Geological Remote Sensing Group

GRSG AGM 2010
PROGRAMME

Geo-Environmental Remote Sensing

The 21st Annual Meeting of the Geological Remote Sensing Group

1st – 3rd December 2010

Tuesday 30th November

6.30pm	**Icebreaker –** The Glassblower, 40-42 Glasshouse Street, Piccadilly, W1B 5JY

Wednesday 1st December

8.30am	Registration Opens
9.15am	Welcome and Opening Remarks
9.30am	**Geo-Environmental Applications I** – Tara Byrnes, GeoEye
11.00am	Coffee and Tea
11.30am	**Measuring a Changing Surface, Interferometric Applications** – Luke Bateson, BGS
1.00pm	Lunch
2.00pm	**Geological Mapping I** – Stefania Amici, INGV
3.30pm	Coffee and Tea
4.00pm	**GRSG Annual Meeting and Student Awards**
5.00pm	Wine Reception

Thursday 2nd December

8.30am	Registration Opens
9.15am	Opening Remarks
9.30am	**GEO** –Stuart Marsh, BGS
11.00am	Coffee and Tea
11.30am	**GMES** –Stuart Marsh, BGS
1.10pm	Lunch
2.00pm	**Geo-Environmental Applications II** – Cornelia Gläßer, Martin Luther Uni.
3.30pm	Coffee and Tea
4.00pm	**ESA Oil and Gas Programme Keynote Presentation**
4.30pm	**Geological Mapping II –** Charlotte Bishop, Fugro NPA
7.30pm	GRSG 21st Annual Dinner – Masala Zone, Covent Garden, WC2E 9DA

Friday 3rd December

9.00am	Registration Opens
9.20am	**Remote Sensing & Disaster Risk Reduction (RS & DRR),** Opening Remarks – Richard Teeuw
9.30am	**RS & DRR Session 1**. Chair: Richard Teeuw, Portsmouth University
10.50am	Coffee and Tea
11.10am	**RS & DRR Session 2**. Chair: Stuart Marsh, BGS
12.30pm	Lunch
1.20pm	**RS & DRR Session 3**. Chair: Philippa Mason, Imperial College & HME Partnership
2.40pm	Coffee and Tea
3.00pm	**RS & DRR Session 4**. Chair: Richard Teeuw, Portsmouth University
4.00pm	**Discussion: A new RSPSoc Special Interest Group: The Disaster Management SIG**
4.30pm	Concluding comments and close
5.00pm	**Afterglow** – Captain's Cabin, 4-7 Norris Street, SW1Y 4RJ

Day 1 Talk List

9.30am – 11.00am: Geo-Environmental Applications I

Session Chairs: Tara Byrnes, GeoEye

- "Leveraging satellites for emergency and disaster response", Tara Byrnes, GeoEye
- "Integrated horizontal-scan remote sensing for landslide imaging and evaluation", Amer Smailbegovic, TeraElement Ltd
- "Use of Multispectral Remote Sensing in Coastal Risk Assessment", Samantha Lavender, ARGANS Ltd
- "Mapping of environmental impacts of salt mining dumps in Central Germany using spectroradiometric methods", Michael Denk, Martin Luther University Halle-Wittenberg Institute of Geosciences
- "Satellite monitoring of Icebergs, oil spill and polar bears", Sigmund Dehli, KSAT

11.30am – 1.30pm: Measuring a Changing Surface – Interferometric Applications

Session Chairs: Luke Bateson, BGS

- "Ground and building motions determined by radar interferometry from 1995-2007 in the Nottingham area, United Kingdom", Doug Tragheim, BGS
- "Long-term differential InSAR monitoring of the Lampur Sidoarjo Mud Volcano using ALOS PALSAR imagery", Rachel Holley, Fugro NPA Ltd
- "Integration of SAR interferometry modules with analytical modelling illustrated by the Yushu earthquake 2010, China", Clive Farquhar, ITTVIS
- "Crustal deformation of the central Tibetan Plateau measured using InSAR", Matthew Garthwaite, University of Leeds
- "Geological Applications of Interferometry using ERDAS Imagine Radar Mapping Suite", Andy Garratt, ERDAS Inc

2.00pm – 3.30pm: Geological Mapping I

Session Chairs: Stefania Amici, INGV

- "Integration of close-range hyperspectral imaging and lidar for mapping outcrop composition", Simon Buckley, UniCIPR
- "Geological mapping of volcano Teide using hyperspectral and multispectral satellite data", Stefania Amici, INGV
- "BGS-SIGMA Mobile: A digital geological mapping system that enables remote sensing to be integrated into fieldwork", Colm Jordan, BGS
- "Using high resolution digital elevation models and Hyperspectral data to characterize sedimentary sequences on Mars", Doug Tragheim, BGS

Day 2 Talk List

9.30am – 9.50am: Introduction

- "GEO, GMES and Geology: status and opportunities", Stuart Marsh, BGS, UK

9.50am – 11.00am: GEO

Session Chairs: Stuart Marsh, BGS

- "Neural network based predictive mapping with advangeo® and its application in the AEGOS project"
  Andreas Knobloch, Beak, Germany
- "EO-MINERS: EO for monitoring and observing environmental and social impacts of mineral resources"
  Stuart Marsh, BGS, UK
- "Distributed EU information portals: applying geology within GEO", Stefan Gruijters, TNO, Netherlands
- "Coordination of GEO in the European science community", Claire Flemming, BGS, UK

11.30am – 1.10pm: GMES

Session Chairs: Stuart Marsh, BGS, UK

- "2010 Merapi eruption: first satellite results in the context of the SAFER project", Massimo Musacchio, INGV, Italy
- "GMES downstream service on European Volcano Observatory Space Services (EVOSS)", Fabrizio Ferrucci, IPGP, France
- "Terrafrima: a pan-European ground motion hazard information service", Oscar Mora, Altamira Information, Spain
- "SubCoast: A GMES downstream service on coastal subsidence", Luke Bateson, BGS, UK
- "PanGeo: free and open access to geohazard information in support of GMES", Ren Capes, Fugro NPA Ltd, UK

2.00pm – 3.30pm: Geo-Environmental Applications II

Session Chairs: Cornelia Gläßer, Martin Luther University Halle-Wittenberg Institute of Geosciences

- "Can vegetation show pH values and heavy metal content in abandoned lignite mine sites?", Cornelia Gläßer, Martin Luther University Halle-Wittenberg Institute of Geosciences
- "Measuring rock dumps from space? How new technology could change the way we measure rock dumps and tailings dams", Jim Crotty, Mineral Resources Management Dept. Anglo Platinum Ltd
- "Airborne infrared-hyperspectral mapping for detection of gaseous and solid targets", E. Puckrin, Defence R&D, Canada
- "Examples of Hyperspectral Solutions for Geo-Environmental Problems", Conrad Wright, SpecTIR

