Seismic reflection character of the plate interface in the rupture zone of the 2014 Iquique earthquake sequence

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Introduction

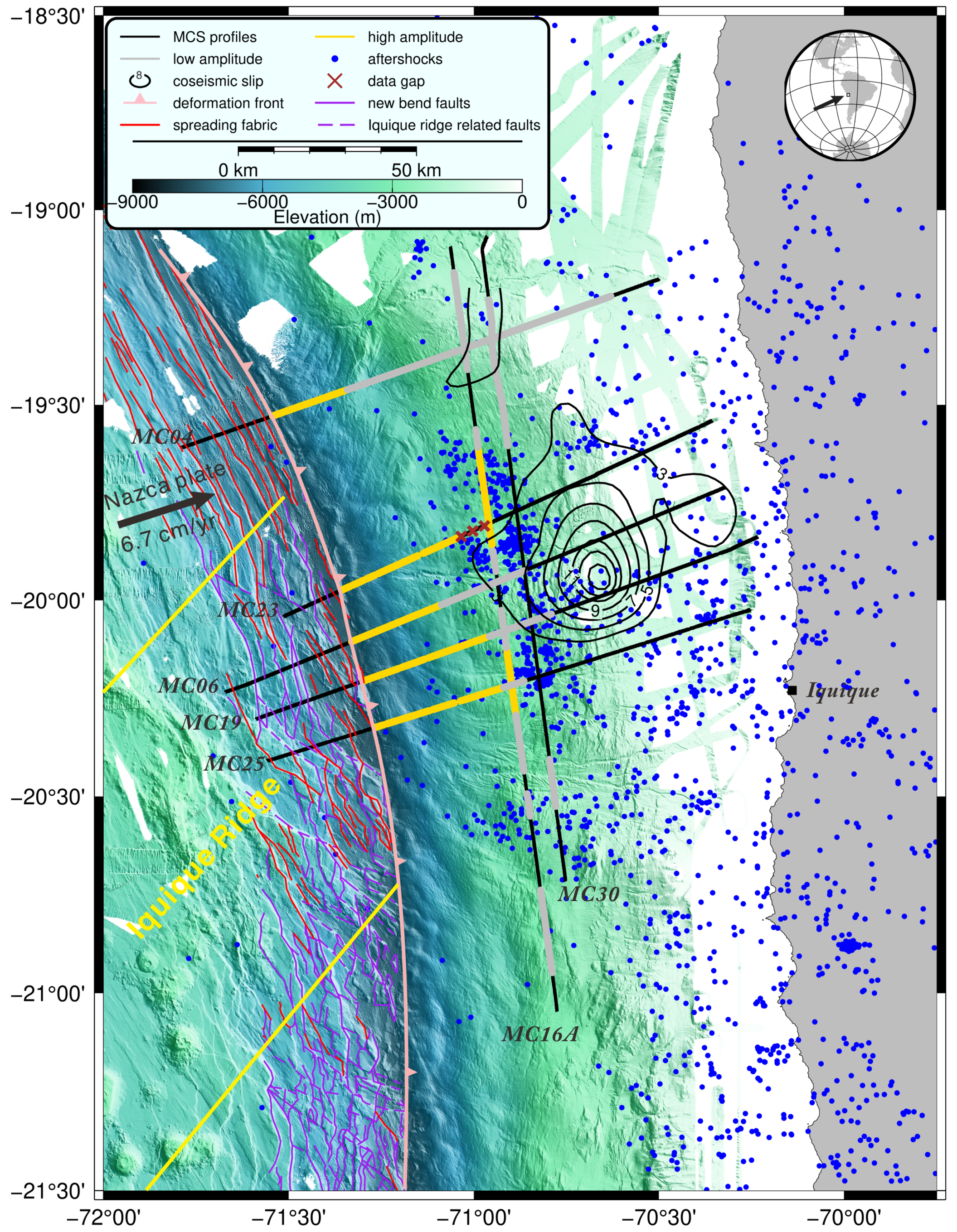

Fig. 1 Location map of MCS profiles offshore of Northern Chile with seafloor bathymetry[1] and aftershocks

On 1 April 2014, the Mw 8.1 Iquique earthquake broke the plate-boundary along the Northern Chilean margin in the region between 19.5 °S and 21 °S [2]. The rupture filled about one-third of the historic Northern Chilean seismic gap which last ruptured in a megathrust earthquake in 1877 with Mw 8.9. Seismic rupture during the 2014 event occurred under the offshore forearc with an updip limit at a plate-boundary depth of 17 km under the middle continental slope. In contrast to the 1877 event, the 2014 earthquake did not cause a major tsunami.

MCS System Overview

Cruise: the R/V Marcus G. Langseth, 2016

MCS Data: 2000 km **Shot Interval**: 125 m **Streamer**: 8 km

Sample Rate: 2 ms **Record Length**: 16 s **Channels**: 640

The multichannel seismic reflection data were pre-stack depth migrated after extensive multiple suppression. Data were processed using the Schlumberger OMEGA2 software.

