

Relationship with geological structures and distribution of surface deformations related to liquefaction in Uchinada Town induced by the 2024 Noto Peninsula Earthquake

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M7.6 Noto Peninsula Earthquake was occurred at 16:10 on January 1, 2024 (Japan Meteorological Agency, 2024) and caused various geohazards, including coastal uplift, landslides, and liquefaction. Among them, Liquefaction was reported in four prefectures: Ishikawa, Toyama, Niigata, and Fukui (National Research Institute for Earth Science and Disaster Resilience, 2024). In particularly Uchinada town, Ishikawa Prefecture, located about 100 km south-southwest from the epicenter has been damaged characterized by lateral spreading due to liquefaction. The damaged area of Uchinada town is concentrated in the behind of the Uchinada Sand Dune, and many cracks and sand boils are observed. In this study, we summarize the characteristics of liquefaction damage and surface deformation and examine the relationship between liquefaction and topographical change and geological structures.

We conducted field surveys on February 21st and 24th, 2024, and created orthoimages using Metashape software from the aerial photograph obtained by drone. And then, we imported these images into QGIS and mapped ground cracks and sand boils.

As a result, cracks are mainly distributed along the west side of Prefectural Route 8, at elevations ranging from 3 to 5 m above sea level. These distributions correspond to the area of uplifts along the west side of Prefectural Route 8, with abundant sand boils. However, in some areas of the Nishiaraya and Miyasaka districts, cracks and uplifts are distributed along the other road to the west. Comparing topographic maps and aerial photographs from around 1930 using the Time Series Topographic Map Viewer of Japan (Tani, 2017), these roads correspond to the former shoreline of Lake Kahoku-gata and are close to inland slopes of the sand dune. Furthermore, the inland slopes of the sand dune had been excavated to a depth of up to about 40 meters, suggesting a relationship between surface deformation and landform transformation. On the other hand, arcuate clusters of cracks are distributed around the Nishiaraya Elementary School. This area corresponds to the range where intense undulations of road were observed. Additionally, comparing the 1961-1969 aerial photograph from GSI Tiles, it is recognized that the sand dune slopes in this area were excavated below the water surface of the Lake Kohoku-gata. Consequently, it is considered that the movement of mass filling materials could have led to extensive ground deformation.

According to data of geological surveys publicly released by the National Geo-Information Center, the groundwater levels around the Muro and Miyasaka districts are very shallow, about 0.5 meters from surface, and fine sand layer (N values: 0-5) was observed to a depth of 5 to 6 meters. Additionally, silty clay was observed to a depth of around 20 meters as the lower layer. This may suggest that liquefaction occurred at the depths of 5 to 6 meters from the surface. At the Uchinada drainage canal, well compacted medium sand layer with N values exceeding 50 was reported beneath the upper loose medium sand layer. This well compacted sand layer is not only developed on the Japan Sea side of the Uchinada Sand Dune but also observed on the inland side. While the upper depth limit of the well compacted sand layer is not clearly due to landform transformation, it is possible that it performed as a basement for liquefaction layers on the edge of the dunes. To understand the depth and sediment layers that liquefaction occurred, additional geological surveys are necessary to obtain geological structure and physical properties.

Keywords: 2024 Noto Peninsula Earthquake, Liquefaction, Lateral spreading , Sand dune

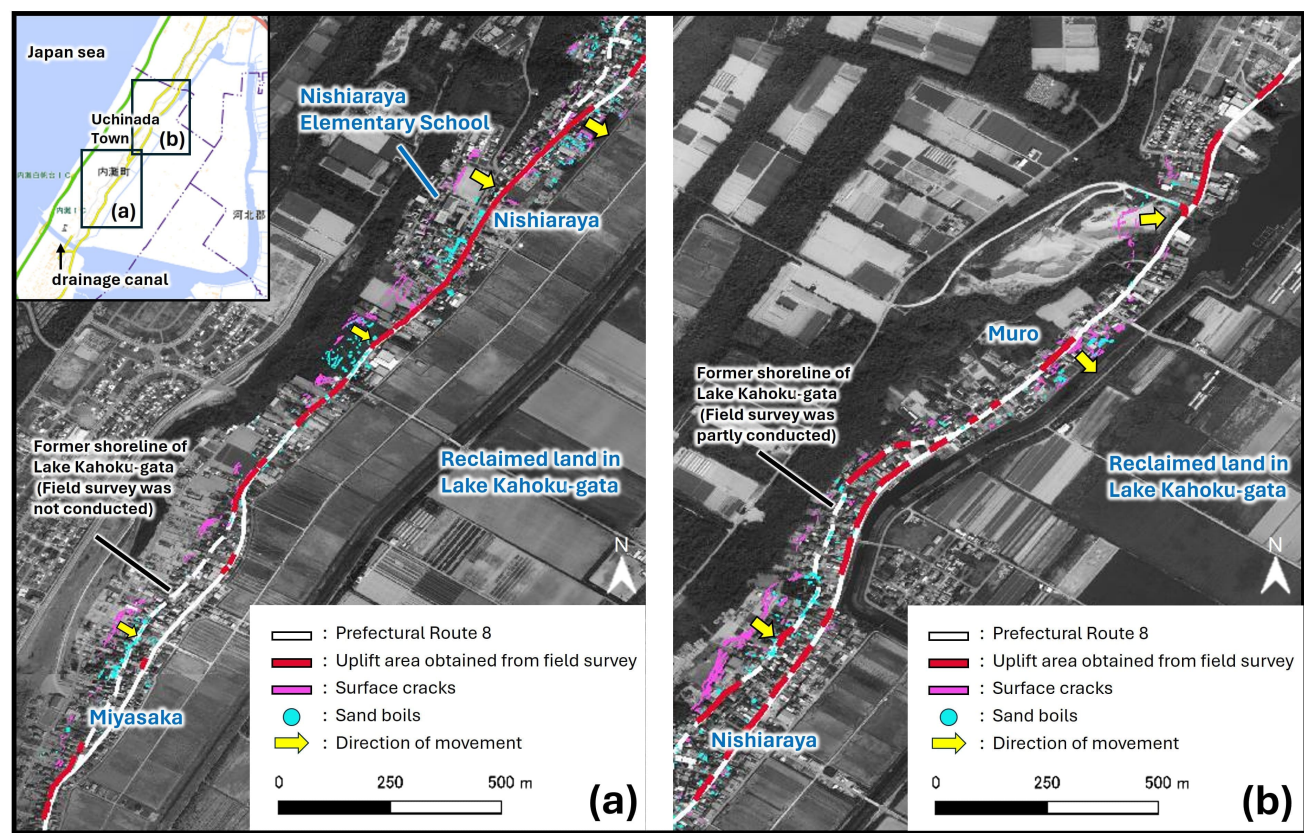


Fig.1. Distribution of surface deformation (cracks, sand boils, uplifts). The area of (a) is from Nishiaraya to Miyasaka, (b) is from Muro to Nishiaraya. The base map is the latest seamless photograph from GSI Tiles. Inset shows regional map of Uchinada town from GSI Maps.