
Antarctic/Scotia plate convergence off southernmost Chile

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| ABSTRACT |

The southern tip of South America off Chile has suffered a long phase of ocean-continent convergence which has shaped the continental margin through different phases of accretion and tectonic erosion. The present accretionary wedge is a discontinuous geological record of plate convergence and records only part of the accretionary processes resumed after Chile ridge consumption (14 Ma). The structural style of the subduction complex, such as rates of sediment accretion and tectonic erosion, structural vergence, width of the accretionary wedge, taper angle and deformation in the forearc basin, varies along the margin. Large taper values are related to narrow wedges and seaward vergent structures. Low tapers occur where deformation at the toe of the accretionary complex is spread over wide areas and is related both to landward and seaward vergent thrust faults. Seismic data interpretation contributes to define more accurately frontal wedge morphology and geometry of subduction and suggests that different modes of accretion together with tectonic erosion may be active concurrently along the trench at different locations. In areas of subduction driven accretionary processes the majority of trench sediments are involved in accretionary processes and sediments are uplifted and piled up in the form of imbricate thrust sheets. In areas where the wedge is non-accretionary the continental margin shows steeper continental slopes associated with narrow accretionary wedges, more intense sediment disruption and very shallow décollement levels. Variation in structural style and in the geometry of the forearc region setting off Southernmost Chile, has been interpreted as related to the existence of different structural domains: the nature of their boundaries is still unclear mainly for the lack of high resolution bathymetric data. They have been tentatively related to tectonic lineaments belonging to the Magellan Fault system and/or to the character and morphology of the converging plates (lateral heterogeneities, sea-mounts and fracture zones), which produce a segmentation of the margin.

KEYWORDS | Plate tectonics. Continental margin. Trench. Subduction complex. Tectonic accretion. Marine geology.

INTRODUCTION AND GEOLOGICAL BACKGROUND

The overall tectonic setting of the southernmost Chilean margin is driven by relative movements between three main plates: the Antarctic (AN), South America (SA) and Scotia (SC) plates. The AN-SC slip vector is oriented

roughly E-NE and the plate boundary is approximately located along the Chile trench, while the triple junction between the plates is interpreted to be a diffuse and unstable area (Forsyth, 1975; Cunningham, 1993) located at the intersection of the Chile Trench and the seaward projection of the Magellan Fault around 52°S (Fig. 1).

South of the triple junction, the history of Late Cenozoic convergence is essentially divided in two phases. The first one took place between Nazca and South America plates, at a rate of about 90 mm/year (Cande and Leslie, 1986; DeMets et al., 1990) and ending with the collision between the Chile-Ridge and the Chile-Trench that occurred between 10 and 14 Ma (Cande and Leslie, 1986). The subsequent phase, from Late Miocene to present, is characterised by plate subduction between Antarctic and Scotia plates, that resumed after the ridge consumption at a considerably slower rate of about 10-20 mm/year (DeMets et al., 1990). This sharp drop in convergence rate resulted from the northward migration of the Chile triple junction along the margin to the site of the modern Taitao Peninsula triple junction (Fig. 1).

The consumption of a mid oceanic ridge below a subduction trench is a catastrophic event that should have disrupted and eroded a huge amount of material of the overriding plate, as reported by many authors in the present day triple junction area (Forsyth and Nelson, 1985; Cande and Leslie, 1986; Behrmann et al., 1994, among others). The present day accretionary wedge is interpreted to be post late Miocene in age (Polonia et al., 1999) built up when subduction resumed after ridge consumption. The Paleo-

zoic and early Mesozoic record of plate convergence is confined within the backstop. On the basis of indirect geophysical observations (Polonia et al., 1997), the backstop has been interpreted to be constituted partly by the Jurassic Patagonian Batholith, and partly by the Paleo-Mesozoic accretionary wedge that constitute part of the continental basement of southern South America (Dalziel, 1982; Forsyth, 1982; Davidson et al., 1987; Grunow et al., 1992).

The 15-20 Ma old oceanic crust (anomalies 6-6a, see Cande and Leslie, 1986) of the Antarctic plate is being subducted at a variable angle from normal at 50°S-52°S to highly oblique at 57°S. This variation in subduction obliquity is related mainly to variation in the direction of the continental margin which shows a 90° bend in the Southernmost Andes between 50°S and 56°S. This sharp bend has been interpreted on the basis of paleomagnetic and structural data (Cunningham, 1993) as a product of tectonic rotation that affected this region since Mesozoic times.

At about 57°S, the Chile Trench passes into the Shackleton Fracture Zone. Little is known about the interaction between these two structures; Herron et al. (1977) assumed that the Shackleton Fracture Zone splays at its northern end into a series of northwest stepping faults that

