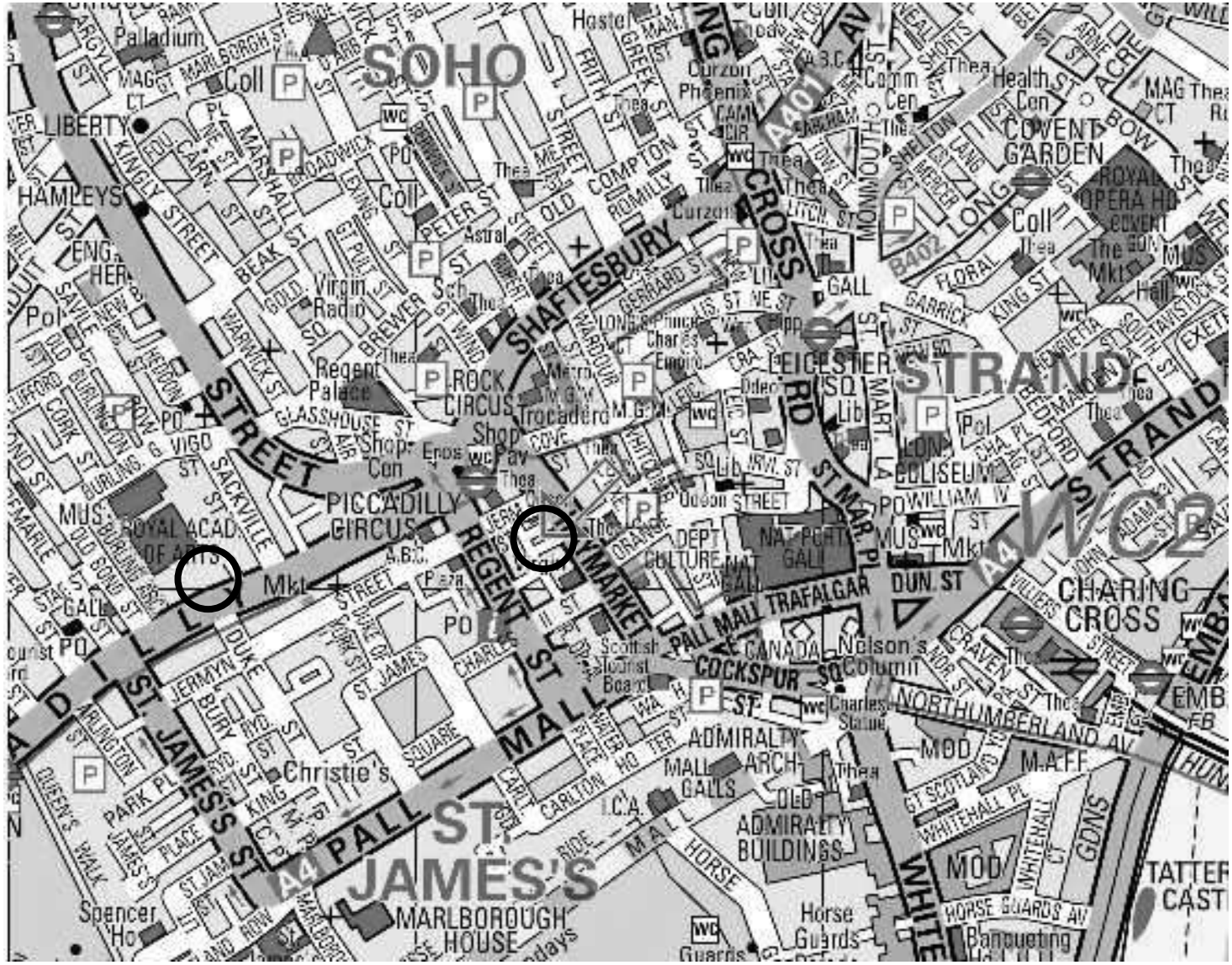
GRSG Annual Meeting
Advances in Geological Remote Sensing – Friday 16 December 2005

