Calibration of Local Magnitude $M_L$ in the Azores Archipelago
Based on Recent Digital Recordings

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**Abstract** — The development of the digital seismic network in the Azores Archipelago during recent years made it possible to obtain the amplitudes (waveform) of recorded motion in a large set of stations. With this new data, maximum amplitudes of the Wood Anderson seismograph are computed, for each station/ component, which, together with epicentral distances, allows for the estimation of local magnitude $M_L$.

We used data recorded in 8 digital permanent three-component stations, with inter-station’s distances up to 300 km, in the period June 1998 – June 2000, corresponding to a set of 1315 events with magnitude ($M_L$ or $M_D$) $2 < M < 5.8$ and epicenters located in the Azores region, to estimate the coefficients of the equation to compute $M_L$, as well as to determine the corrections to be applied to each station. The new set of parameters, formed by attenuation coefficients and station corrections, were introduced in the calculations of the $M_L$, leading to smaller dispersions in the analyzed dataset. We also conclude that the attenuation in the first 150 km is similar to the California values, although higher for longer distances.

**Key words:** Azores, amplitudes, attenuation, calibration of Local Magnitude.

1. Introduction

The Azores Archipelago is located in the Northern Atlantic Ocean, near the triple junction where the American, African and Euro-Asiatic plates converge. As a consequence, the area is characterized by a high seismicity along the arch where the islands are located.

With the recent development of the digital seismic network in the Azores Archipelago in the last few years it became possible to increase quite significantly the quality of the earthquake parameters and the perceptibility of the occurrences. Data are collected in a database from which the Seismological Preliminary Bulletin of Azores (*Boletim Sismológico Preliminar dos Açores*, 1998–2000) is published by SIVISA (Meteorological Institute/University of Azores) on a monthly basis. The activity since 1998 has been dominated by the aftershock sequence of the July 9, 1998

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Faial/Pico earthquake, magnitude ($M_D$) 5.8, which consisted of numerous seismic events. Special attention is focused on the attenuation of seismic waves and to the calibration of $M_L$ determinations.

The concept of local magnitude ($M_L$) was first introduced by Richter (1935) in California and, with the advent of modern digital seismology, several authors revisited the problem of the local magnitude estimation. Bakun and Joyner, (1984) and Hutton and Boore, (1987) looked to updated data in California, Kim (1998) analyzed data from the NE USA, Secanell et al. (1996), González (1999) and González et al. (2000) data from Catalunya, Spain, and Kang et al. (2000) data from the Republic of Korea. More work is being developed presently, Baumbach et al. (2002), Spallarossa et al. (2002), Ferretti et al. (2002), demonstrating the great importance of this topic in modern seismology.

Since the new digital seismic network was installed in the Azores the amplitudes referred to the Wood-Anderson seismograph were determined for all stations and components. These amplitudes are collected in a mentioned database. To date, the local magnitude ($M_L$) for each event, which is also contained in the Bulletin, was estimated based on the algorithm (see section 4) with constants taken from the southern California observations.

2. The Digital Network and Earthquake Database

The installation of digital seismological stations from SIVISA in the Azores was initiated in June 1998, and 8 stations have been in place since October 1999 (Fig. 1). They are all three-component Lennartz MARS88 with 20-bit, some equipped with sensors with constant velocity response in the frequency band 1 Hz – 80 Hz, and others within 0.2 Hz – 40 Hz. Presently, the digital network comprises more stations. Sampling rate is 62.5 per second.

In this study we selected all events recorded in the period from June 1998 to June 2000. These include the events with $5.8 > M > 2.0$ within the geographic region of the Archipelago (with $M$ the maximum from $M_L$ and $M_D$; the value of magnitude $M_L$ used for the selection was taken from the Bulletin — coefficients taken from California; $M_D$ also reported on the Bulletin). The digital stations considered for the analysis, totaling 8, are presented in Table 1 and Figure 1.

Besides the epicentral location, depth, $M_L$ (computed as referred before with the coefficients taken from California), errors in the determinations and arrival times for the identified phases, the database of SIVISA contains, station by station, information on the amplitudes in nanometers (nm) of each component correspondent to the maximum amplitude of the Wood-Anderson response. The determination of these amplitudes was obtained from the original record in velocity, adequately transformed through an algorithm of SEISAN® (Havskov and Ottemöller, 1999) to reproduce the response of the Wood-Anderson