INTRODUCTION

Convergent continental margins are the Earth's principal locus of important earthquake hazards. Some 90% of global seismicity and nearly all interplate megathrust earthquakes with magnitudes >8 occur in the seismogenic coupling zone between the converging plates. Despite the societal, economic, and scientific importance associated with the coupling zone, the processes that shape it and its relation to surface deformation are poorly understood. Seismogenic coupling zones occupy a limited depth range of convergent plate interfaces between 5 to 10 km depth at the updip end and 30 to 60 km at the downdip end (e.g. Tichelaar & Ruff 1993). The location of rupture nucleation and the distribution of slip are probably mainly constrained by stronger asperities or a variation of the material state that control the strength of the otherwise rather weak coupling zone and subduction channel (Ruff 1999, Pacheco et al. 1993). The related extent and degree of seismic coupling plays a major role in the generation mechanism of great interplate earthquakes (e.g. Hyndman & Wang, 1993).

The vision of our integrated study is a quantitative understanding of megathrust earthquake seismicity in subduction zones and its relation to processes at depth and at the surface. We have started with a series of experiments in the area of the 1960 Southern Chile earthquake that are designed to image the processes operating at the seismogenic plate interface and their effect for surface deformation. These experiments – the first integrated marine experiment (SPOC: Subduction Processes Off Chile) completed in early 2002 - are planned in national and international cooperation within the scope of the SALT project (South American Lithospheric Transect) under the auspices of the ILP program. A series of field and lab studies will (1) image a complete seismogenic plate interface from the updip to below the downdip end, in order to (2) yield key petrophysical and mechanical properties. We will also (3) test the variation of properties along different segments of a plate interface which are at different stages of the seismic rupture cycle, and (4) observe and model the surface response to seismic rupture and
identify the controls of hazard distribution. Here, we report first results of project SPOC (Subduction Processes Off Chile) and the scope of future plans within project IMTEQ (Interplate MegaThrust Earthquake Processes).

The southern Chilean convergent margin provides a first test site and natural laboratory for our studies. Here, the largest instrumentally recorded earthquake occurred in 1960 (Mw = 9.5). It ruptured the margin starting at 38°S at a hypocentral depth of some 30 km below the continental forearc towards the south for approximately 1000 km (Cifuentes 1989) with a coseismic slip of up to 40 m, up to 2 m vertical displacement and a tsunami up to 15 m high that affected the entire Pacific (Kanamori & Cipar 1974, Plafker & Savage 1970). Recent GPS data reveal this part of the upper plate to still be in the post-seismic relaxation stage. The unusual width of the seismogenic coupling zone in this area with a downdip end well inland allows observation of this part of the plate interface with onshore based experiments, while most of the ruptured surface is situated beneath the offshore forearc (Diaz Naveaz 1999).

**EXPERIMENT SETUP**

The first component of the study, the ship-borne integrated geophysical experiment SPOC with R/V SONNE, took place in fall and winter 2001/2002 (operated by The Federal Institute for Geosciences and Natural Resources, in cooperation with GEOMAR and the Berlin-Potsdam Andes research group, SFB 267). It will yield a near 3D image of the offshore forearc including the updip parts of the seismogenic coupling zone of the great 1960 Chile-earthquake segment and the seismic gap segment to the north (Reichert & SPOC Scientific Shipboard Party, 2002). The offshore profiles reveal that the slope area in the region is overprinted by a faint lineation pattern with a dominant azimuth of some 120 degrees correlating with onshore structures. The upper plate is split into many segments with pronounced forearc basins and strikingly narrow accretionary wedges. The relatively thick trench fill of up to more than 2,000 m seems to be subducted through a thick subduction channel, thereby suggesting a non-accretionary subduction mode here.

Between 36° and 39° S, a combined onshore-offshore, active-passive seismic experiment was carried out linking the marine profiles to the subduction features observed onshore. It comprised: (1) a 3D-wide angle reflection/refraction component simultaneously recording the airgun pulses from the R/V SONNE with 32 3-component stations deployed in an array and 50 stations along 3 W-E profiles; (2) recording of explosive shots fired at the ends of the three profiles; and (3) an additional pilot seismic reflection experiment covering the coastal onshore-offshore transition at the southern E-W line in order to provide a complete link between the offshore dataset and the landbased experiments with the first complete high resolution coverage of an entire seismogenic plate interface (see also Lüth et al., Stiller et al., this volume).

**RESULTS**

The first results from the near-vertical incidence reflection (NVR) seismic experiment component (located at 37° 15’S) yields an image of the part of the subduction zone between the S-America and Nazca-Plate that is located in the offshore-onshore transition zone. The 54 km long line recorded the offshore profile shot by the R/V SONNE with the airgun array and a series of shots in the Pacific Ocean, and on land resulting in a 45 km long 2-fold CDP line, and a single-fold coverage along 72 km profile length. The data processing gives an image of different
reflection bands in the upper and middle crust. On the entire profile, a c. 2-km-thick strong reflection band is observed between 5 and 10 km depth, which shows almost no dip. On the western half of the profile, prominent reflections dip eastward from c. 15 km down to c. 30 km depth. Finally, in the central part of the seismic reflection profile, some relatively weaker reflections are found between 30 to 45 km depth (SPOC Research Group (onshore), 2003).

Those reflections found between 16-42 km correlate with Wadati-Benioff seismicity and are interpreted as imaging the top of the downgoing plate. In the central part of the profile, a break in reflectivity located below the axis of the coastal cordillera coincides with the intersection between oceanic plate and continental Moho, and also correlates with the downdip end of the seismogenic plate interface defined by geodetic modelling. These new seismic data provide the geometry of the subduction zone in the area, and hence we suggest the relocation of the 1960 Chile earthquake at 73°05’ W.

The SPOC Working Group (onshore)
M. Araneda ¹, K. Bataille ², J. Bribach ³, A. Cser ⁴, C.M. Krawczyk ³, S. Lüth ⁵, S. Martin ⁶, J. Mechie ³, L. Rabenstein ⁴, W. Schnurr ⁵, M. Stiller ³, P. Wigger ⁵
¹ SEGMI (Santiago, Chile)
² Universidad de Concepcion (Concepcion, Chile)
³ GeoForschungsZentrum Potsdam (Germany)
⁴ Universidad de Concepcion (Los Angeles, Chile)
⁵ Free University Berlin (Germany)
⁶ Potsdam University (Germany)

REFERENCES