9.00 – 9.50	Registration
9.50 – 10.00	**Welcome and introduction**, Tim Wright, GRSG Committee
Session 1: Volcanoes	
10.00– 10.25	**Delioma Oramas Dorta et al., University of Coventry** Topographic changes at Arenal Volcano (Costa Rica): GIS, DEM uncertainty and possible implications for topography-controlled hazards.
10.25 – 10.50	**Rachel Holley et al., ESSC, Reading University** InSAR measurements of volcanic deformation at Etna: atmospheric errors and interferogram correction.
10.50 – 11.10	**Jessica Hole et al., ESSC, Reading University** Measuring contemporary deformation in the Taupo Volcanic Zone, New Zealand, using SAR Interferometry.
11.10 – 11.40	REFRESHMENTS
Session 2: Earthquake and Tectonics	
11.40 – 12.05	**Richard Walker, COMET, University of Oxford,** Remote Sensing of active faults in Iran
12.05 – 12.30	**Pedro Barreto, Nigel Press Associates** How can remote sensing reveal orogenic development in the Zagros Mountains, Iran?
12.30 – 12.50	**Juliet Biggs et al., COMET, Oxford University,** Fault Identification in Buried Strike-Slip Earthquakes using InSAR: The 1994 and 2004 Al Hoceima, Morocco Earthquakes.
12.50 – 2.00	BUFFET LUNCH
1.20 – 2.00	Annual General Meeting of the GRSG
2.00 – 2.25	**Christian Haselwimmer et al., Imperial College.** Computer-intensive remote sensing analysis and tectonic modelling of the 2001, Ms 8.1 Kunlun earthquake
2.25 – 2.45	**Ed Nissen et al., University of Oxford,** The 2003 Siberian Altai earthquakes: InSAR, seismology and field observations

Session 3: Environmental Applications	
2.45 – 3.10	**M. van der Meijde et al., ITC, Netherlands,** Pipeline leakage revealed by vegetation anomalies measured with reflectance spectroscopy.
3.10 – 3.35	**H. van der Werff et al., ITC, Netherlands,** Combining spectral signals and spatial patterns using multiple Hough transforms for the detection of natural gas seepages.
3.35 – 3.55	REFRESHMENTS
3.55 – 4.20	**M Clewett et al., University of Portsmouth,** The use of ground based laser scanning for extracting rock mass characteristics for applied geological applications.
4.20 – 4.45	**Mike Smith et al., University of Kingston,** Geomorphological mapping of glacial landforms from remotely sensed data: a summary of the principal data sources and an assessment of their quality
4.45 – 5.10	**Richard Goodman/Derek Ireson, Intergraph,** Underground, Overground - Earth Imaging beneath the Earth
5.10 – 5.25	**Alistair Lamb, Infoterra,** The MicroSAR demonstrator - a UK-developed airborne X-band quad polarised system for high resolution mapping, surveillance and satellite concept support.
5.25 – 5.40	**NPA Student Award Ceremony**
5.40 – 5.45	**Closing comments,** Richard Teeuw, GRSG Chairman
5.45	RETIRE TO CAPTAIN'S CABIN

Location map

Burlington House is circled: take the Piccadilly North exit from Piccadilly Circus tube. The Captain's Cabin pub (corner of Norris St & St Albans St) is also circled.



Topographic changes at Arenal Volcano (Costa Rica): GIS, DEM uncertainty and possible implications for topography-controlled hazards

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Arenal is a small strato-volcano of approximately 33 km^2 of area situated in the North of Costa Rica. Its present period of volcanic activity, which began in July 1968 as a series of explosions and pyroclastic density currents, continues to the present date. Current activity includes small vulcanian explosions, sporadic pyroclastic density currents, lava flows and avalanches. This activity poses a significant risk to the local population and the increasing tourist development in the area.

During this period an estimated volume of 686 Mm^3 of magma has been extruded at an average annual rate of 21.4 Mm^3, generating considerable topographic changes in the volcanic edifice. Several Digital Elevation Models (DEMs) of resolutions ranging from 5 to 30 meters have been acquired or produced using different methods, including a pre-eruption topographic DEM, a photogrammetric DEM from year 1988, and InSAR DEMs from years 2000 and 2004 respectively. A differential GPS campaign was carried out in April 2005 at Arenal, in order to provide controls for developed DEMs. Then, models were integrated in a GIS and were used to assess topographic changes in the volcano and estimate volumes of extruded materials for each period, following a 3-dimensional mapping approach. The importance of fidelity and quality of the different DEMs has been shown through the development of techniques that constrain uncertainties associated with each model type. While estimating volumes of extruded materials, the use of DEMs of heterogeneous origin can lead to uncertainties in the range of tens of thousands of cubic meters for the considered topographic change area, which has surface of 8.5 km^2.

The substantial topographic evolution of the volcano and its possible role on the behaviour of topography-controlled hazards at Arenal is currently being assessed. Models such as TITAN2D will be used for studying the characteristics of pyroclastic density currents at Arenal, with an aim to characterize the evolution of the hazard and its present status.

