Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS38-18 Room:303 Time:May 23 15:30-15:45

Characteristics of long-term strain buildup in the Kuril-Japan subduction zone: a global comparison

IKEDA, Yasutaka[1*]

[1]Dept. Earth Planet. Sci., Univ. Tokyo

Crustal strain is build up in and around a subduction zone in association with interseismic coupling on the plate interface. The elastic component of the crustal strain is released during episodic decoupling events on the plate boundary; the remainder is accommodated as permanent (= inelastic) deformation mainly within the subduction-related orogenic zone. Coseismic deformation is basically elastic, although damped by asthenospheric viscosity and thereby followed by postseismic deformation. Recent GPS observations have made it possible to detect crustal strain precisely and extensively, but are not sufficient in time to cover a whole cycle of strain buildup and release in subduction-related orogens. We propose here that geological methods and data should be used to evaluate inelastic strain buildup quantitatively, thereby to evaluate present-day elastic strain buildup, which may eventually result in gigantic earthquakes.

There has been a discrepancy between long-term (geologic) and short-term (geodetic) strain observations in both horizontal and vertical directions over the Northeast Japan (NEJ) arc. Geodetic observations in the past ~100 years have revealed strain accumulation across the NEJ arc at a rate as high as 10^{-7} strain/yr, whereas geologically observed strain rates are one order of magnitude slower. A similar discrepancy exists also in vertical movements; tide gauge records along the Pacific coast have indicated subsidence at a rate as high as ~10 mm/yr during the last ~80 years, whereas late Quaternary marine terraces indicate long-term uplift at 0.1-0.4 mm/yr. The ongoing rapid coastal subsidence is due to dragging by the subducting Pacific plate beneath the NEJ arc. Thus, most of the strain accumulated in the last 100 years at abnormally high rates is elastic, and is to be released by slip on the coupled plate interface. Only a fraction (~10%) of geodetically-observed crustal shortening is accommodated within the NEJ arc as long-term (inelastic) deformation.

Fairly large (Mw 7-8) subduction earthquakes occurred in the past ~100 years on the Kuril-Japan subduction zone, but they had nothing to do with strain release or coastal uplift. The 2011 Tohoku earthquake of Mw 9.0, whose rupture surface encompassed those of previously occurred Mw 7-8 subduction earthquakes, is likely to be such a decoupling event that effectively releases the elastic strain due to plate coupling. Pattern of interseismic subsidence indicates that, at 50~100 km depths down-dip of the 2011 rupture, there still exists a coupled part of plate interface, on which a large amount of aseismic after slip may occur in the coming decades.

A global survey suggests that gigantic (Mw $\geq$ 9.0) subduction earthquakes are classified into two types: the NEJ type and the Chilean type. The Chilean type strain buildup/release process is simple and straightforward in the sense that seismogenic zone (down to a 40-50 km depth) plays everything. The source areas of the 1960 Chile, 1964 Alaska, and 1700 Cascadia earthquakes lack evidence for interseismic deep coupling. Paleoseismological evidence indicates interseismic uplift around the down-dip edge of coseismic rupture, where coseismic subsidence is observed. This implies that the deeper plate interface is basically decoupled in interseismic periods, although subtle postseismic slip could exist on a transition zone down-dip of the coseismic rupture. In contrast, the NEJ type strain buildup/release process seems to be exceptional in that interseismic coupling occurs to a depth as deep as ~100 km. Its decoupling process is two-fold: seismic decoupling occurs only on the shallower plate interface while the deeper interface (50~100 km depths) decouples aseismically following the earthquake. A possible cause for such deep coupling would be thermal; the oceanic lithosphere of the western Pacific is very old and therefore cold, and has subducted beneath the NEJ-Kuril arc.

Keywords: interseismic coupling, decoupling event, elastic strain release, inelastic strain buildup, subduction-related orogen

SSS38-18 Room:303 Time:May 23 15:30-15:45