4.30pm – 6.00pm: Geological Mapping II

Session Chairs: Charlotte Bishop, Fugro NPA

- "Stereo Satellite Elevation Mapping, Majnoon Project Iraq", Gerry Mitchell, Photosat
- "Developments in deriving best fit thermal inertia and albedo of the surface of Mars", Elliott Sefton-Nash, University of Bristol
- "The study of hydrologic erosion by diachronic imagery and digital elevation models, field survey and soil mechanics, Kinshasa, RDC", Philippe Trefois, Royal Museum for Central Africa
- "Day/night Airborne Hyperspectral Imagery Acquisition Campaign over Cuprite & Yerrington, NV", ITRES

Day 3 Talk List

9.30am – 10.50am: Remote Sensing & Disaster Risk Reduction (RS & DRR) Session I

Session Chair: Richard Teeuw, Portsmouth University

- "The geohazards community of practice in GEO: a roadmap for international cooperation", Stuart Marsh, BGS
- "Remote sensing in support of geohazards assessment in technical cooperation with developing countries", Friedrich Kuehn, BGR, Germany
- "GIS modelling of earthquake damage zones using satellite remote sensing and DEM data", Philippa Mason, Imperial College London, UK
- "Mapping seismic and volcanic hazards with InSAR", Tim Wright, University of Leeds, UK

11.10am – 12.30pm: RS & DRR Session II

Session Chair: Stuart Marsh, BGS

- "Detecting zones of neotectonic activity using freely-available DEMs", Nasos Argyriou, Portsmouth University, UK
- "The British Geological Survey remote sensing of geohazards", Colm Jordan, BGS, UK
- "From Capacity building to Capacity development or from Building Capacity to Building on Capacity?", Freek van der Meer, ITC

1.20pm – 2.40pm: RS & DRR Session III

Session Chair: Philippa Mason, Imperial College & HME Partnership

- "Current status in the remote monitoring of volcanic phenomena", Matthew Blackett, Coventry University, UK
- "Rapid topographic change measured by high-resolution satellite radar and Soufriere Hills Volcano, Montserrat, 2008-2010", Geoff Wadge, Reading University, UK
- "The Thailand Tsunami", Andy Gibson, Portsmouth University
- "Assessment of landslide susceptibility in Paphos District, Cyprus", Andy Hart, Scott-Wilson Ltd, UK

3.00pm – 4.00pm: RS & DRR Session IV

Session Chairs: Richard Teeuw, Portsmouth University

- "AguAAndes amd WaterWorld: fusing geospatial data and process models to support water and food policy", Mark Mulligan, King's College London, UK
- "Crisis and disaster response: is there time for remote sensing?", Anna Mason, MapAction, UK
- Discussion: a new RSPSoc Special Interest Group (SIG) for Disaster Management?

Geo-Environmental Applications I

Abstracts – Day One, Session One

"Leveraging Satellites for Emergency and Disaster Response"

Tara Byrnes, Director of North American Channel Sales, GeoEye

Tara Byrnes, Director of North American Channel Sales, will discuss recent uses of satellite technology in response to natural and man-made disasters and emergencies. With the increased frequency of disasters, both natural and human induced, around the world, it becomes increasingly important and necessary to monitor these events in order to respond properly. Imagery can also be highly valuable in preparation and mitigation efforts by using images captured before an event has occurred. Tapping into the vast archives of imagery dating back 10 plus years and taking advantage of quick tasking capabilities, we can more easily understand and respond to events as they happen.

We will also discuss briefly new dissemination methods being developed by GeoEye to allow users and responders to access imagery quickly and set up monitoring services so that their areas of interest are always monitored. We will also introduce briefly the development of the two next generation satellites, GeoEye-2 and GeoEye-3.

"Integrated horizontal-scan remote sensing for landslide imaging and evaluation"

Amer Smailbegovic[1], **Michael Mendenhall**[2], **Jeffery Clark**[2], **Kyle Gray**[3], **Richard Wooten**[4]

1. TeraElement Ltd., Reno, NV.
2. Air Force Institute of Technology, Wright Patterson AFB, Dayton, OH.
3. Department of Geology and Environmental Geosciences, College of Charleston, SC
4. North Carolina Geological Survey, Department of Environment and Natural Resources, Asheville Regional Office, NC.

Presented by **Amer Smailbegovic**

With hundreds of registered active and potential landslide zones, the Appalachian Mountains of the eastern United States ranks high on a risk scale for property and infrastructure destruction and potential for loss of life. Various climatic, topographic and geologic factors complicate the evaluation and prevention of landslide zones, particularly in urban areas. Historically, crucial risk factors include: drainage, mineralogy, slope, type and density of vegetative cover and anthropogenic elements. Some of these elements may be recognized in advance and modeled to predict zones at high risk of landslide propagation. This study combines the capabilities of passive and active remote sensing methods in determining some of the potential geologic and risk factors on a documented landslide occurrence in the vicinity of Franklin, North Carolina.

The horizontal-scanning LIDAR (LASER imaging, detection and ranging) receiver is used to image the near-vertical surfaces of landslide scarps the study area for identification/definition of sliding plane blocks. We are able to digitally reconstruct the surface where sliding planes can be rotated in multiple orientations to identify kinematic indicators (subtle fissures, cracks and/or movement planes at centimeter resolution) and surface-apparent zones of weakness. LIDAR is also be used to evaluate the cohesiveness of vegetative cover and its contribution to slope-stabilization and can be successfully used in the areas of high relief and ground exposure.

Reflectance spectra is exploited to delineate zones of problematic mineralogy, particularly in the instance of hydrophilic clays (e.g., montmorillonite, illite) which tend to contribute to landslide propagation either by increasing the loading factor of the slope or serving as a low shear strength zones in plane motion. The instrumentation allows us to determining the presence of sulfates (e.g., jarosite) which can be indicative of acid-dissolution and weathering of surface rocks, presence of iron oxides and hydroxides (e.g., goethite, limonite) often indicative of water-rock interactive processes and weakening of surface layers and/or changes in the cohesiveness of the metamorphic host-rock. The combination of both image and point spectra allow us to determine the extent of the problematic zones as well as type and health of the vegetative cover as an indirect observable in determining the propagation-likelihood of the observed area.

Initial results indicate a significant alteration of the exposed surface rocks(partly-to-completely weathered, fractured and folded garnet biotite gneiss and amphibolites) to clay minerals, primarily mixtures of kaolinite/smectite and halloysite/montmorillonite. Also noted are discrete zones of jarosite and gypsum, indicators of weathered pyrite-rich zones (concentrated along fracture planes), suggestive of a continued process of host-rock decomposition. Zones of intense clay-weathering coincide with zones of observed high relief and observed structures, combined with field observations of scarp propagation indicate continued activity in the study area. The results demonstrate the usefulness of a combined multiple stand-off scanning-methodologies in the appraisal of geological factors pertaining to landslide zones opening up possibilities in simultaneous analysis of different elements of landslide formation, propagation and evaluation. The data could be integrated to automated or semi-automated model development for real or near-real-time monitoring of potential landslide zones. The spatial and spectral elements of landslide areas used for the purposes a quantitative or semi-quantitative description of historical landslide risk factors may be extrapolated to a wider area.

