

## The influence of ridge subduction on the geodynamics of the Southern Chile Trench.

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### Resumen

El Chile Margin Triple Junction es el unico ejemplo actuales de la subduccion de un centro de propogacion activo. Datos seimological y gravitacional habian usado para investigar el neotectonics de la region. Terremotos de la region no tienen un origen de empujon encambio la majoria son normal. La gravedad exhibe un baja encima de la posicion del centro de propogacion cual desaparecio hacia 3 Ma.

Key words: Chile Margin Triple Junction, Seismicity, Gravity, Slab Window.

### Introduction

The Chile Margin triple junction at  $46^{\circ}30'S$   $75^{\circ}45'S$ , is the only current example of the subduction of an active spreading centre beneath a continental plate. This situation has been recognised as having occurred all around the Pacific during the past 200My (Cande & Lewis, Stauder 1973). The main aim of the project is to investigate how the geodynamic processes of plate creation and destruction are modified when a ridge and a trench converge. If the extensional processes associated with seafloor spreading continue after subduction, what are the geological manifestations of this on the upper plate and if at some stage the spreading should cease, how are the differing motions of the Nazca and Antarctic plates accommodated.

### Seismological Objectives

The seismicity associated with the normal subduction of the Nazca plate is well known and the shallow seismicity associated with the Chile Ridge spreading axis can be traced into the Trench. However, the seismicity of the area around the Triple Junction is noticeably reduced. There is a decrease in the number of events recorded south of the Triple junction in comparison to the north. This has been attributed to the young age, and the shallow and slower subduction of the Antarctic Plate which may be of limited extent in this area (Stauder 1973).

We hope to assess the seismicity of the slab as it enters the trench and from a study of the focal mechanisms distinguish it from transcurrent motions produced by slip on the transform fault. Most of the Taitao Ridge is still exposed and expected to be seismically active. If so, further work could establish whether the Tres Montes and Esmarelda Ridges which are further inland are also still active and may be located by upper plate seismicity.

The detection threshold for teleseismic data from the region is about  $M=4$  and the apparent lack of seismicity may partly reflect this. So a local microseismic network of ten three-component digitally recorded

stations was set up in Region XI of Southern Chile. Data were collected over a four month period.

### Gravity Aims

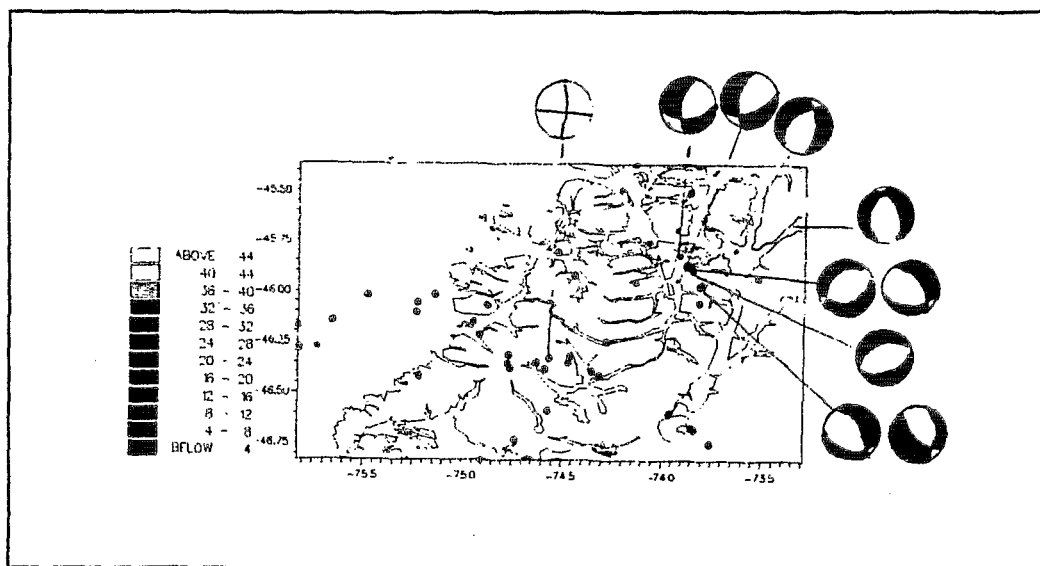
The pre-existing gravity data were mostly marine with very few terrestrial data points. Gravity lows are associated with the trench, Chile Rise and major fracture zones. On land a regional east-west gradient decreases towards the east. Estimates based on the thermal and bathymetric contrasts between differing age oceanic crust across the transform fault suggest that the Taitao Fracture Zone would give at least a 1 mgal Bouguer anomaly at a depth of 20km and distance from the trench of 50 km. It is hoped that a detailed gravity survey will show the anomalies associated with previously subducted ridge segments and transform faults and their relationship to current volcanism and the predicted slab window.

Several base stations were set up in the area on the mainland from where surveys were conducted over as much of the region as possible. 430 new gravity observations were made.

### Seismological Findings

Micro-earthquakes were occurring at a rate of about three a day. The epicentral locations show two linear trends both running WSW-ENE. (fig 1) The more southerly of these lineations lies along the expected location of the Tres Montes Fracture Zone. The more northerly lineation lies along the trend of the Taitao fracture zone indicating that the fracture zones are continuing to be active even though they have entered the subduction zone. It is interesting to note that no activity was recorded from south of the Taitao region confirming that the apparent lack of seismicity associated with the subduction of the Antarctic Plate from ISC data is in fact real.

