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# A group velocity of seismic love surface wave and lithosphere structure in Antarctic Peninsula

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**Abstract** This paper is based on the surface wave seismogram of South Sandwich Island earthquake (Ms = 6.4) recorded by Antarctic General Bernardo O'Higgins Station. We computed a group velocity dispersion of Love surface wave and obtained lithosphere structure by using the method of the matched-filter frequency-time analysis and grid dispersion inversion. Our result shows that crust structure below Antarctic Peninsula may be divided into three layers and their thickness are respectively 5 km, 8 km and 10 km. Upper mantle velocity is 5.32 km/s and gradually changes into 5.11 - 4.9 km/s below 53 km. The mininum velocity is 4.8 km/s. It can be referred that Antarctic mantle is also of layered structure.

**Key words** Antarctic Peninsula, Love surface wave, matched-filter frequency-time analysis, grid dispersion inversion.

## 1 Introduction

Since Gondwana land was disintegrated, Indian Ocean Plate has been fractionalized once more, moved and displaced forward to the south in form of fraction, gradually matched to the Europe-Asia Continent. Continental accretion formed Antarctica, which stands facing the Qinghai-Xizang (Tibet) Plateau across Indian Ocean (Zhu and Teng 1984). The comparative study of Qinghai-Xizang (Tibet) Plateau and Antarctica is undoubtedly very important to inquire into the global continent geodynamics. In order to carry on this study, it is first necessary to have a distinct understanding of earth's interior, especially lithosphere structure. All the geoscience workers of the world attach great importance to the reseaches of the lithosphere structure in Antarctic region. In solid-state geophysics the deep-seated structure was obtained below the station of study region in Antarctica by seismic body wave (Shu and Zhang 1995), the

man-made deep seated quake (Ashcroft 1972) and magnetotelluric prospecting methods, etc. (Kong and Zhang 1995). However, because of the limitation of geographic environment and climatic condition, the study of the lithosphere structure below the broad Antarctic continent and its surrouding sea area is being made preliminarily at present. This paper is based on the surface wave seismogram recorded by Antarctic General Bernardo O'Higgins Station, the most new technique of frequency-time analysis and the methods of grid dispertion invertion (Hu *et al.* 1992) are adopted in reseach of shear wave velocity structure of Antarctic region, the obtained results may help to cognize the lithosphere formation and its evolution in Antarctica.

## 2 Methods and recording

### *2.1 Methods*

The matched-filter frequency-time analysis used in this paper may improve the resolution and the precision of dispersion data in a broader range of frequency with reduced errors (Hu *et al.* 1992). The grid dispersion inversion is considered as a method, which can be adapted in research of the regional tectonics and lateral inhomogenity on a geometry grid scale in a large area , it can be also used to study the lithosphere structure in a broader area below Antarctica. In inversion procedure, the Love wave dispersion are calculated for acquring the lithosphere structure.

### *2.2 Recording*

An earthquake (Ms = 6.4) recorded by Antarctic General Bernardo O'Higgins Station (GBO, 57°54′W, 63°19′S), happened in South Sandwich Island (24°29′W, 57°47′S) at 14h 52min 09.8s, April 14th, 1986 GMT. The earthquake is selected to study the lithosphere structure below Antarctica. The surface wave is considerably certain from the recorded seismogram (Fig. 2). The synthesis is in progress after digitalization, and the Love wave was extracted from radial components in horizontal direction for inversion computation.

## 3 Inversion and calculation dispersion of Love wave

By processing data and computation, the group velocity dispersion curve of Love wave along the focus — station path for 14 periods in the range of 10.45 s to 34.75 s was obtained. On the basis of fitting group velocity dispersion curve the lithosphere structure below Antarctic region along the path had been obtained.

### *3.1 Initial model*

Selection of initial model according to the work and results in Antarctic region has been done. Since surface wave dispersion is sensitive to the velocity of shear

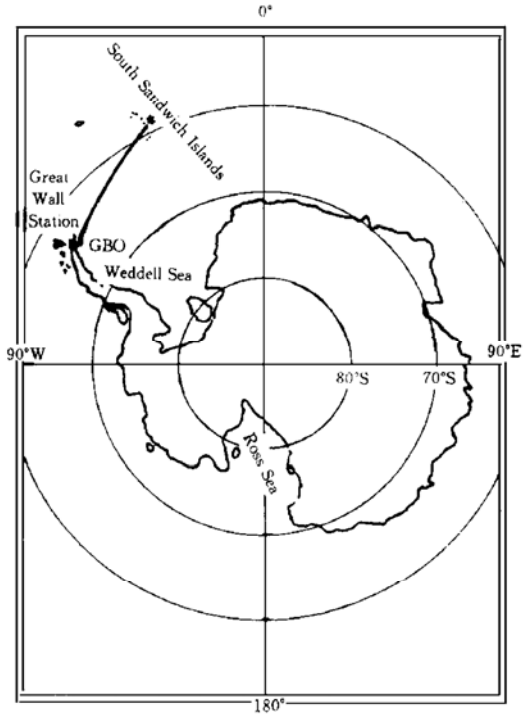


Fig. 1. The erathquake epicenter and seismic station in Antarctica.