InSAR measurements of volcanic deformation at Etna – atmospheric errors and interferogram correction

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Sicily's Mount Etna is one of the most active volcanoes in the world, and has been the subject of numerous InSAR deformation studies. However the high relief results in strong atmospheric effects, both from hydrostatic changes in the water vapour distribution with height, and from the strong turbulence in the wake of the summit. These are exacerbated by the area's coastal climate. A variety of techniques have been proposed to mitigate atmospheric effects, however the majority of these require a large catalogue of previous data (for example Persistent Scatterers and time series), or ground control data such as GPS wet delay. To develop InSAR as a fully operational method for volcanic monitoring, particularly for sudden events in remote areas, correction techniques must not require a large set of previous data or ground-based control. Forward modelling of the atmospheric water vapour fields can potentially satisfy both these criteria.

This study uses Envisat ASAR data obtained for ascending and descending passes over Etna every thirty-five days, from October 2004. The atmospheric conditions at the time of each image acquisition are modelled numerically using the UK Met Office's Unified Model, using the 'nested mode' to initialise a high resolution run from the global model data. The final model produces a 1km horizontal resolution vapour field, and the difference between the vapour fields for a pair of acquisition dates can be used to estimate and remove the atmospheric signal in the interferogram.

The MERIS sensor on board Envisat provides a total columnar water vapour product at 300m resolution, at the same time as the ASAR data are collected. The MERIS can be used for direct correction of the interferograms; however the products are valid only for completely cloud free conditions – less than 10% of potential images over Sicily and a particular problem over the summit itself. The partially cloud-free areas of MERIS data can, however, be compared to the atmospheric model for validation purposes. We present the initial model validation results and examples of corrected interferograms from data acquired in the first year of the study.

Using InSAR to measure deformation in the Taupo Volcanic Zone, New Zealand

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The Taupo Volcanic Zone (TVZ) is an area of active back-arc extension in the North Island, New Zealand that represents the most productive area of rhyolitic volcanism on Earth. The TVZ is also undergoing active extension of about 8mm/year and has a very high heat output, which drives 23 geothermal systems. The tectonic, magmatic and geothermal deformation sources are highly complex and interactive and act on very different length and time scales. The aims of this work are to better understand the surface deformation in the TVZ and to distinguish the contributions from tectonic, magmatic and geothermal components of deformation. In this paper we explore the ability of C-band InSAR to measure the various deformation signals. Archived descending-pass ERS SAR images are available from 1996-2003 and ascending and descending Envisat ASAR images have been collected since 2003 with two different look angles to suit the different styles of deformation. We have shown that C-Band InSAR can been used to measure deformation in the TVZ caused by geothermal fluid extraction. The tectonic and magmatic deformation signals are less easy to identify due to large temporal decorrelation in the interferograms. However, by stacking ERS interferograms, we have identified an area of large scale uplift of 10mm/year north of Lake Taupo. Persistent Scatterer analysis has detected a similar sense of motion across the TVZ which agrees with the results from levelling of Lake Taupo.

Remote Sensing of active faults in Iran

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Simple geomorphological observations of active faulting are applied to a part of Kerman province in S.E. Iran which is often considered to behave as a rigid block within the Arabia-Eurasia collision zone. GPS studies show that present-day rates of deformation are not resolvable with the existing coverage, and must be less than 2~mm/yr. In addition very little seismicity is recorded. The remote sensing observations reveal a major oblique fold-and-thrust belt, active in the late Quaternary, which may be capable of producing destructive earthquakes in the future.The active faults appear to link the Sabzevaran right-lateral strike-slip fault in southeast Iran to other strike-slip faults within the interior of the country and may provide the means of distributing right-lateral shear between the Zagros and Makran mountains over a wider region of central Iran. This study shows how widely available remote sensing data can be used to provide information on the distribution of active faulting across large areas of deformation, with implications both for interpreting the tectonics of deforming regions, and also as a first step in identifying potential sources of earthquake risk.

How can remote sensing reveal orogenic development in the Zagros Mountains, Iran?

Pedro Barreto,

Structural Geologist, NPA Group

The Zagros Fold and Thrust Belt, part of the Alpine-Himalayan Belt, started to form during the Oligocene as result of the collision between the Arabian plate and the Iranian microplate. It consist of linear series of anticline ridges that extends for about 2000 Km, from Northern Syria and Iraq to western and southern Iran, reaching more than 4000m high.

