SIO227A Homework

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**8.3**

a) This is most likely a Raleigh wave, since it has significant amplitude in the vertical component. Love waves appear primarily in the transverse component.

b) We eyeball the time separation between successive waveform troughs to find the trough times in the following table. We then take the differences in these times to find the period of incident waves, and divide the distance between the source and this station by the periods to find group velocities.

|  |  |  |
| --- | --- | --- |
| Time of Trough (s) | Period (s) | Group Velocity (km/s) |
| 3250 | 60 | 3.95 |
| 3310 | 60 | 3.88 |
| 3370 | 35 | 3.81 |
| 3405 | 45 | 3.77 |
| 3450 | 40 | 3.72 |
| 3490 | 35 | 3.68 |
| 3525 | 35 | 3.64 |
| 3560 | 35 | 3.60 |
| 3595 | 30 | 3.57 |
| 3625 | 35 | 3.54 |
| 3660 | 35 | 3.51 |
| 3695 | 25 | 3.47 |
| 3720 | 35 | 3.45 |
| 3755 | 30 | 3.42 |
| 3785 |  |  |

We plot the group velocity vs period to allow us to visually compare it to the results shown in Figure 8.6.

This is reasonably close to (but lower than) the values in Figure 8.6.

**8.5**

*“The earthquake source may be thought of as a delta function that generates energy at all frequencies. However, Earth’s lowest normal mode has a period of 54 minutes. Thus the normal mode representation for seismic displacements is incomplete because it cannot represent very long period energy generated by the source (i.e., periods longer than 54 minutes).”*

The above assertion is false.

A modal representation of any system is a complete description of all the waves present in that system.

This is clear in the Fourier series representation of a signal, which we know to be a complete representation of any signal as the number of terms in the series approaches infinity. The ability of the modal analysis to resolve individual frequency components depends only on the number of terms in the series.

Looking at this another way, the system cannot support periods longer than the period of the lowest mode. Modes are a function of the environment, and the source excites the system. The system will not experience periodic motion as a result of forcing on timescales longer than the period of the lowest mode.

**8.4**

MATLAB code used to generate these plots is attached.

a) Phase and group velocity dispersion curves as a function of period



b) Synthetic seismogram



c) We can see that two peaks in the 150deg plot are about 100 seconds apart.

At this period, the group velocity should be about 3.806 km/s.

The wave packet traveled about 16650 km in about 4350 seconds.

That's a speed of 3.82 km/s, which is very close to the group velocity we calculated.

d) Synthetic seismogram with df = 0.00002 Hz to remove wraparound phase at 5000s:



We notice that the long period (low frequency) waves are missing from this seismogram due to the window we have applied.

To restore them, we use a right-side half-Hamming window instead, such that only high frequencies are attenuated.



This allows us to see the long period waves.

We note that removing the window entirely results in substantial ringing, and is probably not desirable:

