Rayleigh wave analysis over Mid-oceanic Ridge

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Abstract:

The Aim of our study is to extract the 1-D shear velocity structure over the axis of Mid-oceanic ridge. One of the methods to achieve this is the Rayleigh wave group velocity analysis. The cluster of events are selected, which is recorded at single station. Here the both events and station located on mid-oceanic ridge. The Rayleigh wave dispersion curve is obtained for a period between 10 to 70 sec from a cluster of events and inverted for 1-D shear velocity structure. The result shows the oceanic crust has two layers, first layer is 1km thick with shear velocity Vs 3.33 km/sec having a average density of 2.66 gm/cc and second layer thickness is about 4 km, shear velocity Vs is 3.7 km/sec with an average density of 2.8 gm/cc. The Moho is not sharply defined because of viscous nature of mid-oceanic ridge and my study shows the Moho depth occurs at the depth of 8.5 km.

Key words – Shear velocity, Rayleigh wave, Moho, Cluster, Dispersion.

1. Introduction

Generally the Mid-oceanic ridges are always seismically active, the reason is, it is the place from where the magma up-well and form the new oceanic crust . The viscous magma result in low seismic velocities. My study has been done on south-east Indian Ridge because of availability of seismic station, events and the ray path is sampling the ridge. To study the earth structure one of surface wave called Rayleigh wave is suitable for its non-dispersive nature. But if there is a inhomogeneity in the sub-surface Rayleigh wave get dispersed. This property we use to study the crust and upper mantle structure of the earth. The depth of penetration increases with increasing period of the wave and increasing distance of its propagation trajectory. This method was used by many to investigate sub-surface structure (McEvilly 1964.); (Mei Feng et,al ,2004); (Luigia Cristiano ,2010). To calculate the Rayleigh wave group velocity we used a technique called Multifilter technique (MFT). MFT was developed by Dziewonski et al. (1969), to obtain group velocity dispersion curves for a specific mode from complex multi-mode dispersion signal. Then I inverted the Rayleigh wave group velocity for shear wave velocity structure. To accomplish this a program called surf96 is used which was developed by (Hermann and Ammon, 2002). This program is a damped least square method .

2. Data

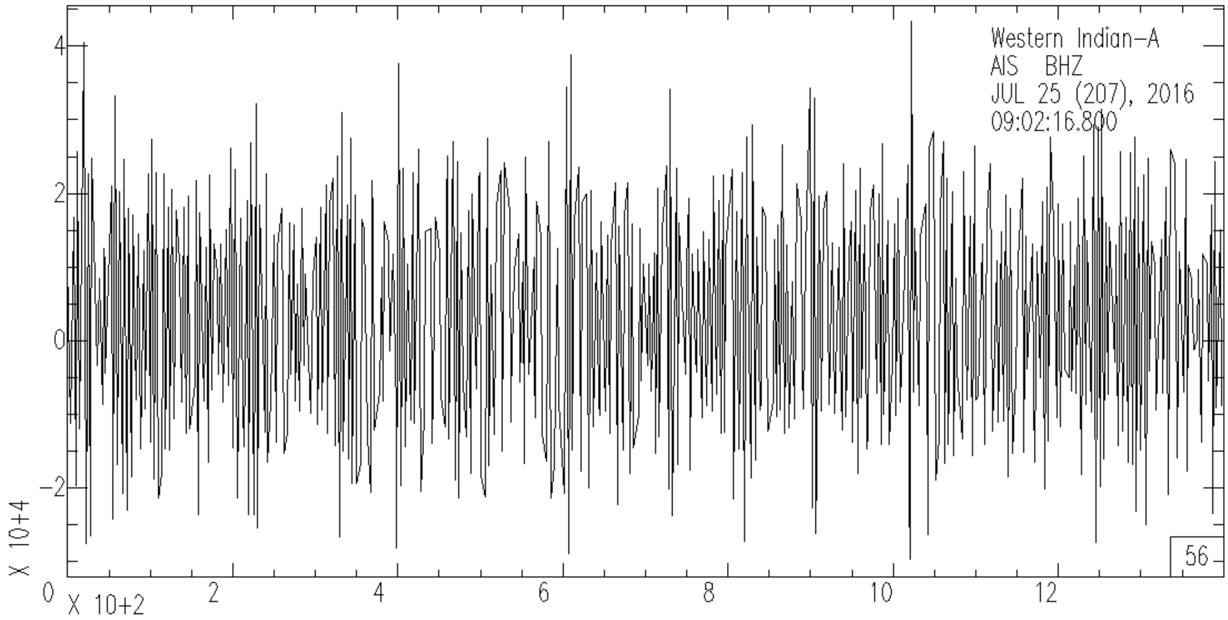
Here a vertical component seismogram is used for Rayleigh wave analysis. The Events which occurred in between 2014-2017 and having a magnitude between 5 to 6.5 is selected listed Table.1. The digital waveform downloaded from IRIS data management center for the station AIS of GEOSCOPE network. The station AIS have sensor installed is broad band seismometer which is STRECKEISEN STS2.

