AGU FALL MEETING
San Francisco | 12–16 December 2016

S54A-04: Seismic resonances of acoustic cavities

Friday, 16 December 2016
16:45 - 17:00
Moscone South - 303

The goal of an On-Site Inspection (OSI) is to clarify at a possible test site whether a member state of the Comprehensive nuclear Test Ban Treaty (CTBT) has violated its rules by conducting a underground nuclear test. Compared to atmospheric and underwater tests underground nuclear explosions are the most difficult to detect.

One primary structural target for the field team during an OSI is the detection of an underground cavity, created by underground nuclear explosions. The application of seismic-resonances of the cavity for its detection has been proposed in the CTBT by mentioning "resonance seismometry" as possible technique during OSIs. We modeled the interaction of a seismic wave-field with an underground cavity by a sphere filled with an acoustic medium surrounded by an elastic full space. For this setting the solution of the seismic wave-field can be computed analytically. Using this approach the appearance of acoustic resonances can be predicted in the theoretical calculations. Resonance peaks appear in the spectrum derived for the elastic domain surrounding the acoustic cavity, which scale in width with the density of the acoustic medium. For low densities in the acoustic medium as for an gas-filled cavity, the spectral peaks become very narrow and therefore hard to resolve. The resonance frequencies, however can be correlated to the discrete set of eigenmodes of the acoustic cavity and can thus be predicted if the dimension of the cavity is known. Origin of the resonance peaks are internal reverberations of waves coupling in the acoustic domain and causing an echoing signal that couples out to the elastic domain again. In the gas-filled case the amplitudes in time domain are very low.

Beside theoretical considerations we seek to find real data examples from similar settings. As example we analyze a 3D active seismic data set from Felsőpetény, Hungary that has been conducted between 2012 and 2014 on behalf of the CTBTO. In the subsurface of this area a former clay mine is situated, which is connected to a karst cave of 30 m diameter in 70 m depth. Our aim is to investigate whether resonances predicted from theoretical models can be also observed in data from such real experiments. Observation of spectral resonant peaks could serve as the foundation of a cavity detection method that could be utilized for nuclear verification.

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