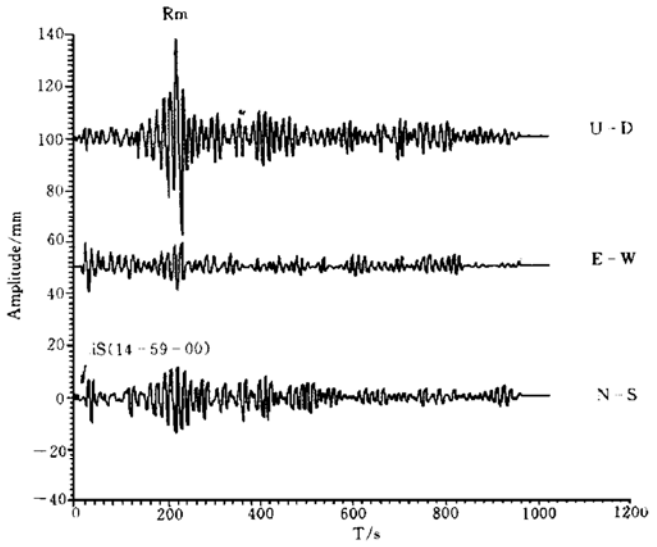


Fig. 2. A surface wave seismogram recorded by GBO Station in the Antarctic Peninsula.

wave, so in carring out inversion, S-wave velocity of each layer is regarded as an independent variable, density and P-wave velocity can be deduced by experiential formula, the thickness of each layer is modified during inversion.

### *3. 2 Dispersion curve*

It is shown in Fig. 3 that the theoretical dispersion curve of Love wave is fitting in observed dispersion, and by comparison with them, the one is fairly good in line with the other. Obviously, it indicated that the intial model and inversed result are acceptable and stable.

### *3. 3 S-wave velocity structure*

According to the group velocity dispersion of Love wave, Harkrider's (1964) algorithm and Rodi's (1975) generalized linear inversion program are used to inverse the S-wave velocity, which is regarded as an only variable in stochastic inversion, and the final model of lithosphere structure has been obtained (Table 1) after calculation.

Table 1. The lithosphere structure in the Antarctic Peninsula region

| Station position | Epicenter position | Depth /km | Thickness /km | S-wave velocity /km·s$^{-1}$ | Station position | Epicenter position | Depth /km | Thickness /km | S-wave velocity /km·s$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|
| Antarctic Peninsula | South Sandwich Island | 5 | 5 | 3. 03 | Antarctic Peninsula | South Sandwich Island | 48 | 15 | 5. 11 |
| | | 13 | 8 | 3. 56 | | | 63 | 15 | 4. 98 |
| | | 23 | 10 | 3. 95 | | | 83 | 20 | 4. 89 |
| | | 33 | 10 | 5. 32 | | | 166 | 83 | 4. 80 |

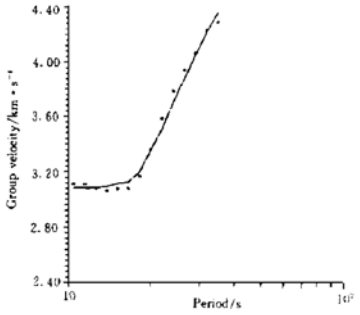


Fig. 3. A group velocity dispersion curve of Love surface wave. ●:Observed; —:Calculated.

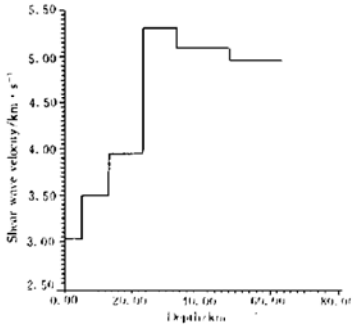


Fig. 4. A velocity-depth curve of S wave and lithosphere structure on the path between seismic station and epicenter.

## 4 Results and analysis

On the basis of inversion and calculation above, the S-wave velocity structure in lithosphere along the peak of Peninsula to South Sandwich Island path has been obtained. Obviously, it is shown in Fig. 4 that the lithosphere is also layered struture in this region, that the velocity of each layer increase with the increasing of depth, and crust is divided into three layer which depths are respectively 5 km, 13 km and 23 km. Moho boundary is seated at the depth of 23 km. On the top of mantle is a cap rock of 10 km, of which the velocity is 5.32 km/s. Under the depth of 33 km, the S-wave velocity decreases from 5.11 km/s to 4.8 km/s at least with increasing of depth where it may be the top of low-velocity layer in upper mantle. It is obvious that the lithosphere is layered structure in Antarctic region, and, moreover the crust thickness and the depth of asthenosphere are shallower than those in the region of mainland of China (Teng *et al.*, 1995).

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