

Mapping of Soft Soil Deposit's Thickness Using Boreholes and Microtremors Data for Seismic Micro-Zoning of Kashiwazaki City, Niigata, Japan.

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Micro Zoning Nakamura H/V
Microtremors GIS
Array Analysis Sediment Depth

1. Introduction

Recently many earthquakes have been observed in Niigata prefecture that is believed to be associated with the boundary between the Eurasia plate and the Pacific tectonic plates e.g. the 1964 (M7.5), 1995 (M5.4), 2004 (M6.6), and the latest, on July 17, 2007 Niigata-ken Chuetsu Oki earthquake (37.557N 138.608E Depth 17Km) brought tremendous damages to the buildings and facilities in Kashiwazaki plain and neighboring area in the region.

Kashiwazaki City which is located about 20-30km from the epicenter, suffered heavily from this event. The City is also home to the Kashiwazaki-Kariwa nuclear power plant, suffered from fire, radioactive water spill and land failure (IAEA 2007).

2. Geology of the Measurement Field

Niigata Prefecture is on the eastern part of "Shinetsu Sedimentary Basin" also called as "Eastern Marginal area of Fossa Manga" that have been separated from the Pre-Tertiary rocks of Echigo and Ashio Mountains by Shibata-Koide Tectonic Line therefore the geology of this area is different from that not only the main part of Fossa Manga but also the other marginal areas (Kato, 1992). The Holocene sediments in northern Shin-etsu sedimentary basin from SSW to NNE are Takado, Kashiwazaki and Niigata Plains. Takado and Kashiwazaki are separated by Kubikiku and Yone-yama hills. Stretch of Kubikiku and Nishiyama hills separates Kashiwazaki plain from Niigata, the largest Holocene sediments in the area, that on east is reaches to Uonuma and Higashi-yama hills and further east reaches to Echigo mountains.

Fig. 1 shows the geology of central Kashiwazaki City that are mainly formed by the sediments of sand in some points with a thickness of 60 meters over layers of various thickness of Pleistocene stiff sand and clay over the base Tertiary rocks. This figure also shows the area of main damage after the 2007 Earthquake that was concentrated inside the city which is located northwest of Hokuriku expressway and stretched along the Sea of Japan between Saba-ishi River in north and Yu River in south west

3. Borehole Data

Total of 133 borehole data has been collected around and inside city downtown but only 23 in downtown area and 21 in vicinity have the significant depth to the engineering base (N-values more than 50). Fig.1 shows the distribution of the significant boreholes in the area. The Kyoshin network (K-net) has only one station in the area (NIG018, 38.7262N 141.5109E). This station has a very shallow borehole data including P and Vs

profile and does not reach the engineering base. (Fig. 2 right) The insufficient soil characteristics data suggests the use of other means of S-wave evaluations such as array measurements.

4. Microtremors Array Measurements

We made microtremors array measurements at seven sites in the city as the locations shown in Fig. 1. A sample is shown for the array near K-Net station. In all cases a seven channel double triangle of vertical sensors with radiuses 40 and 20 meters is used to cover a range of interval distances from 10m to 70m. Recording where made for at least 20min with 100Hz sampling rate. Popular modified SPAC method (Aki 1957) used to obtain the phase velocity dispersion curve and estimated Vs profile. A uniform velocity distribution of Vs=200m/s for a depth of 55m can provide the best results with minimum misfits.

5. Microtremors Measurements

The boreholes coverage is not adequate. Microtremors measurements are a very useful method to obtain ground characteristics, by applying the predominant period and the site amplification factor (Enomoto et al, 2000; Rahimian and Seo 2002; Yamamoto et al. 2007). We measured microtremors on the stations scattered around downtown where the damage reported to be the most. The locations are shown in Fig. 1. A three components accelerometer, were used for the measurements. Velocity amplitudes of microtremors at a sampling frequency of 100 Hz were recorded for 300 seconds at each station. We

