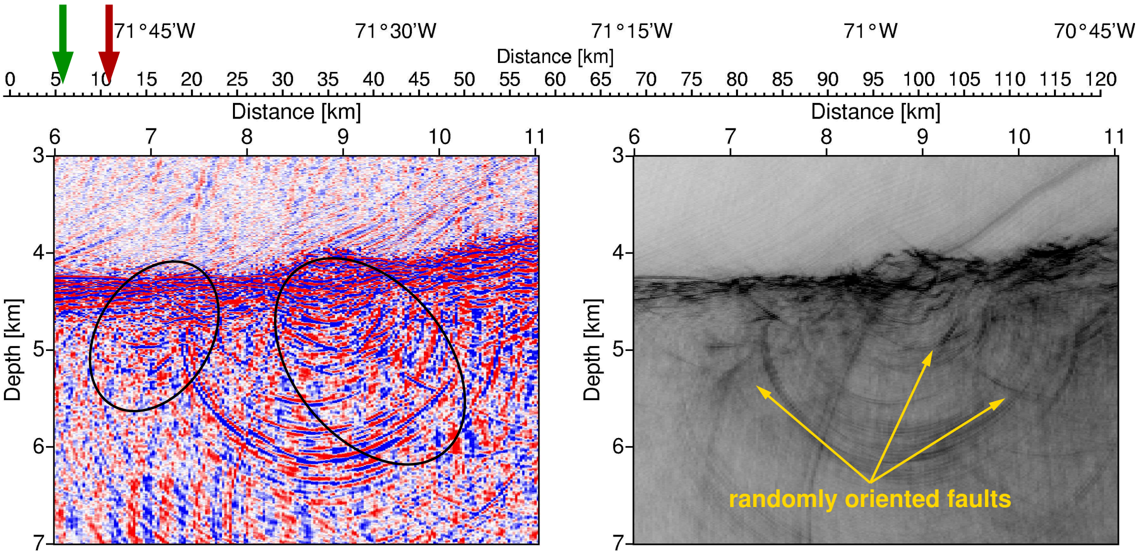
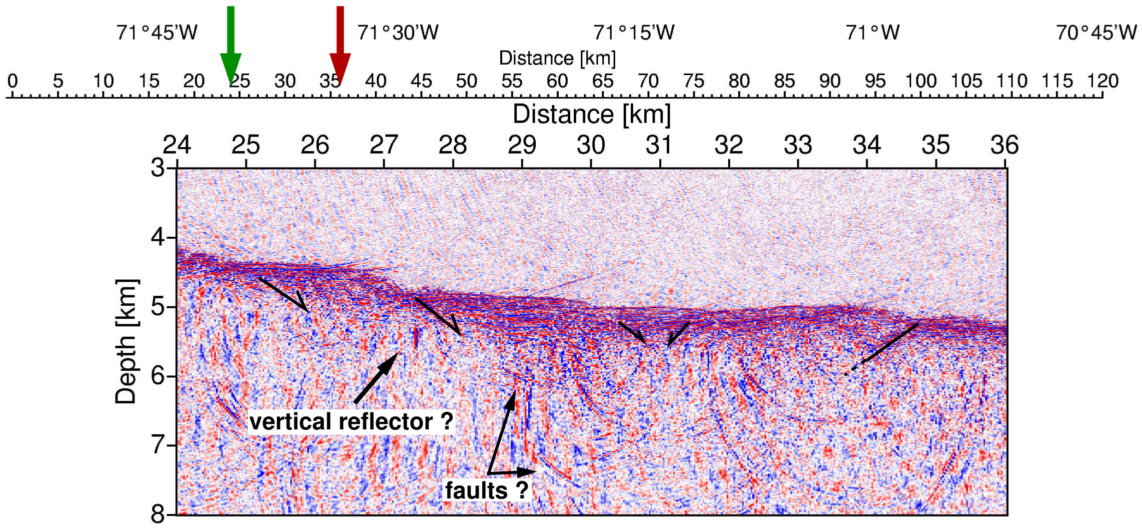


(a) Kirchhoff Prestack Depth Migration. *(b) Absolute stack image of (a).*

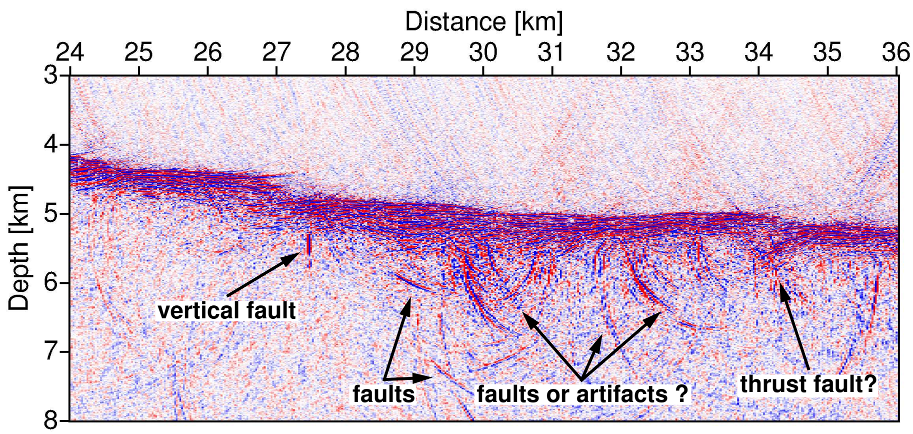
(c) Fresnel Volume Migration. *(d) Interpretation of (c).*

Figure 5.5: Image of the near surface structures west of the seamount between 6 km and 11 km. (a) Kirchhoff image. (b) Absolute stack of the Kirchhoff depth migrated single shots. (c) Fresnel Volume Migration. (c) Interpreted Fresnel image.

