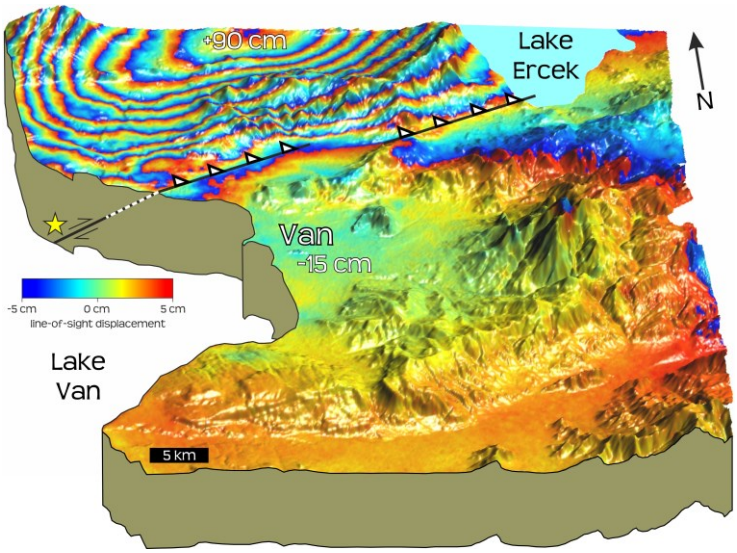
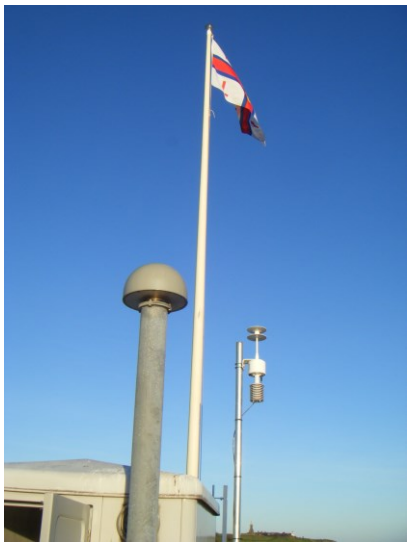
ROYAL ASTRONOMICAL SOCIETY SPECIALIST DISCUSSION MEETING

Seismology from Space: Geodetic observations and early warning of earthquakes

Organisers:
Professor Peter Clarke (Newcastle), Professor Tim Wright (Leeds)
and Professor Marek Ziebart (UCL)





Left: interferogram of 2011 Van earthquake (J Elliott). Right: real-time GNSS station NSLG (P Clarke)

Friday 9th May 2014

Royal Astronomical Society Lecture Theatre
Burlington House, Piccadilly

In recent years the availability of high-rate (1 Hz sampling or faster) GPS/GNSS data, often telemetered in near-real-time, has enabled the observation of strong ground motions, teleseismic waves, and "permanent" co-seismic deformation in the immediate aftermath of an earthquake. Likewise, multiple-mission InSAR data have facilitated the observation of surface deformation at lower temporal but much higher spatial resolution. This meeting will bring the UK geodesy and seismology communities together to examine the prospects for these techniques to enhance our understanding of the earthquake rupture process and provide early warning of earthquake mechanism and magnitude for the mitigation of earthquake-related hazards such as tsunamis.

This Specialist Discussion Meeting is open to all; admission is free for RAS members, £15 for non-members (£5 for full-time students). For further details of location and times see www.ras.org.uk/ or phone the Society on 020-7734-3307.

Seismology from Space: Geodetic observations and early warning of earthquakes

Organisers: Peter Clarke (Newcastle), Tim Wright (Leeds) and Marek Ziebart (UCL)

Friday 9th May 2014

Royal Astronomical Society, Burlington House

10:00 Registration and coffee

10:30 Welcome and introduction

10:35 **Observations of recent earthquakes and the future of geodetic analysis of earthquakes under Sentinel**
John Elliott, Department of Earth Sciences, University of Oxford

11:25 **Earthquake Alert: Blending seismic and GPS data to reduce risk**
Richard Allen, Berkeley Seismological Laboratory, University of California

12:15 Discussion

12:30 Lunch* and posters**

13:30 **Integrating SAR, high-rate GPS, and seismology for natural hazard monitoring & response: Applying geodetic science to improve situational awareness**
Susan Owen, NASA Jet Propulsion Laboratory, Pasadena, California

14:20 **Bringing earthquake science to market: a probabilistic and a deterministic example**
John McCloskey, Environmental Sciences Research Institute, University of Ulster

15:10 Closing discussions

15:30 Tea [Geological Society Library]

16:00 **RAS Monthly A&G (ordinary) Meeting** [Geological Society Lecture Theatre]

18:00 Reception [RAS Burlington House Apartments]

** Lunch is not provided. There are several sandwich shops within easy distance of the RAS.*

*** Poster presentations are welcome, especially from students and early career researchers. A title and 100-150 word summary must be sent to Peter.Clarke@newcastle.ac.uk by 30th April. Acceptance of posters will be confirmed by 1st May at the latest.*

Registration is £15 cash on the day (£5 for students) or free for RAS members. To assist with planning, potential attendees are requested to email Peter.Clarke@newcastle.ac.uk by 1st May.

