Receiver functions obtained for seismic station Vitosha (VTS)

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Abstract

Receiver function technique was applied to the data from 11 seismic stations from National Digital Seismological Network (NDSN). The depth of Mohorovicic discontinuity was estimated beneath 10 of the seismic stations. Station Vitosha (VTS) is the only one, where the depth was not calculated. The reason for this is the very complex structure, obtained beneath this station.

Data and Method

Receiver function technique was developed from to the seismic processing methods to obtain crustal and mantle structure in regions where not enough seismic stations are presented. Seismic array used in other methods is replaced by a set of earthquakes with certain parameters – epicentral range between 30^o and 95^o and magnitude in range 5-7 (Vinnik, 1977, Langston, 1979).

The seismogram is first rotated into a new coordinate system – LQT (or P-SV-SH). L component is in the direction of the main P wave energy, the Q component is perpendicular and in the direction opposite to the earthquake epicenter and the T component is perpendicular to the LQ plane. After the rotation if the media beneath the stations is homogeneous and discontinuities horizontal, the whole energy of the P wave is along the L component, the whole energy of the P wave coda is on the Q component and on T component one should not observe P wave energy. Then receiver functions are computed with deconvolution of the horizontal component (Q) by the vertical (P, L). A moveout correction is also needed.

To compute earth's crust thickness the method of Zhu and Kanamori and seismic inversion can be used.

Results for station VTS

Seismic station VTS is located in Vitosha mountain close to Sofia. In this station several types of seismometers are installed but in this study the data from STS1 is used. VTS is the station from NDSN with lowest noise level (Dimitrova&Nikolova, 2011) thus it is very good station for different seismological studies.

Receiver functions were computed for 211 seismic event, recorded in station VTS. A good azimuthal coverage was reached although there are several intervals without data - 110^o-124^o, 178^o-210^o, 308^o-329^o, 2^o-348^o. (Fig. 1.)

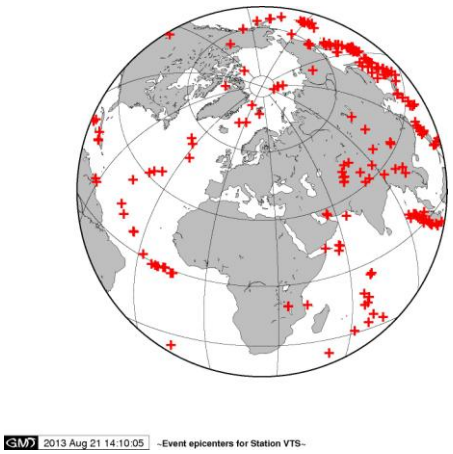


Fig. 1. Map of earthquakes, recorded in station VTS and used in the study.

