Source models for the 2020-2024 Noto Peninsula earthquakes based on GNSS data

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Since November 30, 2020, an intense earthquake swarm and transient deformation have been continuously observed in the Noto Peninsula, central Japan, which is a non-volcanic/geothermal area far from major plate boundaries. During the earthquake sequence, M_w6.2 and M_w7.5 earthquakes occurred on May 5, 2023, and January 1, 2024, respectively. We report the transient and coseismic deformation based on a combined analysis of multiple Global Navigation Satellite System (GNSS) observation networks, including one operated by SoftBank Corp., relocated earthquake hypocenters, and tectonic settings. The start of the transient deformation coincides with a burst-type activity of small earthquakes in late 2020. A total displacement pattern in the first two years shows horizontal inflation and uplift of up to ~60 mm around the source of the earthquake swarm. The coseismic horizontal and vertical displacements of the M_w7.5 earthquake reached ~2 m westward motion and uplift along the northern coast. The postseismic displacement for the first month shows horizontal displacement directed toward the source area and the differences between co- and post-seismic displacements are a gentle spatial decay of horizontal displacement from the source area and subsidence in and around the source area during the postseismic period. Based on the observation, we suggest that fluid with a few 10^7 m^3 of volumetric increase was upwelled to mid-crust, and that the fluid spread at a depth of ~16 km through an existing shallow-dipping permeable fault zone. Then it diffused into the fault zone, triggering a long-lasting aseismic slip below the seismogenic depth. The aseismic slip further triggered intense earthquake swarms including the M_w7.5 earthquakes at the updip.

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Keywords: GNSS, Crustal deformation, Earthquake swarm, Noto Peninsula

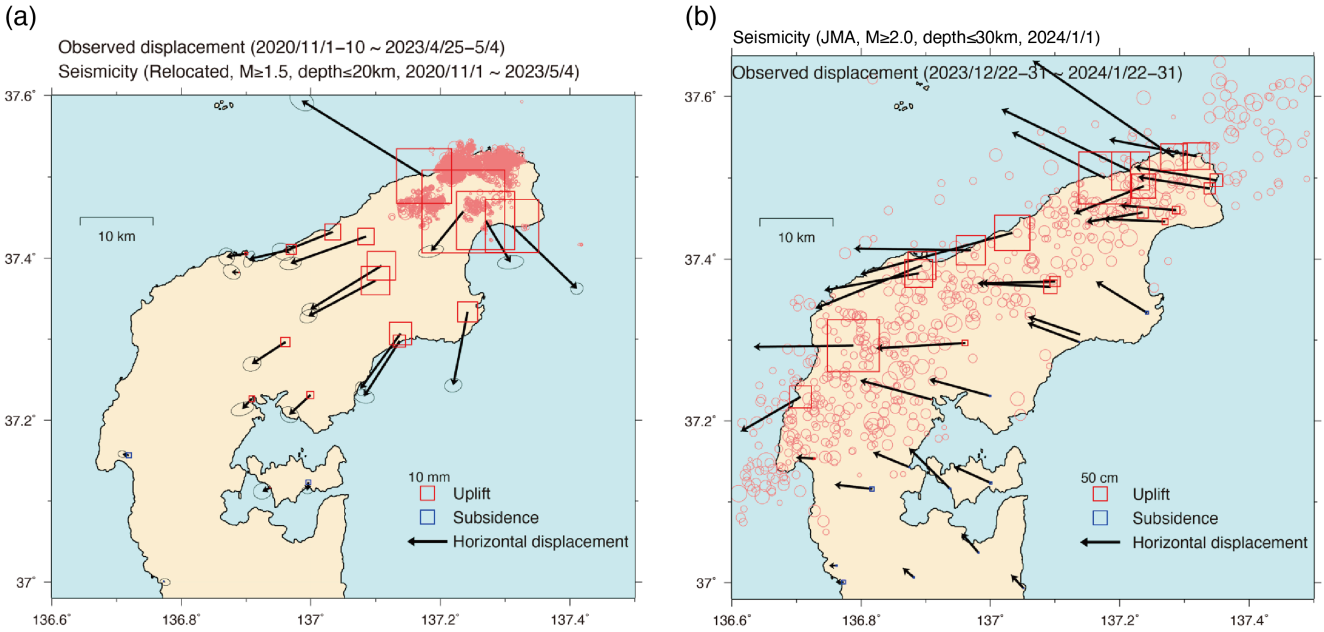

Figure 1. GNSS displacements associated with the 2020-2024 Noto Peninsula earthquakes. (a)Transient crustal displacement from November 2020 to April 2023. (b) Coseismic displacement of the 2024 M7.6 earthquake.