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Liquefaction case histories and empirical relations of earthquake magnitude versus distance from the broader Aegean region

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Abstract

In this study, historical and seismotectonic data from the broader Aegean region, which are relevant to liquefaction phenomena, have been collected in order to investigate the relationship between epicentral (R_e) and fault (R_f) distance versus magnitude. Initially, a preliminary catalogue of sites where liquefaction induced ground failures or structural damages is presented. These liquefaction case histories have been triggered by 88 earthquakes since 1509. Based on these data, an upper bound of maximum epicentral distance (R_{emax}) for a given earthquake magnitude M_s is calculated. The corresponding equation is $M_s = 4.742 + 4.655 \times 10^{-3} R_{emax} + 0.8907 \log(R_{emax})$. This curve fits well with those proposed by previous studies and shows that the epicentral distance increases along with increasing magnitude. The lower limit of earthquake magnitude that induced liquefaction within the study area is $M_s = 5.0$, while the upper limit is $M_s = 7.6$. Furthermore, the closest distance of the liquefied sites to the causative faults was estimated in order to determine a distance–magnitude relation and to give numerical results for seismic hazard assessment. The calculated regression that is suggested is: $M_s = 5.224 + 7.34 \times 10^{-3} R_{fmax} + 0.488 \log(R_{fmax})$ for $5.5 \leq M_s \leq 7.1$ and it concerns normal faulting data. The strike-slip faulting data were few and the attempt to estimate regression for this category of faulting was unsuccessful. Moreover, the distribution of data reported to the instrumental era (after 1900) indicates that there is a rise in the values of the epicentral distance of liquefied sites triggered by earthquakes of magnitudes $M_s > 6.6$. The equation of the best-fit curve based on these data is: $M_s = 0.01R_e + 6.463 \pm 0.46$. In addition, an attempt was made to calculate regressions of R_e on M_s, according the focal mechanism of the event. In what concerns the normal faulting data, the equation of the best-fit curve and the upper bound curve are $M_s = 0.01R_e + 6.38 \pm 0.38$ and $M_s = 0.021R_{emax} + 5.3$, respectively, for M_s values between 5.5 and 7.1.

Keywords: Aegean region; Earthquake magnitude; Epicentral distance; Liquefaction; Seismic hazard assessment

1. Introduction

After the Niigata earthquake of 1964 in Japan several researchers worked systematically on the phenomenon of liquefaction and its sequences. For the evaluation of liquefaction potential of an area, several criteria must be examined such as historical, geologic, compositional and state criteria (Krammer, 1996). According to Iwasaki (1986), sites that liquefied during the past earthquakes have high potential to re-liquefy by future events.

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