Geotechnical characterization of trench- and slope sediments off Southern Chile: preliminary results *Vortrag*

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Introduction

To understand seismogenesis in shallow parts of subduction zones, it is vital to know about strength and frictional parameters of subducted sediment. For this purpose, PETROTEC, as part of the TIPTEQ-Project, gathers geotechnical data for sediments deposited on the incoming Nazca Plate, the trench and the slope off the southern Chilean coast during the last 5 Ma, and whose equivalents are now being underthrusted into the seismogenic zone beneath South America (Fig. 1).

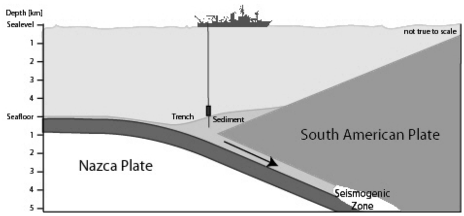

Figure 1: Principle of sampling the southern Chile Trench for geotechnical purposes.

Material comes from gravity cores collected during R/V SONNE Cruises SO181 (Flüh E.& Grevemeyer I (Editors) 2005), SO102 (Hebbeln D, Wefer G, et al. 1995) and SO156 (Hebbeln D, et al. 2001), as well as from ODP Leg 141 (Behrmann, JH et al. 1992) drill cores (Fig. 2).

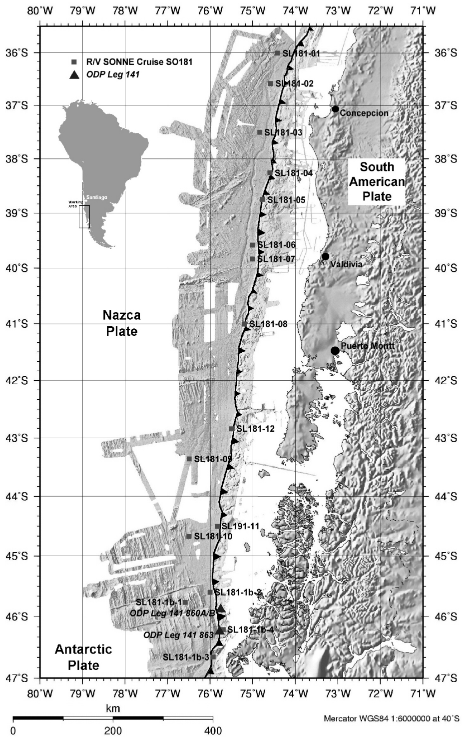

Figure 2: Swath bathymetric map of the southern Chile Trench between 36°S and 47°S, after Flüh E & Grevemeyer I (Eds) (2005), with gravity core sampling localities, and ODP Leg 141 drill sites.

Sediment strength and frictional properties are determined by triaxial testing, ring shear testing and direct shear testing.

First results from triaxial testing show that Young's moduli are much lower (3–20 kPa) in comparison to diatom-rich muds from equivalent depths in the Japan Trench area (180–240 kPa; Roller et al 2003). Internal angles of friction from ring shear testing, direct shear testing, and triaxial testing yielded coherent results. Values from ring shear testing differ depending on material, normal stress and shear velocity, and