The enigmatic evolution of the Zagros Fold and Thrust Belt (Z.F.T.B) resulted in the curvature of the Orogen, a feature usually referred as Dezful Embayment. Basement structure, variations on the distribution of the Hormuz salt decollement level and different erosion and sedimentation rate are some of the causes usually invoked to explain the formation of this area. The Z.F.T.B. is an example of a young and active orogenic belt where geomorphology and seismicity provide invaluable constrains on the deformation style and evolution, in ways not possible with ancient and inactive orogens.

Landsat ETM+ and ASTER imagery were used in combination with SRTM and ASTER Digital Elevation Models (DEM), to map the lithological units of the area and generate a structural model for the Dezful Embayment. Rivers patterns observed from the |DEMs revealed different uplift ratios between Dezful and surrounding area suggesting the importance of erosion and sedimentation in the accentuation of the curvature. Earthquake and Gravitic data corroborate geological evidences for a basement geometry that played the most essential role in the triggering of the curvature and consequent higher uplift on the Dezful Embayment. The completely different characteristics of the surrounding Lorestan and Fars areas suggest the existence at depth of lateral ramps, materialized at the surface by the Balarud High and Hencijan fault.

Reactivation and inversion of basement geometries and posterior structures concentrated the deformation around specific faults resulting in the three major steps on the stratigraphy and topography.

Although some theories tend to simplify the geneses of the Dezful Embayment as the result of the inexistence of Hormuz salt decollement level in this area, this unit was reported in the Dezful imbricated zone and was also inferred to exist in the Simply Folded zone where it acts as a major decollement level.

Fault Identification in Buried Strike-Slip Earthquakes using InSAR: The 1994 and 2004 Al Hoceima, Morocco Earthquakes.

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The 1994 and 2004 Al Hoceima earthquakes are the largest to have occurred in Morocco in the last century, and give valuable insight into the poorly understood tectonics of this area. On May 26th 1994, a Mw6.0 earthquake caused great damage and two fatalities, and on February 24th 2004 a Mw6.5 earthquake killed over 600 people with 40,000 made homeless. Preliminary studies, using aftershock locations and surface observations, have been unable to identify the fault plane for either earthquake conclusively. ENVISAT ASAR acquistions were used to construct both ascending and descending track interferograms for the 2004 earthquake and a pair of ERS SAR acquisitions were used to produce a coseismic interferogram for the 1994 earthquake.

Both earthquakes have strike-slip mechanisms with nodal planes striking approximately NW-SE and NE-SW. They are excellent examples of the symmetry present in seismological and geodetic analysis of moderately-sized, buried earthquakes and the difficulty in distinguishing between the fault plane and the auxilliary plane. For the 2004 earthquake, we initially use a uniform slip model and produce models assuming each of the nodal planes was the fault plane. Both models fit the first order deformation pattern well and have similar misfits to the data. However, the NE-SW model, has an unrealistically high fault slip-to-length ratio and we therefore reject this model. We carry out tests on synthetic data for a buried strike-slip earthquake in which the orientation of the fault plane is known a priori. We find that, independent of geometry, missing data, and correlated noise, models produced assuming the auxilliary plane to be the fault plane have very high fault slip-to-length ratios.

We conclude the fault plane that ruptured in the 2004 earthquake was the NW-SE striking nodal plane and slip was right-lateral. We then further refine the model to include distributed slip. A relocation of aftershocks, using the InSAR models as absolute locations for the 1994 and 2004 mainshocks, is consistent with this conclusion and suggests that the 1994 earthquake occurred on a NE-SW fault. In contradiction to previous tectonic models of the area, which proposed a bookshelf model of block rotation with NNE-SSW left-lateral faults, we propose the earthquakes happened on a pair of conjugate faults striking at 25 degrees and 115 degrees.

Computationally-intensive Image Analysis and Tectonic Modelling of the 2001, Ms 8.1, Kunlun Earthquake

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3) Fears Structural Engineering Laboratory, University of Oklahoma.

The Ms 8.1 Kunlun earthquake occurred on 14th November 2001 in Northern Tibet along the westernmost Kusai Lake segment of the predominantly left-lateral Kunlun fault. The event was the largest earthquake in China for 50 years and produced a surface break in excess of 400km long which makes this the longest rupture for an earthquake on land ever identified. The Kunlun fault is one of a number of large, seismically active strike-slip faults that are thought to be important in accommodating the continued convergence of India with Asia. The quantitative investigation of this event is important for understanding the dynamics of the earthquake deformation and may yield clues as to the tectonic processes operating at the regional-scale.