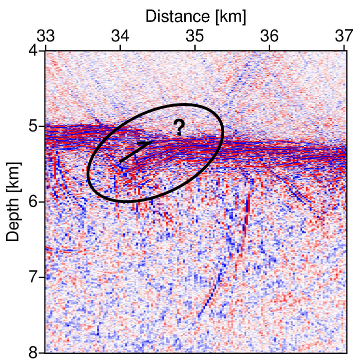
As already mentioned above, the ocean bottom between the seamount and the trench is dominated by apparent horst-and-graben structures. The first of those formations, located between 24 km and 36 km is depicted in Figure 5.6 where possible normal faults are marked by black arrows. Below the ocean bottom an almost vertical structure arises at 27.5 km (Figure 5.6(b)). Aside of the latter, two weak reflections are visible at 29 km and 30 km within the Kirchhoff image (Figure 5.6(a)), respectively. The latter features, as well as the vertical structure, arise as much stronger reflection events in the Fresnel image (Figure 5.6(b)) whereas the fault at 29 km



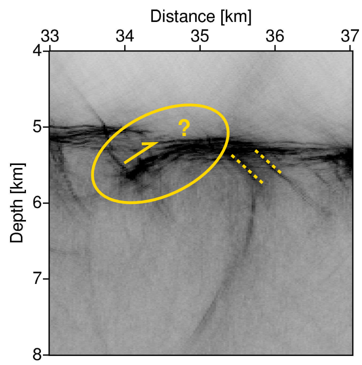
(a) Kirchhoff Prestack Depth Migration.



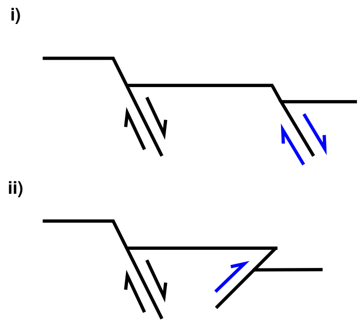
(b) Fresnel Volume Migration.



(c) Enlargement of a fault structure.



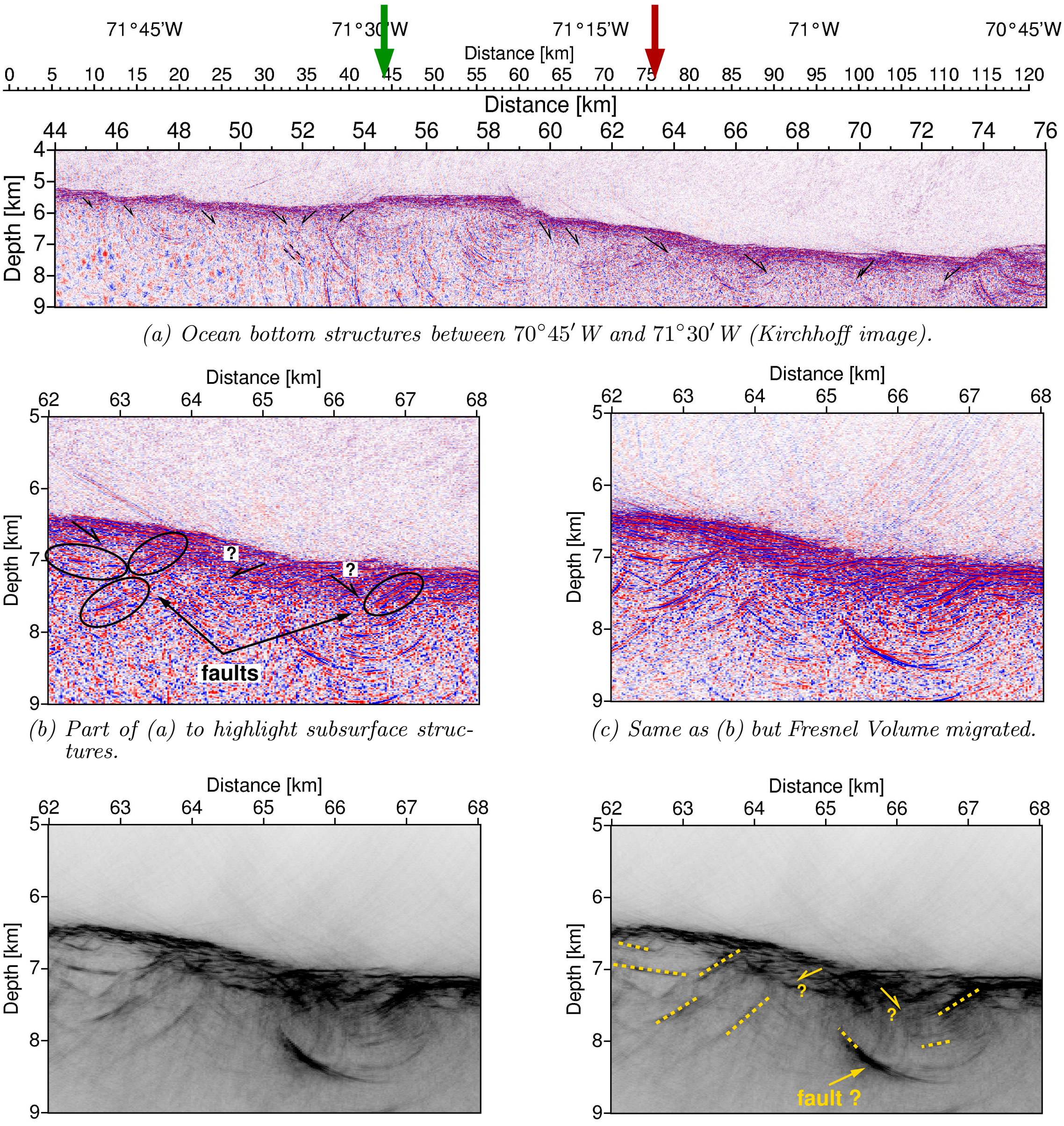
(d) Absolute stack.



