Geophysical Research Abstracts, Vol. 8, 03089, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03089

Seismic wave simulation on Arenal Volcano (Costa Rica): Evidence of topographic effects

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Volcano topography can have a pronounced effect on seismic wave propagation and hence locating the source. To quantify the effects of the topography on Arenal volcano (Costa Rica) synthetic seismograms were generated using a finite-difference solution to the 3D elastic wave equations. The finite-difference method used was a fourth order in space and second order in time velocity-stress formulation with a staircase stacking method for the inclusion of topography. The numerical model spans a volume of 10.24 x 8 x 2.4 km^3 with a spatial resolution of 16 m. A 1-D velocity model is used. It was obtained in a previous work on Arenal volcano from an array analysis using the spatial autocorrelation method. The source simulates an explosion or a transient phenomenon associated with an internal deformation. Several simulations were performed for sources located at different depths below the crater. Synthetic seismograms were calculated for 25 arrays each one composed of 9 stations. The arrays were centred on the volcano with a spacing of 1600 m. The distances between stations in the arrays varied from 48 m to 96 m. At each array, the apparent velocity and the back-azimuth of wave propagation are estimated from the time delays between the sensors obtained with the cross-spectral method. By crossing the back-azimuths obtained with each array, we define a probability density function (PDF). The maximum of the PDF gives an estimate of the source location in the horizontal plane and its spread produces an estimate of the corresponding error. Preliminary results show that the back-azimuth estimated for some arrays, in particular those closest to the source, are not pointing to the source suggesting strong topographic effects. For other sites, the maximum of the PDF deduced by crossing the back-azimuths of these arrays coincide exactly with the

source. The resolution of the location method is also tested varying different parameters, the number of stations per array, the number of arrays, the array-source distance and the depth of the source. The first results show that this kind of study could be done prior to the installation of seismic arrays to select the sites that minimize the topographic effects. The topographic effects generated by the numerical method are consistent with observations made during a previous field experiment.