-developed event association algorithm based on a backward time migration approach.

2) The TIPTEQ 2004-2005 Experiment (BEFORE)

In 2004/05 a temporary seismic array was installed in the nucleation area of the 1960 Chile earthquake, which coincides with the Southern rupture area of the 2010, Maule, earthquake (Rietbrock et al., 2005). A detailed tomographic image based on local earthquake data was obtained imaging the subduction thrust directly before a large earthquake (Haberland et al., 2009).





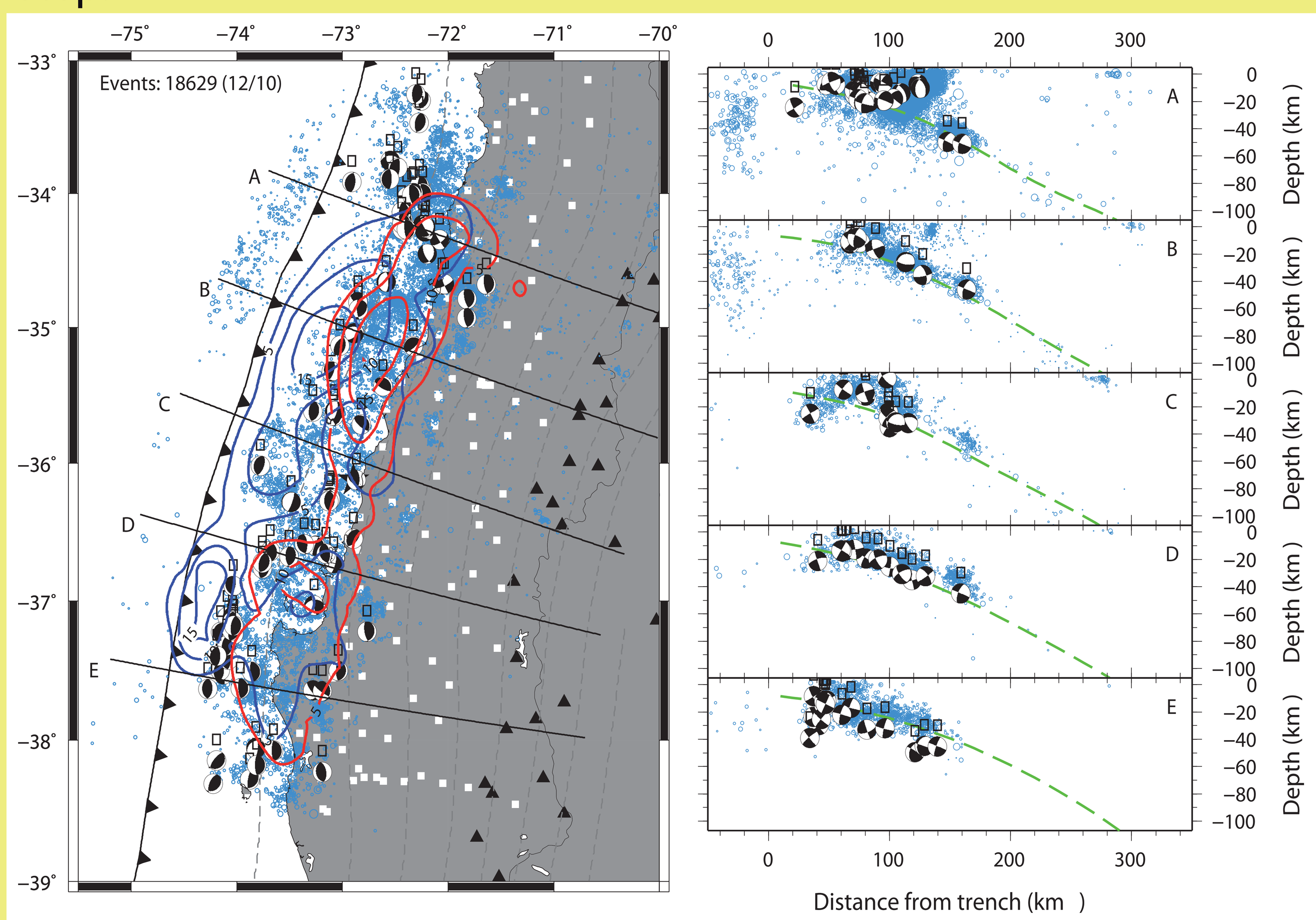


Major findings of previous study:

