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Seismicity analysis of Southern Ghana II: Updated crustal velocity model and hypocentral parameters

Susana Custódio[1], **Hamzeh Mohammadigheymasi**[2], Nasrin Tavakolizadeh[3], Luis Matias[1], and Graça Silveira[4,1]

[1]Instituto Dom Luiz, Faculdade de Ciências, University of Lisbon, Lisboa, Portugal (susanacustodio@campus.ul.pt)
[2]Department of Computer Sciences, University of Beira Interior, Covilhã, Portugal
[3]Institute of Geophysics, University of Tehran, Tehran, Iran
[4]Instituto Superior de Engenharia de Lisboa (ISEL), Lisbon, Portugal

A small network of six broadband seismic sensors operated in southern Ghana between October 2012 and April 2014 (GHDSN). During this period, no seismicity was reported by the global data centers, however application of the Deep Learning algorithm EQTransformer resulted in the detection and subsequent location of 73 earthquakes. Preliminary constant crustal velocity models with vp=5.55 km/s and vs=3.36 km/s have been utilized since 2002 to locate the local earthquakes in southern Ghana. Using this crude velocity model resulted in scattered seismicity, hinting into a likely inadequacy of these preliminary velocity parameters to represent the elastic properties of the area. In this study, we perform a joint-inversion for estimating an updated 1D crustal velocity model and the hypocentral parameters of the 73 recently detected local earthquakes. A grid search method is implemented and a 6-layer velocity model is defined, down to 45 km crustal depth. The space of velocity model parameters is searched by altering the upper depth of the layers (ud), P-wave velocity in each layer (vp), and the ratio of vp/vs. The optimized velocity model and hypocenteral parameters are evaluated by minimizing the RMS error function between the observed (533 picked phases consisting of 282 P and 251 S phases) and calculated arrival times. A two-step implementation is devised to increase the computational efficiency of the inversion process. Initially, the optimum vp/vs is estimated by implementing a coarse grid search on vp and ud values. Then, incorporating the optimum vp/vs a fine grid search on vp and ud is applied.
The results yields layers with 1, 13, 8, 13 and 10 km thickness, with vp = 5.9, 6.1, 6.3, 6.5, 6.9 and 7.2 km/s, respectively. The updated velocities for the first and last layers are 6% and 26% percent higher than the previously reported constant velocity models. Furthermore, the updated vp/vs=1.70 is 0.03% higher than the corresponding value vp/vs=1.65 of the constant velocity model. The updated hypocentral locations of the 73 earthquakes with 2.5<ML<3.9 are concentrated on five major clusters. Two clusters are located on the AFZ, indicative of the active role of this structure in the seismicity of the region. Two other clusters, which have the highest rate of activity, are positioned in the intersection between the AFZ and CBF. The last cluster consists of scattered earthquakes that coincide with mapped segments of the AFZ. Incorporating the updated velocity model for estimating the hypocentral parameters resulted in enhanced seismogenic source delineation in southern Ghana. This research contributes to the FCT-funded

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