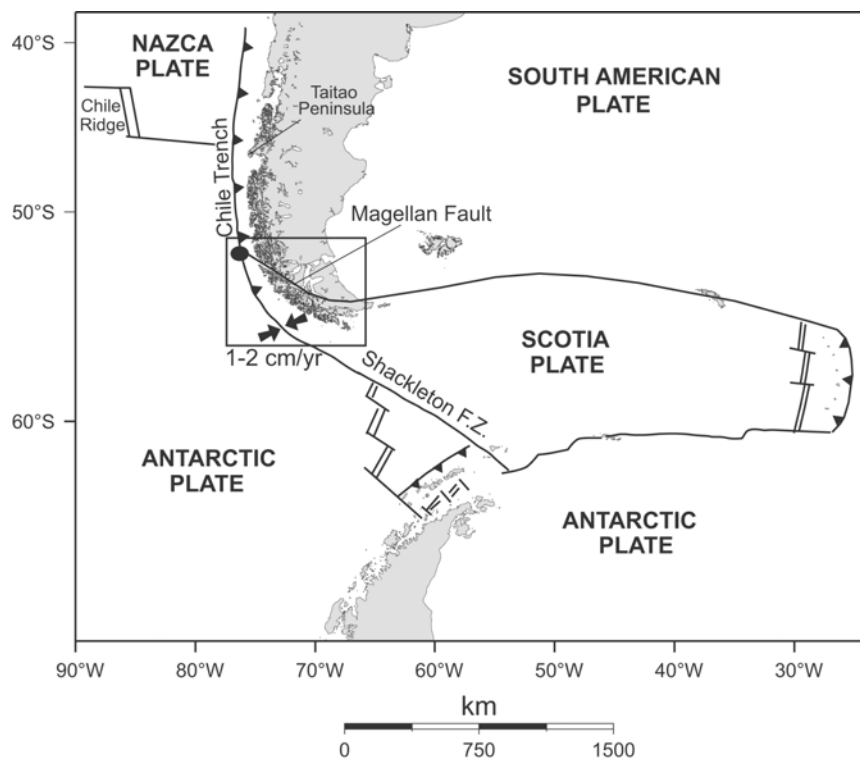


FIGURE 1 | Regional structural map, showing the main tectonic features of the studied area. The Antarctic, Scotia and South American plates meet together at the triple junction indicated by the black dot at about 51°S, located at the seaward projection of the Magellan Fault. The Chile triple junction, at the Taitao Peninsula, where the Chile ridge is being subducted below the Chile trench, is also indicated. The slip vector is indicated by the black arrows.

follow the continental margin. A gradual change from orthogonal subduction to transpressive and mainly transcurrent motions is likely too.

Seismicity along the margin is low. The slow convergence rate across the Antarctic/South America or Antarctic/Scotia boundaries is probably the main reason for the observed low seismicity of the western margin of South America south of 46°S (Herron et al., 1977). However, shortening and active accretion occur at the toe of the accretionary wedge where a thick section of sediment resting on the Antarctic plate approach the outer deformation front (Polonia et al., 1997; Polonia et al., 1999; Rubio et al., 2000). The earthquake that occurred near the southern tip of Tierra del Fuego in 1987, shows a thrust fault solution at a shallow depth (11 km), which indicates active underthrusting along a shallowly dipping nodal plain (Pelayo and Wiens, 1989).

Oblique convergence between plates, transcurrent motion, and tectonic rotation, make the geodynamic setting more complex than that of the central Andes. Contraction and uplift in the trench occurs at the same time that rifting is active on land. The Magellan strait, for instance, forms part of a Neogene rift system perpendicular to the orogen (Dirai-

son et al., 1997) and all major depressions onland are interpreted as rifts or half-graben developed during Neogene and still active today.

In this paper we present a set of multichannel seismic reflection profiles that cross the subduction complex from 51°S to the Drake Passage. In this work we analyse the structural and stratigraphic record of subduction along the continental margin, and in particular we describe the structural domains in the subduction complex and their variations in cross section and along strike.

GEOPHYSICAL DATA

Seismic data presented in this paper were collected during two expeditions in April 1995 and 1997, between the western end of the Strait of Magellan and Cape Horn by the Italian R/V OGS-EXPLORA in the frame of the Italian Antarctic Research Program (PNRA). Most profiles run approximately orthogonal to the margin crossing the subduction complex from the oceanic trench to the continental shelf. Two profiles, however, were collected in the forearc basin parallel to the margin (Fig. 2).

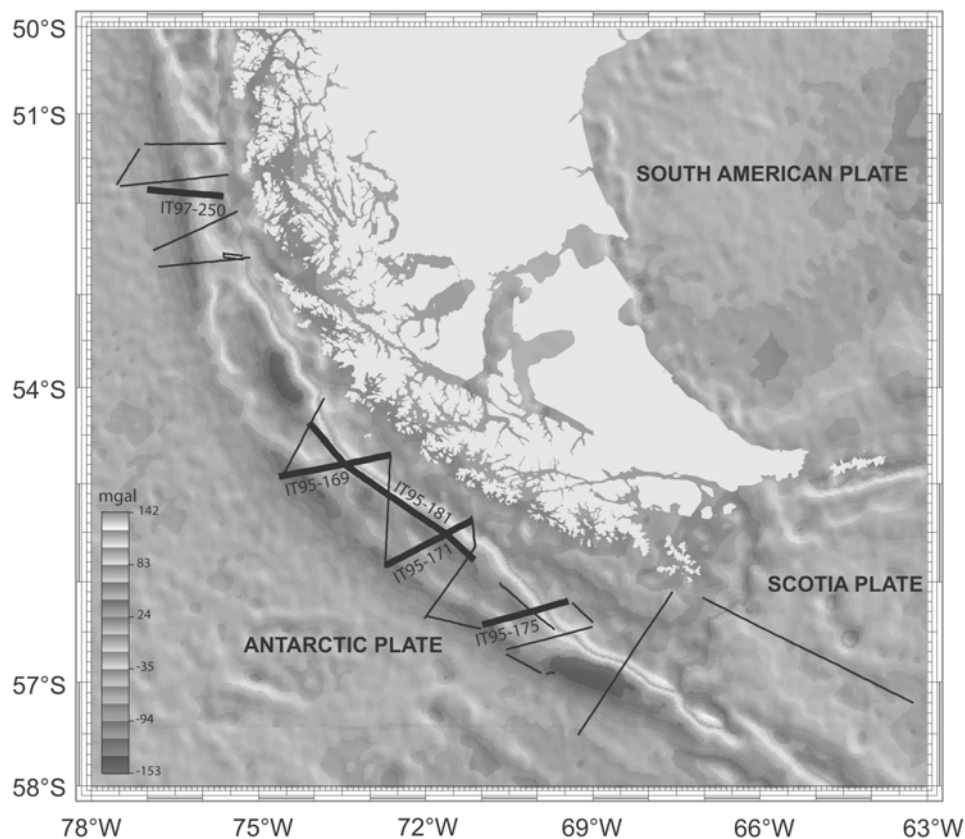


FIGURE 2 | Satellite derived gravity map (Sandwell and Smith, 1997) with the location of the OGS-EXPLORA seismic profiles. Thick black lines represent the multichannel seismic profiles described in this work.

Acquisition and processing parameters are described in detail in Polonia et al. (1999) to which we refer. The table below summarises the main parameters.

