Turbiditic cover of Southern Chilean seamounts: remnants of “giant uphill” turbidity currents

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Abstract: Two sediment cores taken from top and flanks of a pair of isolated seamounts located within the Chilean Trench suggest that the structures were periodically overwhelmed by very large turbidity currents, capable of transporting medium-grained sand 200-300 m above the seafloor.

The generation of large, powerful turbidity currents in the Chilean trench is favoured by the steepness of the continental rise and slope, the high sediment load of rivers draining the Southern Andes, the concentration of downslope momentum by few large canyons and high regional seismicity.

Grain size distribution of the turbidite layers, provenance of the mineral assemblage and microfossil remains are used to understand pathways ot these “superturbidites”. The detailed bathymetry can be used to model the flow numerically in order to get an understanding of their size and energy.

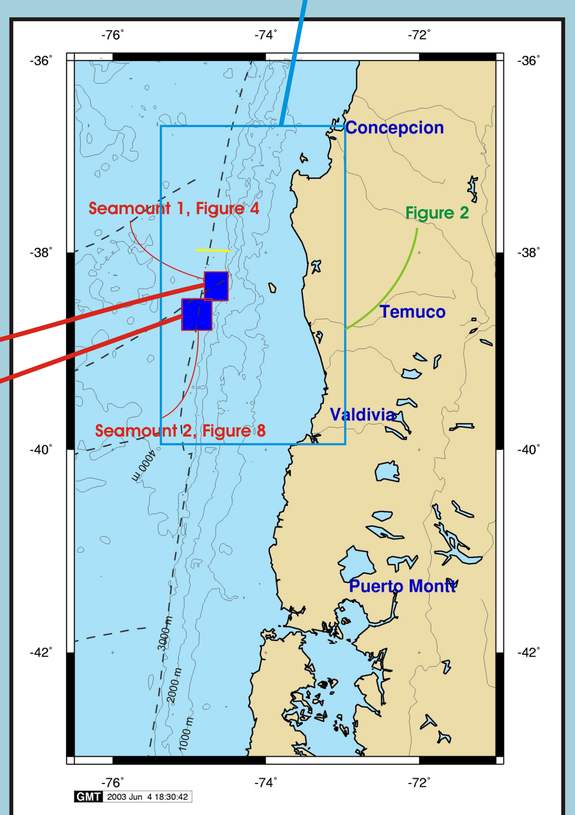


Figure 1: General bathymetry offshore Southern Chile. The detail maps of the seamounts (figs. 4 & 8) are indicated as blue boxes.

Introduction:

Two unnamed seamounts, located in the sediment-filled Chilean Trench were targets of a sediment sampling programme of SONNE cruise 161-5 (figure 1). The structures rise 300 m and 200 m, respectively, from the generally flat seafloor at a water depth of 4500 m. The distance from the bathymetric base of the lower continental slope of Chile is 15 and 25 km.

The examination of gravity cores from these seamounts showed several turbidite layers (see figures 4,5,7 & 9,10). While the bulk of the core consists of grey-green, monotonous, subtly laminated hemipelagic clays, several cm-thick beds of clay-free, black, graded medium-to fine-grained sand of mafic provenance occur (figs. 6). We interpret these layers as thin Tb(c) deposits representing turbidity-current-conveyed shoreline deposits of the Southern Chile shelf.

The elevation of the coring sites and the position of the seamounts suggest, that turbidite currents dropped from the continental margin, washed across the abyssal plain and still had enough momentum to climb the seamounts.

Within the Chile Trench the sediment cover is incised by an 8 km-wide, 170 m-deep erosive channel which serves as a pathway for the northward transport of sediments. This channel provides a likely pathway for turbidity currents, which therefore may come from further south.

Numerical modelling will be applied to estimate frequency and size of the events resulting in the observed sediment pattern. The simulation of the sedimentation process will be done with the program SEDSIM of Tetzlaff & Harbaugh.

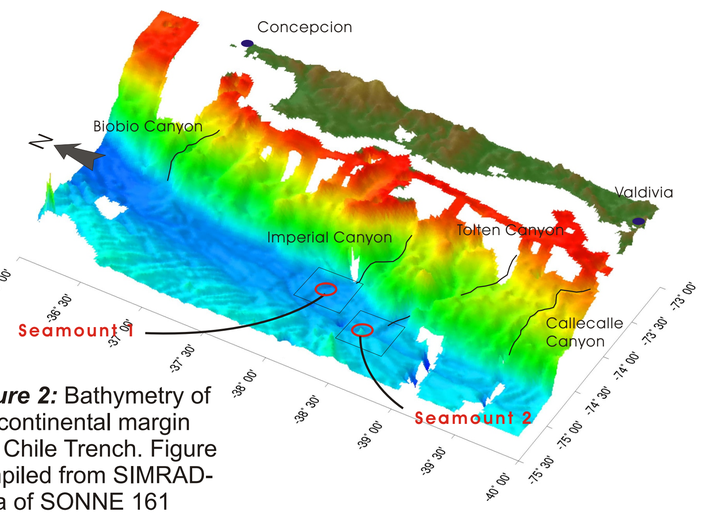


Figure 2: Bathymetry of the continental margin and Chile Trench. Figure compiled from SIMRAD-Data of SONNE 161 cruises. Dots show location of seamounts.