"Use of Multispectral Remote Sensing in Coastal Risk Assessment"

S. Lavender[1,2], **P-M Schuwerack**[2], **J. Buxton-Smith**[2] & **M. Knul**[1,2]

1. ARGANS Ltd, Plymouth, Devon, UK
2. School of Marine Science and Engineering, University of Plymouth, Plymouth & Britannia Royal Naval College, UK

Presented by **Samantha Lavender**

Remote sensing, in particular analysis of high to very high multispectral satellite data, has become a well recognised and established method of data collection in remote locations. Flooding from extreme natural hazards, like tropical storms and tsunami, is a major concern in low-lying coastal and island settings throughout the Caribbean with global warming potentially exacerbating the risk. Hazards often become disasters through the erosion of resilience, driven by environmental change and human action. In economically developed regions, like Florida, social resilience from strong institutions, early warning systems, and a high capacity to deal with hurricane storm surges confine the impact to manageable proportions, but across the Caribbean endemic socio-economic vulnerabilities often give rise to human disasters of a far greater magnitude.

Mangrove and coral reef ecosystems may provide significant protection to coastal communities who are particularly at risk from coastal flooding due to their physical exposure and socio-economic vulnerability. Recent research has studied the use of Landsat and SPOT for mapping mangrove extent and species (Schuwerack and Lavender, 2008; Buxton-Smith et al., 2009). One study focused on Hurricane Ivan's (2004) affect on Grand Cayman in the Cayman Islands. The category 5 storm (UN et al. 2005) caused widespread damage partly due to 6-9 ft storm surges, coupled with waves exceeding 25ft which caused significant flooding of low lying areas (Young 2004). A second study looked at the impact of Hurricane Ike (2008) on the mangroves of the Turks and Caicos Islands.

The presentation will show the results of these studies and more widely discuss the application of multispectral satellite data to Coastal Risk Assessment and Vulnerability Assessment.

"Mapping of environmental impacts of salt mining dumps in Central Germany using spectroradiometric methods"

M. Denk, **C. Gläßer**,& D**. Schwefel**

Martin Luther University Halle-Wittenberg, Institute of Geosciences, Department of Remote Sensing and Cartography, Von-Seckendorff-Platz 4, D - 06120 Halle (Saale), Germany, Cornelia.glaesser@geo.uni-halle.de

Presented by **Cornelia Gläßer**

There are numerous large dumps of abandoned potash and salt mines in many areas of Central Germany. Highly dynamic leaching processes cause's intensive environmental influences on different land use types, such as wetland and farm land and small anthropogenic water bodies in the surrounding of the dump. Accumulation processes forms new built terraces of minerals in a depression. The dump mainly consist gypsum and anhydride.

The dumps are encrusted with glassy and white hard materials composed of a mixture of mirabilite and thenardite in addition to minor amounts of halite and polyhalite. The area occupies a depression (wetland) located approx. 0,5 km from the dump, with a wooded lignite bearing area in-between. The dominant minerals are gypsum and iron oxides, with small amounts of halite, mirabilite and thenardite. The sediment surface consists of polygonal ridges that evolve into cascade-like compartments. Gypsum grows in these pools as radial, fibrous and acicular crystals by free precipitation and displacive growth in the muddy, Fe_2O_3-rich sediments. Halite crystals grow as rafts or skeletal crystals that sink to the floor. Fe-ions, dissolved in the brine, form thin films of Fe-hydroxides floating on the brine or precipitating on the floor. It is supposed that mirabilite was formed during cool or freezing winter seasons, whereas gypsum and halite formed during summer seasons. These variations are controlled primarily by the variation in composition of the leached dumps, the flow route of meteoric water or ascending groundwater from an aquifer with variable composition with descending infiltrating meteoric water.

The detailed investigation and assessment of the mineral phases requires large variety of geochemical analyses as well as extensive field and laboratory spectroscopy. Seasonal field campaigns and time series measurements serve information on temporal changes. Qualitative and quantitative analysis are done using X-ray diffraction and X-ray fluorescence. To understand the spectral signal we measured with the ASD FieldSpecPro a large variety of samples: from sieved, air dried samples to original field samples. So we can investigate the influences of moisture and grain size of the intensity of the signal and the depth of the absorption features. More over we develop a system for time windows for best classification results as well as limitation depending from seasonal aspects.

A time series of Hymap data (2003, 2008, 2009) enable the classification and monitoring of the spatio- temporal distribution of the different minerals and their environmental influence to the different land use types and water bodies using different methods like Spectral Angle Mapping, Binary Encoding and Spectral Feature fitting is discussed.

"Satellite monitoring of Icebergs, oil spill and polar bears"

Sigmund Dehli, KSAT

The increase in human activity in the Arctic region has led to a rise in the need for improved management, monitoring and surveillance of the region. The weather conditions may change quickly and dangerously, while the presence of sea ice poses an increased risk to ships. For these reasons, the need for frequently updated information has increased.

In addition, as human activity increases so does the risk of contamination from an industrial accident, such as an oil spill from a sinking ship, to the local ecosystem increase with detrimental consequences.

The sinking of a ship is also a worst case scenario for the local authorities. Any accident will be in a remote and inaccessible location, and this will hinder the planning and execution of any rescue operation. Therefore real-time knowledge of where ships are, and the ice conditions in the surrounding area, which will in turn determine how long they are away from a ship in distress, are vital.

Due to the size of the polar regions the amount of information available from ground-based observations is small relative to the region of interest. As a result satellite observations have been employed to obtain spatial coverage of the polar regions.

As human activity in the Arctic waters increases, issues related to sovereignty, security and safety, as well as social, cultural and environmental concerns will arise.

A long-term data set of high resolution ice charts when combined with GPS (Global Positioning System) data from polar animals will allow dynamic habitat regions to be identified and managed.

Measuring a Changing Surface – Interferometric Applications

Abstracts – Day One, Session Two

"Ground and building motions determined by radar interferometry from 1995-2007 in the Nottingham area, United Kingdom"

D. Tragheim[1], **K. Smith**[1], **L. Bateson**[1], **U. Wegmuller**[2], **J. Leighton**[3], **A. Sowter**[3], & **R. Bingley**[3]

1. British Geological Survey
2. Gamma Remote Sensing
3. IESSG, University of Nottingham

Presented by **Doug Tragheim**

This study reports some of the results obtained from an ongoing research and development project which is analysing ground and building motions in the Nottingham area, United Kingdom. The aim of this project is to provide reliably calibrated Persistent Scatterer Interferometric Synthetic Aperture Radar (PSInSAR) results, using GPS and corner reflectors at selected locations as ground control. One of the main reasons for undertaking this study is to develop an accurate and reliable surveying technique from space, to identify and monitor large urban areas for ground motions which can cause damage to buildings. These might be related to man-made environmental geohazards, such as legacy underground coal mining.