Table.1 Event information used in this analysis

Event Date	Event Origin time	Depth	Magnitude
YYYY-MM-DY	**HR-MN-SEC**	**KM**	**Mw**
2016-07-25	09-02-16.766	10	5.8
2016-07-25	09-04-14.953	10	5.5
2016-09-06	12-08-19.762	10	5.3
2016-11-10	12-26-48.288	10	5.2

3. Methodology

Since the wave form recorded at station have also contain certain amount of noise, at first from the wave form instrument response is deconvolved by using poles and zero file and then band pass filter is applied to remove unwanted noises. Now one can compare the noise data and noise free data given in **Fig.1**. Next we applied a MFT (Multiple Filtering Technique) developed by Dziewonski et al. (1969); Herrmann (1973); Bhattacharya (1983) Herrmann & Ammon (2002); Herrmann (2013) to obtain the dispersion curves for a cluster of earthquakes recorded at AIS station. The basis of this method is the property of a dispersive signal that different frequency components arrive at different times. This method consists of application of an array of narrow filters to the complex seismic signal. These narrow filters may resolve transient signals composed of several dominant periods that arrive at the recording station almost simultaneously. Using the filtered amplitude, I calculate the group velocity for a period between 10 to 70 sec, **Fig.2**.



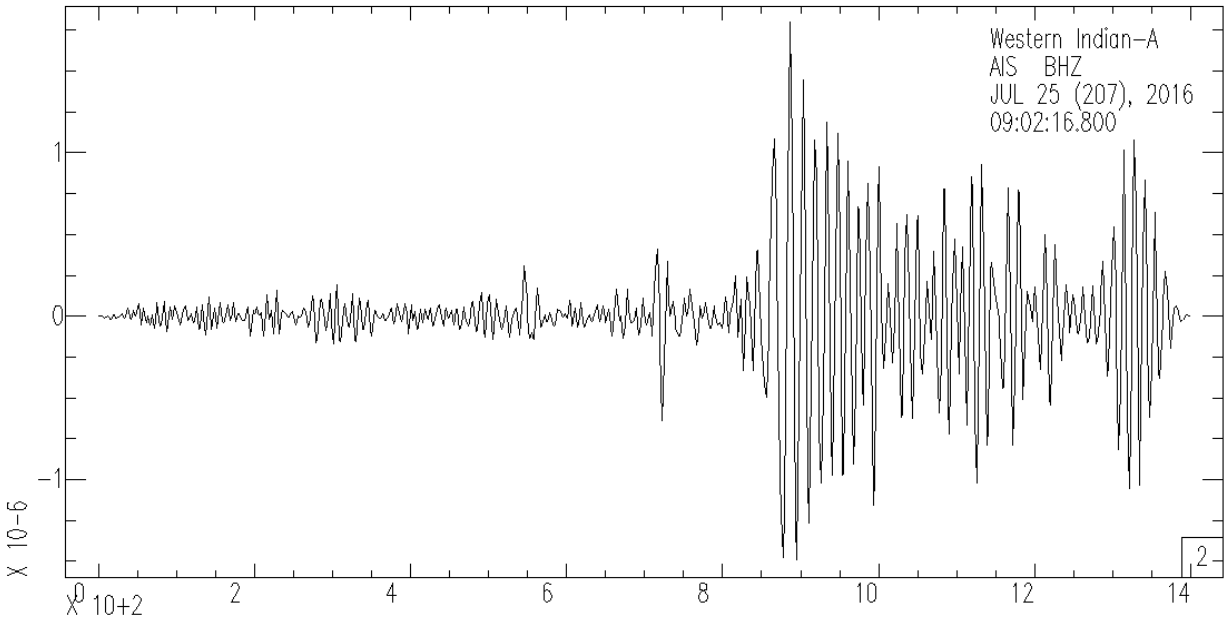


Figure 1. The top image is noised data and below image is noise filtered data.

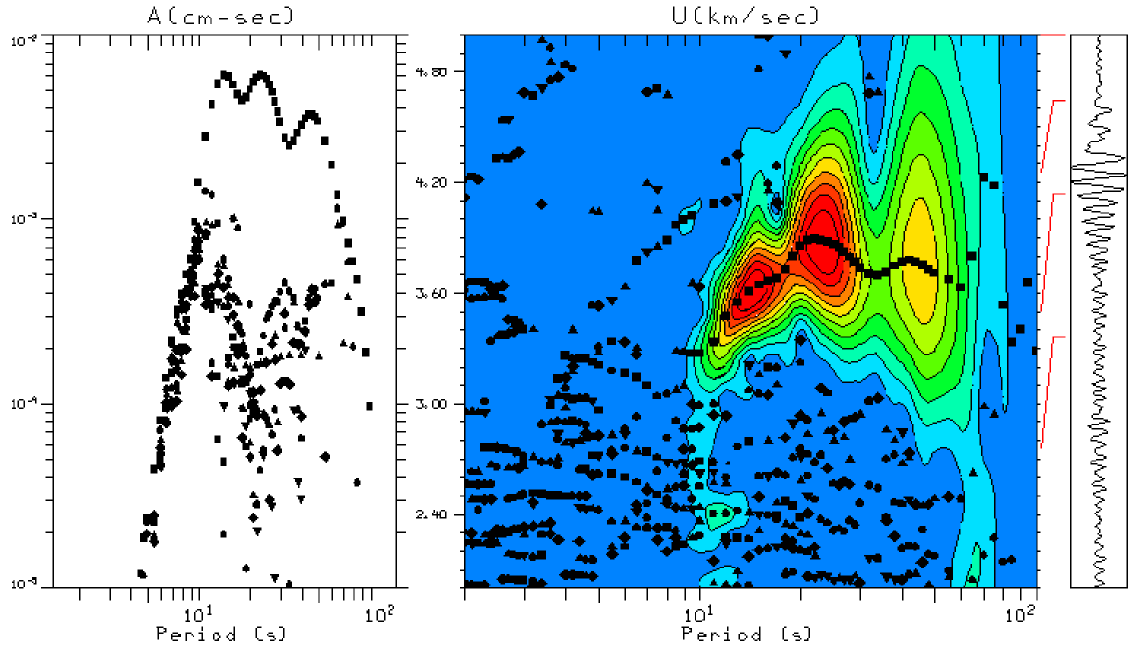


Figure 2. Left Image is amplitude spectrum and Right Image is Rayleigh wave dispersion curve

After getting a dispersion curve, we used a program called SURF96 of Herrmann & Ammon (2002) to invert a dispersion curve into a 1-D shear velocity model. This method is damped least square method which is a type of linear inversion. SURF96 produces a more regular solution mostly because it is typically run with a smoothing constraint. It provides a good fit to the data, but convergence is dependent on the starting model. For inversion we need to input a initial model file, and here I used a model LITHO1 of Pasyanos et,al (2014). The initial model is parameterized into a thin layer of 1km upto Moho depth and then to 5km thick upto bottom of asthenosphere. The inversion result are shown in below **Fig.3.**