Streamer length	3,000 m
Active channels	120
Group interval	25 m
Shot interval	50 m
Nominal fold	30
Sample rate	2 msec
Source	36 gun array

CONFIGURATION OF THE CONTINENTAL MARGIN

The structural and sedimentary record of subduction varies along the accretionary complex both in cross section and along its strike. We analysed five seismic profiles (Figs. 3, 4, 5, 6 and 7) in order to define structural variations in the subduction complex and their tectonic implications.

The profiles collected orthogonal to the margin from the oceanic domain to the continental shelf south of 54°S (Figs. 2, 3, 4 and 5) image a terraced forearc with a well developed accretionary wedge and forearc basin. From west to east we define the following domains: Antarctic oceanic domain (trench), the outer part of the accretionary complex, the inner accretionary wedge and the forearc basin (Fuegian Terrace), and the Scotia plate continental setting (continental backstop).

Oceanic domain

The trench has no topographic expression because a 2 km thick, rather undeformed, sedimentary section com-

pletely buries the structural trough. Locally, a proto-thrust domain is present and deformation, in the form of double verging thrust faults bounding pop-up structures, involves at least part of the abyssal plain sediments. Small deformation related to normal faults affects the sedimentary cover and locally propagates within the oceanic basement. Oceanic crust is bounded at its base by the Moho that is imaged on the seismic sections at about 2 sec TWT below the top of oceanic basalts. Within the oceanic crust, oblique reflectors can be ascribed either to shear zones, or to boundaries between mafic-ultramafic cumulate layers.

Outer accretionary wedge

As the outer deformation front is reached, the flat and rather undisturbed sedimentary section in the abyssal plain is scraped off from the descending plate and piled up along thrust faults. The wedge has an average 2,500-3,000 m structural relief and width ranging from 25 km (line IT95-169 and -175) to more than 40 km (line IT95-171). Deformation is mainly related to folding and thrusting, which account for sediment shortening and uplift. The main thrust faults are well imaged at the transition from the abyssal plain to the accretionary wedge. Evidence of thrusting is provided by morphologic breaks of the seafloor, presence of low angle, generally landward dipping reflections, and truncation of reflectors below and above them. Thrust faults sole out on the main décollement level, which represents the boundary between off-scraped sediments (above it) and sediments below, which will experience underplating or subduction processes. The underplated section has variable thickness. In line IT95-169 and -171 (Figs. 3 and 4) the décollement reaches the top of oceanic basalts, implying that all the sedimentary section in the trench is accreted. On the other hand, in line IT95-175 (Fig. 5) the décollement is shallower and only part of the sedimentary section is scraped off from the descending plate.

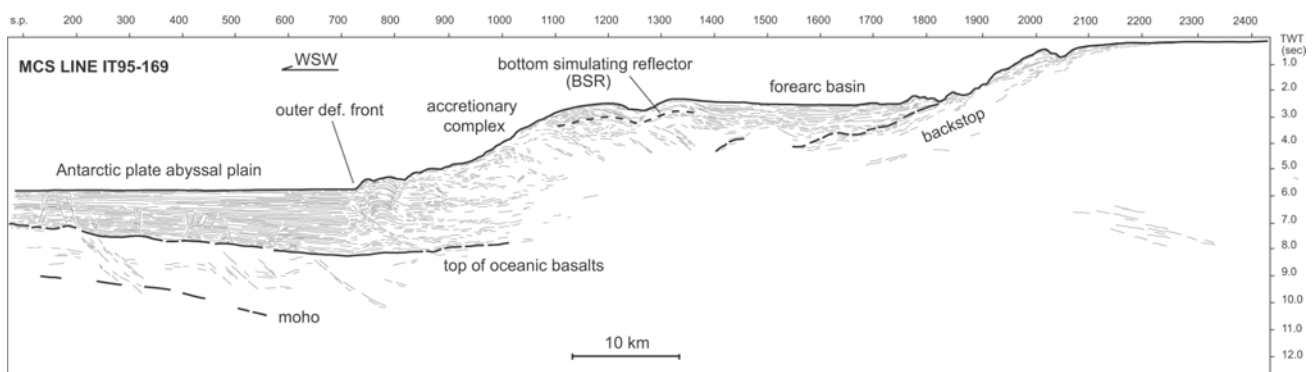


FIGURE 3 | Line-drawing of multichannel seismic profiles IT95-169 in the northern sector of the area investigated in 1995. Main structural domains are indicated. See Figure 2 for its location.

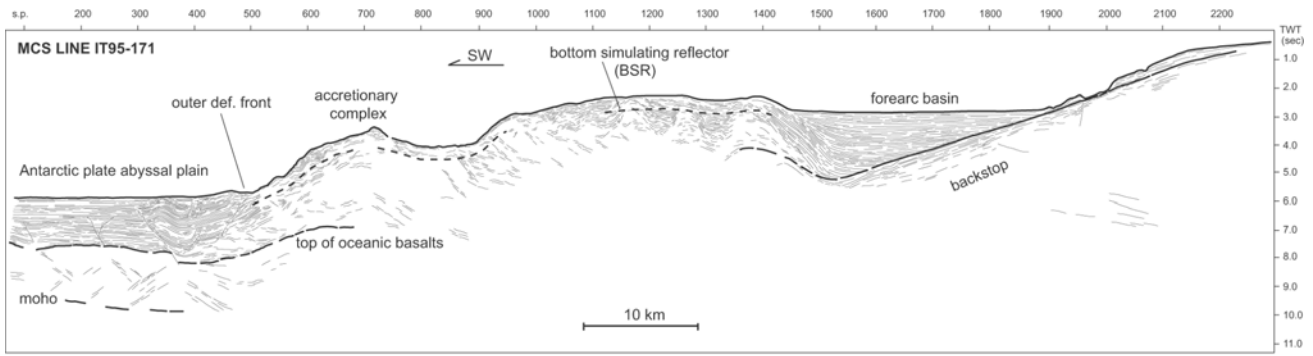


FIGURE 4 | Line-drawing of multichannel seismic profiles IT95-169 in the northern sector of the area investigated in 1995. Main structural domains are indicated. See Figure 2 for its location.

