P027 STRUCTURE OF CRUST OF KURIL-KAMCHATKA REGION FROM 2-D INTERPRETATION OF REFRACTION DATA

V.B. PIIP and A.L. VOLOKH
Moscow State University, Geological faculty, Vorobjovy Gory, 119899 Moscow, Russia

Abstract

Structures of the crust including zones subduction and rift zone were obtained from the reinterpretation of refraction data of past years in the region of Kuril trench and Sea of Okhotsk. Numerous faults and thrust break the subducting slab in the Kuril trench. Complex and deformed blocks of oceanic crust and upper mantle form the hanging wing of subduction zone. In the central part of the Sea of Okhotsk the structure of relic subduction zone is obtained. The rift or spreading structure is present in the cross sections of central part of the Kuril basin. Remnants of subducted plate are revealed in the cross sections near the Sakhalin shores. Slab-melting is present in active subduction zone near shores of Kamchatka. The depth of Moho agrees with the data of former interpretation.

Introduction

Kuril-Kamchatka region is key region for understanding of global plate tectonics. Two continental plates, the Eurasian and North American, and oceanic Pacific plates contact in this region. Several subduction and collizional zones divided these plates. All of them are characterized by high seismisity and generate active volcanic chains. Over 30 profiles of the Deep Seismic Sounding were carried out at the period of International Geophysical Year in 1958-1959 by Institute of Physics of Earth of Academy of Sciences of USSR (Fig.1). Seismic stations were placed at the distances of 20-70 km and the shots were produced at 2-5 km interval. Interpretation of these data at the past time had served by basis for studying of geological structure of the region (Structures…1964). The former cross section contained only 2-3 seismic boundaries. Now the traveltime curves of first arrivals along 26 profiles have been reinterpreted using new computer technique.

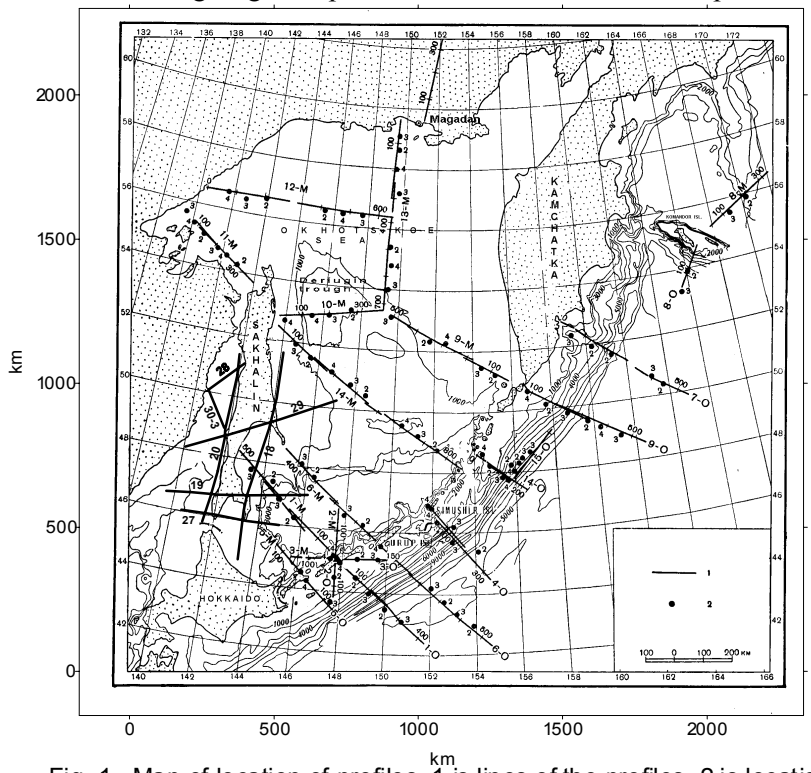

Fig. 1. Map of location of profiles. 1 is lines of the profiles, 2 is location of seismic stations

Method of interpretation

The method of homogeneous functions was used for reinterpretation (Piip 1991). Method is based on the local approximation of real velocity fields by homogeneous functions of two coordinates. It allows receiving automatically 2-D velocity fields defined in the nodes of rectangle grid. Cross sections are represented as field of velocity contours with constant interval (usually 0.1-0.2 km/s). Seismic boundaries and faults are seen in these cross sections. Such representation of cross sections allows easily to compute horizontal depth velocity maps-slices if several seismic profiles were interpreted in the area. Any initial model is not used for this interpretation technique. Ray tracing method had verified reliability of them. In fig. 2 the observed traveltime curves along profiles 1M-1O is shown. For the cross-section along these profiles the times have been computed in 1912 points and RMS has been obtained 0.4 s.

