Episodic creep events on the Chihshang fault, Taiwan

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Fault creep has mostly been well documented on strike-slip faults in tectonically-active continental regions, but there are only a few studies on creeping thrust and normal faults. Due to lack of recognized creep on dip-slip faults, the nature of fault creep and its role in large earthquake generation remains unknown. The Longitudinal Valley fault (LVF) in Taiwan serves as one of the best examples of active reverse faults that rapidly creep at the surface (1-3 cm/yr), while is also known to host a destructive earthquake sequence compose of 12 magnitude greater than 6 events (including four M7 events) in 1951, from 21 October to 5 December. Numerous observational studies have been carried out to develop the current understanding, yet a definitive resolution of where fault creep has reminded elusive. This is mainly due to the seaward-dipping fault hence limited coverage of seismic and geodetic stations to image deep fault slip.

Using 2359 M2.0-4.3 repeating earthquake sequences (RES) along the LVF over a 12 year period beginning in 2000, we aim at obtaining the time dependent aseismic slip at seismogenic depths and comparing with surface deformation, to better understand how the fault creeps. Along the 160-km-long LVF, the RES are highly concentrated in two segments, namely the Hualien and Chihshang segments. They are mainly located at a depth of 10-25 km and showing strong regional difference in creep behavior. In the Chihshang area the creep rate increases dramatically from 1.6 cm/yr to 5.6 cm/yr under the influence of a M6.4 earthquake in 2003, whereas in the Hualien area the creep rate remains high (4.9 cm/yr) over the study period. Applying moving window analysis, the time evolution of aseismic slip reveals a semiannual recurrence. Such episodic creep events in the Chihshang region are found to anti-correlate with declustered seismicity at the same depth where RES concentrate, while no significant correlation is seen with seasonal variation from GPS data. This suggests that the mechanism of deep creep may not be the same with shallow creep. Higher aseismic moment release equivalent to higher aseismic slip, is likely to correspond to less frequent seismicity in the immediate neighborhood, and therefore, wide areas allowing freely sliding.