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## S31A-2720: A 3D Numerical Survey of Seismic Waves Inside and Around an Underground Cavity

Wednesday, 14 December 2016

14:33 - 14:48

📍 Moscone South - 307

Motivated by the need to detect an underground cavity within the procedure of an On-Site-Inspection (OSI) of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO), which might be caused by a nuclear explosion/weapon testing, we present our findings of a numerical study on the elastic wave propagation inside and around such an underground cavity.

The aim of the CTBTO is to ban all nuclear explosions of any size anywhere, by anyone. Therefore, it is essential to build a powerful strategy to efficiently investigate and detect critical signatures such as gas filled cavities, rubble zones and fracture networks below the surface. One method to investigate the geophysical properties of an underground cavity allowed by the Comprehensive Nuclear-test Ban Treaty is referred to as "resonance seismometry" - a resonance method that uses passive or active seismic techniques, relying on seismic cavity vibrations. This method is in fact not yet entirely determined by the Treaty and there are also only few experimental examples that have been suitably documented to build a proper scientific groundwork. This motivates to investigate this problem on a purely numerical level and to simulate these events based on recent advances in the mathematical understanding of the underlying physical phenomena.

Our numerical study includes the full elastic wave field in three dimensions. We consider the effects from an incoming plane wave as well as point source located in the surrounding of the cavity at the surface. While the former can be considered as passive source like a tele-seismic earthquake, the latter represents a man-made explosion or a vibroseis as used for/in active seismic techniques. For our simulations in 3D we use the discontinuous Galerkin Spectral Element Code SPEED developed by MOX (The Laboratory for Modeling and Scientific Computing, Department of Mathematics) and DICA (Department of Civil and Environmental Engineering) at the Politecnico di Milano. The computations are carried out on the Vienna Scientific Cluster (VSC).

The accurate numerical modeling can facilitate the development of proper analysis techniques to detect the remnants of an underground nuclear test, help to set a rigorous scientific base of OSI and contribute to bringing the Treaty into force.

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