Meeting organised by:

Professor Peter Clarke, *School of Civil Engineering and Geosciences, Newcastle University*
Peter.Clarke@newcastle.ac.uk

Professor Tim Wright, *School of Earth and Environment, University of Leeds*
T.J.Wright@leeds.ac.uk

Professor Marek Ziebart, *Department of Civil, Environmental and Geomatic Engineering, UCL*
M.Ziebart@ucl.ac.uk

The organisers gratefully acknowledge financial support from the Royal Astronomical Society, the British Geophysical Association, and the NERC COMET+ consortium.

Observations of recent earthquakes and the future of geodetic analysis of earthquakes under Sentinel

Dr John Elliott
Department of Earth Sciences, University of Oxford
john.elliott@earth.ox.ac.uk

The past 20 years has seen an increase in the geodetic observations of ground deformation resulting from earthquakes beneath land globally that have greatly increased our knowledge of faulting and the earthquake cycle. Over 100 earthquakes have been measured with InSAR across a range of tectonic environments and have been critical in determining precise locations, fault geometries and static slip distributions. I will present a few examples of the observations made with a variety of InSAR satellite platforms, and the inferences that can be made regarding faulting and seismic hazard. I will then speculate on the capability to measure earthquakes globally in the era of Sentinel and monitoring deformation following on from these events.

Earthquake Alert: Blending seismic and GPS data to reduce risk

Professor Richard Allen
Berkeley Seismological Laboratory, Dept. Earth & Planetary Science, University of California, Berkeley
rallen@berkeley.edu

Today, 50 people get an alert before earthquakes in California. Recent legislation says everyone should get a warning. Seismic and GPS systems contribute to the alerts now, but in the future, your phone will detect earthquakes as well as warning you. In the era of big data and the Internet of Things, how can seismology harness new technologies both for the purpose of science, and to reduce the impact of future disasters around the world? In this seminar, we will discuss the current status of real-time earthquake information using existing seismic and geodetic networks. We will also speculate on what might be possible in the near future as the quality and number of sensors in consumer electronics increase by orders of magnitude.

Integrating SAR, high-rate GPS, and seismology for natural hazard monitoring & response: Applying geodetic science to improve situational awareness

Dr Susan Owen
NASA Jet Propulsion Laboratory, Pasadena, California
Susan.Owen@jpl.nasa.gov

The Advanced Rapid Imaging and Analysis project is a joint JPL/Caltech effort to automate InSAR and GPS imaging capabilities for scientific understanding, hazard monitoring, and hazard response. We have built an end-to-end prototype geodetic imaging data system that incorporates state-of-the-art InSAR and high-rate GPS analysis algorithms from technologists and scientists. Geodetic imaging's unique ability to capture surface deformation in high spatial and temporal resolution allows us to resolve the fault geometry and distribution of slip associated with earthquakes in high spatial & temporal detail. In certain cases, it can be complementary to seismic data, providing constraints on location, geometry, or magnitude that is difficult to determine with seismic data alone. We will present results that show the capabilities of this data system in terms of latency, data processing capacity, quality of automated products, and feasibility of use for analysis of large SAR and GPS data sets and for earthquake response activities.

Bringing earthquake science to market: a probabilistic and a deterministic example

Professor John McCloskey
Environmental Sciences Research Institute, University of Ulster
j.mccloskey@ulster.ac.uk

Here we describe two techniques in earthquake physics aimed at bringing the science closer to market. Aftershocks occur close to the mainshock and immediately after it; two of the big unknowns in earthquake forecasting, when and where, are strongly constrained for this problem. Further, advances in earthquake stress triggering studies, including recent observational support for the ideas of rate and state friction, show real potential for further localising the events in space. We are working with Concern Worldwide to apply these insights, in combination with classical laws of seismology, to the problems they face in deploying and maintaining their operations in disaster response. We argue that rapid assessment of surface displacements using InSAR will be a vital component of future development of these techniques.

That seismic energy release is controlled by the accumulation of energy, or slip deficit, on a fault plane is an unassailable assumption. Attempts to use reconstructions of the slip deficit field on a fault to forecast its future behaviour have been confounded by lack of information on the initial conditions on which the field is constructed. Here we introduce a Bayesian Monte Carlo technique to invert for slip in historical earthquakes giving new insights into the nature of earthquake recurrence and identifying locations of high strain accumulation.