The radar data was provided by the European Space Agency (ESA) as part of a Category-1 approved project (#3518) for a PhD topic "GPS and PSI Integration for Monitoring Urban Land Motion" which was successfully undertaken by J. Leighton from 2005-2010 at the Institute of Engineering Surveying and Space Geodesy (IESSG), Nottingham University. In order to provide an independently processed reference dataset, the British Geological Survey (BGS) commissioned GAMMA Remote Sensing to process ERS data covering the wider Nottingham area, from 1995-2000 and ENVISAT data from 2002-2007. Using the GAMMA Interferometric Point Target Analysis (IPTA) method, 148,885 points were processed from the ERS data stack with a master scene dated 1 November 1997. From these initial points, 116,638 of them could be further identified in the ENVISAT data from 2002-2007, and further processed using a different master scene dated 30 October 2004. Additional ENVISAT scenes up to February 2009 were processed separately by J. Leighton for his PhD, using the licensed GAMMA software at BGS. A network of 6 trihedral metallic corner reflectors were set up in mid 2006, a permanent one at the BGS and two others on the roof-tops of buildings at the University of Nottingham. The other 3 were episodically attached to specially designed mounts on OS trig pillars and monitored with GPS for a minimum of 6 hours during the ENVISAT overpass, with the BGS one for many days.

The radar interferometry results reported here are mainly from those processed by GAMMA Remote Sensing. The Nottingham region is shown to be relatively stable, or has undergone gentle uplift from March 1995 to January 2007. Some exceptions have been found, the most enigmatic is at Hucknall, in north Nottingham. Here a NNW-SSE trending elliptical-shaped region experienced line-of-sight subsidence of 7 to 9mm/year or more, between 1995 and 2000. This then reversed to one of uplift at 5mm/year from 2002 to 2007. In the north west of Nottingham, the Eastwood area showed a NW-SE trending broad elliptical area of uplift, which was greatest from 1995 to 2000 but continued at a reduced rate from 2002 to 2007.

"Long-term Differential InSAR Monitoring of the Lampur Sidoarjo Mud Volcano using ALOS PALSAR imagery"

R. Holley[1], **D. Waring**[2], **A. Thomas**[1], **R. Burren**[1], **D. Shilston**[2] & **C. Meikle**[3]

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2. Atkins, Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW, UK
3. (Formerly of Atkins Limited) Golder Associates Pty Ltd., 124 Pacific Highway, St. Leonards, New South Wales, 2065, Australia

Presented by **Rachel Holley**

The Lampur Sidoarjo mud volcano (Java, Indonesia), colloquially called LUSI, first appeared in May 2006. Its cause, whether the result of natural or anthropogenic activities (or a combination of both), is still being debated within the academic, engineering and political communities. The mud volcano expelled up to *150*,000 m^3 of mud per day during its peak; covering more than ~6 km^2 to depths of some tens of metres, and displacing approximately 30,000 residents. The mud continues to threaten local communities, businesses and industry.

With such a large volume of mud being expelled it is inevitable that there will be some ground surface movement and instability issues at the main vent (source of the mud), and in the vicinity of the mud volcano footprint. Due to the dynamic ground surface conditions, engineers and academics alike have found it difficult to reliably monitor ground surface movements within the affected region using conventional surveying techniques. Consequently, Atkins geohazard team were asked by the owners of a site near the mud volcano to advise on the risk posed by LUSI to their assets. The team decided to use satellite interferometry to monitor the hazard.

This study presents the results of a long-term ALOS PALSAR Differential Interferometric (DifSAR) monitoring campaign across the LUSI mud volcano. In contrast to established C-band (5.6 cm wavelength) radar instruments commonly used for InSAR, PALSAR's L-band (23.8 cm wavelength) SAR presents a number of advantages, including the ability to map larger-scale ground motions over relatively short timeframes, in tropical environments, without suffering as significantly from signal decorrelation associated with C-band imagery. DifSAR processing was applied to a sequence of images acquired on a 3 to 6-month basis since May 2006. The results highlight the capability of ALOS PALSAR in detecting decimetres of coherent ground subsidence to assist the geohazard team in their analysis of the structure, dynamics and overall impact of the mud volcano on the surrounding region.

"Integration of SAR interferometry modules with analytical modeling illustrated by the Yushu earthquake 2010, China"

S. Atzori[1], **P. Pasquali**[2], **M. Barbieri**[3], **A. Cantone**[2], **C. Farquhar**[3], & **T. Bahr**[4]

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Presented by **Clive Farquhar**

SAR Interferometry and related techniques have gained in the last years a very high acceptance as a tool for the precise measurement of small displacements of the Earth surface. They provide crucial information for the understanding of geophysical and geological phenomena like earthquakes, land subsidence, volcanic activity, long-term tectonic movements, etc. Therefore these measurements, together with other geodetic observations, cannot be intended as a final product, but instead as input for the modeling and representation of the phenomenon under investigation.

This contribution presents the approach followed by the authors [1] and [2] in the integration of a set of geological modeling tools within the SARscape® COTS interferometric software. This software suite allows the end-user to better understand and describe the geological/geophysical phenomenon. Outcomes of such integration are shown by means of results obtained exploiting SAR data from the ALOS PALSAR (© Jaxa), and ENVISAT ASAR (© ESA) sensors, distributed within the Supersites initiative, over the 2010 Yushu Earthquake (China).

The 2010 Yushu earthquake struck on April 14, 2010, and registered a magnitude of M_W 6.9 by USGS or 7.1M_S (CEA, CENC). This quake occurred on the Yushu fault which is part of the Yushu-Garzê-Xianshuihe fault zone, one of the most active fault zones in eastern Tibet.

The coseismic displacement field, that was derived by the authors [1] and [2] from ALOS PALSAR data, shows a ground deformation in the viewing direction of the sensor (39 degrees from the vertical and looking east) with a peak motion of 42 cm away from the sensor on the south side of the fault and 32 cm towards the sensor on the north side. The fault rupture strikes NW-SE and is about 65 km long with a clear discontinuity for 30 km for the eastern half of the rupture indicating the fault slip reached the surface there.

This resulting displacement pattern was modeled by the authors [1] and [2] with the elastic solution of Okada [1985]: the ALOS PALSAR displacement map has been first used to identify three rectangular faults with constant displacement (non-linear solution); then a linear inversion has been performed to obtain the final displacement distribution, which can explain the real coseismic slip distribution.

According to the fault model the slip is concentrated within the upper few kilometers of a nearly vertical fault, peaking at 2.5 – 2.75 m near surface, which is consistent with offset maps and field data. The observed and modeled coseismic displacement maps show a RMS < 3 cm.

"Crustal deformation of the central Tibetan Plateau measured using InSAR"

M. Garthwaite[1], **T. Wright**[1] & **H. Wang**[2]

1. School of Earth and Environment, University of Leeds, UK.
2. Department of Surveying and Engineering, Guangdong University of Technology, Guangzhou, China.