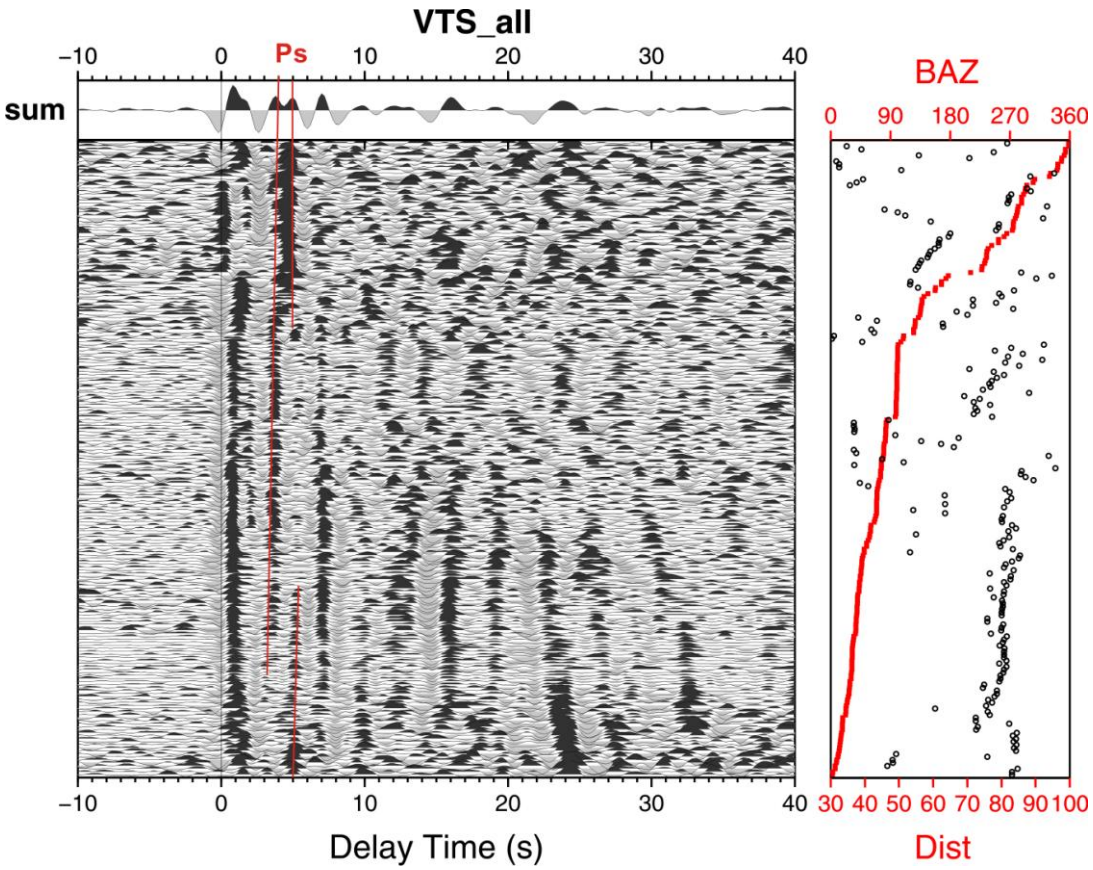
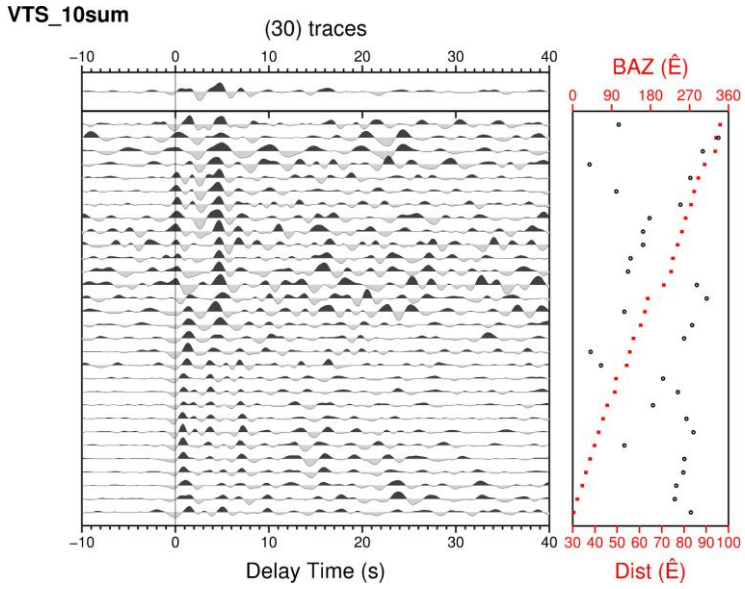


Fig. 2. Stacked and sorted from 0° to 360° azimuth receiver functions, obtained for VTS station. Red squares in right

Seismic station VTS has the best conditions for application of the receiver function technique compared to the other stations from NDSN. On the other hand stacked receiver functions (Fig. 2.) show very complex nature. The converted P-to-S (Ps) phase is presented with two clear phases. First of them has 3,7 s onset and the second has 5 s onset. In the azimuthal range 40°-140° Ps phase has an earlier onset than in azimuthal range 160°-30°. The time difference in both intervals is about 1,3 s. In range 40°-100° both phases



are observed. The earlier phase which indicates a discontinuity in the crust also has different onset time in

Fig. 3. Receiver functions sumed in every 10° azimuth and then stacked and sorted.

some azimuthal intervals. Such stacked receiver functions plot can be obtained in several cases: if the bondaries are not horizontal, or if one or more anisotropic layers are presented in the crust (Eckard&Rabbel, 2011). The different onset times is also very well visible when sum receiver function for every 10° and then stack and plot them together (Fig. 3.)