(e) i) Typical normal faults; ii) Observed dip.

Figure 5.6: (a) Kirchhoff image of the first horst-and-graben-like structures along profile. (b) Fresnel Volume Migration of the same region. (c) Enlargement of (b): A possible thrust fault. (d) Absolute stack image corresponding to (c). Figure 5.6(e): i) Typical dip of normal faults. ii) Observed dip in Figure 5.6(c) and (d).

dips with a slightly shallower angle than the indicated normal fault at 27.5 km. Between about 34 km and 35 km along profile (Figure 5.6) a fault is located with seaward dip (solid black line in the Kirchhoff image). Both the configuration of the ocean bottom and the direction of dip indicate that it is rather a thrust fault than a normal fault. The enlargement (Figure 5.6(c)) and the absolute stack (Figure



(a) Ocean bottom structures between 70°45′ W and 71°30′ W (Kirchhoff image).

(b) Part of (a) to highlight subsurface structures.

(c) Same as (b) but Fresnel Volume migrated.

(d) Absolute stack of slice (c).

(e) Interpretation of (d).

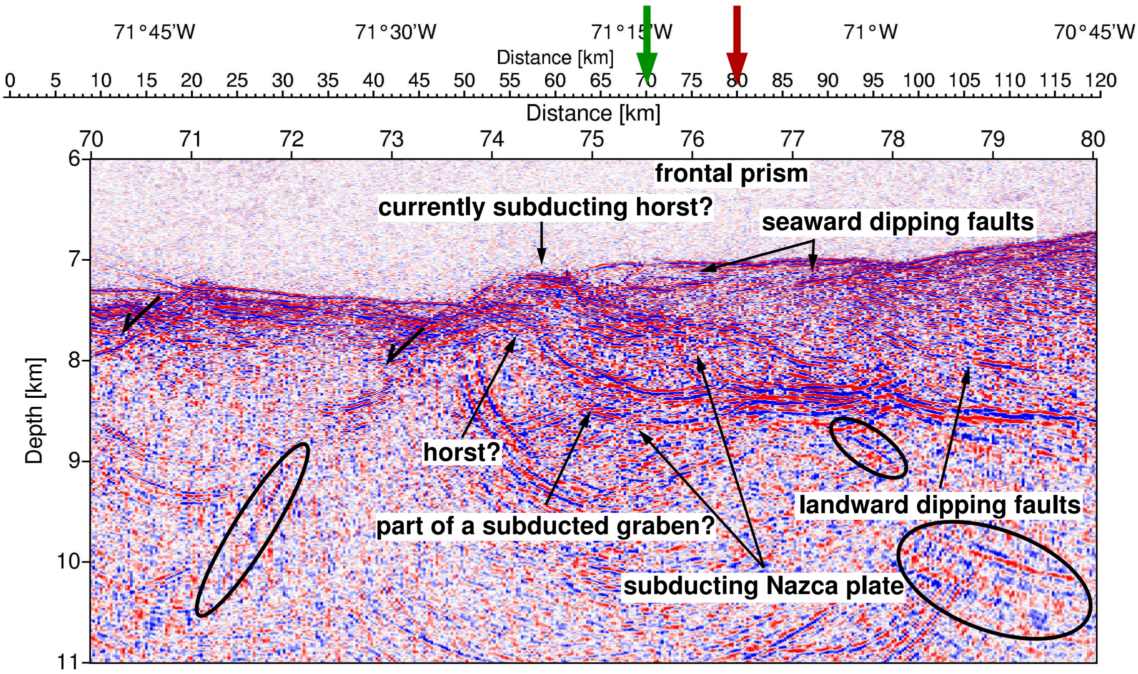
Figure 5.7: (a) Kirchhoff image of the ocean bottom formation west of the trench between 44 km and 76 km. (b) Enlargement of a part of (a). Again, the Fresnel images ((c) - (e)) provide more details of the actual subsurface structure.