We present the preliminary results of an investigation into the Kunlun earthquake using a combination of computationally intensive remote sensing image-analysis and tectonic modelling. We have developed a geoinformatics infrastructure that uses 2D measurements of co-seismic surface deformation, derived from pre- and post-event optical satellite images using the imageodesy technique, to drive 2D (and ultimately 3D) computer simulations of the earthquake deformation based on the Finite Element Method. Both these tasks demand significant computing resources and have been implemented on supercomputers based at Imperial College London (Imageodesy) and the University of Oklahoma (Finite Element Modelling).

The results of applying imageodesy to pre- and post-event Landsat 7 ETM+ satellite images present the first 2D picture of co-seismic deformation due to the Kunlun Earthquake and indicate clearly that the block of crust south of the Kunlun fault has moved towards the east relative to the stable block north of the fault. Imageodesy-derived measurements of X- and Y-shift have been successfully ingested into low-resolution, 2D finite element models that have allowed us to predict the shear strains arising during the Kunlun earthquake. These first model runs have successfully demonstrated our technique and laid the groundwork for future modelling where we will be fully investigating the dynamics of the Kunlun earthquake.

The 2003 Siberian Altai earthquakes: InSAR, seismology and field observations

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In 2003, a sequence of four large earthquakes struck the remote Siberian Altai mountains in the northern part of the India-Eurasia collision zone. The earthquakes ranged from Mw 6.3 to Mw 7.2 and were clustered both spatially (all within a ~50km long fault zone) and temporally (within five days of one another).

We investigate the earthquakes using SAR interferometry, seismic bodywave modelling and fieldwork. The former provides a detailed map of the cumulative surface deformation but as the interferograms span the whole earthquake sequence, it is difficult to distinguish between the effects of each individual event using InSAR alone. In contrast, the seismology tells us about how the earthquakes were distributed in time but suffers from inaccuracies in source location.

We are interested to see whether by combining InSAR and seismology, with further help from fieldwork, we can overcome these limitations and decipher the detailed history of a large, clustered earthquake sequence.

Pipeline leakage revealed by vegetation anomalies measured with reflectance spectroscopy

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Underground pipeline leakage inspection is an open problem with large economical and environmental impact. Traditional methods for investigating leakage and pollution, like drilling, are time consuming, destructive and expensive. Reflectance spectroscopy (or hyperspectral remote sensing) proved to be a tool that offers a non-destructive investigative method for pipeline leakage detection.

This study presents the results of 2 years of field campaigns in May 2004 and 2005 in Holland, investigating a test trajectory of a 21 km long pipeline, and a HyMap scene covering the whole pipeline. The pipeline is 'sweating' benzene condensates at approximately 50% of the connection points between the 9 meter segments of the pipeline. Hydrocarbons can establish locally anomalous zones that favor the development of a diverse array of chemical and mineralogical changes. Direct detection of hydrocarbons and/or the chemical and mineralogical changes is often very difficult. However, vegetation present in these zones is likely to be influenced by the hostile and polluted environment. Geobotanical anomalies occur as a result of the effect of hydrocarbons on the growth of vegetation. The most likely changes in the vegetation are expected to occur in the chlorophyll concentrations which are an indicator of the health state.
Therefore, spectral field measurements were conducted at 8 different locations in the test trajectory. The test locations were covered by various types of vegetation. We can confirm the presence of geobotanical anomalies in most of the locations using various spectral interpretation techniques like linear red edge shifts, Carter stress indices, normalized difference vegetation index en yellowness index.
After the interpretation of the geobotanical anomalies, derived from hyperspectral measurements, we compared the findings with information on pollution levels obtained by drilling at some of the locations. We can confirm a strong coherence between high pollution levels derived from the drilling and the geobotanical anomalies interpreted from the spectral measurements.
The HyMap scene will be first interpreted for the test trajectory and validated using the ground measurements. We will present the results of this validation process and show preliminary results of the interpreted HyMap scene in terms of polluted areas. For this we will apply automatic detection algorithms, like Hough transforms, to find weak and non-unique spectral signals with a pre-defined spatial pattern.

Combining spectral signals and spatial patterns using multiple Hough transforms for the detection of natural gas seepages

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This paper presents an algorithm based on serialized Hough transforms, which aims at the detection of botanical and mineralogical alterations that result from natural seepage of carbon dioxide and light hydrocarbons.

The alterations that are commonly found in natural hydrocarbon seepages are not spectrally unique and can thus not be mapped using pixel-based classification lagorithms. Seepage-induced anomalies can however be distinguished from their background by their spatial pattern: several meters wide alteration halos around a central vent that are located along geological lineaments in the shallow subsurface. The actual pattern that is being searched for are multiple circular shapes on a line.

