Deformation rates of island-arc crust estimated from seismic, geodetic, and geomorphic data

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Steady plate subduction brings about steady uplift of the island-arc lithosphere [1]. This process is simply explained as convex upward bending of an elastic plate by the effect of gravity [2]. So, there is no analogy in mechanism between the steady uplift and steady horizontal shortening or stretching of island-arc crust. The island-arc crust is basically elastic, but it includes a number of defects. Brittle fracture and/or plastic flow at these defects, which occur so as to release the overall elastic strain energy produced by mechanical interaction at plate interfaces, cause the horizontal shortening or stretching of island-arc crust [3]. To sum up, the crustal shortening or stretching is a purely inelastic deformation process. In northeast Japan, for example, the evidence of crustal shortening has been reported from seismic, geodetic, and geomorphic data [4, 5]. The point is a discrepancy in its rates. One of the reasons is difference in the length of observation periods. Actually, geodetic observation is too short to cover the entire cycle of large earthquakes. Another, more essential, reason is that different kinds of data provide different information about crustal deformation; that is, seismic and geomorphic data provide information about purely inelastic crustal deformation, whereas geodetic data provide information about total (elastic + inelastic) crustal deformation. So, we cannot directly compare the crustal shortening rates from geodetic data with those from seismic and geomorphic data unless geodetically observed deformation is divided into the elastic and inelastic parts [3].

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Keywords: island arc, deformation rate, inelastic strain, seismic data, geodetic data, geomorphic data