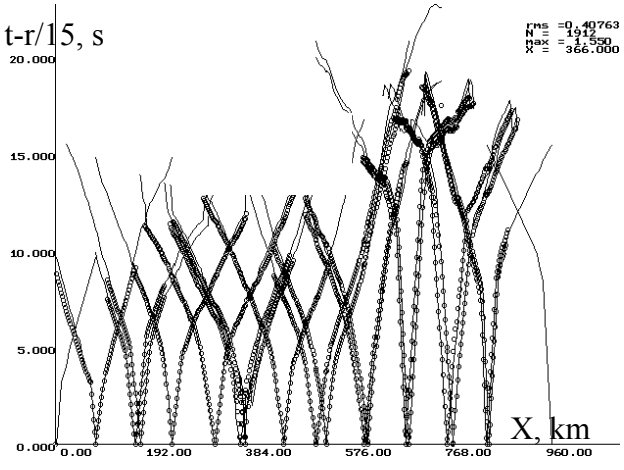

Fig.2. Observed traveltime curves (thin lines) and computed times (circles) for the cross section along profiles 1M-1O. RMS is 0.4 s.

The northern part of the area, Sea of Okhotsk.

Two profiles 9 O and 9 M intersect the Sea of Okhotsk and the Kuril trench near southern edge of Kamchatka peninsula. In the cross section (Fig. 3a) the accretionary prism, subducting oceanic slab, hanging wing of subduction zone are distinguished. Oceanic mantle is characterized by deformations of compression. The thrusts are present in the distances of 750-1000 km of profile. Relatively small accretionary complex is present in this cross section. The areas with low velocity values are located near of edge of subducting slab. This is interpreted as slab-melting. In the north part of Sea of Okhotsk the depth of Moho is over 30 km and therefore the crust of continental type exists there. In the crust three layers, marked as A, B and C are distinguished. Structures, interpreted as relic subduction zones, are present in the Sea of Okhotsk and under Kamchatka peninsula. These structures have approximately equal sizes and the following common features. These are 1) existence of gentle fault (about 15°), penetrating from sediment layer in upper mantle; 2) interruption of Moho; 3) disappearance or decreasing of thickness of layer A. Similar structures at the correspondent distances are present in the cross section of neighboring profile 14 M. The existence of these structures confirms the trench jumped oceanward in this region.

The southern part of the area, Kuril Basin

Two profiles 1 M and 1 O intersect the Kuril basin and Kuril trench (fig. 3b) in the southern part of the area. In the Kuril basin the depth of Moho is 15-20 km and therefore the crust has oceanic type. Two layers (II and III) are represented in the crust. In western part of the cross section the subducted plate is traced. This is a part of subduction zone near Sakhalin shores possible this is relic zone. These results is in accordance with data of reinterpretation of refraction profiles nearby Sakhalin (Piip1997). In the central part of Kuril Basin the rift or the spreading structure is present. Faults forming it penetrate in upper mantle, where zones with anomaly low velocity (7.0-7.5 km/s) are distinguished. Possibly areas of melting rocks is present here. Geologists propose existing of rift structure in the Kuril Basin (Maruyama et al 1997). Under the Kuril Arc (Fig. 3b) the upper mantle has low velocity (7.0 km/s), possibly these are

