

# Earthquake Geology, Tsunami Hazards, and a Clam Bake Midway Along the 1960 Rupture

Post-conference field trip to south-central Chile

20-24 May 2010

Limited to the first 20 who register for the trip before 2 April

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## Registration

Fee: US\$ 720  
Registration deadline: 2 April 2010  
To register: AGU Web site.  
For more information: Contact Marco Cisternas [marco.cisternas@ucv.cl](mailto:marco.cisternas@ucv.cl)

## Itinerary

The trip features coastal geological evidence of the giant 1960 Chile earthquake and several of its predecessors. This evidence, from the last 2,000 years, tells of subsidence, tsunamis, and shaking. We will see it beautifully exposed at an estuary near Maullín and on a beach near Ancud, Isla Chiloé (see index maps). We will also sample culture and cuisine of a picturesque region.

We will depart from the conference hotel near Valparaíso soon after the conference ends on Thursday, May 20. A comfortable overnight bus will deliver us to Puerto Montt the following morning. From there we will continue 45 km to Maullín, a coastal municipality where we will spend the better part of May 21 and 22. We will visit Cocotué Beach, on Isla Chiloé, during the day on May 23. That evening we will board an overnight bus for arrival in Santiago the morning of Monday, May 24.

## Covered by the field-trip fee

- Transportation including overnight bus rides (“semi-cama” service; <http://www.turbus.cl/servicios.html>) and a ferry to and from Isla Chiloé
- Two nights’ lodging in Maullín
- All meals including a *curanto* (shellfish, meat, and bread steamed in the ground)

## Each participant must bring

Clothing for rainy days with temperatures of 5°-15° C  
Knee-high rubber boots or sneakers for walking through water and mud