Presented by **Mathew Garthwaite**

Contrasting models have been proposed to describe the ongoing deformation of the Tibetan plateau as a result of the IndiaAsia collision. One extreme involves rotations of rigid elastic blocks bounded by major faults which penetrate the entire lithosphere. This description implies relatively high slip rates on block bounding faults and distinct narrow shear zones. In the alternative extreme, the bulk continental lithosphere is considered to deform continuously as a viscous fluid. Deformation in the brittle upper crust is driven by tractions imparted on its base from the viscous layer beneath, and distributed on a large number of shallow faults throughout the deforming zone. As a result, slip rates on faults are lower, and their straining zones merge together. There are very few GPS measurements of surface velocity in the plateau interior, therefore it has been difficult to verify either of the proposed models. Interferometric synthetic aperture radar (InSAR) has proved to be a powerful technique which dramatically increases the spatial density of velocity measurements. We use this technique on a network of 32 Envisat ASAR images acquired between 2003 and 2009 on descending track 176 in the centre of Tibet. The swath length of ~1100 km spans the majority of the uplifted plateau and covers three major eastwest trending shear zones Kunlun, Jiali, and Xianshuihe. Interferograms are processed using the Gamma software and we correct for the topographic phase contribution using a DEM derived from SRTM data. Coherence is generally good but degrades close to the mountainous terrain of the Himalaya in the south and in the centre of the track due to seasonal variations in permafrost. Interferograms are unwrapped using the minimum cost flow technique, and we manually correct unwrapping errors using the principle of phase closure. Following this, we use a multiinterferogram network algorithm to determine the orbital error and the atmospheric phase delay due to differences in topography along track. We remove these contributions and solve for the deformation rate at each pixel in a least squares inversion. The large alongtrack extent of the rate map enables recovery of tectonic signals at the hundred kilometre scale using this method. However, we are also interested in the longer wavelength signal across the whole plateau. We therefore adjust the rate map using an initial velocity model constructed from published GPS data. The resulting rate map shows the distribution of strain across the broad deforming zone of the Tibetan Plateau during the interseismic period. We use a velocity profile through the rate map to test the proposed deformation models and find that neither published elastic block models or numerical viscous models can recreate the velocity field measured using InSAR.

"Geological Applications of Interferometry using the ERDAS Imagine Radar Mapping Suite"

Andy Garratt, Director, Sales EMEA, ERDAS Inc

As evidenced by the number and variety of radar satellites recently launched or currently planned, the use of radar imagery is transitioning from research to operational. One field of particular interest and applicability is monitoring human activity and infrastructure. In this realm, radar image processing offers some unique and powerful capabilities. This presentation will focus on operational Geological applications of these tools and will cover the three technology areas below:

Interferometric SAR (InSAR)

By exploiting the information contained in the radar phase, the InSAR capability can quickly extract high-quality Digital Elevation Models (DEM).

Differential Interferometric SAR (D-InSAR)

Combining the capability of InSAR and Coherence Change Detection, the D-InSAR capability quantitatively maps surface change at the sub-wavelength scale. **D-InSAR** provides the analyst with the ability to precisely map surface displacement, anywhere in the world, from space. This opens up the potential to create regional subsidence maps in areas of oil and gas production, aquifer depletion, sub-surface mining or tunneling. Natural phenomena, such as earthquakes or volcanoes, can be monitored or evaluated for relief efforts.

Coherence Change Detection (CCD)

By comparing two radar images taken at different times, the **Coherence Change Detection** functionality can detect changes at the wavelength scale. This means that surface change of an inch or less can be detected over areas of hundreds of square miles. This provides regional monitoring at a previously unattainable level.

ERDAS IMAGINE SAR Interferometry is a single set of wizard driven tools that fully integrates the IMAGINE Radar Mapping Suite's advanced interferometric processing capabilities. With this package even the radar novice can extract high-quality DEMs, generate coherence change products or map surface displacement at the centimetre level.

Expertise Strengthened Through Partnership

Recognizing the need for user-friendly, robust and technically sophisticated interferometric tools, ERDAS partnered with the German Space Agency (DLR) to create this product. World-renown for their development of the SRTM/X-SAR and the new TerraSAR-X satellite, this collaboration leveraged both organizations' expertise to produce state of-the-art algorithms. The technology that processed Space Shuttle Radar Topography Mission (SRTM) interferometric images now forms the heart of IMAGINE SAR Interferometry.

Geological Mapping I

Abstracts – Day One, Session Three

"Integration of close-range hyperspectral imaging and lidar for mapping outcrop composition"

S. Buckley[1], **T. Kurz**[1,2], **J. Howell**[1], **D. Schneider**[3]

1. Uni CIPR, Bergen, Norway
2. Department of Earth Science, University of Bergen, Norway
3. Technische Universität Dresden, Germany

Presented by **Simon Buckley**

Geological applications have benefitted substantially from advances made to terrestrial laser scanning (lidar) and digital photogrammetry, allowing field localities, such as outcrops, to be captured with high resolution and accuracy. These methods allow a more quantitative approach to outcrop analysis, as accurate topographic data provides a framework for measurement and interpretation. Use of photorealistic models, where geometric data is integrated with digital imagery, eases interpretation of geological features and has proven to be invaluable for supporting conventional fieldwork and in education. Despite this, most previous quantitative studies have been related to analysing outcrop topography, and the distribution of mineralogy and lithology has yet to be fully addressed in close range applications.

Close-range, or ground-based, hyperspectral imaging is a promising method for improving the understanding of outcrop composition. Airborne and spaceborne multispectral and hyperspectral sensors have already been successful for mineral prospecting and mapping regional geology. However, these sensors are unsuitable for close range applications, because of their poor coverage of near-vertical cliff sections. New sensors for ground-based hyperspectral imaging are now available, and are capable of measuring in the short-wave infrared (SWIR) part of the electromagnetic spectrum with high spectral resolution. Combining the results of spectral image processing with lidar geometric data and conventional digital imagery in an integrated 3D model offers a new basis for studying outcrop surface composition.

In this research, a pushbroom close-range hyperspectral imager was used to scan geological outcrops, with the aim of assessing the potential of the technique for the remote mapping of lithology and mineralogy. Images were captured covering siliciclastic and carbonate outcrops, and processing was carried out to obtain classification products representing the distribution of outcrop lithology in each setting. Laser scans and digital imagery of the outcrops were acquired simultaneously with the hyperspectral imaging. To relate the spectral products to a real-world coordinate system, the raw images were registered to the lidar data. Because of the pushbroom imaging geometry, a cylindrical photogrammetric camera model was required to give the most accurate integration. This resulted in the ability to locate a pixel in the spectral data in the lidar 3D model with an accuracy of around one pixel following bundle adjustment. The registered hyperspectral results were superimposed, together with the conventional imagery, on the lidar 3D model, resulting in a photorealistic model with multiple texture overlays for each image type and classification result. This integrated product was extremely useful for aiding analysis, validation of image processing, and for visualisation and interpretation. Use of hyperspectral imaging in both of the case studies resulted in new information about the geology, highlighting features that were missed in the field, or that were originally missed by using conventional photography. Consequently, close-range hyperspectral imaging is seen as being a tool applicable to many future geological applications.