a) Asymmetric structure
b) high velocity subducting slab (red colors)
c) low velocity crustal forearc (green, blue colors)
d) shallow upper mantle (red)
e) very good resolution <50 km and West of 72.5
f) **marine forearc low vp and high vp/vs ratio>2**; ovepressured fluids and deminishing seismicity; conditionally stable region
g) **no indication of pervasive mantle serpentinization**

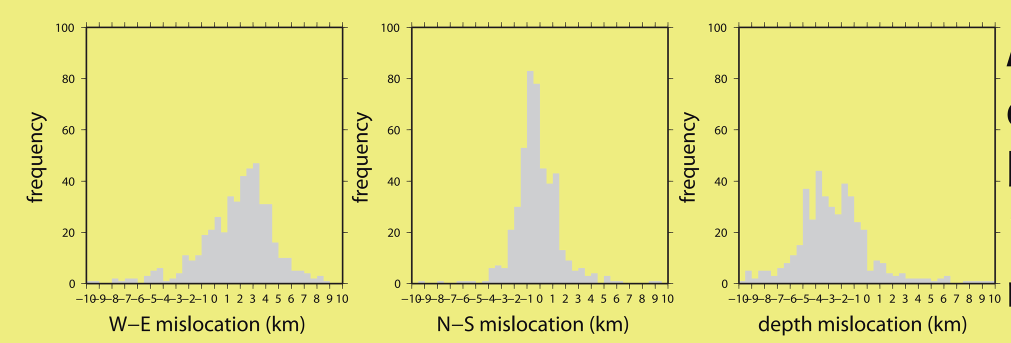
3) 2D locations of the Maule aftershocks

We have carried out an analysis of the combined IRIS, French, GFZ, and Liverpool datasets, which cover in time the first two deployment months (end of March to beginning of June). More than 100,000 seismic events can be identified based on an association threshold of at least 6 P wave arrivals. Since most of the seismicity is located offshore, automatic locations based only on P wave arrival times have poorly-constrained depth estimates. We therefore used an iterative approach to increase the number of P wave arrival time picks, to obtain additional S wave arrival times, and in the same step to increase the accuracy of the automatic picks. Random manual checks were carried out to optimize the processing parameters. Here we present ~18,000 events, in the time period 15/03/2010 - 24/05/2010, which have at least 20 and 10 well constrained arrival times for the P- and S-wave, respectively. The 2D TIPTEQ velocity model (rotated perpedicular to the trench) was used for the final location step.

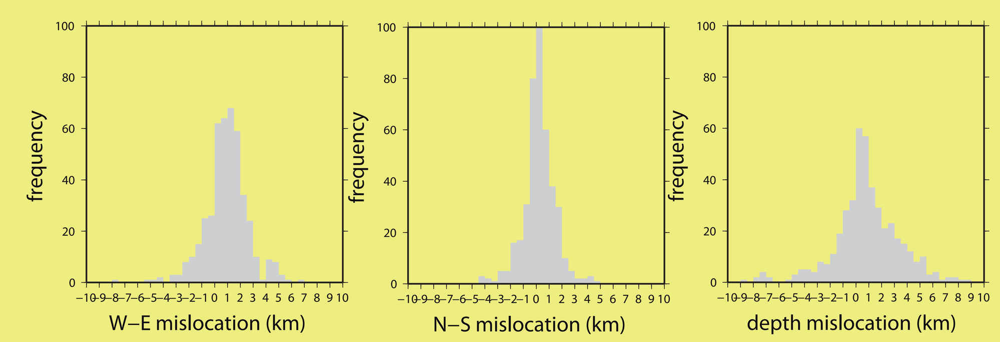


4) Location accuracy

We used the TIPTEQ catalog to asses the errors associated with event locations. We compare 1D and 2D locations and the influence of rotation.



