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Seismicity analysis in southern Ghana- I: Detecting local earthquakes by Deep Learning

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A large volume of digital seismic data was recorded by six broadband seismic sensors equipped with GPS-clock timing in the Ghana Digital Seismic Network (GHDSN) between October 2012 and April 2014. For this period, no public seismicity catalog was reported by the global data centers, International Seismological Center (ISC), and United States Geological Survey (USGS) for southern Ghana. In this study, this database is processed to detect local earthquakes. To facilitate the challenging and time-consuming process of detecting the earthquakes and picking the arrival times of P and S phases, we utilize EQTransformer, a Deep Learning (DL) model deploying Hierarchical Attention Mechanism (HAM) for simultaneous earthquake detection and phase picking. This model utilizes global and local levels of attention mechanism for identifying earthquake and seismic phases deriving benefits from deep neural networks, including convolutional and recurrent neurons. The thresholding values of 0.2, 0.07, and 0.07 are set for earthquake detection, P-picking, and S-picking, respectively. As a result, a list of events for each station of the network with the associated time of detection, as well as P and S phase arrivals are obtained. Taking these arrival times into account, we have devised a so-called ”conservative strategy” to optimally extract all possible earthquakes in the data set, amenable to locate. Initially, a list of preliminary events recorded by at least two stations is created by comparing the earthquake occurrence and arrival times of the P and S phases for all stations regarding a 100 sec time threshold. The list in this step includes 317 events recorded by at least two stations. Eventually, an analyst controls the obtained waveforms in other stations assesses whether EQTranasformer misses the preliminary list of events in those stations. Consequently, a number of 533 picked phases (282 P and 251 S) recorded by a minimum of 3 stations are finalized. Incorporating these phases and removing the instrument response from the waveforms, the hypocentral parameters for 73 earthquakes with $2.5 \leq M_L \leq 4.0$ are estimated. The main concentration of events is on the intersection of the Akwapim fault zone and the coastal boundary fault, with some scattered seismicity along the Akwapim fault zone. The corresponding set of seismic phases is utilized to estimate an updated 1D crustal velocity model for the study area. This research contributes to the FCT-funded projects SHAZAM (Ref. PTDC/CTA-GEO/31475/2017),

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