A natural earthquake observed during hybrid surface wave survey by means of a dense geophone array.

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A natural earthquake event was coincidentally recorded by means of a dense linear geophone array set along the streamline of Kokai River, Tskuba, Ibaraki Prefecture. We were conducting “hybrid surface wave survey” proposed by the author at the site from February 21st to 22nd in 2019. A total of 240 vertical type geophones (fo=4.5 Hz) was planted at 2 m intervals on the high-water floor, about 2 m high from the stream water surface at that time. The major survey parameters were, 2.4-sec recording at 0.5 ms sampling for active seismic measurements, and 50-sec recording at 2 ms sampling for passive seismic measurements. The recorded earthquake occurred in 15h13m45.2sec 21st, its magnitude was about 2.0, and depth was estimated as 45 km. Initial 2 second phases of the earthquake were recorded by superposing on an active shot event. Because the epicenter was located only 20 km eastward and roughly perpendicular to the survey line, it was highly probable that the primary waves propagated vertically to each geophone. Nevertheless, picked events in the primary waves were non-aligned, and showed time differences larger than 30 ms even in a 480m-long survey line. Then we interpreted the time differences as “receiver statics”, and applied it in seismic reflection data processing. Next we correlated it with the time terms derived from seismic refraction analysis. These results were quite concordant with each other. In addition, surface P-wave and S-wave velocity structure profiles were similar to each other too. As known, refraction statics including first break picking is time-consuming process. In contrast, specific event picking in seismic records if exists is relatively easy and practical especially such earthquake prone country as Japan. In conclusion, we demonstrated that dense linear geophone array was useful to delineate the near surface geophysical structure. Moreover, multiphase analysis is quite effective to provide reliable high-resolution geophysical information of the near surfaces.

Keywords: natural earthquake, surface-wave survey, near surface geophysics, surface velocity structure, dense geophone array