Geophysical Research Abstracts, Vol. 7, 02411, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02411

Structure and tectonics of the erosional convergent margin offshore Antofagasta, North Chile

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Subduction erosion has dominated the evolution of the north Chile convergent continental margin since at least the Mesozoic. We investigate the structure of the Antofagasta sector of this margin (23° S) using coincident wide-angle and near-vertical seismic profiling and gravity data collected along a geophysical transect. A 2-D velocity model together with the inter-plate geometry has been obtained using joint refraction and reflection travel time tomography. A velocity-derived density distribution was used to model marine gravity data and substantiate the velocity model. Gravity and velocity models support that the overriding plate of the margin is mainly made of arc-type igneous basement. The upper plate is made of two main rock-bodies separated by a subhorizontal body (˜7-9 km deep) defined by a velocity inversion, the top coincident with a prominent reflection in near-vertical seismic images. The seismic boundary is interpreted as a detachment separating an upper extended domain with large-scale normal faulting from a lower domain apparently undergoing a different type of deformation. Velocity-derived porosity indicates that the front of the margin is probably disaggregated and water-saturated favoring frontal erosion. Fluids carried into the subduction channel within slope debris filling subducted grabens reduce basal friction and probably induce hydrofracturing and basal erosion along the underside of the overriding plate. At depth greater than ˜24 km porosity values indicate that most fluids have been exhausted and that the upper plate is structurally coherent and little fractured. This change in physical properties leads to increased mechanical coupling along the plate boundary and is coincident with the aftershock sequence of the 1995 Antofagasta earthquake (Mw=8.0), indicating that it may be ruptured during great earthquakes.