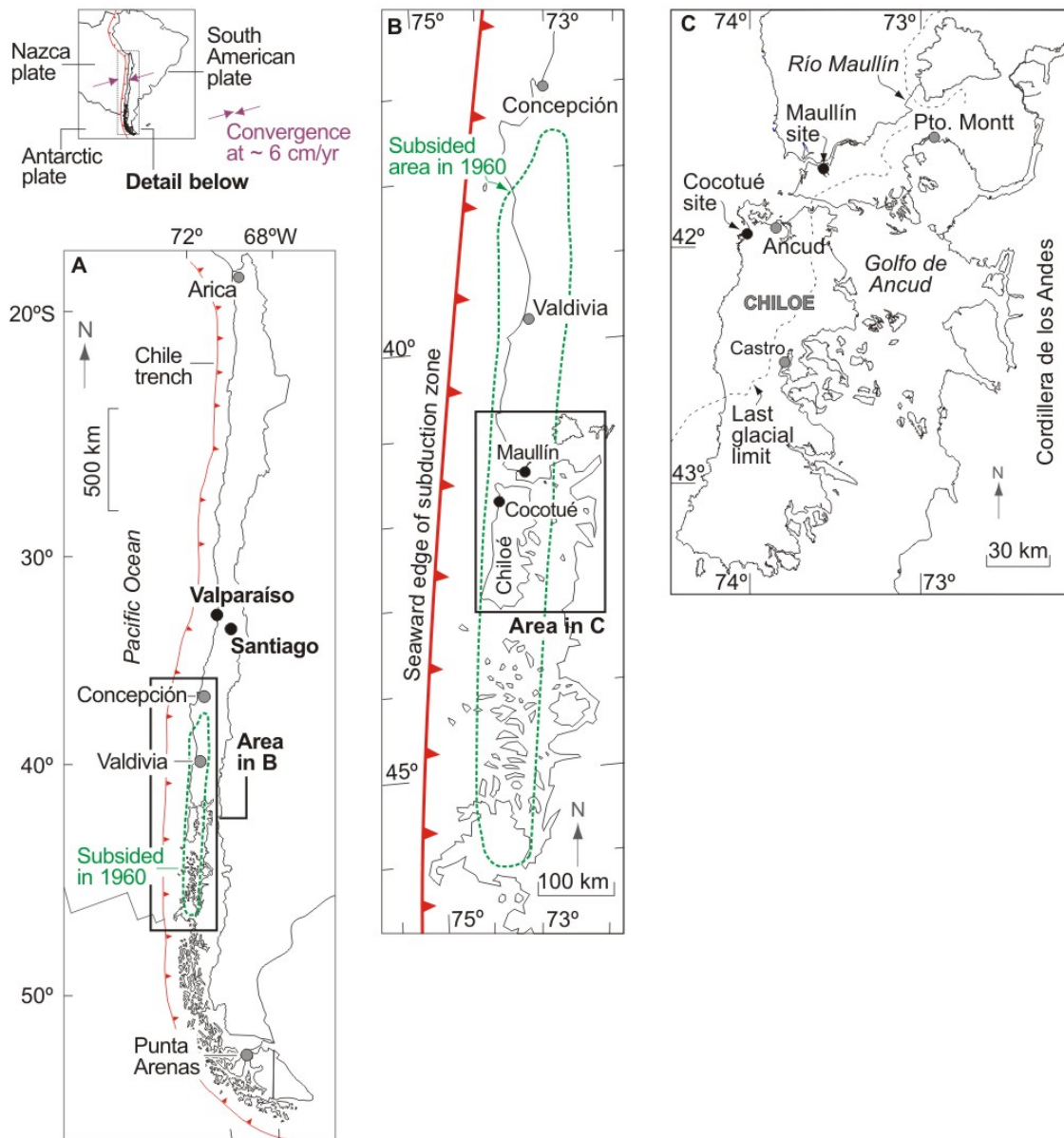
## Guides

Marco Cisternas and Brian Atwater (geology), Marcelo Lagos (hazards), Sra. Cholina and family (clam bake).

## Notes

- Participants are responsible for their own insurance. The field-trip fee covers no insurance of any kind.
- For participants in the Valdivia ceremony on May 22 we can arrange bus transportation between Maullín and Valdivia.
- If fewer than ten persons register, the trip will be canceled and trip fees will be refunded in full.

## Index maps



## Photos from field area



Maullín, where we spend two nights, borders a tidal river 8 km inland from the sea. The 1960 tsunami reached the church, which withstood the earthquake.



Near Maullín we will examine stream banks in which buried soils and sand layers tell of subsidence and tsunamis. Shovel handle 0.5 m long.



We will observe additional earthquake and tsunami geology near Maullín in pits. The examples above show two sand sheets from tsunamis and one sand sheet from coseismic subsidence (left) and soft-sediment cobbles and boulders that the 1960 tsunami derived from pond fill in a beach-ridge breach that a previous tsunami created (right).



The family of Señora Cholina, a survivor of the 1960 tsunami, will host us near Maullín for a *curanto* (shellfish, meats, and breads steamed in the ground).



In this 500-m long outcrop at Cocotué, Isla Chiloé, debris flows and sand sheets tell of shaking and tsunamis from of a series of dissimilar earthquakes. The series includes some of the earthquakes evidenced near Maullín (AD ~1000, ~1300, 1575 and 1960) but also includes intervening shocks of probably lesser size, including the poorly understood earthquake that set off a trans-Pacific tsunami in 1837.

### Partial list of related publications

Atwater, B.F., H. Jimenez Nuñez and C. Vita-Finzi (1992). Net late Holocene emergence despite earthquake-induced submergence, south-central Chile. *Quaternary International*, **15-16**, 77-85. doi: 10.1016/1040-6182(92)90037-3

Atwater, B.F., M. Cisternas V., J. Bourgeois, W.C. Dudley, J.W. Hendley, II and P.H. Stauffer (2005). Surviving a tsunami—lessons from Chile, Hawaii, and Japan. U.S. Geological Survey Circular 1187. 18 pp. <http://pubs.usgs.gov/circ/c1187/>

Bartsch-Winkler, S., and H. R. Schmoll (1993). Evidence for late Holocene sea level fall from reconnaissance stratigraphic studies in an area of earthquake-subsided intertidal deposits, Isla Chiloé, southern Chile, *in* Tectonic controls and signatures in sedimentary successions, L. E. Frostick and R. J. Steel (eds), International Association of Sedimentologists Special Publication 20, 91-108.

Cisternas, M., B.F. Atwater, F. Torrejón, Y. Sawai, G. Machuca, M. Lagos, A. Eipert, C. Youlton, I. Salgado, T. Kamataki, M. Shishikura, C. P. Rajendran, J. K. Malik, Y. Rizal and M. Husni (2005). Predecessors to the giant 1960 Chile earthquake, *Nature*, **437**, 404-407. doi:10.1038/nature03943

Nelson, A.R., K. Kashima, and L.-A. Bradley (2009). Fragmentary evidence of great-earthquake subsidence during Holocene emergence, Valdivia estuary, south central Chile, *Bulletin of the Seismological Society of America*, **99**, 71-86; doi:10.1785/0120080103

Plafker, G. and J.C. Savage (1970). Mechanism of the Chilean Earthquakes of May 21 and 22, 1960. *Geological Society of America Bulletin*, **81**, 1001-1030. doi: 10.1130/0016-7606(1970)81[1001:motceo]2.0.co;2

Sievers, H., G. Villegas, and P. Saint-Amand (1963). The seismic sea wave of 22 May 1960 along the Chilean coast. *Bulletin of the Seismological Society of America*, **53**, 1125-1190.

Wright, C. and A. Mella (1963). Modifications to the soil pattern of south-central Chile resulting from seismic and associated phenomena during the period May to August 1960. *Bulletin of the Seismological Society of America*, **53**, 1367-1402.