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Editorial: Special issue on "Earthquake swarms in Korea"

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1. INTRODUCTION

Seismicity over 10 days in 2020 in Haenam, Korea, raised serious concern among residents and authorities, owing to the possibility that this swarm-type activity was a precursor to a large earthquake. Although such seismicity is not common in Korea, swarms had occurred previously in Boryung in 2013 and Baekryung in 2019. It is thus necessary to understand the nature of this swarm-type seismicity.

This special issue, entitled "Earthquake Swarms in Korea," presents the results of detailed investigations by research groups on historical and instrumental observations of swarm-type seismicity in Korea and the implications for estimation of seismic hazard and risk. An earthquake swarm is defined as a sequence of earthquakes occurring in an area within a short period of time. A unique feature of an earthquake swarm is the lack of an identifiable mainshock, in contrast to the commonly observed mainshock-aftershock or foreshock-mainshock-aftershock sequences. Although swarm-type seismicity in Korea has not caused any significant infrastructural or other damage, residents in the affected areas have felt shaking and shown concern. Besides the implications for seismic hazard, swarm-type seismicity provides clues to understanding the mechanism of earthquake nucleation, propagation, and interactions among nearby faults. Case studies in this special issue have taken advantage of state-of-the-art instrumentation to identify and characterize swarm-type seismicity in Korea. A total of eight papers were accepted for publication in the special issue.

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2. CONTENT OF THE SPECIAL ISSUE

Kyung (2021) investigates ancient Korean documents describing earthquake swarms in Sangwon from 1565 to 1566 and identifies more than 100 earthquakes with magnitudes between 3.0 and 4.6. As the Sangwon earthquake sequence is the only non-volcanic swarm seismicity in historical records of Korea, and given that the source area of the Sangwon historical earthquake swarm is also an area of high instrumental seismic activity, the review is of significance regarding the relationship between seismicity and hazard for the Korea Peninsula.

Lee et al. (2021) present a compilation of seismic data collected by permanent seismic networks by the Korea Meteorological Administration (KMA), Korea Institute of Geoscience and Mineral Resources (KIGAM), Korea Institute of Ocean Science and Technology (KIOST), and Pusan National University (a temporary seismic array established to monitor the short-lived Haenam earthquake swarm). The authors characterize swarm seismicity by using precise earthquake hypocenters and focal mechanism solutions. They further propose the fault planes responsible for the 2020 Haenam earthquake swarm and whose rupture area corresponds closely to the established magnitude-rupture area relationship. The authors also briefly review recent earthquake swarms in western Korea.

Son et al. (2021) use cross-correlation-based earthquake detection and location methods to achieve a several-meter uncertainty in earthquake hypocenters using permanent seismic network data and propose the fault plane that ruptured during the Haenam swarm activity. The authors also conceptualize and demonstrate a model of fluid-driven earthquake evolution for the deep-rooted earthquake sequence. Their approach is of particular interest for understanding intraplate seismicity, the role of fluids in earthquake nucleation, and interactions among earthquakes.

Sheen (2021) reports the precise locations of 74 earthquakes that occurred in Haenam, southwestern Korea, during April–

May 2020. The author gives details of the earthquakes, including high-precision hypocenters, the stress drop, and the focal mechanism solution, which is consistent with the regional tectonic stress field. The fault motion of the mainshock is proposed as left-lateral strike-slip. The analysis also presents a complex fault system that is located at approximately 20 km depth and which was re-activated during the earthquake sequence.

Han et al. (2021) deployed a temporary seismic network with eight short-period all-in-one stand-alone seismometers on 30 April 2020 in the Haenam area. They successfully recorded earthquakes, including the largest in the swarm sequence, with M_L (local magnitude) 3.1, on 3 May 2020. The authors identify several hundred earthquakes, 299 of which were located with a high level of confidence. They examine the influence of natural and cultural noise on the detection threshold of microearthquakes using a dense temporary seismic network.

Jang and Oh (2021) review major faults in the area and their relationship to earthquakes and the 3-D shear-wave velocity model proposed by Jung et al. (2011). The authors demonstrate that the distribution of earthquakes at depths of < 12 km trends NE but at > 12 km trends NW. They also show that anomalies in the 3-D shear-wave velocity model are highly correlated with rock type, fault zones, or shear stress. Their model indicates highly heterogeneous shear-wave velocity with depth.

Kang et al. (2021) focus on the development of a new town on land reclaimed along the coast. To evaluate the seismic hazard caused by site-specific amplification of ground motions by artificially filled and unconsolidated cover, the authors measured microtremors at 144 sites across the area of the recent Haenam earthquake swarm. They use a horizontal-to-vertical spectral ratio technique to define depths to regions of high impedance or bedrock. The authors also use a novel approach to quantify the seismic vulnerability of the ground and produce information for urban planners in the area.

Ahn et al. (2021) take advantage of high-quality Haenam earthquake swarm data in a stable continental area to characterize source and ground motions. Their results indicate that the attenuation in the area is lower than that of global observations. The authors also identify variation in the effects of earthquake magnitude on attenuation intensity. Their results and detailed analysis are of particular relevance for developing region-specific ground-motion models for the southwestern Korean peninsula.

3. CONCLUSIONS

This Special Issue in Geosciences Journal should promote an open exchange of ideas and information regarding earthquake swarms among scientists and engineers, local and central authorities, and the general public.

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