It is of note that most of the events recorded display very simple seismic signatures. Most show only P and S-wave phases. The high quality, low-noise, three-component, digital data enables us to use the Gaussian Relative Amplitude Method (GRAM) developed by Rogers and Pearce (1989) to deduce focal mechanisms. Out of the ten focal mechanisms obtained, nine of them showed normal faulting with one strike slip event. There were no thrust mechanisms that are usually associated with subduction zones. This is probably due to the subduction of young crust with a low rigidity. The normal mechanisms are probably a product of the northwards motion of the Chiloe Block in relation to the main continental plate along the Liquini Ofqui Fault.

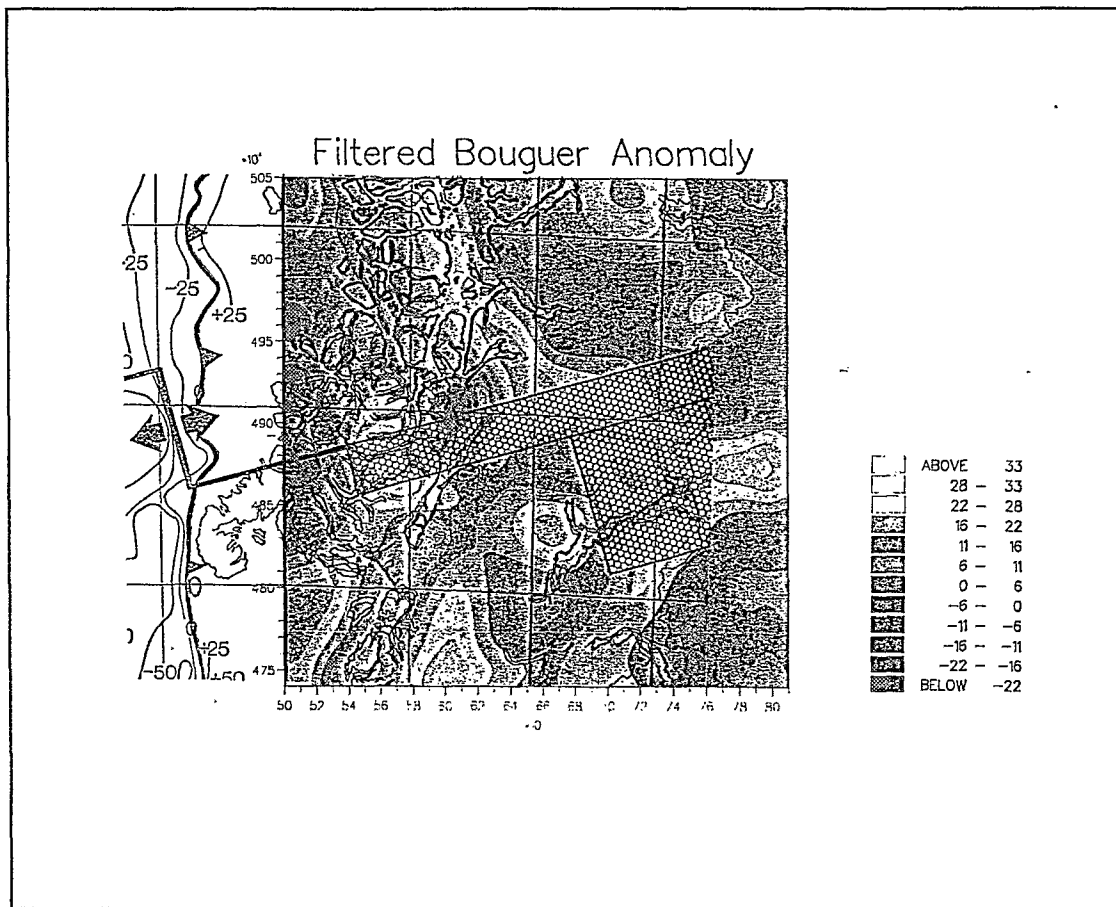


**Figure 1** Seismicity and source mechanisms for events detected on the microseismic network from the Taitao region.

Gravity Findings

Figure 2 shows a band-pass filtered Bouguer anomaly map of Region XI. which has had the regional trend removed and then been filtered to remove the high frequency content. . The map shows that the main feature is a Y-shaped, negative anomaly of amplitude -22 mgal which lies along the Golfo Elefantes, crosses perpendicular to the Andes and then strikes eastward for approximately 100 km up the Rio Ibanez, toward the Argentinian border. The north-south trending arm of the low appears to be related to the Liquifi Ofqui transcurrent fault which appears to have been produced to accommodate the differential movements between the plates north and south of the Triple Junction. The low along the Ibanez valley corresponds fairly well to the position of the postulated window in the subducted slab which has opened up due to the differing subduction rates of the Nazca and Antarctic plates as suggested by Ramos and Kay (1992).

The Power spectrum of the Bouguer anomaly show linear segments with a slope indicating spectral estimates of the depths to the causative density contrast of about 70km. If we take the angle of subduction to be 15°, the top of the subducted slab would lie at a depth of 53km. It therefore seems possible that this contrast is related to thermally-derived density differences across the Lithosphere/Asthenosphere boundary at the base of the subducted slab. The gravity anomaly observed is an order of magnitude larger than initial estimates based simply on the effect of a simple subducted ridge. This appears to imply the emplacement of a significant volume of low-density material possibly as an asthenospheric upwelling beneath this region.



**Figure 2** Filtered Bouguer Anomaly map of the Taitao region with the position of the proposed slab window of Ramos and Kay (1992).

### Conclusions

This area is definitely shows seismic activity with the majority of events having normal source mechanisms These are probably related to the Liquini Ofqui Fault which is moving the Chiloe Block northwards in relation to the rest of the continent. The gravity data shows the postulated current position of the Tres Montes Ridge segment and the size of the Bouguer indicates that there has been an injection of a low density material in the region.

### References

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