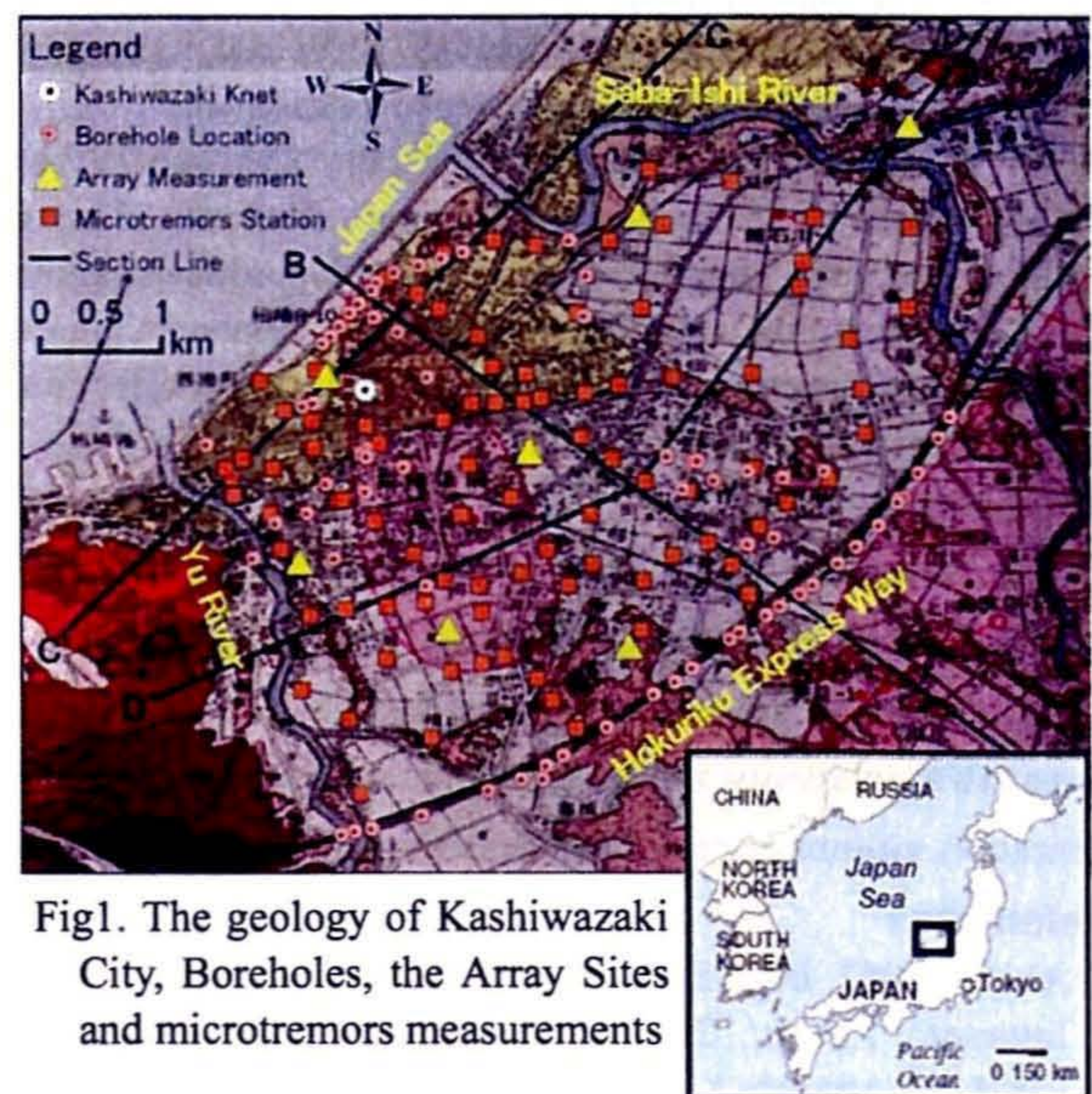


Fig1. The geology of Kashiwazaki City, Boreholes, the Array Sites and microtremors measurements

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