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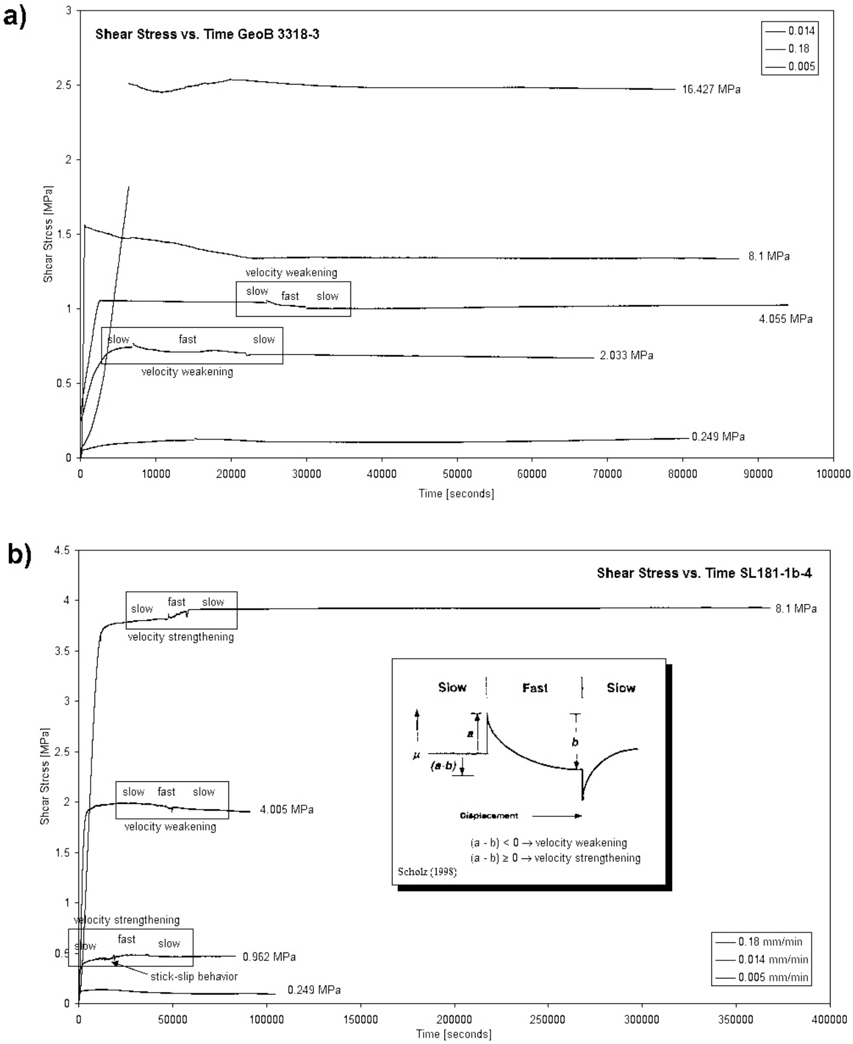

Figure 3: Shear stress *vs.* time diagrams, derived from ring shear testing, showing the rate- and state-variable friction law (Box after Scholz (1998)).

vary from 9° to 34°. With increasing shear velocity, there is at first a decrease of the internal angle of friction, followed by an increase. Values from direct shear testing range up to 27° and angles of friction determined from triaxial testing show values of about 10° to 20°.

Results from ring shear testing show compliance to the rate- and state-variable friction law as described by Scholz (1998). Fig. 3 shows two examples of shear stress *vs.* time diagrams. In diagram a), the material shows velocity weakening behaviour at low normal stress (up to 4 MPa). Material from another specimen shown in diagram b), however, shows velocity strengthening behaviour at low (1 MPa) and high (8 MPa) normal stress, but velocity weakening behaviour at intermediate normal stress values (4 MPa). Preliminary data show no pattern or a connection between velocity weakening/strengthening behaviour and different normal stress values. Stick-slip behaviour is observed at high shear velocities, not depending on normal stress (Fig. 3b).

In addition to sediment strength properties, permeabilities were determined on the basis of consolidation data during triaxial testing. Values range from 1.0953×10^{-8} to $8.7 \times 10^{-10}\,\mathrm{m\,s^{-1}}$. Average permeability is $10^{-9}\,\mathrm{m\,s^{-1}}$, an expected value for marine clays to silts.

We discuss possibilities to extrapolate laboratory data (up to 40 MPa effective stress, equivalent to 1.5 km depth) to upper seismogenic zone conditions (equivalent to 100–150 MPa effective stress).

Results so far raise questions: what causes different velocity strengthening/weakening behaviour at varying normal stress values and in which way is seismogenesis affected?

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