Study on Uplift Estimation by Using Fluvial Terraces for Characterization of Quaternary Tectonic Movement

Background

Uplift estimation in an inland area is very important for site screening and long-term safety of the geological disposal of high-level radioactive waste projects, but is delayed remarkably in comparison with those in a sea-side area. For quantitative estimation of late Quaternary uplift in an inland area, the method using fluvial terraces was proposed in previous studies. It is based on the assumption that terraces are formed while controlled by the cyclic glacio-eustasy, and relative height between terraces formed under similar climate such as glacial age or inter-glacial age.

Objectives

(1) A viewpoint of terrace correlation and chronology, which is a base of uplift estimation, is proposed newly. (2) It is verified that the method using fluvial terraces is available for estimating the uplift for the last 100,000 years in an inland area quantitatively. (3) Tectonic movement in the inland area is clarified on the basis of uplift distribution.

Principal Results

1. A viewpoint of terrace correlation and chronology that attaches great importance to topography and geological features

The viewpoint of terrace correlation was proposed on the basis that the age of the lowest part of a terrace-covered layer does not show the correct time of terrace formation, but gives the upper limit of the terrace formation age (Fig.1). It is stressed that it is very important to combine the information of geomorphologic stratigraphy, geomorphologic analysis, geologic stratigraphy, tephra chronology and numerical dating data comprehensively. Furthermore, we did the case study on terrace stratigraphy in two areas (Kawasaki basin, Miyagi pref., and Naka river area, Tochigi and Ibaraki pref.), and showed that our method is practical.

2. Uplift estimation method using fluvial terraces

We verified the uplift estimation method by using fluvial terraces (Fig.2). Uplift for the last 100,000 years, which is estimated on both the side of the Ayashi fault in Miyagi prefecture and the Sekiya fault in Tochigi Prefecture by using the relative height of river terraces, is almost equal to vertical displacements of these faults for the last 100,000 years. Hence, the method using fluvial terraces is available for estimating the uplift for the last 100,000 years in an inland area quantitatively.

3. Tectonic movement in the inland area shown by the uplift distribution

It is possible to find the geotectonic features that were so far overlooked as deformed zones along active faults, tectonic style of uplift and subsidence by obtaining the 3-dimentional distribution of uplift in the last 100,000 years (Fig.3). Methodology and concept proposed in this study give practical survey method of late Quaternary 3-dimentional uplift characteristics for the long-term safety of geological disposal of high-level radioactive waste. By applying this method to Quaternary research, new insights on the Quaternary tectonic movement may be given.

Future Developments

To upgrade reliability, precision and practicality, we will study terrace correlation methods that use erosion features of terraces and/or weathering of terrace gravels, and develop a numerical dating method. Furthermore, we will examine the relationship of geodetic data and geological-time-scale tectonic movement, for characterization of tectonic movements on the larger-scale.

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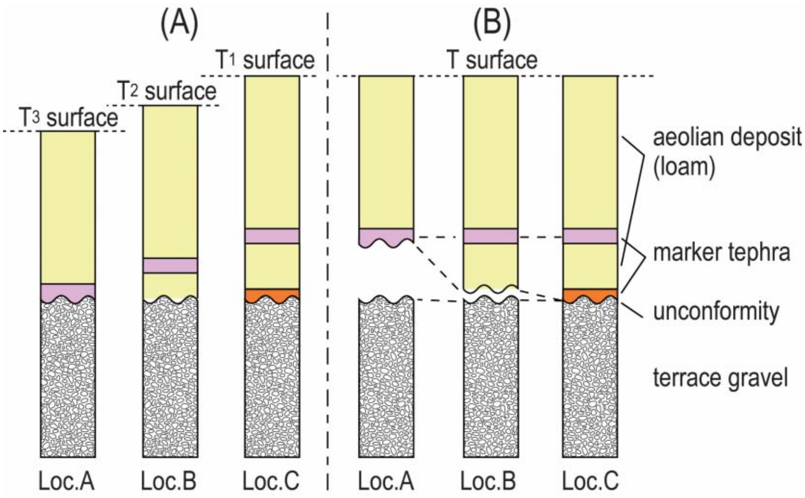

Fig.1 A viewpoint of terrace correlation and chronology in this study

The case A and B are the same data set of geological column. The case A shows terrace correlation when an age of the lowest part of a terrace-covered layer is considered to be a terrace formation age. Three terraces are different each other. After development of tephra chronology, many researchers accepted it. However when three terraces are the same topographically, the case B hypothesis is more proper because the age of the lowest part of a terracee-covered layer does not show the correct time of terrace formation, but gives the upper limit of the terrace formation age.