The Hough transform is a frequently used method for detecting shapes in images. This technique fits a parameterized shape through a point dataset (for example pixels in an image) and combines the parameters needed to describe the shape, its position and its orientation with the number of pixels covered by this shape. Our algorithm is deployed in three phases: first a spectral classification that is followed by two sequential Hough transforms. The first Hough transform fits circles through spectrally optimal matching pixels. Next, the centers of the detected circles are piped into the second Hough transform that detects points that are located on a line. Both Hough transforms have been adapted to work with remotely sensed imagery for the detection of natural objects with some resulting changes in spatial and spectral characteristics.

Results show that our algorithm is successfull in detecting the seepage-induced alteration halos. The number of false anomalies is, compared to pixel-based algorithms, greatly reduced. It can be concluded that this approach allows the detection of seepage-induced anomalies.

The use of ground based laser scanning for extracting rock mass characteristics for applied geological applications

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Light Detection and Ranging (LIDAR) has been used extensively in the fields of archaeology and construction, but its potential applications to applied geology have only recently been recognised. Discontinuity surveys, visualisation of planes and their orientations and block volume measurements can all be performed on data obtained from a laser scan of a rock face and lessens the need for time consuming and sometimes; (in the case of steep high faces) dangerous manual surveys. The technology can also be applied when studying geohazards, specifically rock falls and rock slides.

The south coast of the Isle of Wight has long been subject to these types of ground movements, which have included large-scale rock falls from the cliff faces at Blackgang, located on the southernmost tip of the island. Here, falls from the cliff, whether large or small pose a danger to those using the site and similarly with other hazardous cliff faces around the country, a way to assess and if possible reduce risk is often required. A Riegl LMS Z420i laser scanner was used to scan two areas of the cliff face at Blackgang. The resulting 3-D model was used as a tool to perform a hazard and rock mass assessment using RiScan Pro. 3-D photographic images overlaid on the point cloud data from the scan provided a freely moveable model of the cliff face. In addition planes constructed from the data could be visualised, their orientations measured and intercept points located. The data sets retrieved from the scans also included volume measurements of potential falling blocks. Some of these datasets were input to other software packages to assess the rock fall hazard for the Blackgang cliff.

This study aims to further highlight the use of LIDAR scanning as a tool for collecting and analysing applied geological data for hazard and rock mass assessments.

Geomorphological mapping of glacial landforms from remotely sensed data: a summary of the principal data sources and an assessment of their quality

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Glacial systems are believed to have a dynamic and pivotal role in the control of global climate. Therefore, precise and accurate representation of the evidence required to understand glacial and glacio-fluvial processes, and to model past glacier behaviour, is critical. Palaeo-glacial landforms can be used to instruct about the behaviour of past ice-sheet systems, although any interpretations need to be validated against contemporary systems. Of the two sources of evidence necessary to carry out this task (landforms and sediments), sediments have been the subject of extensive research. Landforms have been received far less analysis recently, as landform mapping has been considered either unreliable when derived from topographic maps, or time consuming and of variable reliability when derived from field mapping.

Remotely sensed data are increasingly being used for mapping glacial landforms due to the large areal coverage and speed of landform mapping and subsequent map production. However the reliability of maps generated from computer workstation based mapping is critical to their use in the understanding, and modelling, of glacial systems. This research utilises satellite imagery (Landsat Thematic Mapper winter acquisition), a range of digital elevation data (Shuttle Radar Topography Mission, Landmap, Ordnance Survey Panorama, Ordnance Survey Profile, NextMap) and aerial photography (1:10,000 and 1:25,000) for a region in Scotland, UK glaciated during the LGM and Younger Dryas. We test the reliability of individual datasets against detailed field based geomorphological mapping of over 100km2 of terrain, incorporating measures of dataset completeness (errors of omission and commission), locational accuracy and landform classification. We conclude with recommendations as to the suitability of different datasets for mapping glacial landforms.

Underground, Overground - Earth Imaging beneath the Earth

Richard Goodman, Derek Ireson,

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Within the complicated world of geospatial data capture, management of information and extraction of data, working within one seamless environment might seem like a distant dream. This reality is much closer though, as this presentation will show. Fully integrated software working from an enterprise data management backbone, with distributed processing, data storage and clients, yet with centralised retrieval, security, query and backup tools. With varying data sources, and varying data outputs, getting the data to the client can be very hard. The Internet is a great tool, but the end client can still require a bespoke viewer. What if the data could be retrieved, viewed and manipulated all with Microsoft Explorer, the 'standard software' on any machine? Using Intergraph's Z/I Imaging hardware, ImageStation, TerraShare and Imaging software, in conjunction with third party software as required, this enterprise workflow is a reality.
Contact Derek Ireson (Z/I Imaging UK General Manager) for further details – derek.ireson@intergraph.com

The MicroSAR demonstrator - a UK-developed airborne X-band quad polarised system for high resolution mapping, surveillance and satellite concept support.