As it was mentioned before, the T component should not have energy. If we look at the T component for station VTS, we can see very clear positive and negative phases (Fig. 3). This means that after rotation of the seismogram some P wave energy remains on the T component. Such case usually indicates that beneath the station anisotropic layer maybe presented. It can be also geological structure beneath the surface. In the case of VTS station such geological structure can be the Vitosha fault, situated close to the seismic station. Receiver functions for VTS station are also azimuth dependent.

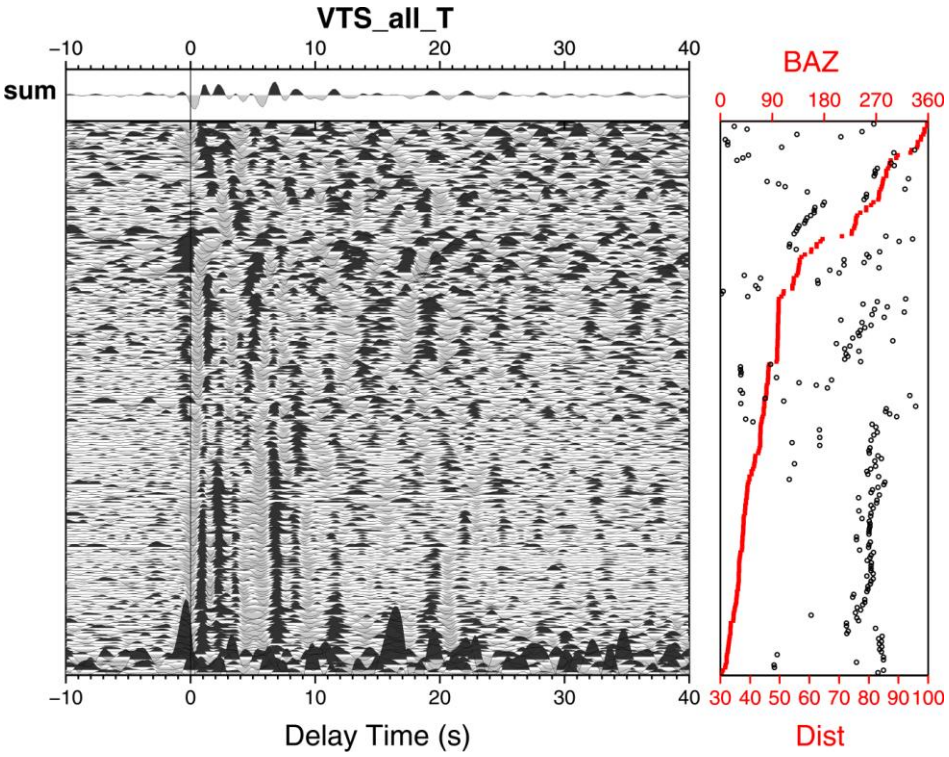


Fig. 3. Stacked and sorted T components for station VTS.

Zhu&Kanamori (2000) method is usually used with receiver function technique to obtain the depth of Mohorovicic discontinuity. It was also applied to the data recorded in seismic station VTS. The receiver functions were grouped in two azimuthal intervals according the onset time of converted phase. First of them is the range between 30° and 70° and the second between 100° and 30°. The depth in the first interval is estimated about 35 km. In the second interval it is more than 50 km. Vp/Vs ratio is very hight – 1,8-1,9. Such values are typical for the regions with active volcanos and subduction zones. There is no information for such activity near Vitosha. So I can conclude that the Zhu and Kanamori method is not good for VTS station.

To obtain the Moho structure and depth beneath the VTS station more studies are needed including other geophysical methods.

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Функции на приемане за сеизмична станция Витоша (VTS)

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Въведение

Методът на функциите на приемане беше приложен към 11 от станциите на Националната цифрова сеизмична мрежа (НЦСМ) и за 10 от тях беше определена дълбочината на границата на Мохоровичич. Станция VTS е единствената, при която не беше определена дебелината на земната кора. Причината за това е изключително сложния строеж, който беше получен за района на станцията.