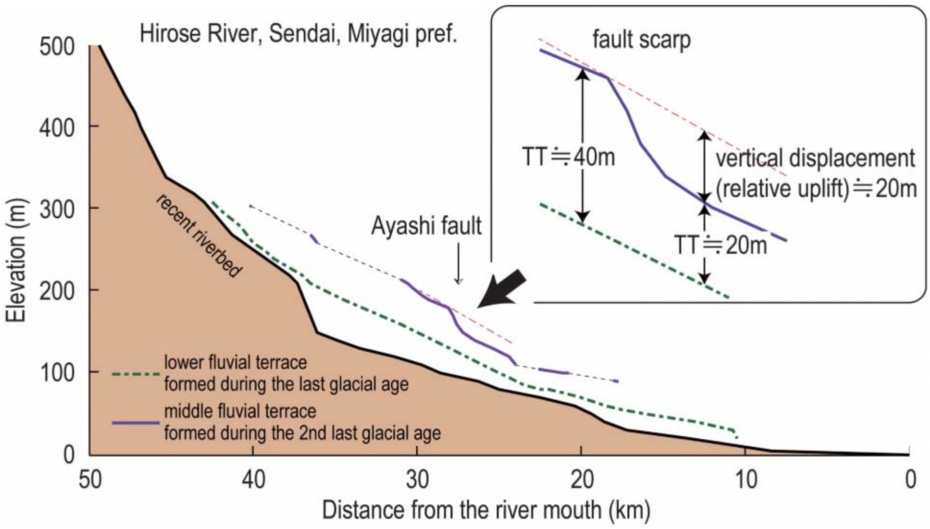

Fig.2 Verification of the uplift estimation method by using fluvial terraces

A hypothesis that differs from previous results was given by the above viewpoint, and was supported by our data obtained (stratigraphy, tephra etc.).

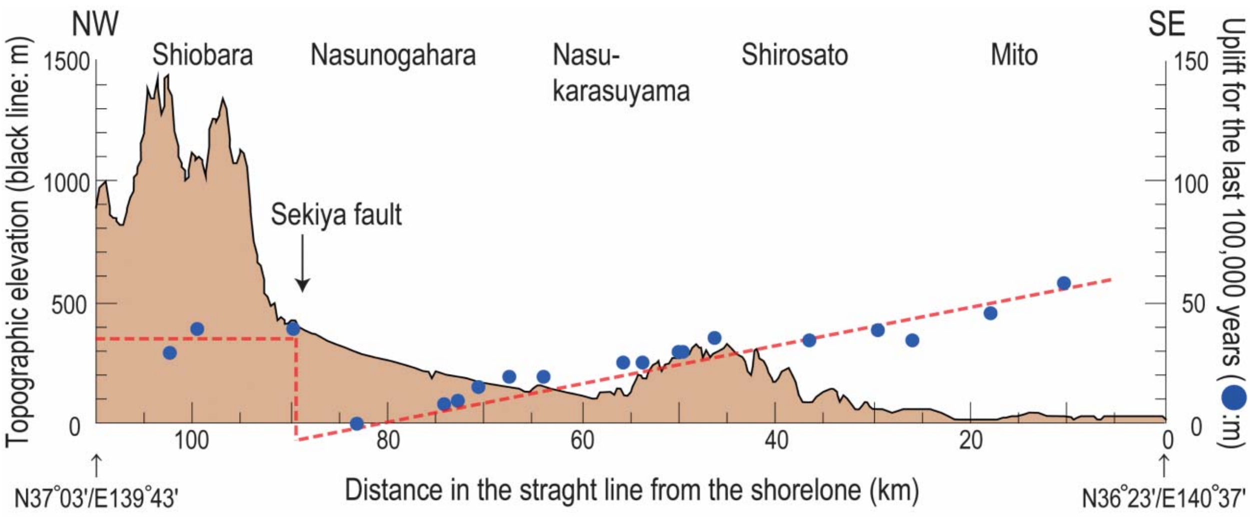

Fig.3 Late Quaternary tectonic movement along the Naka river

Distribution of uplift for the last 100,000 years reveals that there is a tectonic block of over 80km in width to reach Nasunogahara area from Mito area in the east from the sekiya fault (active fault), and that it tilted toward the west during late Quaternary.