The northern Chilean margin has been long recognized as dominated by subduction erosion [e.g. Kulm et al., 1977; von Huene and Lallemand, 1990]. Tectonic erosion has been active here since the late Jurassic, as inferred from the progressive eastward migration of the volcanic arc during the past ~140 m.y. [e.g. Rutland, 1971]. The Jurassic arc crops out along the coastal areas and the location of the current arc indicates a total eastward migration of ~200 km. I In this work, we have used data from profile SO104-401 recorded with 15 OBHs (IFM-GEOMAR) and 4 PDAS land stations (GFZ-Postdam) deployed along a ~225 km-long transect extending from the outer rise of the oceanic plate to the western segment of the emerged forearc, across the trench axis and continental slope, together with coincident marine gravity data to obtain the velocity and density structure of the margin offshore Antofagasta (23.5° S). The geophysical models are used to infer the nature of the margin rocks, their porosity and the fluid distribution. The distribution of physical properties has been integrated with the tectonic structure from coincident seismic reflection images [von Huene and Ranero, 2003] to investigate how material properties and fluid distribution influence subduction erosion processes and the long-term tectonic evolution of the margin. Furthermore, changes in physical properties with depth are found to correlate with the transition along the plate boundary from aseismic creep to the stick-slip behaviour of the seismogenic zone defined by the aftershocks of the 1995 Antofagasta Mw 8.0 earthquake [Husen et al., 1999].

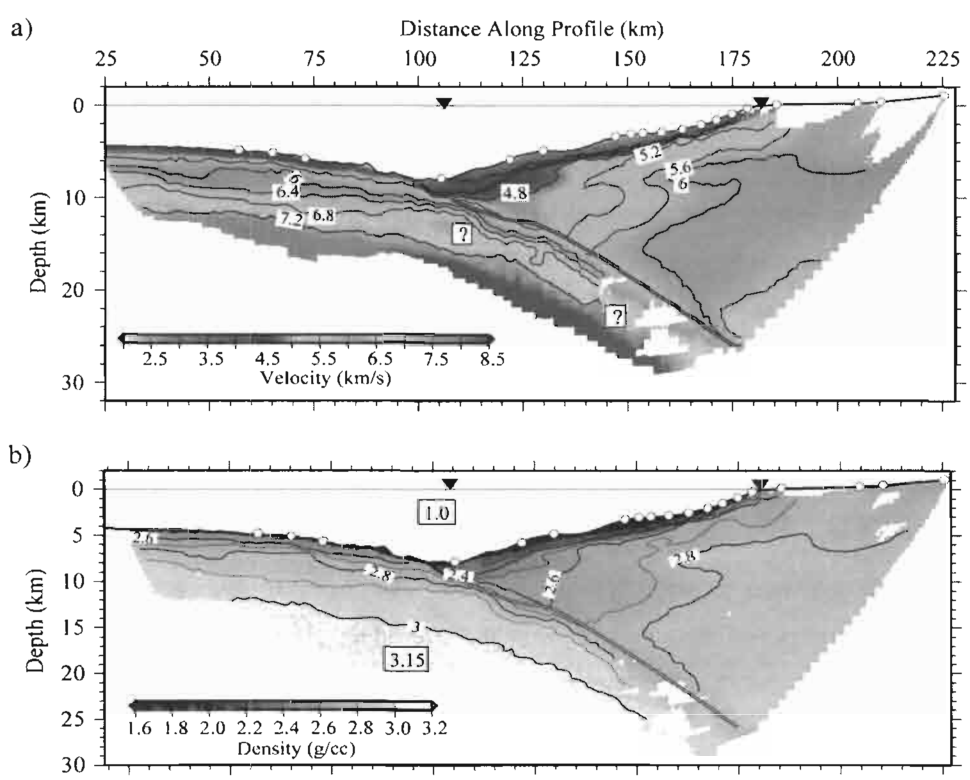

Figure 1.- (a) Final velocity model with isovelocity contours. Thick white line shows location of the inter-plate boundary. White circles indicate OBH and landstations locations. Arrows show the location of the trench and the coast line. (b) Density model along the transect derived from the velocity model displayed in panel a. Arrows show the location of the trench and the coast line.

