Reconstruction of vertical crustal movement accompanying restriction of depositional ages of Quaternary shallow marine

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1. Introduction:

For geological and geographical evaluation of crustal movements around the Japanese Islands during Quaternary, it is important to establish high-resolution crustal subsidence reconstruction method, and to use the established method together with uplift reconstructing method using marine terraces. Shirai and Tada (2002) proposed a reconstructing method of vertical crustal movement using shallow marine sedimentary cycles, by which crustal subsidence is evaluated. The method is applicable to the reconstruction at a bounding zone between uplifting and subsiding zones. Whereas, the method demands accurate age estimates on strata. Because the Quaternary sedimentary cycles are generally correlated to glacio-eustatic cycles only with cycle-order accuracy, it is difficult to apply the method into other sedimentary cycles. So, I propose an improved reconstruction method of vertical crustal movement. Reconstructing vertical crustal movement and ages of strata in sedimentary cycles alternately, the new method can be applied into many Quaternary shallow marine sequences without accurate age indices.

2. Reconstruction method:

Relative sea level change is defined as a change in distance between elevation of the basement (vertical crustal movement) and eustatic sea level. It is also expressed as a sum of changes in water depth and sediments thickness above the basement. Depositional ages of the strata and vertical crustal movement are alternately estimated using changes in eustatic sea level, elevation of the basement, water depth, and sediments thickness.

(i) Combining altitude of the basement during interglacial maximum in each glacial-interglacial cycle, approximated vertical crustal movement (C/0) is guessed.

(ii) Subtracting approximated vertical crustal movement (C/0) from eustatic sea-level curve, relative sea level curve (RSL/1) above the basement is calculated. Relative sea level changing pattern is also estimated as sum of depositional depth and sediments thickness. Overprinting the relative sea-level changing pattern on RSL/1, depositional ages of strata (T/1) are estimated.

(iii) Depositinal ages of strata (T/1) allow us to estimate more accurate vertical crustal movement (C/1). Using changes in eustatic sea level, water depth, and thickness of the sediment, many boxes showing possible elevations of the basement are defined. Assuming constant tectonic uplift or subsidence rate during a move of crustal movement, I estimate vertical crustal movement (C/1), passing through all the boxes.

(iv) Alternately repeating procedures (ii) and (iii), the best estimate of vertical crustal movement is obtained.

3. Application of the method:

As a case study, the new reconstruction method is applied into the middle to upper Pleistocene at the Oga Peninsula, northeast Japan. A result of the new reconstruction method is compared with the result of Shirai and Tada (2002), which needs accurate age indices of strata such as high-resolution tephro-chronology. The comparison of the results shows that vertical crustal movement and ages of strata reconstructed with both methods are similar each other. It shows that the new reconstruction method is reliable enough as a reconstruction method of vertical crustal movement.