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# Ground motion characteristics in Bucharest area due to moderate and strong Vrancea intermediate depth earthquakes

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The Bucharest metropolitan area is one of the most vulnerable urban areas in the World at the impact of the earthquakes generated in the Vrancea seismic source, at 150 - 170 km epicentral distance. For example, the earthquake of 4 March 1977 (Mw = 7.4), occurred at 94 km depth, caused the collapse of 32 buildings of 8-12 storeys, while about 150 old buildings of 6 to 9-storeys were strongly damaged, many of them being subsequently demolished. The Vrancea seismic region is characterized by an unusual concentrated seismicity at intermediate depths (60 - 180 km), located beneath South-Eastern Carpathians, in Romania. Historical information over one thousand years suggests a rate of 2-3 damaging earthquakes per century. The Quaternary sedimentary deposits consist of a succession of several lithological horizons: 'Fratesti layers', marl complex, 'Mostistea sands', intermediate clays, 'Colentina gravel and sands' and loesslike deposits. The entire complex undergoes a slight descend from south to north, accompanied by an increase of the deposits thickness in the same direction from about 150 m to 350 m. The predominant periods of oscillation of the subsurface layers over Bucharest territory range between 1.0 and 1.9 s, increasing from south to north, in correlation with the constant increasing of the thickness of the Quaternary cohesionless deposits. We considered in our analysis all the data available recorded by the networks of the National Institute for Earth Physics and National Institute for Building Research for the largest Vrancea earthquakes (4 March 1977, Mw = 7.4; 30 August 1986, Mw = 7.1; 30 May 1990, Mw = 6.9; 31 May 1990, Mw = 6.4) to which we added more recent and best recorded moderate size events (15 events with magnitude between 4.0 and 5.3). Initially, in 1977, only one station was available in the Bucharest area, while now 12 K2 digital accelerometers are installed

in cooperation with the University of Karlsruhe (Collaborative Research Centre 461 Programme). On the basis of spectral analysis of the considered waveforms (power spectral density, response spectra, H/V spectral ratios) two predominant periods are identified, one around 0.4 s, other around 1.4 s, independently of site position in the city area. They correlate very well with the local structure layering and parameters, as shown by the theoretical amplification curves. However, the weight of these predominant periods in the observed ground motion is strongly varying as a function of the earthquake size. For example, the most dangerous 1.4 s period resonance which causes the collapse of the high tall buildings, insignificant for moderate shocks, is severely amplified when the magnitude exceeds 7. Bucharest is to our knowledge, one of the particular cases where extremely large damage is induced at relatively large distance by the intermediate-depth earthquakes as a consequence of the coincidence of the predominant period of vibration of the seismic radiation with the natural period of resonance of the entire succession of Quaternary unconsolidated deposits, underlying the city area.