SAR-detected crustal deformation and topographic changes of the 2024 Noto Peninsula earthquake

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An intense seismic swarm and transient crustal deformation have started in the Noto Peninsula, central Japan since the end of 2020, followed by a moment magnitude 7.5 earthquake occurred on January 1, 2024**.** Here we report on SAR-detected ground deformation and the geodetically estimated fault model. The GNSS data show that the northern part of the peninsula, which is distributed in the east-west orientation, uniformly moves westward by up to ~2 m. Large uplifts with ~ 1 m are observed at stations deployed in the northern coast of the peninsula. Although the GNSS data provides us with large ground deformation, SAR-derived deformation map estimated by InSAR and pixel offset methods unveils the displacement field in more detail (Fig. 1). Large uplift is distributed along the northern coast with two main areas: The maximum uplift reaches ~4 m in the northwestern tip of the peninsula, and the second largest uplift, reaching ~2 m, is located in the west of the epicenter.

In the large uplift area, we identify clear difference on the microwave backscatter of SAR intensity images acquired before and after the earthquake. Comparing the two images, new land can be recognized along the coast, which has not been identified in the image before the earthquake. To clarify the land emergence more clearly, we applied an additive color process to the SAR intensity images, resulting in an RGB composite image. Combining these two images, areas where backscatter increased, decreased, and remained unchanged turned out to be red, cyan, and gray, respectively (Fig. 2). A clear red-colored zone can be observed extending in the coastal area, where the backscatter intensity increased significantly. The results mean that the seafloor uplifted and the shoreline shifted seaward. The total distance of the red zone is estimated to be about 90 km.

Our fault model for the coseismic deformation consists of three fault segments with almost pure reverse motions: The westernmost fault extending a north-northeast orientation has a slip amount of ~10 m which produces the uplift of ~4 m on the ground. The fault next to the east extends in almost east-west orientation along the coast, and includes a right-lateral slip motion. The easternmost fault segment changes direction to the northeast on the west side of the epicenter, and has a large slip with ~10 m off the east coast of the tip of the peninsula. Comparing the past seismic activities in the Noto peninsula, we found that the coseismic slip stops around the eastern tip of the 2007 seismic event (M_J6.9). Further, our model clarifies that the fault rupture of the 2024 event occurred significantly shallower than aseismic slip that had continued with active seismic swarm since the end of 2020.

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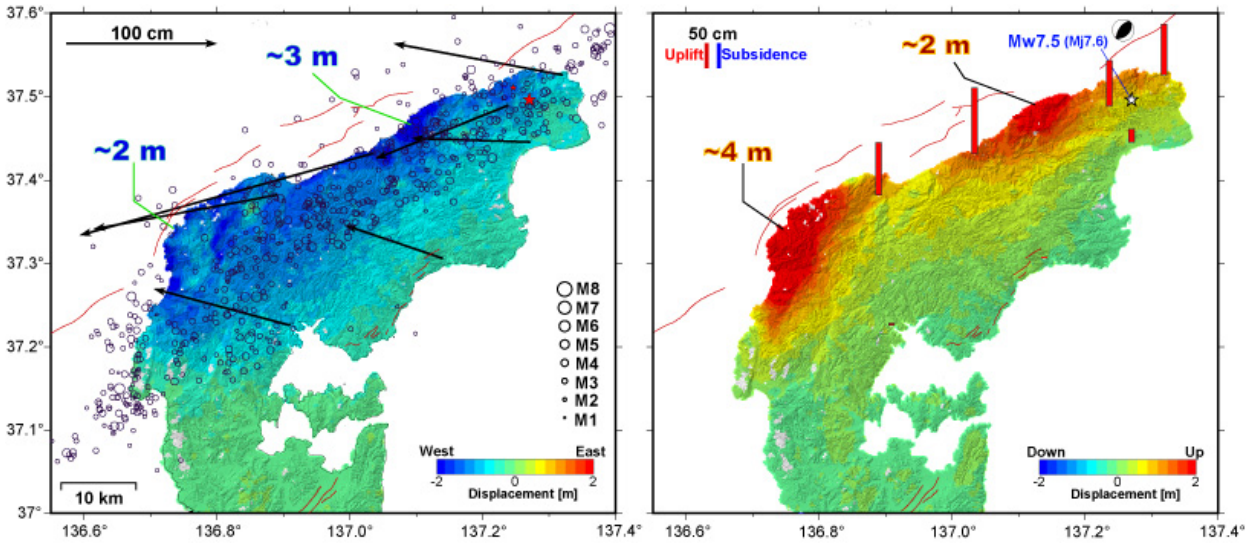

Fig. 1 SAR-derived crustal deformation

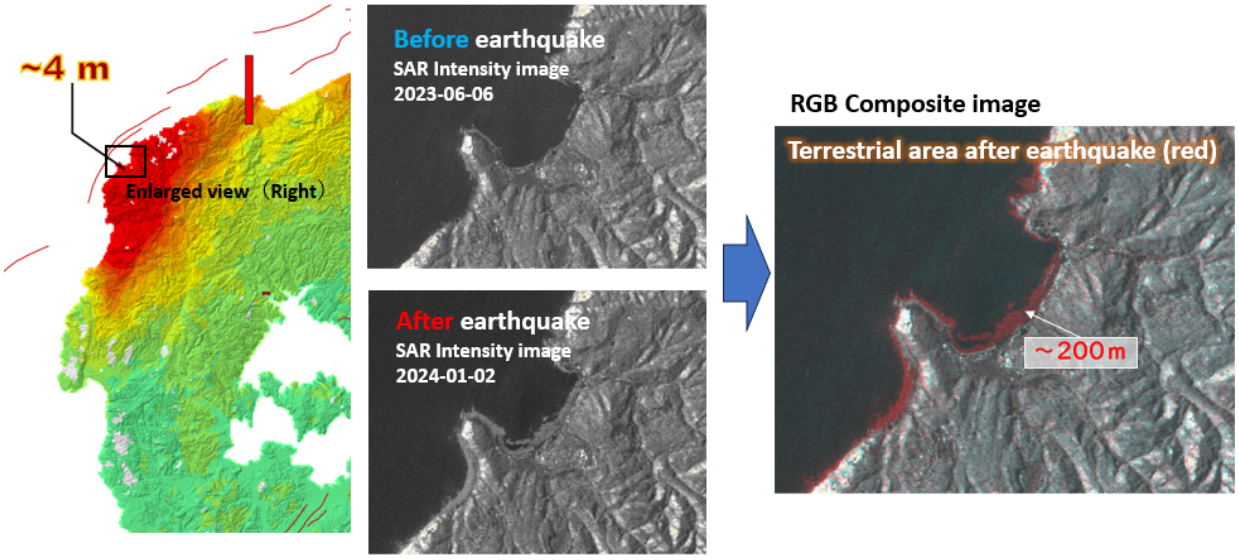

Fig. 2 Land emergence along the coast detected by SAR intensity images.