Surface creep along the Longitudinal Valley fault, Taiwan from InSAR measurements

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Received 12 September 2005; revised 6 February 2006; accepted 14 February 2006; published 25 March 2006.

[1] We use interferometric synthetic aperture radar (InSAR) analysis in eastern Taiwan to study reverse creep on the Longitudinal Valley fault (LVF). A stack of the three highest-quality image pairs spanning 1997–2000 shows sharp range change offsets along the eastern side of the Longitudinal Valley, suggesting 11–35 mm/yr of surface creep between 23 and 23.4°N. No shallow slip was observed along the northern or southern ends of the valley, nor on mapped fault traces on the western edge of the valley. The width of the zone of deformation varied, suggesting distributed shear in shallow sediments above the creeping fault in some places. The InSAR results support the view that although surface creep is rapid in certain locations, significant portions of the LVF are locked and thus represent a substantial seismic hazard.
Citation: Hsu, L., and R. Bürgmann (2006), Surface creep along the Longitudinal Valley fault, Taiwan from InSAR measurements, *Geophys. Res. Lett.*, *33*, L06312, doi:10.1029/2005GL024624.

1. Introduction

[2] Some of the most rapid tectonic uplift rates in the world occur in Taiwan, where the Eastern Coastal Range is being thrust up along the east-dipping Longitudinal Valley fault (LVF). The LVF accounts for ∼30 mm/yr of present-day shortening [*Yu and Kuo*, 2001], or 30% of the total plate convergence [*Angelier et al.*, 2000]. The fault zone displays both creeping and locked segments and has produced moderate to large earthquakes [e.g., *Cheng et al.*, 1996; *Kuochen et al.*, 2004]. Active shallow creep has been monitored by creepmeters [*Lee et al.*, 2003, 2005], GPS [*Yu and Kuo*, 2001; *Chen et al.*, 2004a], leveling [e.g., *Yu and Liu*, 1989], and repeat surveying of manmade structures [*Angelier et al.*, 2000]. This study presents interferometric synthetic aperture radar (InSAR) results from the Longitudinal Valley, which complement existing measurements, providing greater spatial coverage of the surface deformation along the LVF. We focus on establishing the distribution and magnitude of near-fault deformation associated with shallow localized fault creep.

2. Geometry and Kinematics of the Longitudinal Valley Fault

[3] Relocated seismicity south of 23.5°N suggests a 45–60° east-dipping fault near the surface whose dip shallows with depth and connects with a décollement at ∼20–40 km depth [*Kuochen et al.*, 2004; *Rau et al.*, 2005]. The seismicity indicates that the fault geometry in the northern half of the LVF is more complicated, with no obvious fault plane extending to the surface [*Kuochen et al.*, 2004]. A left-lateral strike-slip component is inferred along the fault zone that may be partitioned between sub-parallel thrust and strike-slip fault segments along portions of the fault [*Angelier et al.*, 2000; *Hu et al.*, 2001]. There is still debate about how much regional deformation is accommodated by the LVF, a possible Central Valley fault to the west, and offshore faults to the east [e.g., *Bos et al.*, 2003; *Shyu et al.*, 2005].

[4] Along-strike, the existing deformation measurements suggest highest creep rates near Chihshang and decreasing rates toward the northern and southern tips (Figure 1). Shallow creep rates inferred from GPS velocities vary longitudinally [*Chen et al.*, 2004a] and may reach up to 40 mm/yr in the southern section [*Hsu et al.*, 2003]. The local creep rate of the fault near Chihshang as derived from near-fault data is ∼26–28 mm/yr in a N40°W direction [*Angelier et al.*, 2000; *Chen et al.*, 2004a]. However, uncertainties remain regarding the spatial extent and degree of localization of along-strike and cross-strike surface deformation.

[5] Creep rates along the LVF appear to be variable in time, at both seasonal and decadal scales. *Lee et al.* [2003, 2005] found creep rates two to three times higher during the wet period (Apr.-Oct.) than during the dry season (Nov. to Mar.). Decadal trends in repeat ground-surveying of man-made structures suggest a 25% decrease in rate from the 1980s to the 1990s [*Angelier et al.*, 2000], possibly continuing up to the M_w = 6.8 Chengkung earthquake of 10 December 2003 [*Lee et al.*, 2005]. Millennial uplift rates derived from Holocene river incision into terraces suggest a 20 mm/yr uplift rate (J. B. H. Shyu, manuscript in preparation, 2006). Some geodetically determined slip rates appear to exceed the sparse geologic estimates and active slip is generally variable in time. Creep rate estimates determined from the 1997–2000 InSAR data should thus only be directly compared to other measurements obtained during that time period.

3. InSAR Processing and Results

[6] We use synthetic aperture radar data obtained by the European Space Agency's ERS-1 and 2 satellites. Along descending track 461, we selected 11 scenes covering the southern Longitudinal Valley and 6 scenes covering the northern valley, acquired between 23 June 1993 and 11 May 2002 (Table S1).[1] We processed the data with the Repeat

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0094-8276/06/2005GL024624$05.00

[1]Auxiliary material is available at ftp://ftp.agu.org/apend/gl/2005gl024624.