Critical taper (topographic slope plus the dip of the décollement) varies from 3 degrees (line IT95-169) to more than 15 degrees (line IT95-175) which is high if compared with other accretionary wedges (Davis et al., 1983). The taper is essentially related to the type of sediments involved in accretion and to the basal friction on the décollement. Assuming that sediments in the trench are homogeneous, variations in the taper are thus interpreted as related to different boundary conditions on the décollement.

A well-developed Bottom Simulating Reflector (BSR) is present within the accretionary wedge in all the profiles and discussed below.

Inner accretionary wedge and forearc basin: the Fuegian Terrace

At the rear of the outer accretionary complex, at depths of the seafloor spanning from 2.5 to 4 sec TWT (about 1,900-3,000 m), a bathymetric low separates the most recent accretionary wedge from a flat region to the back. This flat, mid-slope area is known in literature as “Fuegian Terrace” (Herron et al., 1977) and corresponds

partly to the crest of the accretionary wedge and partly to the forearc basin. The topographic low at the rear of the outer high is associated, at depth, with a series of deep landward dipping reflectors that are imaged on the seismic sections to about 5-7 sec TWT (Figs. 3, 4 and 5). The depression that bounds the “Fuegian Terrace” to the west is interpreted as the transition to a more compacted accretionary wedge or, as a major thrust belt or shear zone, which segments the wedge along its strike. In both these interpretations, the topographic low would thus represent the site of a modern slope basin, which has not been filled by sediments because most of the continental sediment inputs are trapped in the forearc basin.

Seismic penetration within the inner part of the accretionary complex is poor as a result of pervasive sediment disruption. Thrust faults in the accretionary wedge progressively steepen, as a result of the ongoing deformation that produces progressively more rotated thrust blocks. In all the profiles, tilted and deformed sediments are topped by a less deformed, sub-parallel layered unit draping the seafloor that may represent the hemipelagic sedimentation. The maximum extension of this domain is reached

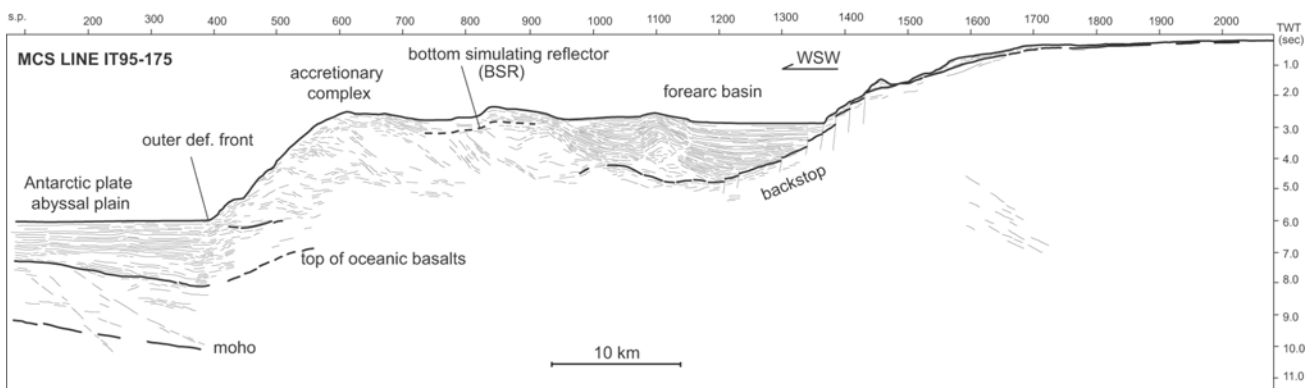


FIGURE 5 | Line-drawing of multichannel seismic profile IT95-175 in the southern sector of the area investigated in 1995. See Figure 2 for its location. The taper angle is very high (about 15°) if compared to the other analysed seismic profiles.