5.6(d)) of the Fresnel Volume Migration result clearly illustrate a thrust fault. In contrast to typical normal fault as displayed in Figure 5.6(e) i), the observed fault rather corresponds to a structure similar to that depicted in Figure 5.6(e) ii). Other structures, located between 29 km - 33 km in the Fresnel image (Figure 5.6(b)), might be steeply dipping faults or remaining artifacts. Within the absolute stack Fresnel image (Figure 5.6(d)), two additional faults are observable cross-cutting the sedimentary layers and dipping to the east.

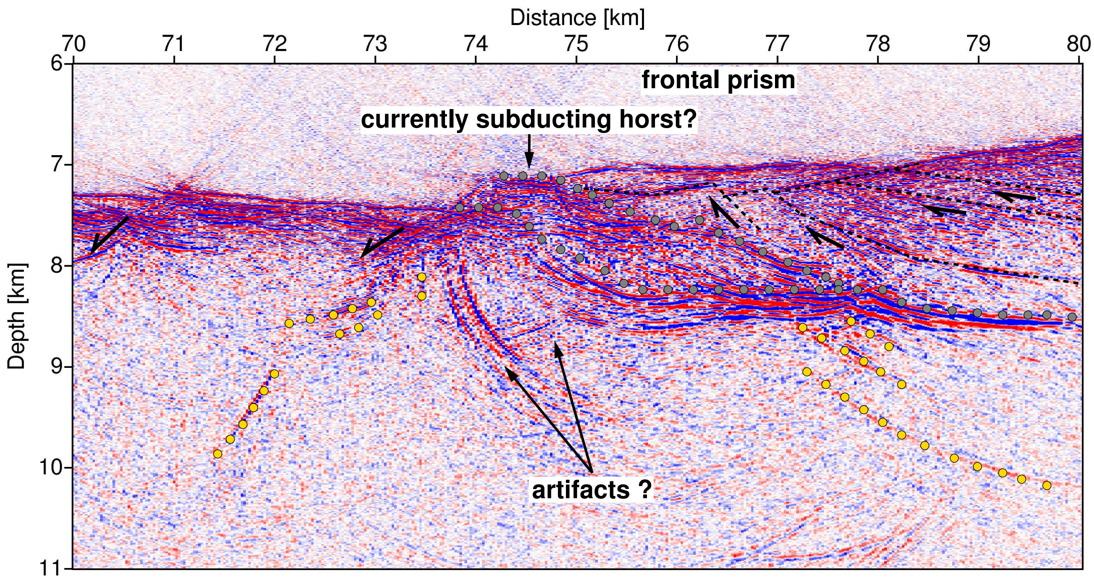
Figure 5.7(a) depicts the Kirchhoff image of the seafloor and the oceanic crust between 44 km and 76 km including the most pronounced ocean bottom structure (54 km - 59 km) with a height up to 1000 m. The near surface seems to be transected by normal faults but in some areas, e.g. at 65.5 km along profile (Figures 5.7(b) - (e)), it is not clear whether they are actual normal faults or thrust faults. However, the ocean bottom roughness continuously increases with decreasing distance from the trench. Due to the ambiguous characteristics of the fault at 65 km it is not totally clear if the increasing topography is exclusively caused by plate bending but it might also be, at least partially, a result of compression. Two more faults can be found in the Kirchhoff image at about 51.5 km at a depth of 7 - 8 km. Besides the feature at 65 km, the enlargement of the Kirchhoff image (Figure 5.7(b)) depicts several weak reflections (surrounded by black ellipses) which are superimposed by strong noise and migration artifacts between 65 km and 68 km. The Fresnel image (Figure 5.7(c)) shows an improved image of this area, i.e. the noise is suppressed and the faults are clearly visible. Here, it can be observed that the subsurface in this area is penetrated by a couple of single faults indicating a complex internal structure of the oceanic crust near the trench. The absolute stacks (Figures 5.7(d) and (e)) additionally highlight these features. Several faults can be identified in Figure 5.7(e) (dashed yellow lines), most of them exhibit a seaward dip but some are nearly horizontally oriented. The strong event in Figure 5.7(d) between 65 km and 68 km is composed of two different features. A small eastward dipping fault, located between 65 km and 65.5 km (cf. Figure 5.7(c)), and a slightly shallower dipping event between 65.5 km and 66.5 km can be observed whereas the latter, however, could also be a remaining part of a migration artifact.

5.3.2 The trench region

The prestack depth migration results provide an insight into the trench region and expose unknown structures of both the subducting Nazca plate and the overriding continental crust. Due to the lack of a huge sedimentary cover of the ocean bottom only some debris from the slope might be transported into the subduction channel when a graben subducts. Here, the other situation can be observed, i.e. a snapshot



(a) Kirchhoff image of the trench.



