Induced Seismicity at the Preston New Road Shale Gas Site in Lancashire, UK – Site Characterisation and impact on the TLS

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Recent examples have shown that fluid injection during hydraulic fracturing can result in felt, or even damaging, seismic activity. In the vicinity of the Preston New Road site (Lancashire, UK), almost 200 earthquakes of ML -0.8 to 2.9 have been recorded by the British Geological Survey (BGS) over the period from October 15th 2018 to September 2019. This corresponds to the period during which hydraulic fracturing (fracking) was carried out by the operator, Cuadrilla Resources. Throughout the operation, fracking had to be suspended temporarily five times as the ML 0.5 ‘red light’ of the UK regulatory Traffic Light System (TLS) was exceeded. Since 2017, the University of Liverpool has operated a seismic monitoring network comprising nine broadband Nanometrics Trillium 120 across the Blackpool-Preston region in order to determine the baseline seismicity and monitor induced events associated with the fracking operations at the site. In addition to this network, both Cuadrilla and the BGS deployed seismometers-including borehole geophone strings-over the region making it one of the best places in Europe for monitoring induced seismicity. The superficial geology of the region is dominated by thick sand, till and clay deposits, potentially leading to significant amplification of seismic waves. This amplification may lead to over-estimation of earthquake magnitude, and therefore increased likelihood of triggering mitigation measures associated with the TLS. In order to understand amplification effects near the PNR site, surface-wave measurements (both MASW and seismic Ambient Vibration Arrays, AVAs) have been used to derive dispersion curves and obtain VS profiles through an inversion process for station-site characterization. By using small local arrays (hundreds of meters wide) to regional arrays (tens of km wide), we reconstruct a velocity model down to the bedrock depth. This velocity model can then be used to compute a parsely non-ergodic ground motion and subsequently seismic hazard assessment. This approach allow us to account for site to site variability and result in reduced uncertainty in the hazard assessment. We find Vs30 in the range 200 – 300 m/s at the sites investigated, leading to significant amplification effects that may bias event magnitudes determined on a surface array.