Geophysical Research Abstracts
Vol. 18, EGU2016-4663, 2016
EGU General Assembly 2016

Wave propagation in a medium with cavities

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The detection and imaging of cavities is still difficult, but it generates a lot of interest because of its potential applications.
We have developed a code based on Lattice Springs and Lattice Boltzmann which can calculate wave propagation through a three dimensional composite medium. The theoretical background of these techniques will only be briefly addressed during the talk. The solid phase may have properties which are variable in space; the solid matrix may contain voids of arbitrary shapes which are filled or not with a mixture of air and water. In addition some of the voids may be empty. The surface of the ground is also arbitrary and it may be hilly.
The source may be either a disturbance applied to a region of the solid phase or an overpressure applied to a particular cavity. In both cases, the disturbance and the overpressure can be arbitrary in time. Several sources can be simultaneously employed.
Any region can be recorded, but a particular attention is paid to surface signals since they are the ones which are usually measured.
The code is parallelized.
Systematic applications of this tool have been done in order to analyse the response of a medium containing cavities to various signals.
This complete parametric study has analyzed the most important parameters.
The shape and the nature of the source have been addressed first; step functions of a limited or of an infinite duration have been studied and they are shown to result in simpler outputs than Ricker functions.
The position of the source with respect to the ground surface has been varied. If it is deep, the reflection of the initial signal with the surface complicates the analysis of the surface measurements.
The distance between the source and the cavity does not appear to be a critical parameter as long as the signal remains sufficiently large when it interacts with the cavity. Moreover, when this distance is large, the signal is transformed into a plane wave.
The influence of the shape of the cavity was also studied.
A lot of attention is paid to one of the specific possibilities of our code namely the possible existence of air and water. Two applications are addressed and will be discussed. First the cavity may be partially filled of water or not; the influence of the cavity saturation has been studied in a systematic way. Second the medium itself can contain pores which are partially saturated.