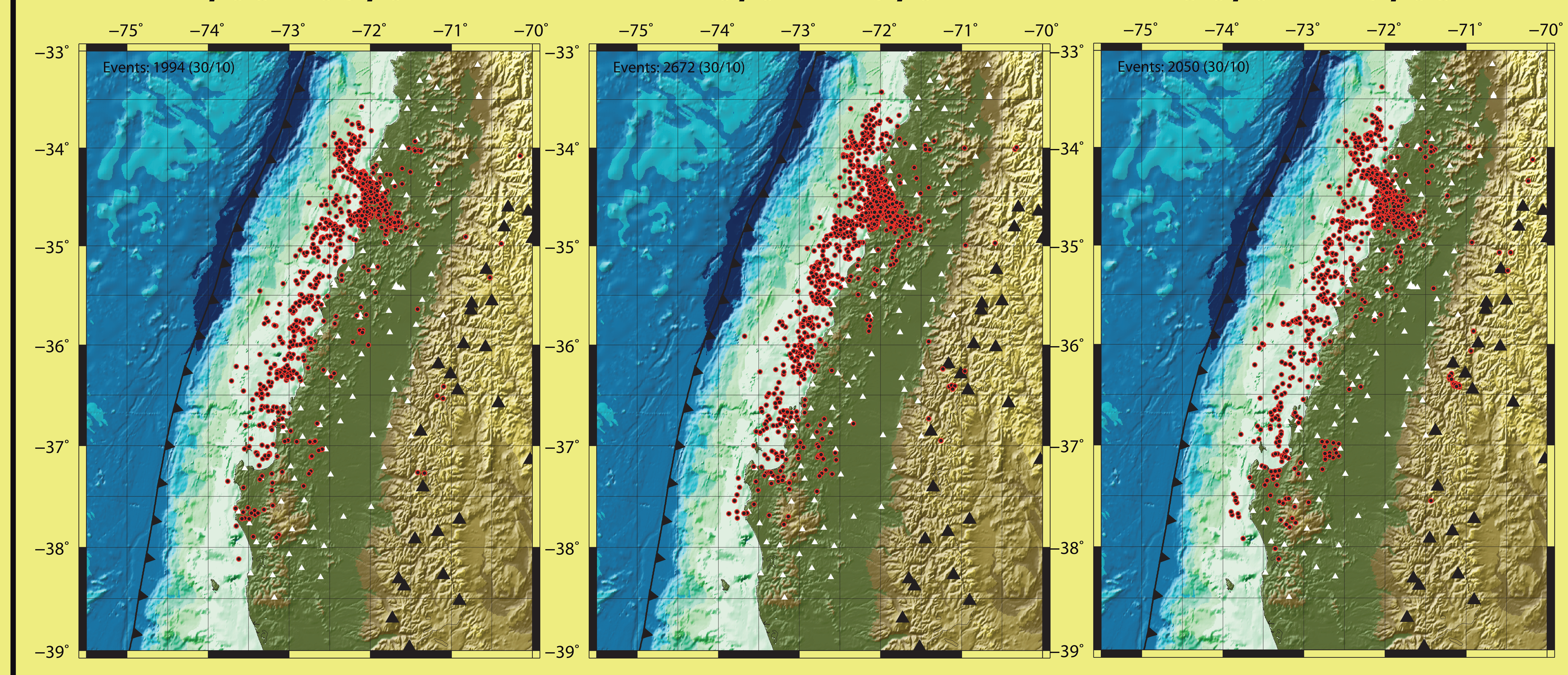
A) Shows the difference in event locations between locations in a 1D and 2D velocity model.



B) Shows the difference in event locations between locations in the original and rotated 2D velocity model.