Seamount 1 (gravity core SI050)

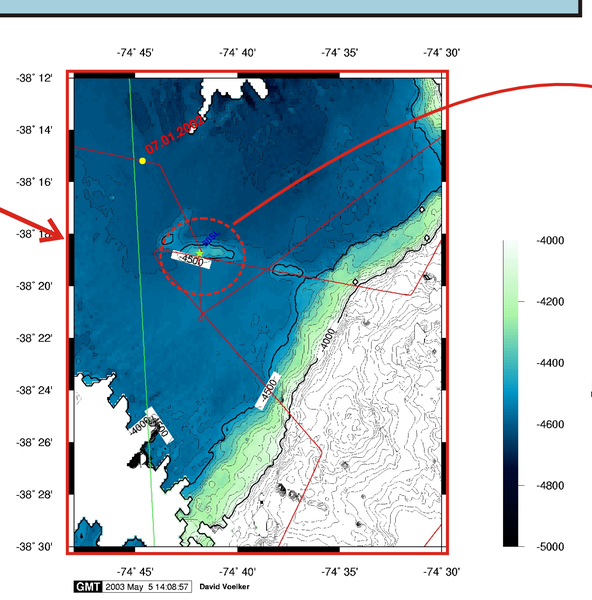


Figure 3: Detailed bathymetry of seamount 1 area and location of gravity core SI050 from SONNE cruise

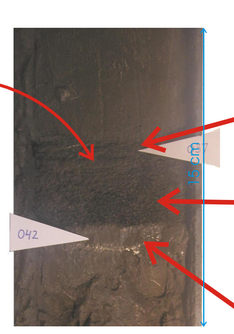


Figure 4: Image of gravity core SI050, showing turbiditic section.

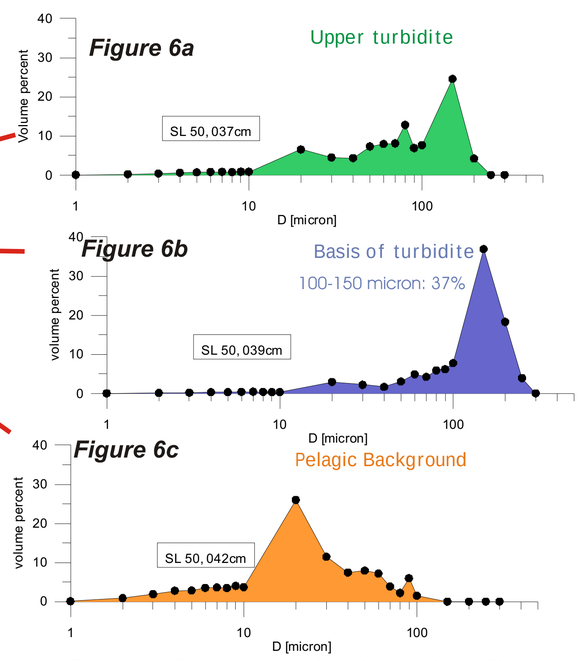


Figure 5: Grain size distribution of turbiditic layer of gravity core SI050 (LPS measurement)

Turbidite Layer on Seamount 1

Seamount 1 rises 200 m from the surrounding flat, turbidite filled floor of the Peru-Chile Trench (Figs. 2, 3).

Gravity core SI 050 was recovered on top of the seamount in 4380 m water depth.

The basal part of the turbidite layer is composed of **37% of particles within the fraction of 100 to 150 micron** (Fig. 5b). It is therefore easily identified in contrast to the normal pelagic background sedimentation which has a grain size distribution with a maximum around 20 micron (Fig 5c).

The mineral composition of the coarse fraction of the turbidite layer is dominated by siltstones containing volcanic rock fragments (80%).

The coarse fraction contains shells of benthic and planctonic Foraminifera, as well as remains of Echinodermata and Bryozoa (Figure 6).

The benthic Foraminifera represent different habitats and depth ranges. The majority of the species are indicative of low oxygen conditions and are typical dwellers of the oxygen minimum zone. **Thus, we can constrain the depth range of the origin of the turbidites to a depth of less than 400 m**

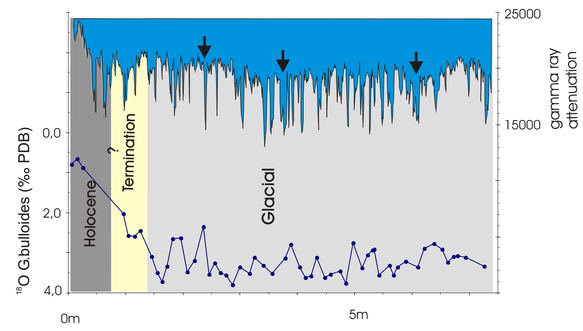
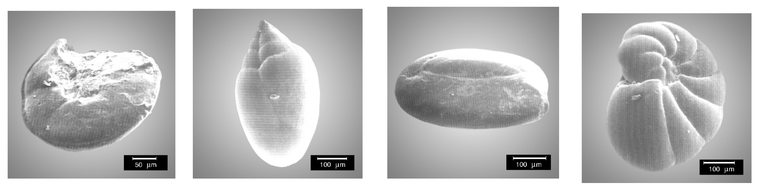


Figure 7: Oxygen isotope stratigraphy indicates a very limited Holocene sequence with hardly any turbiditic beds. Most of the core represents turbiditic sedimentation of the last Glacial.

