AOB & COE Seminar

「Repeating Microearthquakes on a Creeping Plate-Suture: the Chihshang Fault of Eastern Taiwan」

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--- Abstract ---

Creeping crustal faults often generate repeating microearthquakes, and not very common, they may also produce large earthquakes that rupture the brittle crust. The Chjihshang fault in eastern Taiwan is one of the few cases known in the world that possess such a fault behavior. Study of such a fault may help us to understand how a fault can simultaneously creep at the surface and produce large earthquake at depth. The Chihshang fault is the most active segment of the collision boundary between Eurasia and the Philippine Sea plate in eastern Taiwan. Except for one M_L 6.4 earthquake occurred in Chihshang area on 10 December 2003, the fault has been considered as a creeping fault and undergone 2-3 cm/yr surface slip rates for the last two decades. By analyzing microearthquake activities in Chihshang area, we investigate the fault behavior at depth using the repeating earthquake sequences observed along the Chihshang fault. We identified 211 repeating microearthquakes with waveform cross-correlation coefficient larger than 0.95 using the Central Weather Bureau 1992 - 2003 earthquake catalogue. They were organized into 45 repeating sequences, including 3 to 13 events, with both quasi-periodic and aperiodic types. The quasi-periodic repeaters tend to have longer inter-asperity distance and smaller range of sizes than aperioidic sequences. Those repeating events occurred at depth of 12 - 23 km with recurrence intervals of 1.1 - 6.0 years and magnitude from 1.9 - 3.8. More than 90% repeating earthquakes are located in the northern half of the 30-km-long fault zone, where the fault slip rates derived from 15 repeating sequences are 3.4 - 4.8 cm/yr, which is consistent with surface deformation rate (4 cm/yr in average). The southern half portion showing much less appearance of repeating earthquakes, and the slip rates derived from 2 repeating sequences are 6.0 - 6.2 cm/yr (~2 cm/yr higher than surface measurements). Those repeating events were located either away from or on the edge of the focal zones of large earthquake sequences. By analyzing the characteristics of repeating earthquakes observed in Chihshang area, we separate the Chihshang fault into two sections. The northern section is a creeping segment with large numbers of repeating earthquake sequences, which has deep fault slip rate consistent with surface deformation. The southern section, location of large magnitude focal zone, is a seismogenic zone. It has very few repeating earthquake sequences, and the only two sequences indicating 2 cm/yr slip rate deficit. Comparing the repeating behaviors in Chihshang and Parkfield areas, we found that repeaters tend to occur at the same depths that most seismicity concentrated. Besides, the repeat time is directly controlled by the regional tectonic loading rate. Furthermore, to quantify the candidate of repeating earthquake activities, we propose a r_{creep} - model by the square of event number over magnitude in an area of 2 × 2 km² on the fault plane. We found the areas with the highest 30% of r_{creep} value coincidentally occupied by repeating earthquakes. The good correlation found in both Chihshang and Parkfield provides the practicability of the r_{creep} - model to detect other repeating-event-abundant areas.

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