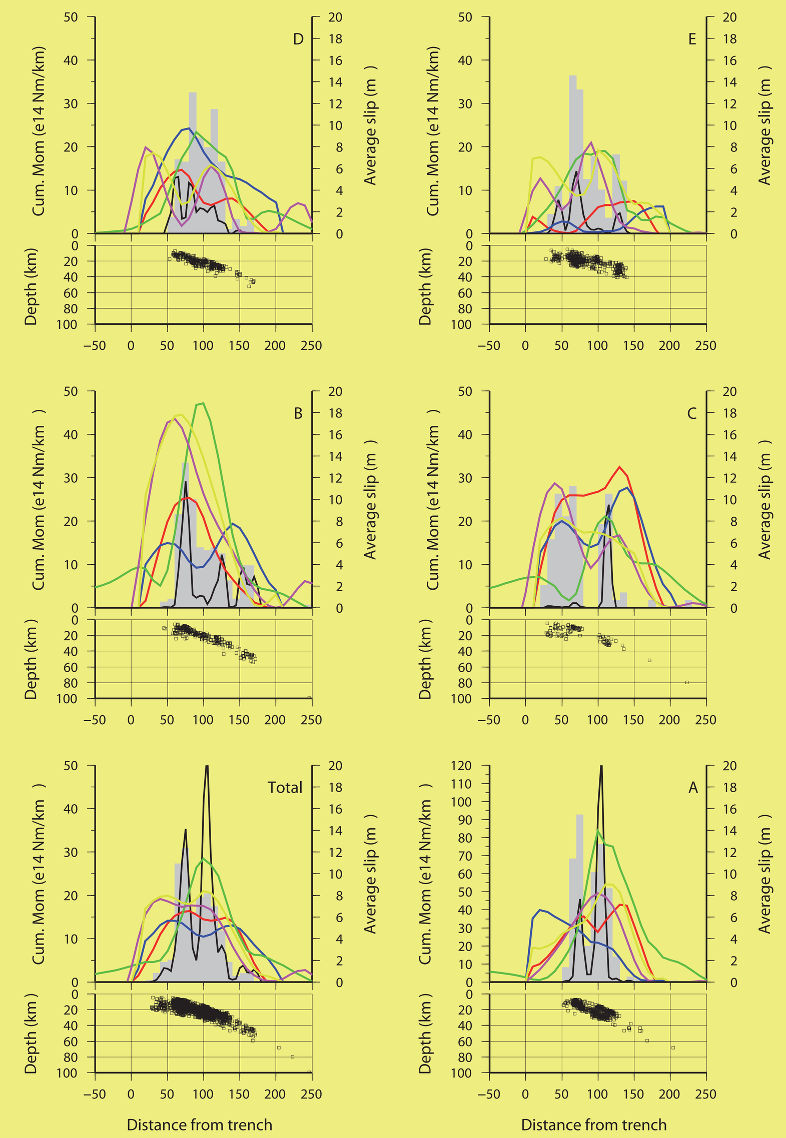
5) Crustal seismicity

21/03 - 09/04 **10/04 - 29/04** **30/04 - 19/05**



Numbers of events in each time period is given in the left upper corner of each pannel.

6) Slip models



Comparison between number of events plotted as percentage values (gray histogram) and average co-seismic slip as a function of distance from the deformation front. The slip models of Vigny et al. (2011) and Lorito et al. (2010) are shown in blue and red, respectively. The black lines represents average cumulative moment release based on our moment estimates. Only events that are located in a depth corridor of +-10km from the predicted slab interface (SLAB 1.0) are taken into account for the average moment release and event histogram. Cross sections show event distribution along each of the profiles (B, C, D, and Total) cut out for histogram and moment release calculations.

7) Conclusions

a) Very **high seismicity** rate is observed between March and May.
b) Crustal seismicty is dominated by the Mw=6.9 Pichilemu event (11/03/2010).
c) Increased crustal seismicity is seen in the **volcanic arc** starting in late April.
d) Seismicity rate at the subduction thrust is much higher in the North compared to the South.
e) Based on the aftershock distribtution we prefer slip models with **larger slip close to the trench**.
f) An **aseismic gap** is observed at the lower end of the seismogenic zone between approximately 30km and 40km depth. Focal mechnisms indicate thrus faulting.