A REVIEW ON SONIC WAVE PROPAGATION IN ROCKS

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ABSTRACT

Different theories on the propagation of sonic waves in rocks are studied. Early laboratory works show that the attenuation of sound waves, which based on the definition includes seismic waves as well, is frequency independent. Most of the theories also agreed that absorption in rocks is independent of frequency. Therefore it is possible for the high frequency signals of an earthquake to reach the distance. However, seismometers and accelerometers which are utilized for measuring the seismic wave fields, have a rather short bandwidth. An experiment was done in 1980s to measure the sonic signals accompanying earthquakes other than those measured by seismometers and accelerometers. But the effective frequency bandwidth of the recording system in this experiment was between 40-70 Hz. More measurements are needed to investigate the quality of sound waves that come with an earthquake.

INTRODUCTION

Sound, which is defined by "a mechanical disturbance from a state of equilibrium that propagates through an elastic material medium" (Sound, 2014), includes seismic waves as well. Sound waves can have a wide range of frequencies. At very high frequencies, sound waves can not propagate efficiently. Above a frequency of abourt 1.25×10^{13} hz, no medium (solid or liquid) can pass a logtudinal waves, because the molecules of the medium cannot vibrate rapidly enough (Ultrasonics, 2014).

In solids, molecules can vibrate in different directions. Therefore sound waves can propagate in four different modes which are longitudinal waves, shear waves, surface waves, and plate waves (Propagation, 2014). In longitudinal waves, particles vibrate parallel to the wave direction. In shear waves, they move sideways to the direction that the wave is traveling.

There are two types of seismic waves: surface waves and body waves. Surface waves travel over the surface of the earth. Body waves pass through the earth's interior parts and reach to the surface again.

There are two basic types of seismic body waves: Primary waves (which are longitudinal waves) and shear waves. Primary waves travel faster than other type of seismic waves. Primary waves and shear waves are called P (primary) waves and S (secondary) waves respectively, because they are the first two types of seismic waves that reach to any point with an earthquake (Weatherwatch, 2014).

To record seismic waves in water hydrophones are utilized (Shearer, 1999). On land, a network of seismometers and accelerometers are places to monitor and locate an earthquake's hypocenter.

The intensity of sound is diminished with distance when traveling through a medium. In ideal materials, the only cause for attenuation of the signal amplitude is wave spreading. In natural materials, sound is further weakened by scattering and absorption. Attenuation is the collective effect of scattering and absorption (Attenuation, 2014).

The attenuation of seismic waves is described by the quality parameter Q. Q is commonly defined as the "maximum energy stored during a cycle, divided by the energy lost during the cycle" (Kjartansson,