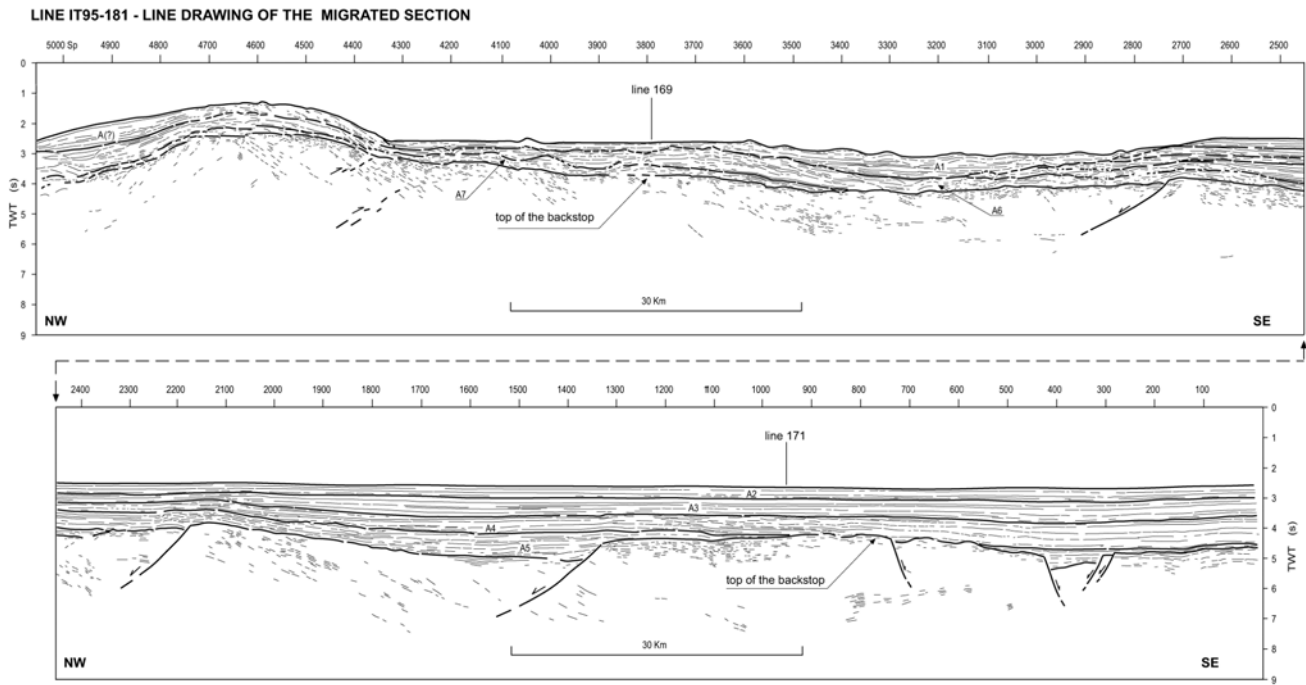


FIGURE 6 | Line drawing of multichannel seismic profile IT95-181 across the Fuegian Terrace. See Figure 2 for its location. The sedimentary section belonging to the forearc basin is formed by several stratigraphic units resting directly on the continental basement. The backstop is affected by a series of normal faults dipping towards north which do not propagate into the sediments. At s.p. 4,300 the flat and rather undeformed sedimentary infill is sharply uplifted to form a swell which rises about 1.5 sec TWT (1,100 m) from its surroundings. At the base of the topographic high, low angle northward dipping reflectors are imaged and they may be interpreted as thrust faults that presumably reactivate ancient normal faults.

in the central area we have investigated (profile IT95-171, Fig. 4). In profile IT95-171, a series of symmetric antiforms bounding box shaped basins, are well imaged between s.p. 1,100 and 1,400 (Fig. 4). These antiforms have average wavelength of 5 km and maximum amplitude of about 1.5 sec TWT (corresponding to about 1,500-1,700 m). The amplitude and wavelength of these structures decrease towards SW where they become progressively shallower: the last antiform (Fig.4, s.p. 1,150) reaches the seafloor and is under present day erosion. At this stage of data analysis, we propose a tectonic origin for these structures (folds?) although mobilisation and movement of undercompacted or overpressured material may originate these features too (mud/shale diapirism?).

At about 500 msec TWT under the seafloor, a strong reflector is well imaged in all sections. In contrast to positive seafloor reflection, this reflector has negative reflection coefficient (Polonia et al., 1999) and this suggests that it corresponds to a transition between gas hydrates bearing (above) and free-gas bearing (below) sediments (Bottom Simulating Reflector). In some areas (lines IT95-171, Fig. 4) the extent of the BSR is very large, being present from the outer deformation front to the forearc basin. To the North and to the South its occurrence is reduced to the inner part of the accretionary wedge.

The forearc basin has a width of the order of 20 km, while sediment thickness in the depocenters spans from 1.5 to 2.5 sec TWT (about 1,500-2,500 m). The contact between the basin and the accretionary complex is not clear in the seismic profiles. Strata next to the western end of the basin are tilted and truncated at the seafloor as a result of forearc deformation, which produces a progressive shift of the depocenter towards the continent. This implies that at least the shallow part of the inner wedge is constituted by sediment of the old forearc basin (Fig. 4, line IT95-171, s.p. 1,350-1,450).

The continental backstop forms the basement on which forearc basin sediments rest with onlap geometry. The boundary between basement rocks and forearc basin is extremely flat in line IT95-171, suggesting an erosional origin in shallower water. In the other profiles the top of the backstop is disrupted by normal faults. Beneath the forearc basin the uppermost section of the continental basement shows evidence of internal layering conformable to its top. This suggests that the upper part of the forearc basin subsided and was tilted before the onset of sedimentation.

The profile 195-185 was collected parallel to the margin within the forearc basin (Profile IT95-181, Fig. 6). The sedimentary section filling the forearc basin is

formed by several stratigraphic units, which rest directly on the continental basement. The backstop is affected by a series of normal faults mainly dipping towards north. The faults are confined to the continental basement and do not appear to propagate into the sedimentary cover. At s.p. 4,300 (Fig. 6) the otherwise flat and rather undeformed sedimentary infill is sharply uplifted to form a swell which rises about 1.5 sec TWT (1,100 m) from its surroundings.

Sediment deformation within the basin varies widely. In line IT95-169 the sedimentary infill can be subdivided into three units separated by unconformities; the lower two units are chaotic with no continuous internal layering; the upper one is progressively more tilted and deformed moving towards the accretionary wedge (Figs. 3 and 6 at s.p. 5,000). In profile IT95-171 the sedimentary section is thicker and less deformed (Fig. 4). In the southernmost profile, IT95-175, the basin infill shows deformation in the form of a wide and thick pop-up structure that may be related to localised transpression (Fig. 5).

The forearc basin is bounded towards the continent by the continental backstop, whose top has average dip ranging from 7° to 16°. The thickness of the sediments draping the upper continental slope widely varies and these variations are mainly controlled by the presence of normal faults, erosional processes and gravitative failures.

STRUCTURAL VARIABILITY ALONG THE CONTINENTAL MARGIN

Seismic images analysed in the previous chapter point out how the overall geometry of the subduction complex and the structural style in the accretionary wedge vary along the margin. Width, elevation and critical taper of the accretionary wedge vary along the margin, as well as the extension and thickness of the forearc basin.

In most profiles the wedge has a convex shape which is a direct mechanical response to lithification of sediments during accretion. This is because the critical taper is relatively high for the porous, weak sediments near the toe, while further back in the wedge, the stronger sediments require a relatively modest critical taper and therefore a lower bathymetric slope to be stable under the same tectonic compression (Zhao et al., 1986). The concave shape in line IT95-169 is not a common feature of accretionary complexes. Dahlen (1984) demonstrated that only a cohesive critical wedge with uniform properties, including a constant cohesion, has a slightly concave topographic profile if the décollement is planar.