Alistair Lamb, Martin Cohen

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The UK has long been a centre of expertise in EO SAR systems, with a heritage in ERS-1, ERS-2, ASAR and Radarsat-2, as well as being one of ESA's Processing and Archive Facilities (PAF) for ERS archiving and dissemination.

The MicroSAR demonstrator has been in development by Astrium Ltd since 2002, initially conceived as a testbed for future satellite opportunities, with an emphasis on reduced size, weight and power consumption, with improved bandwidth.

MicroSAR collects simultaneous single-pass quad-polarized data (HH, VV, HV and VH) at X-band (3cm) wavelengths, resulting in colour imagery in the 1-3m resolution class, with 2-10km swath widths depending on operational mode. It has also been tested for InSAR-derived DEM's. The system has been flown over various urban, industrial and rural test sites in southern UK, to collect data to support ongoing hardware improvements and application demonstration. Experience strongly points towards an operational airborne potential, additional to its original role of supporting spaceborne instrument definition. The instrument last flew in July 2005 and the results from this campaign are being shown to the UK EO community to encourage national interest in applications development.

Posters

Ruptures found up to 60km south of the major fault zone after 14th Nov 2001 Kunlun earthquake from Landsat-7 ETM+ imagery

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In order to reveal the regional co-seismic displacement of the Ms 8.1 Kunlun earthquake, an 'Imageodesy' (using normalised local cross-correlation) study has been carried out using pre and post event Landsat-7 ETM+ images. The two scenes, Kusai Lake and Buka Daban, extend over a vast region that extends 320km from W-E (E90°~E93°) and more than 180 km N-S and covers the majority of the fault rupture zone. The co-seismic displacement measured based on the X- and Y-shift images derived indicate an average 4-5 m left-lateral shift along the Kunlun fault.

The large coverage of the data has also revealed a significant eastward shift 60 km south of the major fault zone along the Kusai Lake segment. This clue led us to carry out a thorough visual interpretation of the pre- and post-earthquake ETM+ images in the region. The results indicate the presence of significant and previously unreported surface rupturing in the region around the Zhuonai Lake. These curved linear features are clearly shown in the post-earthquake image but do not appear in the pre earthquake image except for faint features in a few sections.

The tectonic implication of these newly found rupture zones is a topic of further research. Our preliminary explanation which draws on existing knowledge of the Kunlun fault and the earthquake is that the central to eastern section of Kusai Lake segment represents a transpressive flower structure. The new ruptures identified within this investigation represent the surface expressions of buried northerly dipping thrust faults that are connected at depth to the main Kunlun fault. These discontinuities having accommodated the thrust component of strain release that could not be released along the steeply dipping Kunlun fault.

Preliminary list of delegates

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Future Meetings with GRSG Involvement

Geoscience Information Group and Geological Remote Sensing Group
Elevation Models for Geoscience
23 March 2006

Abstracts are requested for the above meeting to be held at Burlington House on 23rd March 2006. This meeting builds on the successful NERC workshop that looked how NEXTMap Britain has been used for different applications within NERC. The purpose of the public "Elevation Models for Geoscience" meeting is to examine the different types of elevation data available and to discuss their application within the Geosciences. Examples of data to be included are:

Stereo Satellite data e.g. ASTER
Aerial Photography
LiDAR
NEXTMap
OS elevation datasets

Abstracts are invited for oral and poster presentations at the meeting. Abstracts should be around 400 words long and submitted before 6th January 2006. Papers will also be considered for a special publication of the Geological Society that will be produced following the meeting.

