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Hypocenter relocation of microearthquake sequences in the Gyeongsang Basin, Korean Peninsula

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We have studied microearthquake sequences that occurred beneath the southeastern part of the Korean Peninsula. From January 2009 to May 2012, 40 earthquakes occurred at the area (35.6∼35.9ºN/129.3∼129.5ºE) and were reported in the bulletin of KIGAM. We computed cross-correlation for 40 earthquakes' waveforms recorded by the station at the center of the studied area. Based on the results, we selected 19 earthquakes that showed high cross-correlation coefficients for their location in the bulletin. The selected 19 earthquakes have low local magnitudes (<2.2). We relocated these 19 microearthquakes in this study.
Arrival times were re-picked with waveform cross-correlation that is ideal for spatially concentrated earthquakes with a waveform similarity. To reduce the effects of lateral variation of the upper mantle structure, stations at epicentral distances larger than 90 km were not considered. We aligned the selected 19 earthquakes' waveforms recorded at the station closest to the epicentral region. In comparison with alignment to the bulletin's arrival times, alignment to the arrival times picked with cross-correlation showed little time differences among the 19 earthquakes' waveforms.
The selected earthquakes were relocated by using the double-difference algorithm (HypoDD). The relocated epicenters lay in area smaller than 5 square kilometers. The relocated hypocenters formed a linear pattern along depths in particular. We infer that the 19 microearthquakes are associated with a single fault. The epicentral region of the relocated microearthquakes is nearby the Ulsan fault system, the eastern margin of the Gyeongsang Basin. The Ulsan fault system comprising 18 faults has a length of 50 km with a NNW-SSE strike. Faults in the Ulsan fault system are mainly reverse. The relocated results and the estimated focal mechanism using P-wave first-motions suggest that the Ulsan fault system would be an adequate explanation for the microearthquakes.
In addition, a large number of microevents were newly detected by waveform cross-correlation from continuous seismic records at the station closest to the epicenters of the relocated microearthquakes. The detected microevents are not reported in the bulletin of KIGAM, but have similar waveforms with the relocated earthquakes. We suggest that the detected microevents have the location and faulting geometry corresponding well with those of the relocated microearthquakes.