(b) Fresnel image of the trench.

Figure 5.8: (a) Kirchhoff image of the trench region between 70 km and 80 km along profile. The most pronounced reflectors are labelled. Possible fault structures within the oceanic crust are surrounded by black ellipses. (b) Fresnel image of the same region. Grey circles mark reflectors corresponding to the downgoing Nazca plate. Yellow circles depict faults within the oceanic crust. Dashed black lines indicate a fault system located in the frontal prism.

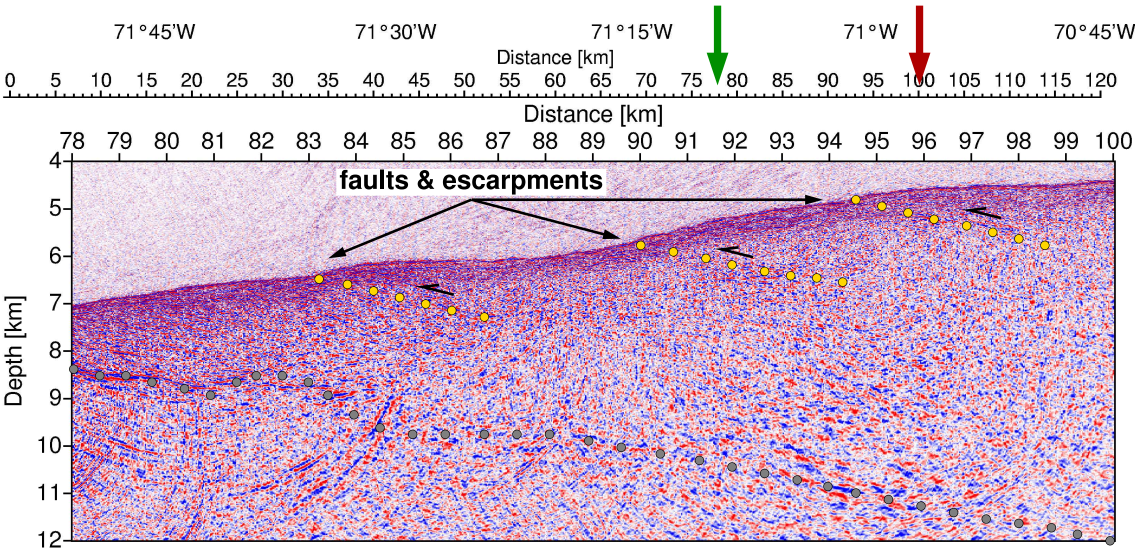
of a horst-like structure arriving and subducting underneath the continental crust (Figure 5.8). Besides two apparent normal faults between 70 km and 74 km, the Kirchhoff Prestack Depth migration result (Figure 5.8(a)) shows some interesting features. At about 74.5 km a horst-like structure is situated directly at the trench. Below the latter, a quite similar reflection can be observed. The image of the frontal prism exhibit several details: a small seafloor ridge at approximately 75.5 km appears which can be associated with the deformation front; directly below the seafloor, slightly seaward dipping faults can be found; at greater depth, between 7.5 km and 8.5 km, landward dipping faults are located. Black ellipses in Figure 5.8(a) surround possible structures transecting the upper part of the oceanic crust. Two distinct reflectors are visible below the trench (74 km - 78 km) indicating an ambiguous geometry of the upper boundary of the downgoing slab.

The Fresnel Volume Migration result (Figure 5.8(b)) shows a considerable improvement of the image. Here, the intra-plate boundary (grey circles) is significantly more pronounced than in the Kirchhoff image (Figure 5.8(a)). Except from the events between 73.5 km and 75 km, which were interpreted as remaining artifacts, the structures within the oceanic crust (yellow circles) can be definitely interpreted as faults. Compared to Figure 5.8(a), the Fresnel image reveals some more details underneath the frontal prism. Here, the seaward and landward dipping faults might be connected. The illustrated part of the prism seems to be penetrated by normal faults (marked by dashed black lines in Figure 5.8(b)) which pass, at a depth of about 7.5 km - 8.5 km, into plate parallel orientation and enclose a zone of strong reflectivity (77 km - 80 km along profile). The counterclockwise rotation of these normal faults might be a result of erosion or entrainment of debris within a subducting graben.

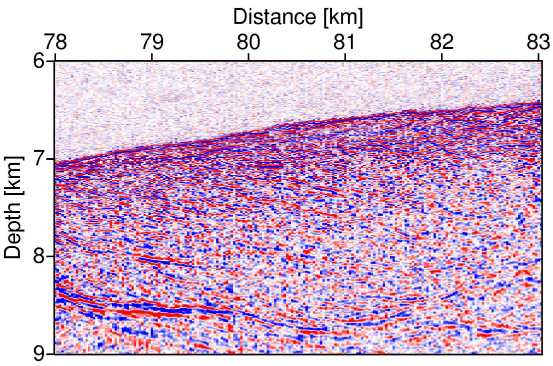
As mentioned above, the downgoing oceanic crust has an ambiguous geometry at the trench. The lower reflector (grey circles in Figure 5.8(b)), if it is related to a downdip graben, might be a result of underthrusting since the horst-like structure at 74.5 km might be wedged at the continental crust.

