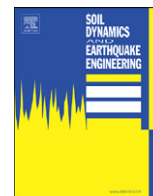




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Assessment of site-effects using acceleration time series. Application to São Sebastião volcanic crater

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ABSTRACT

The Azores archipelago is located at the North America, Eurasia and Africa triple junction and shows seismicity and volcanism typical of an active plate boundary. Terceira Island has been affected by several damaging earthquakes being the 1980 January 1st event ($M=7.2$) the strongest in Azores during the last century.

São Sebastião volcanic crater, at Terceira Island, exhibits stronger ground motion during seismic events than its surrounding areas. Inside this crater there is a village that has shown an anomalous seismic behaviour including heavy damages during past earthquakes. Both the local geology and the geotechnical characteristics of the soil deposit play a major role in the seismic ground shaking characteristics at the site. Recent geophysical and geological surveys executed in 2006 and 2007 added new information that allows a better comprehension of the damage distribution observed during the 1980 earthquake.

During the two seismic crises of 1997 and 1998 it was possible to obtain several records at three different places inside the volcanic crater: Escola, Junta and Misericórdia strong-motion stations. Comparison between seismic records allowed the identification and analysis of site effects inside the crater. Moreover, two of the most usual site-effect assessment techniques were used, namely, the spectral ratio between the records at the crater and a given reference site (reference-site spectral ratio) and spectral ratios for different components of the same accelerometric station (horizontal-to-vertical spectral ratio). The combined use of these techniques proven to be a very efficient way to characterise the different site effects observed inside the volcanic crater.

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1. Introduction

The Azores archipelago is located in the middle of the Atlantic Ocean at the North America, Eurasia and Africa triple junction; the Mid Atlantic ridge separates the American plate from the others, while the Azores-Gibraltar fault zone is the boundary between Eurasia and Africa plates (Fig. 1a). The central group of the Azores islands occupies a broad sheared region, called Azores microplate or block, which absorbs the deformation induced by the eastward differential displacement of the Eurasia in relation with the African plate. The deformation is represented by a widespread active faulting of the islands and surrounding seafloor [1]. The high seismicity and volcanism of this area is due to its location on an active plate boundary.

This paper focuses on the São Sebastião volcanic crater area, located in the south-eastern side of Terceira Island in the central group of the Azores archipelago (Fig. 1b).

The islands of the central group were affected in the historical times, by several seismic events, including weak to moderate events or swarms and occasionally by some strong earthquakes with magnitude near 7 (Tables 1 and 2, Fig. 2). The last large earthquake, named the Terceira earthquake, occurred on January 1st 1980 with magnitude $M=7.2$ [6] and showed that the seismic response of the São Sebastião volcanic crater is characterised by an amplification of ground movements inside the crater with respect to the surrounding area (Fig. 3). Recently (27/01/2008) a $M_L=4.2$ earthquake with an epicentre 30 km E-SE of Terceira Island was mainly felt on São Sebastião area with an IV/V intensity (Mercalli Modified) [8].

Terceira Island has two cities, Angra do Heroísmo, which is the island capital and Praia da Vitória. The main city areas are where the population density is higher. São Sebastião is one of Terceira's rural and historic villages. The building stock at Azores is similar in all areas, being mainly with one or two floors and the traditional

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