"Geological Mapping Of Volcano Teide Using Hyperspectral And Multispectral Satellite Data"

S. Amici[1], **A. Piscini**[1], **M. F. Buongiorno**[1], & **D. Pieri**[2]
1. Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
2. Jet Propulsion Laboratory, Pasadena, California USA

Presented by **Stefania Amici**

This work is an evaluation, to which degree geological information can be obtained from modern remote sensing systems like the multispectral ASTER or the hyperspectral Hyperion sensor for a volcanic region like Teide Volcano (Tenerife, Canary Islands). The Canarian Arcipelago is made up of seven islands that represent different stages of geologic evolution. Tenerife is the central island of archipelago and has developed within the complex formed by the rifts associated with the Teide-Pico Viejo (T-PV-Lat 28° 16' 30" Lon 16°38' 42") stratovolcanoes that reach a height of 3718 m, 7500 above the ocean floor. It is an active, though currently quiescent shield volcano, which last erupted in 1909. In the frame of the European Project FP6 PREVIEW-EURORISK (PREVention, Information and Early Warning pre-operational services to support the management of risks) (http://www.preview-risk.com/) a field campaign was carried out on Tenerife island to improve the retrieval algorithms and techniques, a field campaign has been realized on Pico de Teide (Tenerife island - Spain) from the 16th and 24th of September 2007. The validation campaign has been performed in order to acquire spectra used as ground truth data on the Pico de Teide in an area also know as Las Canadas Caldera (LCC). The time window was chosen taking into account different factor as: meteorological characterization, satellites scheduled passage, availability of both on Tenerife and INGV team. The measurements were localized on the summit area of the Tenerife Island and in particular within the Teide Caldera in order to identify suitable test sites both for cal/val activities and to study the geological setting of Pico the Teide volcano by image spectroscopy. Measurements in situ of reflectance and emissivity were realized very close/close the satellite passages. During the campaign atmospheric profiles and ground atmospheric measurements were acquired contemporaneously with the satellite acquisitions. A characterization of reflectance at summit crater surfaces was realised in order to complete the spectral characterization of different surfaces. The spectral measurements have been used as "ground truth" to realise the first classification map by satellite data of Teide volcano. In particular, the Support Vector Machine (SVM) supervised method has been applied to both ASTER and Hyperion data. The results are compared and discussed in this work.

"BGS•SIGMAmobile: A digital geological mapping system that enables remote sensing to be integrated into fieldwork"

Colm Jordan, BGS

The British Geological Survey (BGS) first explored the concept of digital field data collection in the early 1990's, with the conclusion that the mobile computing hardware at that time was not suitable. The development was therefore postponed indefinitely. However a stakeholder review of onshore geological mapping, including the means of collecting data, was undertaken in 2001. The review proposed a major change in survey methodology to include "digital field data capture and desk-top compilation" with "a consistent approach across all terrains and scales of survey" (Walton, 2001). These review outcomes initiated a major new project to update our mapping systems and workflow; the project was called SIGMA (System for Integrated Geoscience Mapping). One outcome of the new workflow is an implemented digital field data collection system designed and built in BGS; it is called BGS·SIGMAmobile. The system has won awards from both ESRI and the AGI.

Examples from BGS mapping projects in the UK and overseas will be used to briefly outline the current capabilities of the BGS system, which is available for free download from the BGS Internet site. We hope that making the BGS system freely available will encourage shared development of an international standard system, leading to increased cooperation and knowledge exchange. 650 licenses are used globally by professionals, amateurs and academics alike.

Furthermore, geologists have long understood the potential of remote sensing data. They have used it from its earliest days to gain an understanding of the terrain prior to fieldwork and to help navigate in regions where topographic maps are unavailable. Systems for manipulating digital EO datasets in the office are ubiquitous, however until recently the only way to take imagery and derived products into the field was to produce paper plots, with stereo imagery viewed using pocket stereoscopes. Making the most of remote sensing imagery (in digital form) in mobile situations in the field is still in its infancy, however BGS•SIGMAmobile also enables the geoscientists to carry vast quantities of EO data, to visualise it and manipulate it at the outcrop in ways previously not possible.

"Using high resolution digital elevation models and hyperspectral data to characterize sedimentary sequences on Mars"

D. Tragheim[1], **J. Bridges**[2], **P. Grindrod**[3], **J.-P. Muller**[4], **J. Kim**[4], **K. Hill**[2], **K. Smith**[1], & **S. Davies**[5].

1.British Geological Survey;
2.Space Research Centre, Department of Physics & Astronomy, University of Leicester;
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4.Mullard Space Science Laboratory (MSSL), Department of Space and Climate Physics, University College London;
5.Department of Geology, University of Leicester.

Presented by **Doug Tragheim**

The Mars Reconnaissance Orbiter (MRO), which is currently orbiting Mars, is returning some spectacular very high spatial resolution stereoscopic data using the High Resolution Imaging Science Experiment (HiRISE) camera. Pixel sizes can be as small as 25-30cm obtained from orbit heights of 250-300km, allowing objects up to 75-90cm to be resolved. As of 1 November 2010, the University of Arizona has released nearly 19,600 images, 1938 of them forming 969 stereo-pairs, and 872 black & white anaglyphs. Only 55 stereo DEMs have been publically released to date from HiRISE. There is also a Context Camera (CTX) producing imagery at about 6m resolution covering a much larger area, so that these scenes can be located relative to other previous generation (Mars Odyssey) thermal imagery such as THEMIS (which generally has a pixel size of about 90m but can be as small as 20m), or the current European Space Agency High Resolution Stereo Camera (HRSC) images with pixel sizes from 3m to 12.5m in B&W and larger in colour.

Onboard MRO the hyperspectral instrument Compact Reconnaissance Imaging Spectrometer (CRISM) obtains images with 544 spectral bands covering the range from 0.4 to 3.9 microns, and a pixel resolution of circa 18-20m.

We have been using a system developed at MSSL (Kim & Muller, 2009) and one using SOCET SET photogrammetric software following methods established by the USGS to make digital elevation models (DEMs) and the CRISM Analysis Tool (CAT-ENVI) developed by Brown University and other methods to process the hyperspectral images.

We will show how we are employing the HiRISE and CRISM processed datasets to characterise several sedimentary sequences (Interior Layered Deposits) on Mars. The CRISM analyses help to identify the mineralogy and the DEMs the thickness of individual beds comprising the sediments, and their possible environment of deposition. By analysing and comparing several alternating repetitive sequences from different locations, we hope to eventually establish a connection with global climate change on Mars.

GEO

Abstracts – Day Two, Session One

"GEO, GMES and Geology: status and opportunities"

Stuart Marsh, British Geological Survey

The Group on Earth Observations (GEO) is an intra-Governmental Grouping with almost 100 member states, including the UK, most other European countries and the EC. It is half-way through its first 10 year plan, which is designed to build a Global Earth Observing System of Systems (GEOSS). There are geologic observing systems within GEOSS (OneGeology is the digital geology layer; the Global Seismic Network is a member; NASA, ESA and USGS contribute relevant EO satellites like ENVISAT and ASTER). The main geological applications focused initially on disasters but now extend across water, energy and minerals. Future applications could include global soil characterisation and palaeo-climate. Global Monitoring for Environment and Security(GMES) is a joint initiative of the European Commission and the European Space Agency to build global monitoring systems and related services for Europe across a range of environmental domains, including for example geohazards. It is often characterised as Europe's main contribution to GEOSS. This talk will describe the two initiatives and their relationship with and to geology. It will act as an introduction to the following talks, which will examine the contribution of geology to the observing systems and the application of those GEO and GMES observations to geology in the fields of mapping, geohazards, energy and mineral resources.