In the oceanic domain, main structural features are rather uniform in all the profiles. The average depth of the seafloor corresponds approximately to the 4,350 m isobath (5.8 sec TWT) though it deepens towards south of about 300 m. The Moho is 2 sec TWT below the top of oceanic basalts in all the profiles. Larger differences are mainly related to the geometry of the subduction complex and to the extension of the continental shelf. In the northern and southern regions, the continental shelf is wider and the accretionary wedge narrow (in line IT95-175 it is only 25 km wide). In the central region (profile IT95-171) the shelf break is shifted about 20-25 km landward. This is reflected in the extension of the subduction complex, which reaches its maximum width implying that a larger volume of sediments has been involved in accretion.

The forearc basin is well imaged in the satellite-derived gravity data (Fig. 2) where it corresponds to a large gravity minimum. From the integrated analysis of the satellite derived gravity map and the multichannel seismic data it is clear how the forearc basin widens and closes and is characterised by different depocenters separated by areas where the basin is narrow and deformed or not present.

Differences in the overall geometry of the subduction complex are accompanied by variations in structural style within the accretionary wedge. Critical taper is progressively higher to the South, and it is accompanied by a narrowing of the accretionary wedge. The taper angle is strongly dependent on the physical properties of the material involved in accretion, as well as the basal friction over the plate boundary. The critical taper increases by an increase in the coefficient of basal friction, whereas it decreases by an increase in the internal friction angle (Davis et al., 1983; Dahlen, 1990). This implies that where the critical taper is high (southern region, line IT95-175) the shear stress on the décollement should be high and/or the internal strength of the wedge low. Assuming that the material involved in accretionary processes along the Chilean margin is rather homogeneous, the first hypothesis is the favoured one. On the other hand, low tapers (northern and central region) suggest low basal friction on the décollement.

Seismic images have pointed out that where the taper is high and the wedge narrow, only seaward vergent thrust faults are present and the transition from the undeformed abyssal plain to the accretionary wedge is abrupt. Where the wedge shows its maximum width, the critical taper decreases, deformation is spread over a wider area (proto-thrust domain, Polonia et al., 1999) and both landward and seaward vergent thrust faults are active at the toe of the wedge. Accretionary wedge models show that

the seaward vergence is the most common structural vergence to develop in the outer part of the wedge. The majority of accretionary wedges confirm this model with few exceptions which are mainly represented by the Cascadia margin (MacKay, 1995; Goldfinger et al., 1996) and southern Chile (Polonia et al., 1999).

Landward vergent thrust faults are favoured in areas where low basal shear stress causes the angle between the maximum stress and the décollement to be very small (MacKay, 1995). This generally occurs where the décollement is weak (evaporites or fluid overpressuring) and/or the wedge particularly strong. The analysis of multichannel seismic data has pointed out that variations in structural vergence are mainly related to variations in the depth of the décollement level. In line IT95-171 the décollement is located on the top of the oceanic crust while in line IT95-175 the décollement is shallower and located within the sediments. Only the sediment pile above the décollement is accreted while sediments below are underthrust (underplated section) or subducted with the oceanic basalts.

Structural variations along the margin are highlighted by the profiles collected to the north, close to the Strait of Magellan (Fig. 7). The structure of the continental margin at these latitudes significantly differs from that encountered south of the Strait of Magellan. Deformation rates within the wedge are presumably higher as deduced by the lack of internal structures on the seismic section, and this is possibly related to the geometry of subduction which is more orthogonal producing a larger amount of shortening in the wedge. The abyssal plain as well as the top of oceanic basalts and the Moho are at least 1 sec (TWT) shallower than in the other profiles. The main décollement is shallow and located within the sedimentary section implying that a thick section of sediments is

involved in subduction and/or underplating. The continental margin is not terraced as the forearc basin is not present. The geometry and structure of the subduction complex (steep continental slopes, narrow accretionary wedge, very shallow décollement) suggest that the wedge is non-accretionary (Fig. 7). These features are peculiar of the northern region that faces the Strait of Magellan but are present also to the south where they alternate with the structural pattern of typical accretionary margins. In some of these areas the toe of the backstop is close to the trench implying that the volume of accreted sediments is very limited.

DISCUSSION

The analysis of the seismic profiles pointed out how structural development varies along the margin, both in the geometry of the subduction complex, and in the structural style (structural vergence, taper, strain rates). The combined analysis of seismic data and satellite derived gravity map highlights how the progression of structures does not show any gradual trend, but variations are sharp and centred in small areas. They can not be ascribed to some gradual change in tectonic and/or stratigraphic parameters that control subduction. For this reason, we prefer to consider the margin as formed by different domains within which structural style, internal deformation, and seafloor morphology are more or less homogeneous. These domains are separated by topographic highs that rise above their surroundings. The nature of these topographic highs is still debated. One of them, at about $54^{\circ}30'$, was investigated during the survey and it is imaged in profile IT95-181 (Fig. 6, between s.p. 4,300 and 5,000). Although the seismic resolution is poor, we recognise a series of reflections at the base of the high which we ascribe to low angle, northward dipping thrust faults. In this frame the fault represents the site of crustal

