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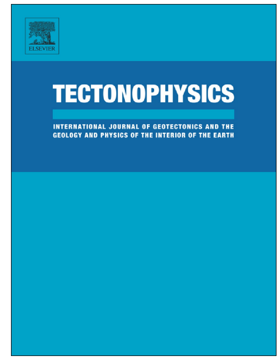

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Crustal model of the Southern Central Andes derived from ambient seismic noise Rayleigh-wave tomography

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Abstract

The distribution and the interconnection of magmatic bodies beneath volcanic arcs is key to asses volcanic hazard and eruptive processes taking place at convergent margins. We use ambient seismic noise Rayleigh-wave tomography to investigate the three-dimensional shear-wave crustal velocity structure of the Southern Central Andes between latitudes 33°S and 38°S (for the upper 30 km). We investigate the occurrence of magmatic reservoirs in the upper crust and show how their geometry is affected by local tectonics. The first prominent feature to be observed is the shear-wave velocity contrast between the volcanic arc and the faster fore-arc region. We further identify areas of low shear-wave velocity from 3 km to 10 km depth beneath the volcanic arc, striking N-S, that we interpret as zones of fluid-rich crust, possibly characterised by confined regions of partial melts.

Our results allow us to derive a model for the crustal structure of the Southern Central Andes. We propose that partial melts, marked by lower shear-wave velocity anomalies, are connected to shallower structural levels and reservoirs by brittle regions where dikes and exsolved fluids may propagate.

Keywords: volcanic arc, magmatic reservoirs, ambient noise, tomography

1. Introduction

In the southern part of central Chile the Nazca plate subduces obliquely with an average velocity of approximately 66 mm/yr beneath the South American plate (Fig. 1). This causes the development of a volcanic arc (herein Southern Central Andes - SCA) sub-parallel to the subduction trench between latitudes 33°S and 46°S. The region is affected by frequent large-magnitude earthquakes (e.g. M_w8.5 Concepción 1835, M_w8.2 Valparaiso 1906, M_w8.3 Talca 1928, M_w8.3 Chillán 1939, M_w9.5 Valdivia 1960, M_w8.8 Maule 2010) that may promote transient extensional faulting in the forearc (Ryder et al., 2012) and cause short-lived tectonic regimes in the volcanic arc (Lupi et al., 2014). This may lead to enhanced vertical migration of deep-seated fluids within the upper crust (Farías et al., 2011; Ryder et al., 2012; Pritchard et al., 2013; Lupi and Miller, 2014). Several seismic experiments have been conducted onshore and offshore Chile to shed light on the morphology of the subduction interface and the deformation of the overriding plate (Rietbrock et al., 2007; Groß et al., 2008; Haberland et al., 2009). Bohm et al. (2002) deployed 62 seismic stations from 36°S to 40°S to investigate the velocity structure of the upper lithosphere. Yuan et al. (2006) determined the crustal thickness beneath the volcanic arc (about 40 km) and Ward et al. (2013) performed

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