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Inelastic Deformation of Island-Arc Crust and Generation of Intraplate Earthquakes: Basic Ideas

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The occurrence of earthquakes is the sudden release of tectonically accumulated stress by faulting. On this point, there is no difference between interplate earthquakes and intraplate earthquakes. However, on the mechanism of stress accumulation in source regions, there is an essential difference between them. In the case of interplate earthquakes, the stress accumulation results from slip deficit at a stronger portion (asperity) of plate interface (Hashimoto & Matsu'ura, PAGEOPH, 2002; Hashimoto, Fukuyama & Matsu'ura, GJI, 2011). The accumulated stress is almost completely released by sudden fault slip that cancels the slip deficit. On the other hand, in the case of intraplate earthquakes, aseismic pre-slip in a weak portion (nucleation zone) of fault causes stress concentration at its margins, and dynamic rupture starts if the stress concentration goes critical (Matsu'ura, Kataoka & Shibasaki, Tectonophysics, 1992). Tectonic stress field in the source region governs the development of dynamic rupture, and so the problem to be solved is how the local tectonic stress field is formed. The essence of this problem is in the inelastic deformation of island-arc crust and the associated stress redistribution process. From the inversion analysis of CMT data of seismic events in and around Japan (Terakawa & Matsu'ura, Tectonics, 2010), we can understand that the regional tectonic stress field of the island-arc crust has been formed as a result of long-term mechanical interaction at plate boundaries and intraplate tectonic boundaries. On the other hand, from the physics-based strain analysis of GPS data, we can estimate continuous inelastic deformation in the crust (Noda & Matsu'ura, GJI, 2010). If the stress change produced by the inelastic deformation is the same as the regional stress field in sense, seismic activity will increase there. If the sense of stress change is opposite to the regional stress field, seismic activity will decrease there. The validity of earthquake generation models based on such ideas can be tested through the statistical analysis of seismic events with a space-time point process model (Ogata, JGR, 2004).

Keywords: island-arc crust, inelastic deformation, stress redistribution, intraplate earthquake, seismicity