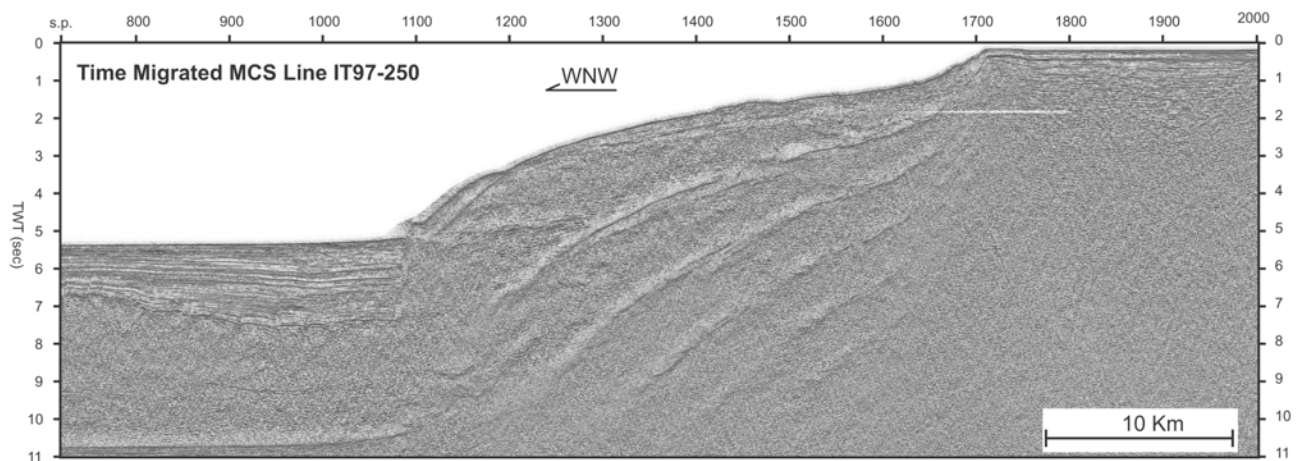


FIGURE 7 | Migrated time section of profile IT97-250 collected in the area close to the Strait of Magellan.

shortening that presumably reactivates ancient normal faults dipping to the north.

The satellite derived gravity map shows the presence of at least other two elevated regions (the first at about 53°S and the second at 56°30') that contribute to separate

different depocenters of the forearc basin. The overall setting of this part of the continental margin is thus represented by structural regions about 200-300 km wide, separated by sill areas that rise above their surroundings (Fig. 8). The structural highs are located where the continental shelf is wider and prominent.

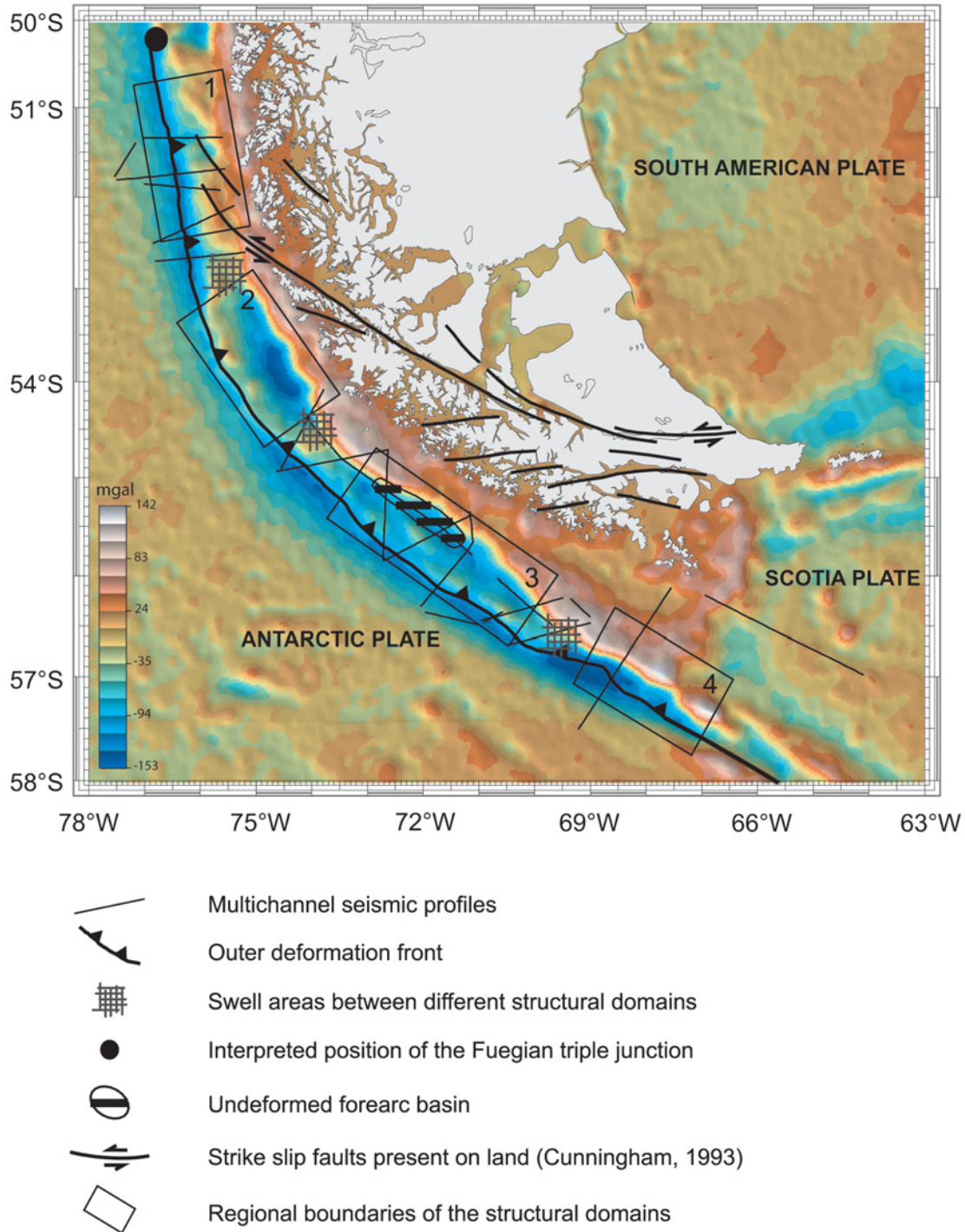


FIGURE 8 | Satellite derived gravity map (Sandwell and Smith, 1997) with the location of the OGS-EXPLORA seismic profiles. The main structures (outer deformation front, strike slip faults on-land, Fuegian triple junction and the areas of closure of the basin) are evidenced.

At this stage of data analysis we propose two different interpretations for the genesis of these structures: they may be related to pre-existing lineaments and lateral heterogeneities on the incoming and overriding plates and/or to neo-tectonic structures possibly related to the obliquity of subduction and strain partitioning.