Please send abstracts to:
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First workshop of the EARSeL Special Interest Group - Geological Applications
Geohazards; with emphasis on lowland hazards (flooding and subsidence)
Warsaw, 2 June 2006

Geohazards have been recognized as one of the prime fields of focus for earth scientists for the coming decade. Also on the political agenda, geohazards are more and more claiming a prominent role. The EU and ESA initiative GMES (global Monitoring of Environment and Security) focuses on environmental control and security issues including land degradation, land cover changes, geohazards etc. In 2008 the foundations and the structuring elements of the European Capacity for Global Monitoring of Environment and Security should be in place and operating. Earth observation plays a vital role in both understanding the geological processes shaping the earth' dynamic environment and the natural hazards that they entail. The workshop will specifically focus on geohazards thus excluding geophysical hazards and meteorological hazards. Issues of relevance to the local situation will be addressed, hence the focus on low-land hazards: flood hazards and land subsidence. Presentations in form of poster or oral presentation are acceptable. Results will be published in the EARSeL proceedings. Selected papers may be submitted for a special issue of the International Journal of Applied Earth Observation and Geoinformation. The workshop is organised on 2 June 2006 back-to-back to the EARSeL general symposium 'New developments and challenges in remote sensing'. The workshop will be held at the National Library of the University of Warsaw (Warsaw, Poland).

Call for papers
Papers are invited for presentation as poster or oral presentations in the various sessions. Abstracts for oral and poster presentations should be submitted by email to the workshop chairman (vdMeer@itc.nl) no later than 14 November 2005. Notification of acceptance is planned for Jan.2006.

Organised in close collaboration with the IGOS working group on geohazards and the Geological Remote Sensing Group. More details can be found through the EARSeL Symposium pages (see http://www.earsel.org for most recent information).

International Association for Mathematical Geology Annual Conference
Quantitative Geology from Multiple Sources
3-8th Sept 2006

The annual meeting of the International Association for Mathematical Geology brings together scientists dealing with Computer Sciences and Mathematics in the Earth Sciences. It is a major forum of discussion on Geostatistics, GIS, Imaging, Modelling, Risk Mapping, etc. The IAMG06 conference will host several specialised sessions in Mathematical Geology with a special emphasis on processing Data from Multiple Sources.

GRSG will be convening two special sessions at the meeting,

- Spectro-spatial classification of images
- Digital Elevation Models Derived from Optical and Radar Satellite Remote Sensing

There are also several other proposed sessions which may be of interest to GRSG members:

- Recent developments in the geologic time scale using orbital tuning
- Mapping indoor radon levels and radon-prone areas
- Quantitative texture analysis
- Geochemical modeling: numerical and statistical approach
- Progressive failure and dynamic triggering of landslides : connecting field observation, lab tests and numerical modelling
- Recent advances in geological hazard and risk mapping : spatial data and models, predictions, uncertainties
- Use of multiple sources in conditioning/calibrating groundwater flow and transport models
- Innovative techniques in geomathematics
- Stochastic modeling of subsurface formations
- Multivariate, multiple sources and spatio-temporal geostatistics
- 3D integration and modelling of geological data

More information on the technical programme plus registration and abstract submission details can be found at http://www.geomac.ulg.ac.be/iamg06/. The deadline for abstracts is Feb 1st 2006.

RSPSoc Annual Conference
Understanding a changing world - Integrated approaches to monitoring, measuring and modelling the environment
5th - 8th September 2006

We live in a rapidly changing world. Monitoring and understanding change is essential for effective environmental planning whether it be in relation to urban, land, marine or atmospheric systems. Remote sensing from ground, air and space provides the eye that lets us see and possibly understand our changing world. Twenty years ago it was a highly technical, specialised and divided discipline. Surveyors using established, traditional techniques of aerial photography regarded new satellite and sensor technology with scepticism and suspicion. Resolution was always too low and data costs too high. Conversely, specialist remote sensing practitioners regarded aerial photography as limited in scope, laborious and dare it be said – old fashioned.

Thankfully all of this has now changed. The ‘experimental’ sensors of twenty years ago are delivering data at all spatial resolutions with unique potential for environmental monitoring, modelling and applications development. Integrated sensor packages are delivering vast amounts of data capable of supporting existing and new environmental applications. Aerial photography and photogrammetry has been revolutionised by digital techniques and new airborne sensors such as LiDAR are providing novel insights into a 3D world. Even home computers can now handle image data in their stride and large quantities of imagery are immediately and freely available via the internet.

The challenge facing the remote sensing community now is integrating these data sources into useable processes, products and models that support both resource management and environmental science. The theme for RSPSoc 2006 is data integration for all aspects of environmental monitoring and change analysis. Issues include linking ground data to imagery; data consistency for multi-temporal analysis; integration of data from different sensors; GIS approaches to data integration and novel results from integrated studies using multiple data sources. The meeting aims to encompass a broad spectrum of interests from developments in new and advanced analytical techniques to applied remote sensing for environmental management. It will be of interest to all practitioners, scientists and students with an interest in environmental monitoring and change.