1 INTRODUCTION

During the 20th century, the first major discoveries about the Earth's interior were made and the plate tectonic theory was developed. More recently, due to extensive research at plate boundaries and thanks to sophisticated and developed technologies, our knowledge about the Earth's interior has significantly improved.

In early 1993, the SFB 267 – Collaborative Research Program “Deformation Processes in the Andes”, funded by the Deutsche ForschungsGemeinschaft, Free University Berlin, GeoForschungsZentrum, Technical University Berlin and University of Potsdam started its scientific activity and has subsequently contributed a great deal to studies of one specific type of plate boundary. This program has run for 12 years and its motivation was to provide insight into the internationally discussed issues related to orogeny in general, but particularly to the Andean convergent margin orogen.

The first two periods of the program were devoted to data collection in the Central Andes at 20–25°S, mainly geophysical and geodetic data, complemented by geological studies. Here, the Western and Eastern Cordilleras confine a 4000 m high plateau, the Altiplano/Puna, which is the second largest in the world. This plateau is a result of the uplift of the central Andean cordillera during the Cenozoic.

The acquisition and processing of gravity data in the framework of the MIGRA campaigns (Mediciones Internacionales de GRavedad en los Andes) was an ongoing task of the gravity group at the FUB, together with the Universidad de Chile in Santiago, Universidad Católica del Norte in Antofagasta, Universidad Nacional de Tucumán and Universidad Nacional de La Plata. Industry data from SERNAGEOMIN (Servicio Nacional de Geologia i Mineria), Empressa Nacional del Petroleo (ENAP), Yacimientos Petroliferos Fiscales (YPF), and CODELCO were also acquired under agreement. The large gravity database comprises tens-of-thousands of stations, especially in the Central Andes.

The Andean mountain belt is characterized by extreme along-strike variations, creating segments variable in width and altitude, climate, age and other properties of the subducting oceanic plate. This segmentation of the western South

American margin is the subject of extensive international research. Therefore, to observe the variations of the Andean mountain belt, a second study area was chosen by the SFB 267 in the Southern Andes at 36–42°S (Figure 1.1). This area, where the largest earthquake was ever recorded in 1960, is characterized by low topography, a narrow volcanic arc and no plateau. The Nazca plate being subducted in the south is younger and seismically less active than in the Central Andes but its dip angle, obliquity, and velocity are similar. The climate in the Southern and Patagonian Andes contrasts to the Central Andes. It is characterized by precipitation of ~2000mm/a, resulting in about 2 km of trench sediment fill and the development of an accretionary wedge. The Central Andes lack an accretionary wedge because the climate is extremely arid and the trench is sediment-starved.

