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Ground motions and geotechnical aspects of the Noto Peninsula earthquake, Japan

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The Noto Peninsula earthquake (M_J7.6, M_W7.5) caused extensive damage to buildings and infrastructure in the Noto Peninsula located in the northern part of Ishikawa prefecture, Japan. The hypocenter was within the area of the earthquake swarm that started in 2020. However, the source fault bilaterally ruptured over a length of 150 km beyond this area. The main residential areas in Wajima, Suzu, and Anamizu are located almost above the western segment of the reverse fault. The geographical features of the Noto Peninsula pose significant challenges for aid and support, particularly due to embankment and soil failures that caused main road closure or limited access. This has led to increased traffic on the few accessible routes, further delaying the arrival of support. The situation has hindered the restoration of essential services such as water and sewage systems and has slowed down the process of demolishing buildings deemed dangerous.

Valuable strong motions were observed during this event. The maximum Peak Ground Acceleration (PGA) in the horizontal component reaching 2.78g was recorded at the K-NET ISK006 station, a location known for significant site amplification around 0.2s. This value aligns with the dominant period in the Spectral Acceleration (Sa), thus the extreme PGA was probably due to the enhanced short-period component in the shallow soil amplification. In addition, K-NET ISK002 and ISK005 recorded large PGVs of 1.31 m/s and 1.59 m/s, respectively, and observed the remarkable Sa with 1.3g and 2.2g at T=1.0s, respectively, which are similar to the damage-prone record in the 1995 Kobe earthquake (JR Takatori record).

In the main residential areas of Anamizu and Wajima, two seismic stations are operated. One is located on the stiff soil ground, and the other is located in zones where residential damage was most severe. In both Anamizu and Wajima, the records at the damage site were amplified in the periods of 1-4 s, suggesting that the residential damage is related to the site amplification. Since the spectral ratio of the weak motions shows the amplification at periods of less than 1s, the major reason for the amplification at periods of 1 to 4 seconds during the main event is due to the nonlinear response of the soil ground.