Pre-existing structures may be represented by fracture zones or sea-mounts on the subducting oceanic crust or inherited structures within the continental overriding plate. The complex tectonic evolution of this region since Paleozoic times has produced distinct structural provinces within the continental backstop that represent inheritance of the different geological history among margin segments. The southernmost part of the forearc of Chile was affected by the detachment of the Antarctic Peninsula that started during Mesozoic times (Ghidella et al., 2002). This may have produced the removal of large part of the ancestral subduction complex and different topography along the margin. Moreover the collision of allochthonous terranes along the margin at these latitudes (Rapalini et al., 2001), and the later rotation during oblique subduction produced a segmentation of the continental margin and this may be responsible of the present-day structural variability.

The southernmost tip of South America has been affected by several episodes of active ridge subduction in the last 80 Ma (Ramos et al., 2005). The presence of promontories, sea-mounts, fracture zones, mid oceanic ridges and, more generally, of heterogeneities on the incoming subducting plate may affect the style of deformation at the plate boundary. The subduction of a mid oceanic ridge for example is generally associated with uplift and subsequent subsidence of the forearc and arc regions, increased thermal gradients and episodes of subduction-driven tectonic erosion of the landward trench slope. At about 53°S an abrupt shift in the location of the largest gravity minima occurs (Fig. 2). North of 53°S it is centred on the deformation front, south, it moves sharply to the site of the modern forearc basin sedimentation. This abrupt change is exactly located in correspondence of the closure of the forearc basin. South of 54°30'S the largest gravity minima moves again along the outer deformation front and this is the location of the structural high described above which corresponds to the site of the Desolación fracture zone (La Breque et al., 1986). The location of fracture zones is thus important to account for the present configuration of the continental margin. For example the erosion of the continental margin related to the subduction of the Chile Ridge is described to have been more efficient when short sections of ridge, offset by large transform faults were subducted (Cande and Leslie, 1986). In this interpretation, the interplay between subduction processes, oceanic plate configuration and sedi-

mentation may thus produce different phases of accretion and tectonic erosion and thus a discontinuous record of convergence inside the accretionary complex and along its strike, as pointed out for the southern Chilean margin by Bangs and Cande (1997).

Oblique convergence along the continental margin has probably created a major shear zone with associated structures within the subduction complex that cannot either be accounted for by 2-dimensional models of accretionary wedges or accurately described with the data available in this area. If the margin has been segmented in different crustal blocks we should recognise strike slip faults oblique to the continental margin. This tectonic setting characterises many oblique convergent margins such as the Cascadia (Goldfinger et al., 1996) and the Aleutian margins (Geist et al., 1988; Ryan and Scholl, 1989).

Strike-slip faults oblique to the southernmost Chilean continental margin have been described on-land by Cunningham, 1993 (Fig. 8), and the faults have been inferred to extend offshore as well (Winslow, 1982). At this stage of our work, the seismic sections orthogonal to the margin do not have clear evidences of the existence of these faults, but strike slip faults are subtle features to be detected through the interpretation of multichannel seismic sections, especially if they are located within a deformed assemblage like an accretionary complex. The tie profile (IT95 –181, Fig. 6) show that the majority of faults belonging to the continental backstop do not propagate into the sedimentary cover of the forearc basin but we can not exclude their existence. We would need high resolution seismics and/or multibeam data in conjunction with seismic sections to map active faults that are difficult to be seen in cross sections. One major fault system has been detected (Figs. 6 and 8) as described in the previous chapter, and this is responsible of the closure of the basin. We can not exclude the presence of other strike slip or transpressive faults.

Future analysis of the seismological data collected in this area (Vera et al., 1999) will address the presence and nature of these boundaries, and possibly clarify if they are neo-tectonic seismogenic lineaments or discontinuities related to the inherited structures of the incoming oceanic plate.

The existence of lineaments that are oblique and/or orthogonal to the margin could explain why the depth of the décollement widely varies in the analysed profiles. Variations may occur just across these tectonic boundaries as it occurs in the Cascadia margin where the depth of the décollement is controlled by strike slip faults oblique to the margin which have been described on the basis of multibeam data (Goldfinger et al., 1996).

Resolution of our available data is not yet sufficient to address in detail the nature of the structures which control the depth of the décollement and structural development. However, we propose that a tectonic control may play a major role. If this control is related to active faults, as in the Cascadia, or to some inherited structures is still not clear. Despite this uncertainty our data suggest that variations in the depth of the décollement strongly influence structural development. A deeper décollement implies a thicker sedimentary section entering the wedge and thus a greater amount of fluids to be involved in accretion. Low tapers, mixed structural vergence, and lower strain rates generally associated with deep décollement regions suggest the existence of low basal shear stress in these areas. The presence of overpressured fluids on the décollement is generally a common reason for reduced basal shear stress on the plate boundary. The maximum extent and continuity of the BSR in the areas characterised by a deep décollement suggests a more intense fluid circulation.

CONCLUSIONS

Seismic reflection profiles along the continental margin from 50°S to 56°S image widely varying frontal wedge morphology, different rates of accretion and underthrusting and a high degree of structural diversity within the accretionary wedge. These observations suggest that different modes of accretion together with tectonic erosion may be active concurrently along the trench at different locations.

The analysis of seismic data, in conjunction with the satellite derived gravity map, highlights how the progression of structures does not show any gradual trend, but variations are sharp and centred in small areas. They can not be ascribed to some gradual change in tectonic and/or stratigraphic parameters that control subduction. For this reason, we propose to consider the margin as formed by at least four domains within which structural style, internal deformation, and seafloor morphology are more or less homogeneous. These domains, about 200-300 km wide, are separated by three regions, which rise above their surroundings. The northernmost boundary is located on the track of the Desolación fracture zone. The central high was investigated during our survey, and data interpretation suggests that it is the site of crustal shortening, presumably reactivating ancient normal faults.

We propose two alternative interpretations for the nature of the boundaries between the structural domains: they may be related to lateral heterogeneities on the incoming oceanic plate or to neo-tectonic lineaments. In the first hypothesis, the continental margin could be considered as a single stable block within which structural

variations are mainly a result of inherited structures. In the second interpretation, the margin would be constituted by blocks bounded by faults possibly originated by the obliquity of subduction and strain partitioning. The domains would thus be separated by oblique structural trends belonging to the Scotia/South America plate boundary.

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