5.3.3 The forearc

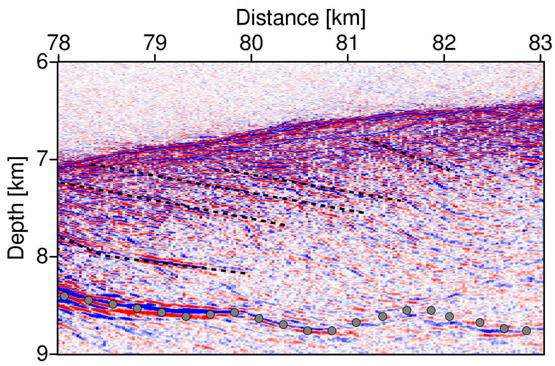
Underneath the continental slope in Figure 5.9, east of the trench, the interface between the continental crust and the subducting plate can be observed down to a depth of about 12 km (grey circles in Figure 5.9(a)). It dips with a subduction angle of about 11° underneath the forearc. This value corresponds to the observations from wide-angle seismics (Lüth, 2000). The small bump in the slab between 81 km and 84 km along profile is likely a subducted horst bordering the possible graben structure



(a) The downgoing Nazca plate underneath the lower continental slope (Kirchhoff image).



(b) Enlargement of the first kilometers of Figure 5.9(a).

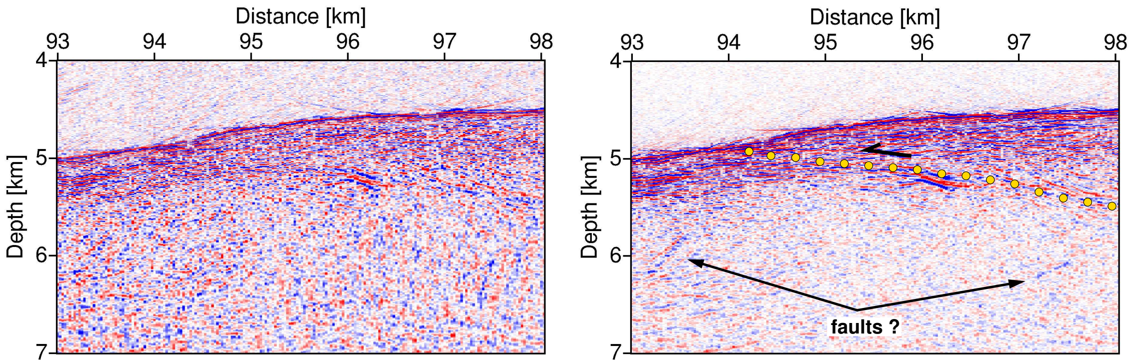


(c) Fresnel image of the same region as shown in (b).

Figure 5.9: (a) Kirchhoff image of the lower continental slope. Grey circles: Upper boundary of the slab shows with a small bump between 81 km and 84 km. Yellow circles: Plate parallel faults. Their outcrops correlate with escarpments at the seafloor. (b) Enlargement of a part of (a) between 78 km and 83 km. (b) Fresnel Volume Migration result of the same region. Dashed black lines: Eastward continuation of the fault system shown in Figure 5.8(b). An enlargement of the region between 93 km and 98 km can be found in Figure 5.10.

in Figure 5.8(a) at its eastern end. Within the overriding continental crust, several slightly eastward-dipping, nearly plate parallel faults are visible at about 83 km, 90 km and 94 km along profile (yellow circles in Figure 5.9(a)). Their outcrops at the ocean bottom correlate with small escarpments at the seafloor.

The enlargements (Figures 5.9(b); (c) and Figure 5.10) zoom in the most interesting parts of the lower continental slope. Already displayed in Figure 5.8(b) are the par-