"Neural network based predictive mapping with advangeo® and its application in the AEGOS project"

Andreas Knobloch, Beak Consultants

Artificial neural networks (ANN) are an excellent tool for the creation of prediction maps based on existing raster and vector data. ANNs analyse complex, non-linear relationships of potential controlling parameters on the probability of any spatially distributed, geo-related event or phenomena. The methodology is based on the ability of ANNs to learn from "examples" and transfer the "knowledge" into a larger area with similar conditions. The software advangeo® has been developed to provide GIS users a software tool to use ANNs for prediction mapping within their standard ESRI ArcGIS environment. Advangeo® has shown its capabilities in prediction of a wide variety of phenomena so far: landslides, erosion processes, mineral occurrences, geological borders, coal fires, forest pests, manganese nodules.

In the frame of the AEGOS (African-European Georesources Observation System) project, advangeo® has been used to demonstrate the project's potential to generate user oriented products. Advangeo-based use cases range from the prediction of erosion gullies in South Africa to exploration targeting for Gold occurrences in NW-Ghana. The modeling was based completely on available data, such as the geological and soil maps, the digital elevation model and its derivations, land use data, data from airborne geophysical survey and satellite images. The ANN models were calibrated by use of existing point (known mineralisation) or polygon data (known erosion gullies).

"EO for Monitoring & Observing Environmental & Societal Impacts of Mineral Resources Exploration & Exploitation"

S. Marsh[1] & **S. Chevrel**[2]

1. British Geological Survey
2. BRGM

Presented by **Stuart Marsh**

In 2007, the European Commission Vice President responsible for Industrial policy declared that "*European industries need predictability in the flow of raw materials and stable prices to remain competitive. We are committed to improve the conditions of access to raw materials, be that within Europe or by creating a level playing field in accessing such material from abroad*". During the G8 Summit on June 2007 a Declaration on "Responsibility for raw materials, transparency and sustainable growth" was adopted. The need to address the sustainable development of the extractive industry and the reduction of its environmental footprint was addressed by several national and international initiatives. One of these, the European Technology Platform on Sustainable Mineral Resources, has as its goal to "modernise and reshape one of the fundamental pillars of the European economy and society". The social acceptability of a mining project, from exploration to closure, is among the major key issues to be dealt with.

EO-MINERS scientific and technical objectives are to: i) assess policy, public and mining company requirements and define environmental, socio-economic, societal and sustainable development criteria and indicators to be possibly met using Earth Observation (EO); ii) use existing EO knowledge and carry out new developments on demonstration sites to demonstrate the capabilities of integrated EO-based methods and tools in monitoring, managing and contributing reducing the environmental and societal footprints of the extractive industry during all phases of a mining project and iii) contribute making available reliable and objective information about affected ecosystems, populations and societies, to serve as a basis for a sound "trialogue" between industrialists, governmental organisations and other stakeholders.

The need to assess policy requirements and define criteria and indicators to be possibly dealt using EO methods and tools will first be addressed through an analysis of policies related to the environmental and social footprint of mineral industries. EO-MINERS then will contribute to develop high level EO-based data products applicable to the different stages of mining activities within the life cycle of mining operations, over three demonstration sites (Czech Republic, South Africa and Kyrgyzstan). The core of the project aims at developing EO-based tools for helping monitor and observe the impact on the environment and on society of the exploration and exploitation of mineral resources. It is also intended to contribute to the development of generic EO data integration schemes, in particular in view of characterising affected ecosystems, populations and societies and prepare indisputable documents for industrialists, governmental organisations and stakeholders. These will address GEO (the Group on Earth Observation) and GEOSS (the Global Earth Observation System of Systems) process and tasks, by using these outputs to define core elements of an environmental observing system and examining how this system fits in GEO and contributes to building GEOSS.

“Distributed EU information portals: applying geology within GEO”

S.H.L.L. Gruijters, TNO Geological Survey of the Netherlands

The Global Earth Observation System of Systems will provide “decision-support tools to a wide variety of users. As with the Internet, GEOSS will be a global and flexible network of content providers allowing decision makers to access an extraordinary range of information at their desk”. This implies that GEO is about monitoring, meaning seeing what happened in the past, but also of course about predicting what will happen in the future. A large number of the societal benefit areas in GEO can be monitored by measuring some sort of key parameter in time. Predicting the changes in these key parameters in the future will need both the data itself, as an understanding of the processes involved that influence the magnitude of these parameters. And this brings Geology into the equation. Disasters, energy, (ground-)water, ecosystems, agriculture, biodiversity, they are all more or less related to the 3D composition of the subsurface. Just think of information on geological instabilities around faults and slopes to be used for predicting earthquakes and landslides; information on groundwater bodies and compressible sediments for predicting subsidence and related flooding events and the presence of energy and mineral reserves for exploration and exploitation of mineral and energy resources.

Within Europe a large number of EU funded projects exist that honor this relationship with geology. They focus on creating information portals based on distributed web systems, combining the geological data and knowledge from the geological surveys in Europe. These projects focus on harmonization of data, developing exchange formats and designing interactive web portals that give users the possibility to find, view, query and download the data. A well known example is OneGeology, a showcase within GEO. In October this year OneGeology Europe was launched, providing free access to a harmonized 1:1M map showing the surface geology of Europe. More or less based on the same principle dedicated web portals are being developed. In Subcoast, TerraFirma and Pangeo geology is used to understand and predict subsidence and landslides. In EuroGeoSource data on energy and minierals is served. Although this project does not use space or airborne earth observations, it does use interpretations of in situ earth observation techniques like boreholes, cpt’s and seismic data. The project will serve geological data for prospection of energy and minerals in at least 10 countries in Europe, together with economical data on production in existing mines, quarries and oil and gas production sites. The portal will be designed as a distributed web system, and allow users to perform queries interactively. The portal as such will provide integrated data to be used as input for a sustainable supply of energy and minerals in Europe in the future.

Projects like EuroGeoSource built on the success of OneGeology and show that geology indeed is very relevant in providing information to understand and predict the future changes of key parameters in the wide range of societal benefit areas within GEO.