Figure 6: Benthic species of Foraminifera within basal turbiditic layer of gravity core SI050. Species are listed in the textbox to the right



left to right:
- Cassidulina Carinata (suboxic)
- Buliminia Elongata (suboxic)
- Quinceloculina (suboxic)
- Norion Labradoricum (anoxic)

Seamount 2 (gravity core SL101)

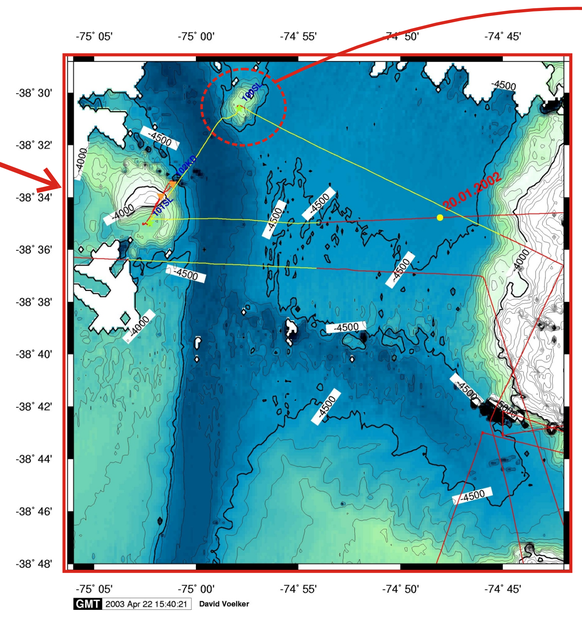


Figure 8: Detailed bathymetry of seamount 2 area from SONNE cruises

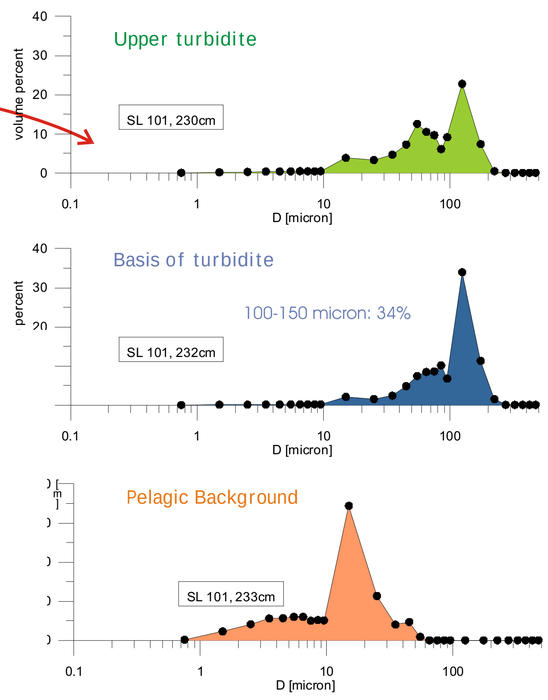


Figure 9: Grain size distribution of turbiditic layer of gravity core SI101 (LPS measurement)

Turbidite Layer on Seamount 2

Seamount 2 rises 300 m from the surrounding flat, turbidite filled floor of the Peru-Chile Trench (Figs. 2 and 8). A deep channel, which was created by the northward transport of sediments winds around the its foot. Some km to the South (upstream), a feeder channel of the Tolten Canyon joins the central channel (Fig. 8).

Gravity core SI 101 was recovered on top of the seamount 2 in 4298 m water depth.

The basal part of the turbidite layer is composed of 34% of particles within the fraction of 100 to 150 micron (Fig. 9b). It is therefore easily identified in contrast to the normal pelagic background sedimentation which has a grain size distribution with a maximum around 20 micron (Fig 9c).

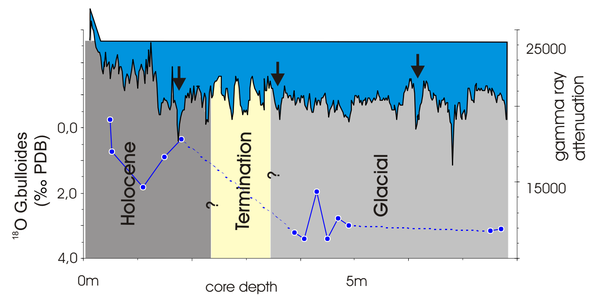


Figure 10: Despite the topographic position of the core the sedimentary record contains numerous turbiditic layers as shown in the gamma ray attenuation curve (minima indicate more dense coarser grained layers). According to the Oxygen isotope record most of the 8 m long section was deposited during the last Glacial; only the topmost 2 m stratigraphically belong to the Holocene.