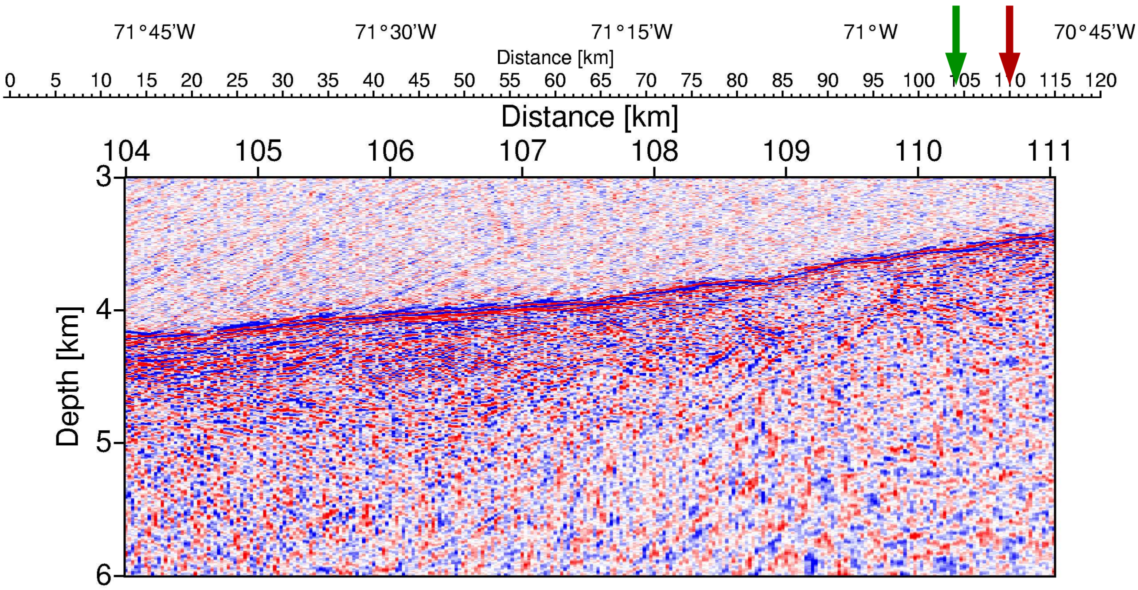


(a) Kirchhoff image of a plate parallel fault. *(b) Fresnel image of the same feature as in (a).*

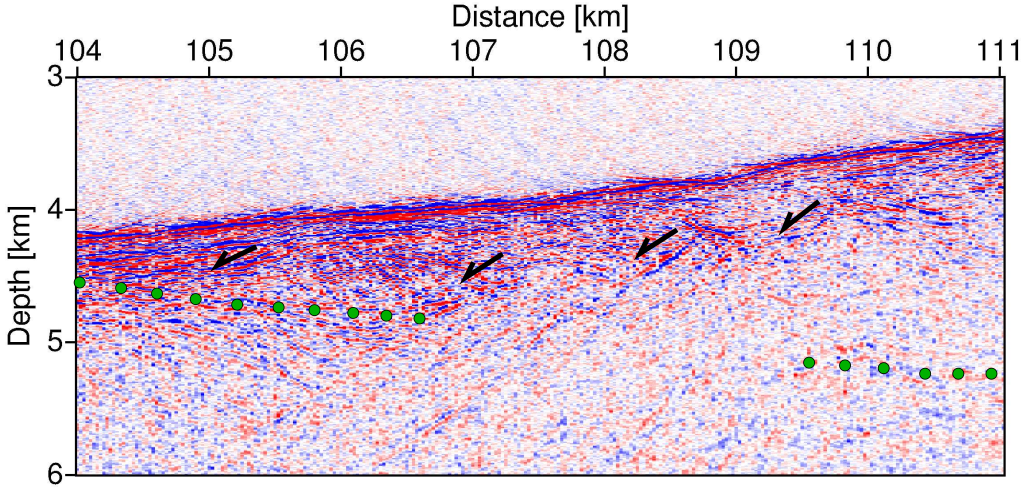
Figure 5.10: (a) Kirchhoff image of a plate parallel fault located between 94 km and 98 km along profile. (b) Fresnel image of the same region.

allel features between 78 km and 80 km (marked by the dashed black lines in Figure 5.9(c)), but here we can observe the eastward continuation of that features to more than 82 km along the profile. A comparison of Figure 5.9(c) with the corresponding Kirchhoff Prestack Depth Migration result (Figure 5.9(b)) shows a significant noise reduction within the Fresnel image (Figure 5.9(c)). The enlargements presented in Figure 5.10 highlight one of the above mentioned plate parallel faults (depicted as yellow circles in Figure 5.10(b)). It can be observed down to approximately 1 km below the ocean bottom. Two weak reflections can be found in the Fresnel image (Figure 5.10(b)) at 93.5 km and 97 km, respectively, which might be identified as faults. However, they are neither connected to the above located plate parallel fault nor to potentially deeper located features.

Below the middle continental slope, between 104 km and 118 km along profile, a landward tilted normal fault system arises (Figures 5.11 and 5.12). Apart from single reflection events between 108 km and 110 km in Figure 5.11(a), these normal faults only appear indistinct in the Kirchhoff images (Figures 5.11(a) and 5.12(a)). In contrast, these fault system can be continuously observed between approximately 105 km and 118 km within the Fresnel images (Figures 5.11(b) and 5.12(b)). At about 104 km, the Fresnel image (Figure 5.11(b)) exhibits a reflector at a depth of 4.5 km as well as a downward continuation of this reflector down to 5 km at 107 km along profile (green circles). This structure as well as further reflector segments (between 109.5 and 111 km in Figure 5.11(b) and between 112 km and 115.5 km in Figure 5.12(b)) indicate a slightly landward dipping detachment (green circles). Besides the normal faults, several reflectors above the normal faults can be found between 112.5 km and 116 km along profile.



(a) Kirchhoff image.

