Identification of ITACA sites with distinctive features in their seismic response

Bindi D.[1], Di Alessandro C.[2], Giorgetti S.[3], Luzi L.[1], Pacor F.[1], Paolucci R.[3], Rovelli A.[2], Smerzini C.[4]

[1] Istituto Nazionale di Geofisica e Vulcanologia, Dept of Milano-Pavia, Milano, Italy: bindi@mi.ingv.it
[2] Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy
[3] Dept. of Structural Engineering, Politecnico di Milano, Italy
[4] ROSE School, IUSS Pavia, Pavia, Italy

Dipartimento della Protezione Civile

Istituto Nazionale di Geofisica e Vulcanologia

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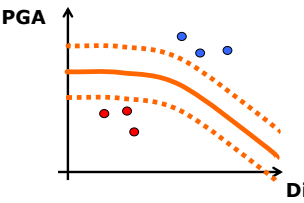
ABSTRACT

We illustrate an empirical procedure to identify strong motion stations of the ITACA database showing seismic response features that cannot be easily explained by simplified classification schemes, so that they are likely dominated by more complex stratigraphic or topographic site effects, or by interaction effects of the recording station with the hosting or surrounding structures. In the framework of Project S4 (Task 4: identification of ITACA sites and records presenting distinctive features in the seismic response), the objective is to enrich ITACA with additional information regarding the identification of such "anomalous" stations, or even anomalous seismic events, in order to improve the rational use of the database. To this end, we identified those stations, or earthquake events, for which the recorded spectral ordinates tend to fall on average significantly above/below the standard deviation band of the attenuation relationship. The method consists of computing the residuals of the recorded 5% damped response spectral acceleration with respect to the predictions from two selected empirical attenuation relationships (Bindi et al., 2009; Di Alessandro et al., 2008) calibrated on the Italian records. The two approaches differ by the site classification adopted, one based on the Sabetta & Pugliese (1996) scheme and the other based on the predominant period of the horizontal-to-vertical response spectral ratio (Fukushima et al., 2007). Residuals are corrected for the inter-event variability, to reduce the specific contributions of the seismic event, and to better highlight the effect of the specific features of the site response of the station.
Residuals for all the stations in the dataset are shown as a function of period. To provide synthetic measures of the observed dependence of residuals on period, the average values of residuals in 4 representative period ranges are calculated. The stations exceeding the threshold of 1.65σ over at least one of the selected period range for the considered site class are identified and discussed.

1 SCOPE

The objective of this work is to identify which stations or which earthquake events exhibit a distinctive trend so that the recorded peak values of ground motion fall above o below the standard dispersion limits of two selected attenuation relationships (GMPEs) calibrated on the Italian data.



- Record from the same earthquake but different site: **ANOMALOUS EARTHQUAKE**
- Record from different earthquakes but same site: **ANOMALOUS SITE**

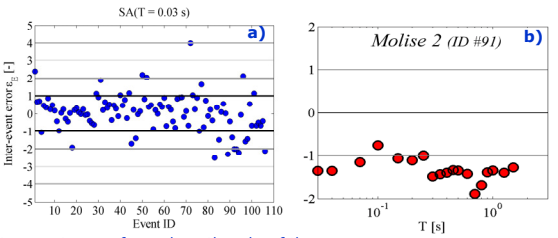
2 PROPOSED PROCEDURE

- **computation of the residuals of the recorded logarithmically-transformed 5%-damped response spectral acceleration SA with respect to the estimate provided by the following GMPEs: 1) Bindi et al. (2009) and 2) Di Alessandro et al. (2008)**

$$r(T) = \frac{Log\left[SA^{obs}(T)\right] - Log\left[SA^{GMPE}(T)\right]}{\sigma^{GMPE}}$$

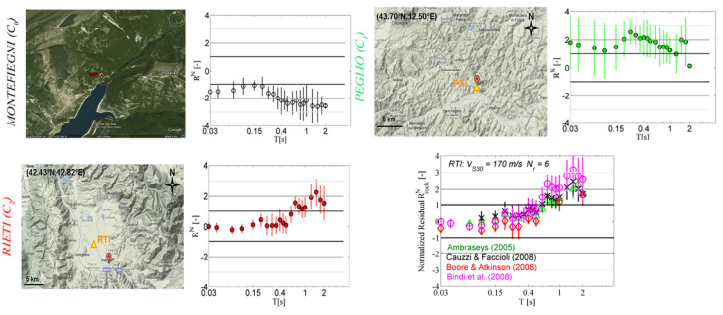
- **correction of the residuals for the inter-event variability, calculated as the average residual over the *N* records from the same earthquake**
- **determination for each station of the average residuals in 4 representative period bands (0.03≤T≤0.15s; 0.20≤T≤0.40s; 0.45≤T≤1s; 1.25≤T≤2.0s)**
- **selection of residuals exceeding the threshold of 1.65σ**

3 INTER-EVENT ERRORS

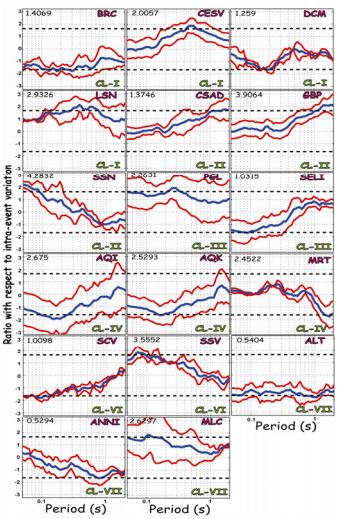


a) Inter-event errors for each earthquake of the dataset under consideration, for spectral acceleration at T=0.03 s. b) inter-event errors as a function of period for the M_W 5.7 Nov 1 Molise second shock.

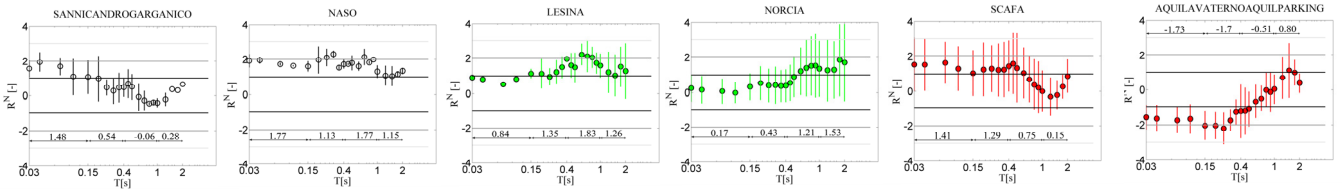
4 RESULTS



Residuals corrected for the inter-event variability for three representative stations: Montefiegni Fiastra - MNF located on rock (C0, white), Peglio - PGL on shallow alluvium (C1, green) and Rieti - RTI on deep alluvium (C2, red). Filled dots indicate the median value, while the vertical bars denote the 16th-84th percentiles. For the RTI station a sensitivity analysis with respect to the adopted GMPEs is also shown (right, bottom pannel)



Absolute average residuals (±1 Standard deviation) computed by means of the procedure proposed by Di Alessandro et al. (2008) for the 17 stations characterized by distinct amplification patterns as they exceed 1.65 times the computed intra-event variation (also known as the station-to-station deviation).



Residuals as a function of period for 6 representative stations belonging to soil class 0 (rock, white), 1 (shallow alluvium, green) and 2 (deep alluvium, red) according to the soil classification proposed by Sabetta & Pugliese (1996).

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