References

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Spatial variations in plate-boundary reflectivity

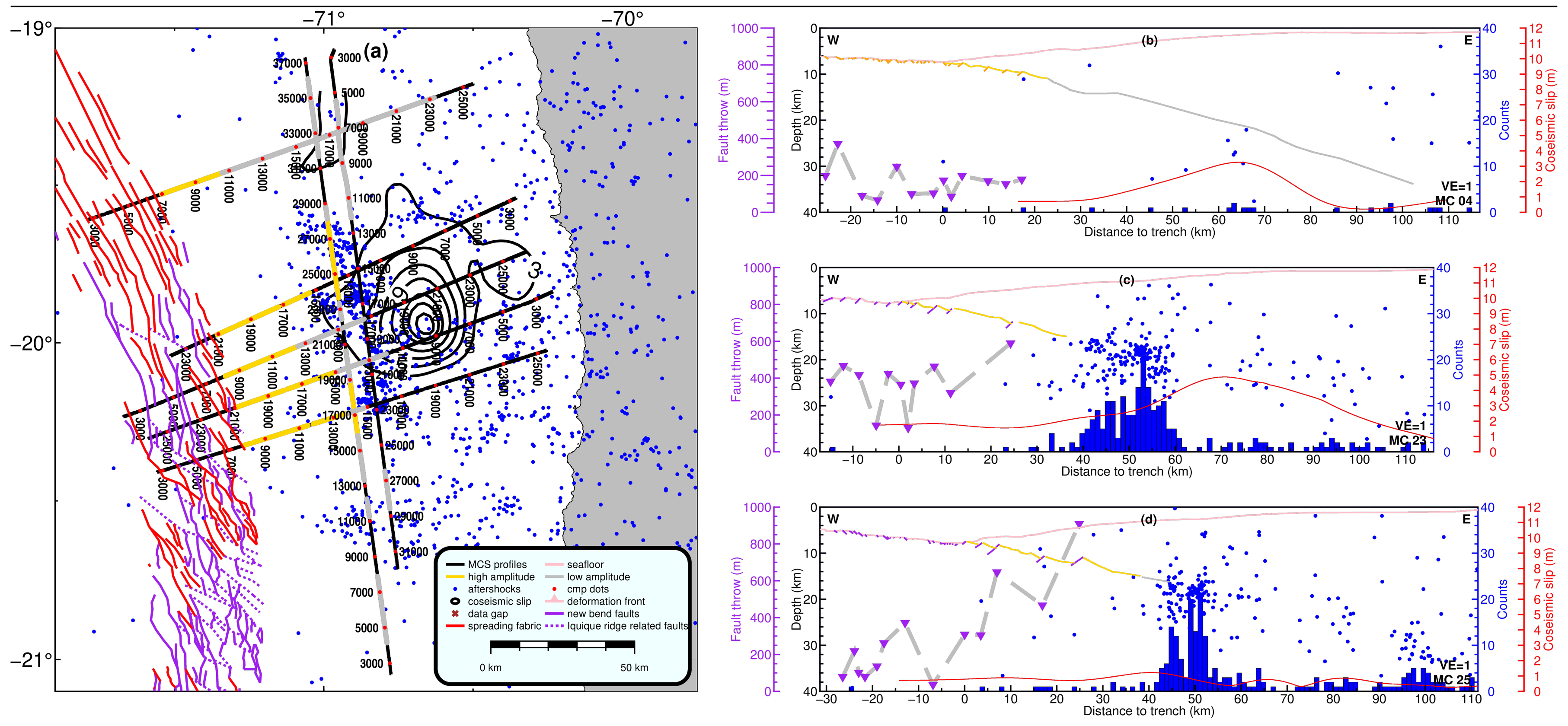

Fig. 2 The relationship between the interface and seismic activities.

The plate-boundary is visible as a seismic reflection throughout all seismic lines from the region of the 2014 Iquique event. However, its amplitude and spatial extent, especially in downdip direction, changes throughout the study region. Along the northernmost line 04, the plate-boundary is visible as a high-amplitude reflector from the deformation front to 23 km landward. Farther southwards, seismic lines 23 and 25 image the plate interface within the rupture area of the 2014 Iquique earthquake. Along lines 23 and 25, the plate-boundary shows up as a high amplitude reflection, similar to line 04, along the first 35 km and 40 km, respectively.

Correlation between reflectivity and rupture

A fundamental observation from our seismic reflection study is the spatial correlation between the reflection character of the plate boundary and the rupture pattern of the 2014 Iquique earthquake. In the region of the earthquake, a high amplitude reversed polarity reflection, observed in all seismic lines, thoroughly outlines the shallow plate boundary and may be related to a high porosity, fluid rich environment. This most updip section of the plate boundary did not rupture during the 2014 Iquique earthquake and did not host significant numbers of aftershocks (Fig. 1). This may be related to changes in fluid pressure. Dehydration of weathered clay bearing basalts at temperatures between 60°-150°C [3] will facilitate a fluid-rich and aseismic shallow plate boundary.

Fig. 3 Comparing line 04 (a) with lines 23 (b) and 25 (c), we notice that the vertical displacement induced by bending related normal faults in the oceanic plate is smaller in line 04 than in lines 23 and 25 (orange and blue polygon). This may lead to a delayed (reduced) vertical flow of pore-fluids from the oceanic-basement towards the plate-boundary along line 04. This implies that while along lines 23 and 25, fluids are expelled from the oceanic basement at relatively shallow depth along the plate-boundary (i.e. under the outermost wedge) they are subducted to larger depths along line 04.

Fluids along the plate-boundary