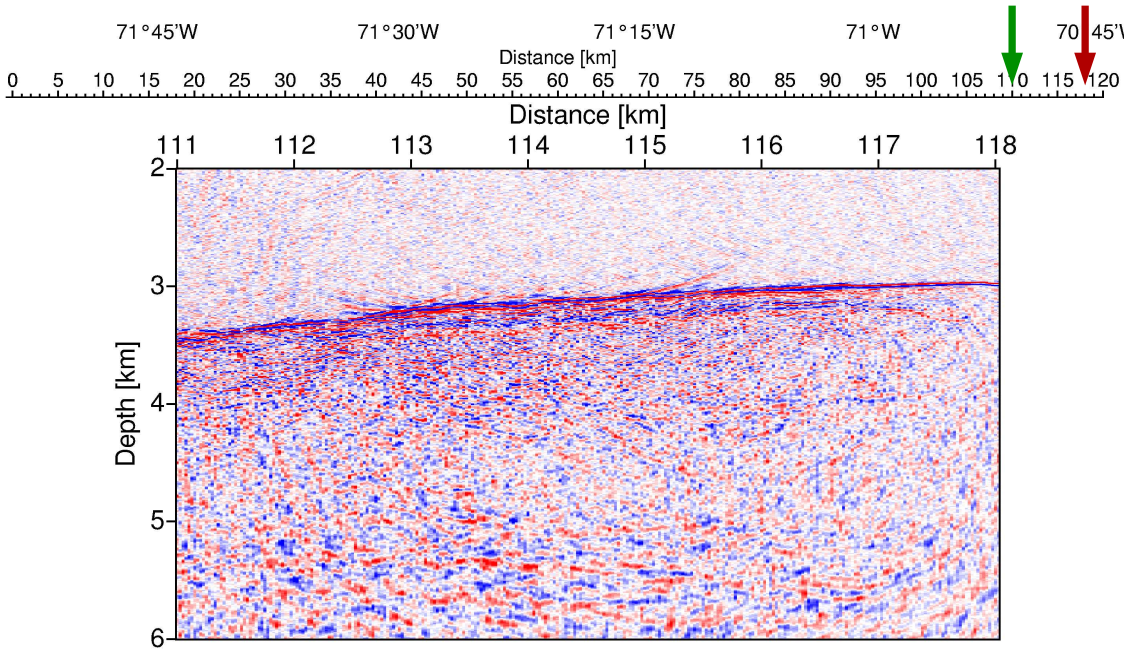


(b) Fresnel image.

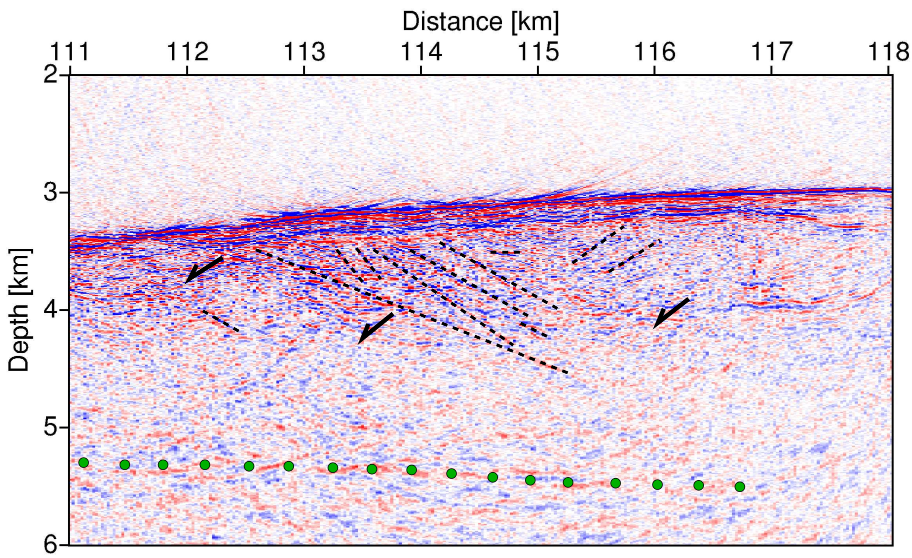
Figure 5.11: (a) Kirchhoff image of the region between 104 km and 111 km along profile. (b) Fresnel image of the same region as shown in (a). The arrows mark the locations of some normal faults and the green circles depict the detachment.

5.3.4 Deep structures

The data quality of the western part is poor. Nevertheless, we observe a slight horizontal reflection at the beginning of the profile at a depth of 7 - 8 km below the seafloor (Figure 5.13). This event, strongly disturbed by multiples which were generated by the seamount, might be connected to the oceanic Moho but it does not continue to the east within the complete line.



(a) Kirchhoff image.



(b) Fresnel image.

Figure 5.12: (a) Kirchhoff Prestack Depth Migration result of the middle continental slope between 111 km and 118 km along profile. (b) Fresnel Volume Migration result of the same region as shown in (a). The dashed black lines indicate faults above the normal faults which are marked by arrows. Again, the green circles depict the detachment.

Apart from the upper boundary of the downgoing Nazca plate, no further reflectivity is found in depth.