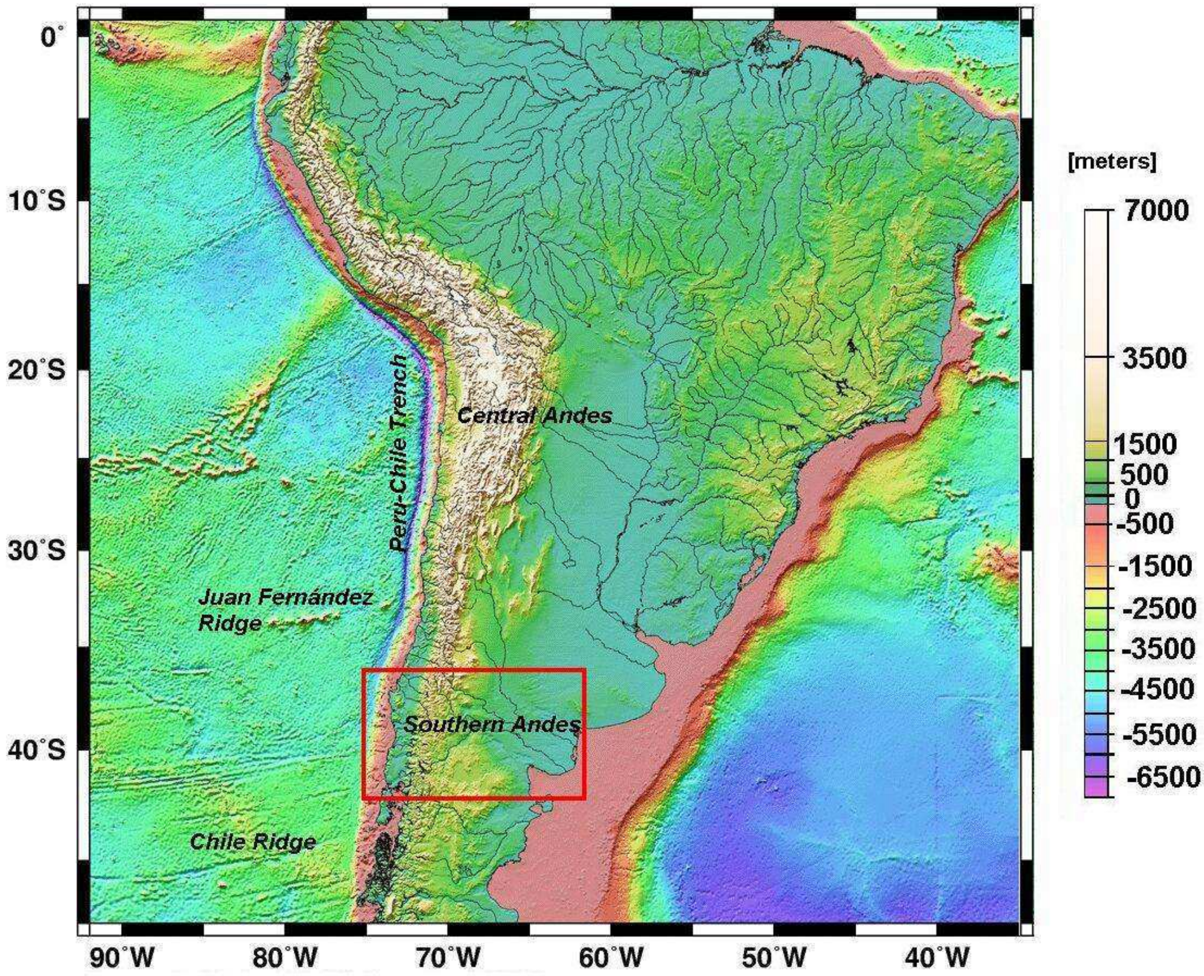

Figure1.1
Topography and bathymetry of the South American region after Smith&Sandwell (1997), DEM GTOPO30 (http://topex.ucsd.edu/marine_topo/gif_topo_track/) showing the study area (red box). The main tectonic provinces and offshore ridges are marked.

Choosing to study these two regions should provide answers to questions about the various mass flux phenomena in the different areas of the Andean orogeny. Thus, the last two funding periods of the SFB 267 have concentrated on identifying key properties and aspects relevant to along-strike variations within a subduction orogeny. Studies have focused on the structure, evolution and rheology of the upper plate, properties of the lower plate and tectonics, climate and mass transfer patterns.

The work of this thesis focuses on the southern target area. Existing geophysical and geological data, together with gravity data, are used to construct a 3D density model, which, based on the recent knowledge coming from the above named data, well represents the study area and provides some answers to outstanding questions.

The following three chapters describe the existing data. In Chapter 2, the geology of the study area is summarized, in Chapter 3 the gravity data are analyzed, and Chapter 4 gives an overview of the constraining data used while constructing the density model.

Chapter 5 describes the modelling method and main features of the density model. The parameters of the modelled structures are explained in terms of densities and geometries, and thus the geological bodies and composition that they represent. Also, an interpretation of the gravity field and the results of the modelling are presented.

Chapter 6 presents a discussion of open questions and problems that could not be answered or have more than one possible explanation. Also, the final density model is here compared to the remaining geophysical data. By varying the input parameters (density and geometry), several tests are performed in order to show the effect and significance of different parts of the oceanic and continental plates, .

Chapter 7 gives a summary of the issues discussed, as well as some suggestions for future work.