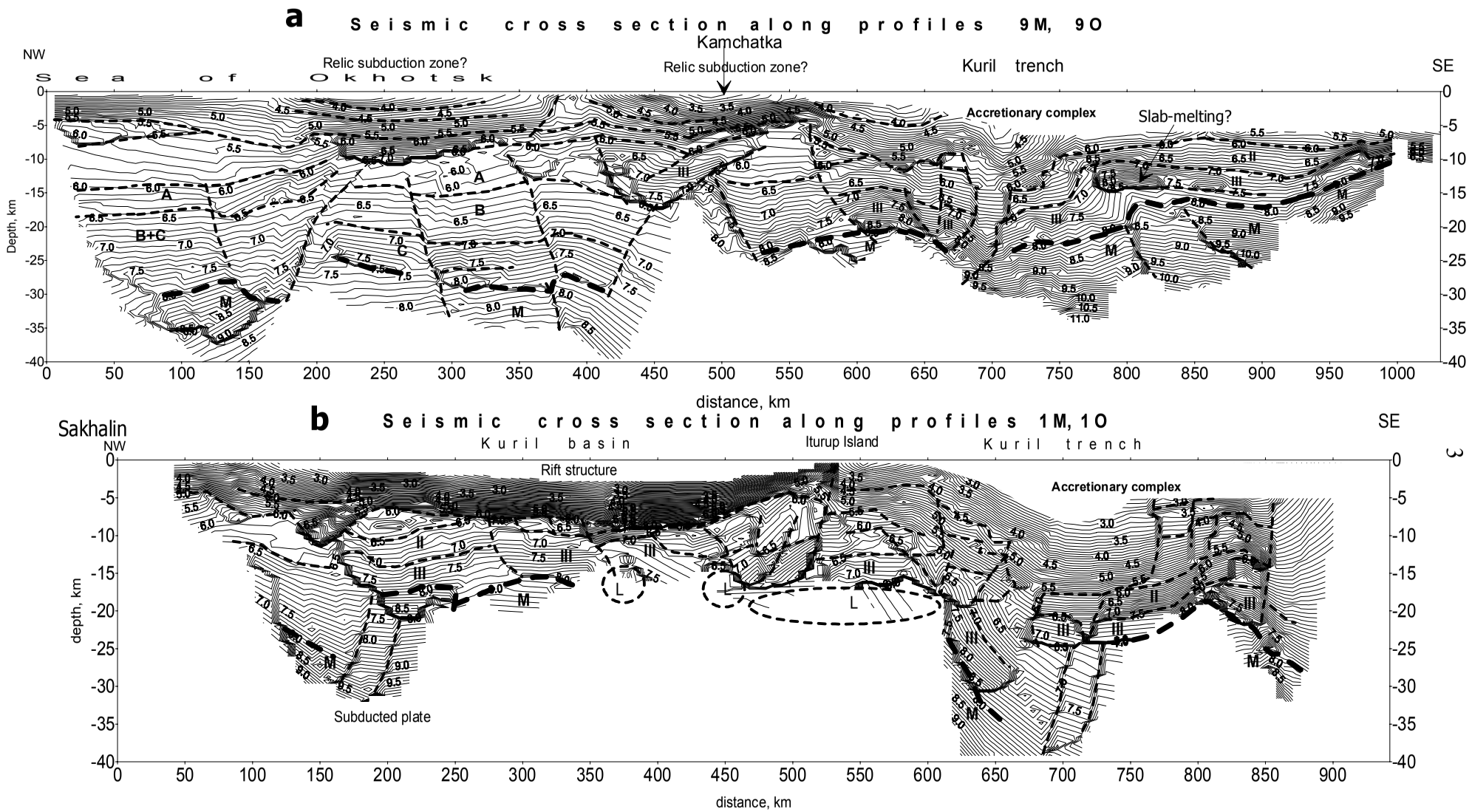

Fig.3. Seismic cross sections along profiles 9M-9O (a) and 1M-1O (b). Thin lines are velocity contours. Contour interval is 0.1 km/s. Faults and seismic boundaries are shown by dash lines. I,II,III,A,B,C mark the layers. M is upper mantle. Supposed zones of melting rocks are designated by L.

zone of melting rocks. Very thick accretionary complex (about 200 x 20 km) in region of Kuril Trench contain the folded layers of sediments and oceanic crust. Complex and deformed blocks of oceanic crust and upper mantle form hanging wing of subduction zone.

The Kuril Trench

Several horizontal map-slices at different depth were constructed. As velocity contours are parallel to seismic boundaries in the cross sections and velocity increases with depth, as a rule, the horizontal velocity map-slices image location of depth structures of crust. Areas with low velocity are troughs and areas with high velocity are uplifts. Faults and thrust also are reflected in velocity map-slices.

In fig. 4 the velocity map-slice at the depth 12 km is represented. The structures of the accretionary prism, third layer of oceanic slab, relic subduction zones and Kuril Basin can be seen in the map-slice. Accretionary prism in region of the Kuril Trench (low velocity zones in Fig. 4) is broken onto large segments which are turned around relatively of axis of the trench. This testifies the oblique subduction in

