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The 2020 Haenam earthquake sequence: The first observation of a seismic front on the Korean Peninsula migrating in a manner similar to fluid diffusion

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Low-magnitude earthquakes (maximum Mw: 3.2) were recorded from late April 2020 onward in the county of Haenam, southwestern South Korea. Moderate to strong earthquakes had not previously been documented in instrumental, historical, or geological records. We identified 226 hypocentres in this earthquake sequence from April 25 to May 11, 2020. The seismic front of this sequence migrated in a manner similar to a diffusing fluid, with a hydraulic diffusivity of 0.012 m^2/s. This is the first observation of natural seismicity on the Korean Peninsula imitating fluid diffusion. We applied a cross-correlation approach to detect unrecorded events, and relocated the hypocentres of the 71 previously recorded and 155 newly detected events using data collected at permanent seismic stations; clear linearity was observed at the metre scale. Spatially, the hypocentres were distributed within a 0.3 km × 0.3 km fault plane at a depth of ~20 km, trending west-northwest–east-southeast with a dip of ~70° in the south-southwestern direction. The moment tensor solution of the largest event had a strike of 98°, dip of 65°, and rake of 7°, which correspond to the fault geometry of the relocated hypocentres. The hypocentres progressed toward the upper eastern edge of the lineament. The largest event occurred at a shallow region of the fault plane, in the direction of hypocentre migration. Together, these results showed that the migration sequence of the 2020 Haenam earthquake mimicked the flow of a diffusing fluid. The structural data indicate that a fault–fracture mesh geometry channelled fluid flow, supporting the concept of a “fluid-driven earthquake swarm” for the 2020 Haenam earthquake sequence. Regarding the final parts of the sequence, there appeared to be a second intrusion at the western end, and a permeability barrier at the eastern end, of the fault plane. The well-constrained hypocentre locations in our study provide essential data for future research, and our interpretations of hypocentre migration during this earthquake sequence may help to elucidate the mechanisms driving earthquake swarms under conditions of intraplate stress.