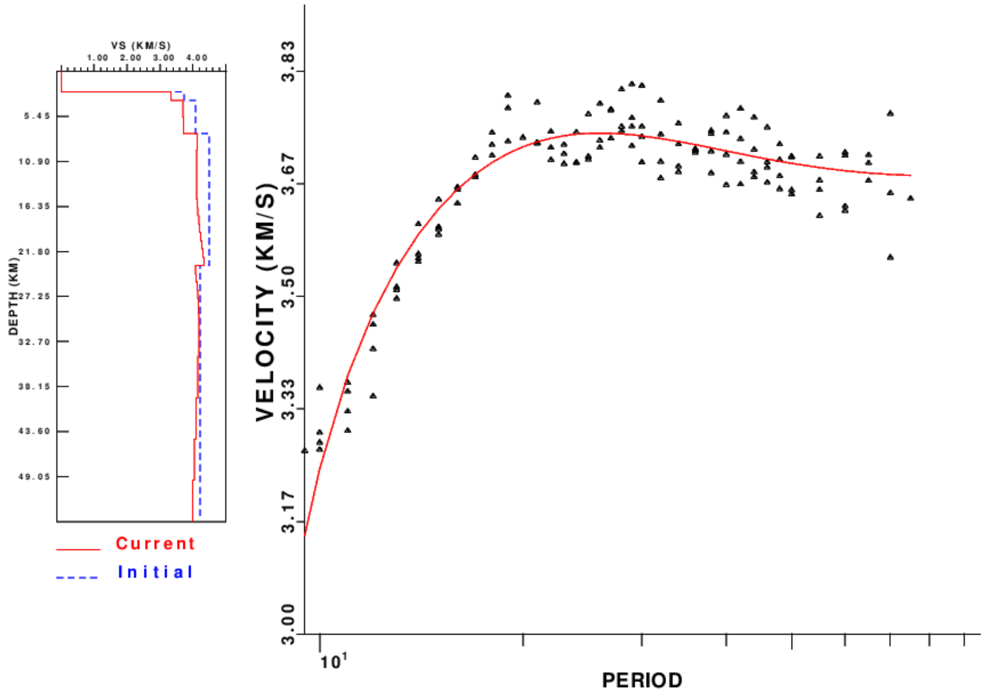


Figure 3. Left image is inverted shear shear velocity 1-D model, and Right image is cluster of dispersion curve and red line is theoretical curve

4. Results:

The out put of my study is the layers parameter of 1-D shear velocity structure. The layers parameters are given in below Tables.2.

Table.2 Layer parameters of Oceanic Ridge

Depth(Km)	Vp(Km/sec)	Vs(Km/sec)	Density(gm/cc)
2.5	1.5	0	1.02
3.5	5.8526	3.3338	2.6659
4.5	6.4759	3.6965	2.8354
5.5	6.4859	3.7022	2.8377
6.5	6.4951	3.7075	2.8399
7.5	6.4999	3.7102	2.8412
8.5	7.2453	4.1284	3.0497
9.5	7.2398	4.1252	3.0492
10.5	7.2316	4.1206	3.0483
11.5	7.2227	4.1155	3.0478
12.5	7.2159	4.1116	3.0483
13.5	7.2142	4.1107	3.0505
14.5	7.2196	4.1137	3.0548
15.5	7.2336	4.1216	3.0617
16.5	7.2568	4.1349	3.0711
17.5	7.2894	4.1534	3.0831
18.5	7.3304	4.1768	3.0971
19.5	7.3787	4.2042	3.113
20.5	7.4322	4.235	3.13
21.5	7.4897	4.2676	3.1482
22.5	7.5485	4.3011	3.1671
23.5	7.6067	4.3342	3.1855
24.5	7.4928	4.0722	3.1454
25.5	7.546	4.101	3.1616

5. Conclusion:

The shear velocity structure over south-east Indian oceanic ridge have been obtained. Our study shows the oceanic crust has two layers, first layer is 1km thick with shear velocity Vs 3.33 km/sec having a average density of 2.66 gm/cc and second layer thickness is about 4 km, shear velocity Vs is 3.7 km/sec with an average density of 2.8 gm/cc. The Moho is not sharply defined because of viscous nature of mid-oceanic ridge and my study shows the Moho depth occurs at the depth of 8.5 km. The overall slowness of the seismic velocity from our study supports the viscous nature structure at Mid-oceanic ridge

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