Postseismic Deformation and Earthquake Triggering

Supervisors

Main supervisor: Doctor Max Werner (University of Bristol)
Co-supervisor: Doctor Juliet Biggs (University of Bristol)
Co-supervisor: Dr. Ake Fagerang (Cardiff University)

Project enquiries - Email: max.werner@bristol.ac.uk **Contact number:** +44 (0) 01173315014

Host Institution: University of Bristol

Project description

Aftershock sequences offer a unique opportunity to understand the physics of what causes earthquakes: information is pouring out of the Earth in the form of seismicity and postseismic deformation. However, current models of aftershock clustering are limited by simplistic assumptions about both the mainshock source of stress changes and the crust's response to these stress changes. For example, most models assume that the crust is an elastic half-space, that the mainshock rupture is a 2D plane, and that postseismic deformation is a negligible source of additional stress. This PhD project aims to improve time-dependent seismic hazard estimates by developing physics-based models of aftershock triggering that are informed by geological fieldwork, constrained by geodetic observations of postseismic deformation and validated against observed aftershock sequences. We seek an enthusiastic student with broad interests in geology, geodesy and seismology.

The student will investigate several aftershock sequences that were well captured by InSAR and GPS observations, including earthquakes in Alaska (2002 Denali), California (1992 Landers, 1999 Hector Mine), Tibet (Manyi), Taiwan (Longitudinal Valley Fault) and New Zealand (2010 Darfield). The objective is to model the evolution of stress during these sequences as a result of co-seismic as well as postseismic deformation. Postseismic deformation may include afterslip, distributed visco-elastic deformation as well as secondary stress changes due to aftershocks. This will require using and refining models of the mainshock sources, the crustal rheologies and the fault zones. The source and crustal model will be informed by geological observations of exhumed fault systems that reveal information about the rheological and structural properties of fault zones and the frictional properties of faults. For this purpose, students will perform about 4 weeks of fieldwork. The calculated stress changes will be compared with the observed evolution of aftershock seismicity and surface deformation during the aftershock sequence to evaluate and validate the models.

This PhD project offers unique opportunities for integrating different approaches to improve seismic hazard and risk estimates. Students will be trained in space geodesy, structural geology, computer modelling as well as data analysis.

References:

Biggs, J., Burgmann, R., Freymueller, J. T., Lu, Z., Parsons, B., Ryder, I., ... & Wright, T. (2009). The postseismic response to the 2002 M 7.9 Denali Fault earthquake: constraints from InSAR 2003–2005. Geophysical Journal International, 176 (2), 353-367.

Meier, M.-A., M. J. Werner, J. Woessner, and S. Wiemer (2014). A search for evidence of secondary static stress triggering during the 1992 Mw7.3 Landers, California, earthquake sequence, J. Geophys. Res. Solid Earth, 119, 3354–3370, doi:10.1002/2013JB010385.

Fagereng, A., Smith, Z., Rowe, C.D., Makhubu, B., Sylvester, F.Y.G. (2014). Stress, strain, and fault behavior at a thrust ramp: Insights from the Naukluft thrust, Namibia, Journal of Structural Geology, v. 58, pp 95-107

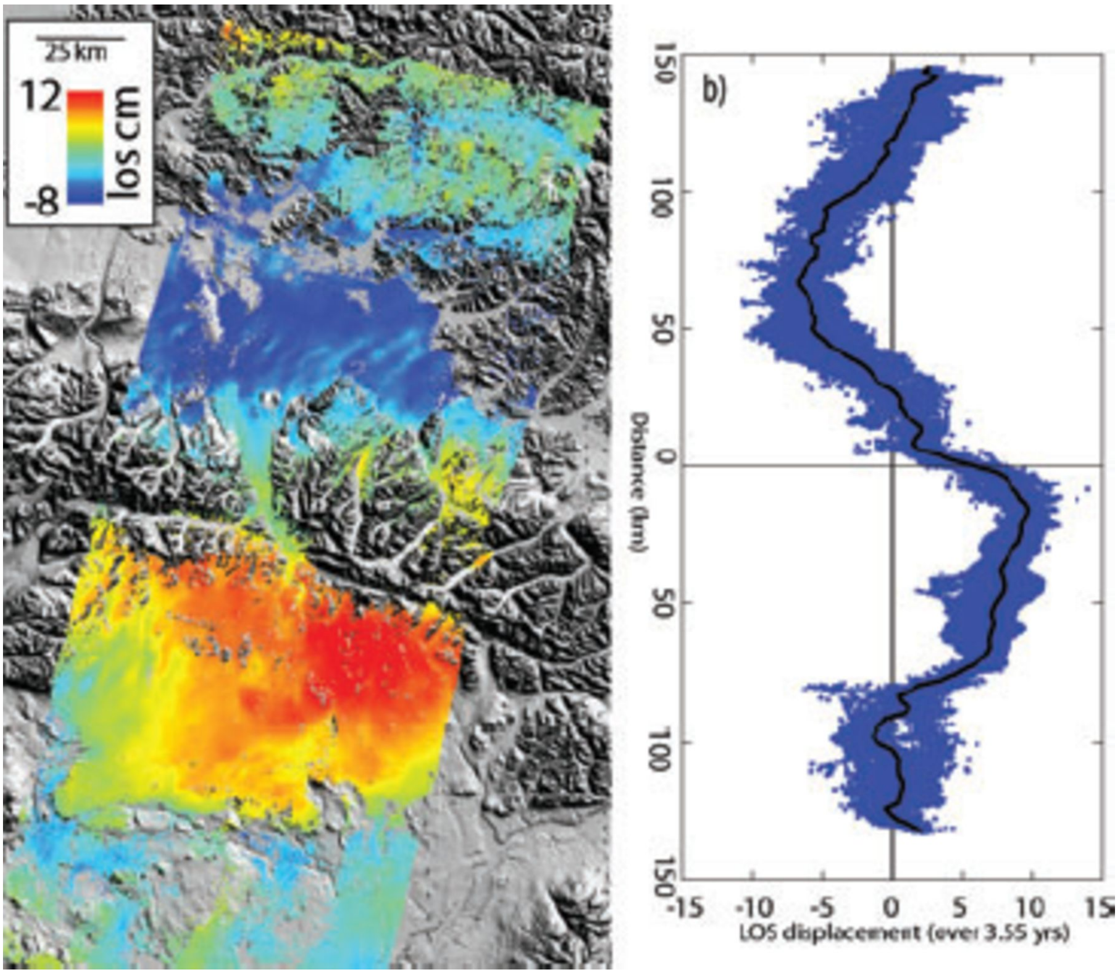

Figure 1: (a) Stack of four interferograms from the time period summer 2003–summer 2004. Total duration is 3.55 yr, giving a peak range change of ?2– 3 cm in the satellite line-of-sight over a 1-yr time period. (b) Profile taken perpendicular to the fault. Peak displacement is located ?50–60 km from the fault in the north. Profile values are taken from the entire image and the black line is a bin average.