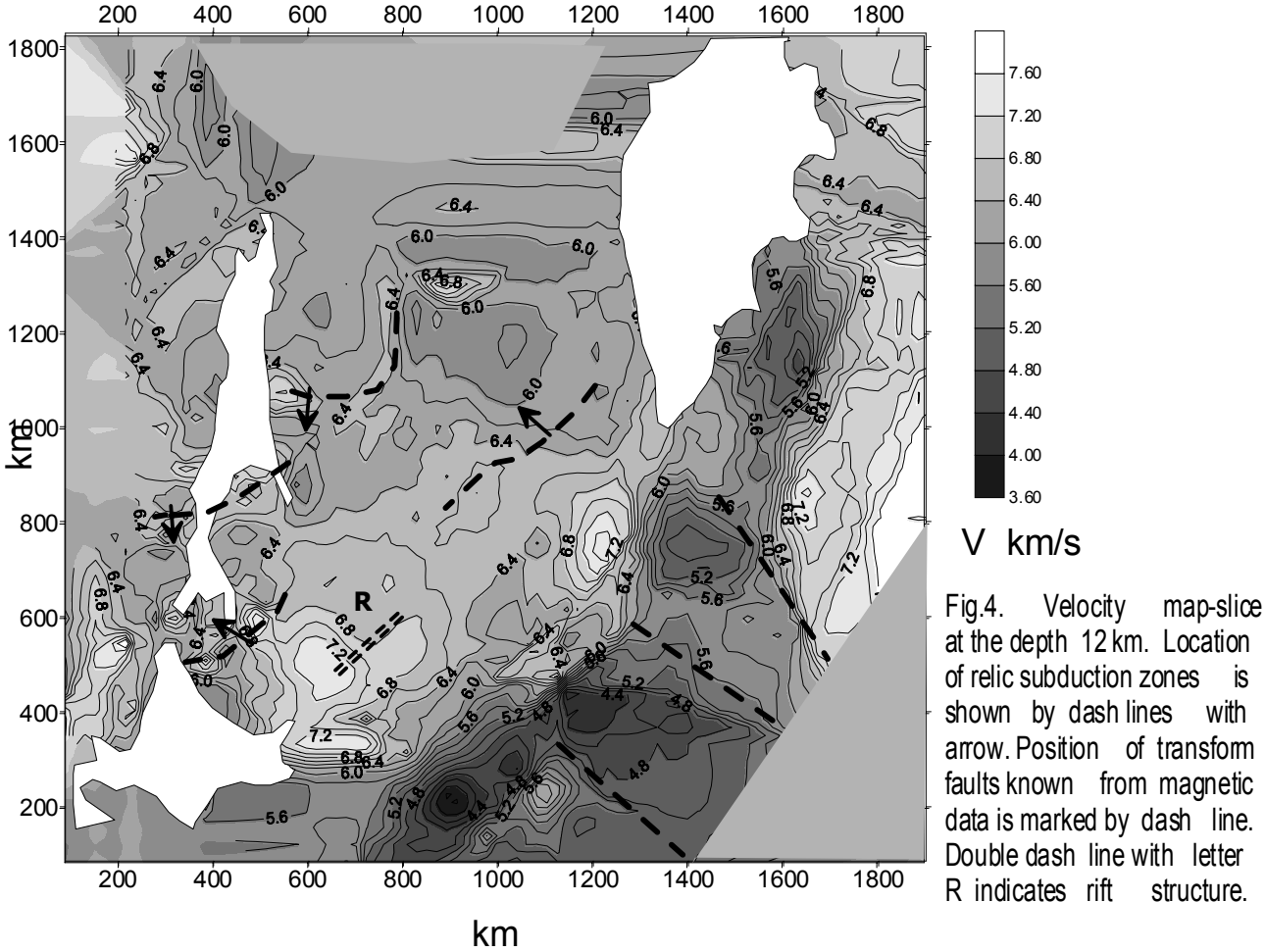

Fig.4. Velocity map-slice at the depth 12 km. Location of relic subduction zones is shown by dash lines with arrow. Position of transform faults known from magnetic data is marked by dash line. Double dash line with letter R indicates rift structure.

this region (Maruyama et al 1997). Several transform faults of Pacific oceanic plate are shown in the map. Location of these faults is known on the seismological and magnetic data.

References

1. Structures of Earth Crust in area of transition from Asia continent to Pacific Ocean. Moscow. 1964. “Nauka”. 308 p. (In Russian)
2. Piip V.B. 1991. Local reconstruction of seismic refraction sections on the basis of homogeneous functions. *Izvestiya, Academy of Sciences, USSR, Physics of Solid Earth* **10**, 844-850.
3. Piip V.B. 1997. Depth Seismic refraction cross sections of Sakhalin (Russia) on the data of reinterpretation using 2-D inversion method. *Proceeding of 30th International Congress,* vol. 20, pp11-20.
4. Maruyama S., Isozaki Y., Kimura J. and Terabayashi M. 1997. Paleographic maps of the Japanese Islands: Plate Tectonic Synthesis from 750 a to the present. *The Island Arc.* Volume 6, Issue 1, March, 91-120.