Results

The velocity and density structure of the margin (Figure 1) indicate that the margin is mainly formed by igneous rocks representing a probably pre-Jurassic magmatic arc, composed by two rock bodies undergoing different deformation styles [Sallarès and Ranero, 2005]. The comparison of the velocity structure with pre-stack depth migrated images shows the correspondence of the main seismic boundaries detected with the two methods and the relation between tectonic structure and velocity distribution (Figure 2). The velocity model displays a well-defined low-velocity zone few km beneath the top of the basement that extends from beneath the coastal area to the middle slope, whose top corresponds to a subhorizontal event in the seismic reflection images, interpreted as a detachment surface where block-bounding faults cutting from the seafloor into the upper plate sole out (Figure 3). The detachment at the top of the low-velocity zone could represent either a rheological boundary formed along a pre-faulting contact between two rock bodies of different nature or a zone of low strength related to the presence of permeating fluids expelled from the subduction channel, a process previously inferred from temporal variations of P-wave to S-wave ratio following the 1995 Antofagasta earthquake [Husen and Kissling, 2001]. Expelled fluids may gradually collect beneath the detachment to form a low-velocity zone. Above the detachment, the size of fault-bounded basement blocks and the fault spacing decreases seaward, indicating progressively increasing extension, thinning and dismembering of the upper plate.

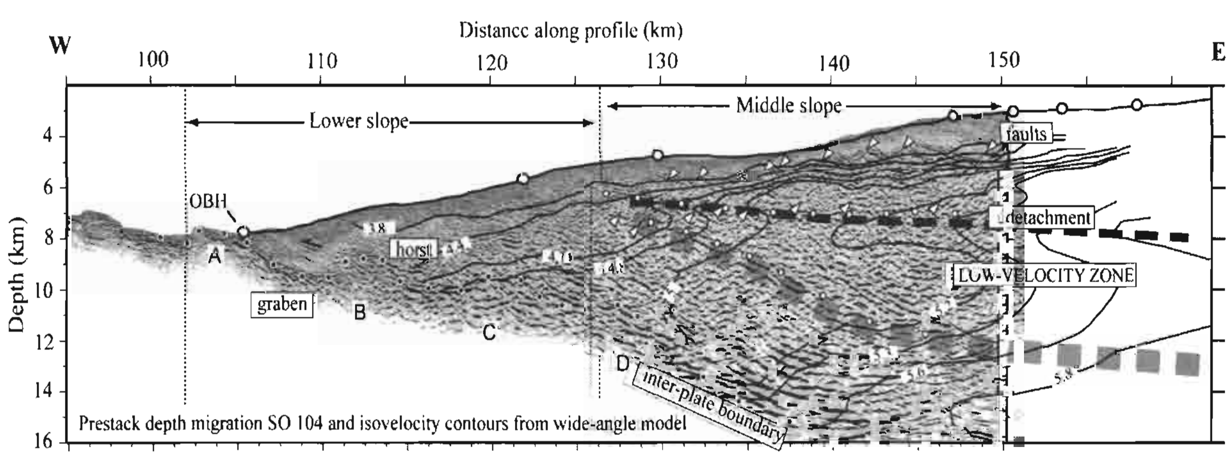

Figure 2.- Pre-stack depth migration image with tectonic interpretation superimposed with wide-angle velocity model shown as selected isovelocity contours. White dots show intra-basement detachment and a landward-dipping reflection at the base of the low-velocity zone. Arrows display block-bounding faults cutting from the seafloor into the upper plate. Black dots delineate the top of the subducting plate. Capital letters correspond to subducting horsts. Dashed lines correspond to the bounds of the low-velocity zone.

A velocity-derived porosity model shows that the upper part of the overriding plate, as well as the frontal part of the margin, are probably made of highly disaggregated and fluid-saturated material. Consistently, seismic images show that the frontal ~20 km of the overriding plate seem to be highly disrupted with pervasive deformation distributed across the plate rather than localized on individual large faults. Also, this frontal area displays along the ~200 km covered by multibeam bathymetry a series of low ridges and valleys that parallel the trend of subducting horst and graben topography of the oceanic plate. This morphological mimicking supports that the upper plate material lacks strength riffling over the subducting topography. The margin front is sufficiently thin to fracture and disaggregate due to repeated thrusting over subducting horsts and subsequent