"Coordination of GEO in the European science community"

Claire Fleming, BGS

The Group on Earth Observations (GEO) is half-way through a ten year implementation plan. Many GEO Tasks in the plan have been implemented by EC 7th Framework Programme projects that are undertaken by a variety of National and European science institutions and member states. This method of implementation has naturally led to a need for coordination. On the national level, each country has a GEO Principal that might be a government department like the Environment Department or agency, such as its Space Agency. But GEO is relevant across the environmental sciences and so many other national agencies can or should be involved. Hence, countries like Germany, Italy and the UK have begun to coordinate GEO activities at the national level. These coordination mechanisms will be described and their typical activities illustrated with examples from the UK. Beyond this, there are similar needs for coordination at the European level. National GEO principals meet with the EC in the European High Level Working Group, but at the same time several projects have been established that aim to provide more practical elements of this coordination. These include the European GEO Network, EUGENE, and an initiative to make European Observing Systems interoperable, EuroGEOSS. The talk will conclude by describing EGIDA, an EC FP7 project established to support the implementation of the GEO Science and Technology Roadmap that aims to involve the scientific community more closely in GEO and at the same time make the Global Earth Observing System of Systems more useful to the science community.

GMES

Abstracts – Day Two, Session Two

"2010 Merapi eruption: first satellite results in the context of the SAFER project"

C. Bignami, **S. Stramondo**, **M. Fabrizia Buongiorno**, **S. Barsotti**, **A. Neri**, **S. Corradini**, **M. Musacchio**, **M. Silvestri**, **A. Piscini**, **F. Prata** & **U. Wegmueller**

Presented by **M. Musacchio**

On October 25th, 2010, Merapi Volcano (Java Island – Indonesia) started its eruption activity characterized by lava flows, ash emission and explosions. The FP7 GMES SAFER (Services and Applications for Emergency Response) project has been activated to perform those activities foreseen able to mitigate the risk and to support the emergency by satellite services. Parallely, as the Merapi is a case study for another FP7 project, MIA VITA, the products and services would be provided to it.

Thanks to the activation of a DAP (Data Access Protocol), DAP_MG1_06, data from the emergency basket of SAFER project have been processed and analyzed in order to deliver information to CVGHM (CENTER FOR VOLCANOLOGY AND GEOLOGICAL HAZARD MITIGATION) and to SAFER User Community. In particular we have received 3 Radarsat-2 data with two post-eruption images (October 6 and 30) and some COSMO-SkyMed data, either Spotlight or Stripmap modes and along ascending and descending orbits, where post-eruption are dated from October 31 to November 8.

The complexity of the scenario has needed the application of different data processing techniques. Indeed the strong topography and the very large displacements overall the volcanic structures hampered the use of SAR Interferometry (InSAR) itself. To investigate sineruptive surface movements the offset shift approach has been applied being able to measure metric displacements by exploiting decorrelation of SAR images due to azimuth and range shifts. Furthermore to highlight the cracks and the progressive widening of the main crater at Merapi top change detection products have been generated.

The analysis of the deformation measured by Radarsat-2 and COSMO-SkyMed in the periods above are in agreement showing a large movement (up to 10 m) of the Southern flank along SW and possibly a subsidence. A new emerging dome has been detected.

Even considering the not ideal weather condition, due to geographical position and season, a systematic analysis has been done based on optical data provided by NASA, JAXA and "Earthquake Research Institute & Institute of Industrial Science U-Tokio" focused on the identification of the volcanic plume content. This analysis has pointed out the ash and SO2 contained in the eruptive plume.

As far as ash since the beginning of the eruption the VOL-CALPUFF code (Barsotti et al. 2008) has been applied to produce preliminary forecasting maps of ash dispersal at regional scale. The most important input data, required by the code, are the geophysical and meteorological datasets, the emitting starting time, the eruptive mass flow rate (or an estimate of column height) and the grain size distribution.

“GMES Downstream Service on European Volcano Observatory Space Services (EVOSS)”

The EVOSS Team is composed of: F. Ferrucci and S. Tait (Institut de Physique du Globe de Paris), N. Theys and M. Van Rozendaal (Belgisch Instituut voor Ruimte Aëronomie), C. Filotico and T. Lefort (Booz&Co. Italy), C. Jordan and S. Loughlin (NERC-British Geological Survey), L. Tampellini and R. Ratti (Carlo Gavazzi Space), P. Valks (Deutsche Zentrum für Luft und Raumfarth), R. Van der A (Koninklijk Nederlands Meteorologisch Instituut), B. Hirn (IES Consulting), M. Bianchi(Tele-Rilevamento Europa), S. Niemeijer (Terrasphere), L. Clarisse (Université Libre de Bruxelles), G. Laneve (Centro Ricerche Progetto San Marco)

Presented by **F. Ferrucci**

EVOSS (European Volcano Observatory Space Services) is a GMES “downstream” service uniquely devoted to volcanic hazard monitoring. It was conceived by six Institutional End Users having responsibility for volcano observatories and observation services spread across eleven volcanic areas worldwide, and experienced in the objective technical needs of managing major, local or distant volcanic unrest.

EVOSS was designed to act from sustained unrest onwards, with adaptive task scaling up to handing over the surveillance to spaceborne observation during events of outstanding areal impact that may lead to withdrawal of personnel from the field or from the observatory. Its original scope – broadly including the European Union territories – fits an Earth ‘disk’ centred on Africa and stretching to the volcanic regions of the Caribbean to the west, and Eastern Africa and Red Sea to the East.

Centred on demonstrated and robust parts of assessed processing techniques for thermal (high temperature only), ground deformation and aerosols, EVOSS’ operations are centred on high-to-very high revisit and multi-satellite observation, aimed to maximize the success rates. Data are subjected to systematic in-orbit (inter-satellite) validation in order to minimize errors . The results, associated with inherent quality/reliability indexes are brought seamlessly to the End User.

Concepts and services will be validated at two to four volcanic sites experiencing severe unrest, at least one explosive and one effusive, all included in the target volcanic regions.

The integration of spaceborne data with ground-based monitoring arrays (when they do exist) is done at the local level. In EVOSS, the concept is voluntarily restricted to EU, Africa and the Eastern Caribbean, but can readily be extended globally. Exploiting the combined potential of geostationary multispectral and Radar LEO observations will enhance the quality and timeliness of the response of observatories to multi-hazard, complex – and trans-boundary events, where appropriate.

Expected developments include the demonstration of system flexibility (in terms of payloads and platforms) and a demonstrated evaluation of the adaptive exporting capacity (to other continents, with adaption to variable types of unrest). There will be special focus on the financial and technical sustainability of the EVOSS model with time. EVOSS started on March 1st, 2010 and is due for conclusion on February 28, 2013.

"Terrafirma: A pan-European ground motion hazard information service"

Oscar Mora, Altamira Information

Supported by the European Space Agency's (ESA) GMES programme, Terrafirma-X is the continuation of the Terrafirma project. This Third Phase of the project was launched in late November 2009 and has as its aim the sustainability of the terrain motion service. TF-X focuses on several thematic lines for terrain motion analysis: - Tectonics - Flooding - Hydrogeology (including ground water issues, landslides & inactive mines) As in previous stages, Terrafirma services are based on advanced satellite interferometry products (in the main using Persistent Scatterer InSAR methodologies), however they exploit additional data sources (including

non-EO) coupled with expert interpretation specific to each thematic line.

In addition to the three thematic lines a wide area terrain motion mapping service will be developed and tested. The project consortium is lead by Altamira Information, with TNO (Dutch geological survey) leading the flooding theme , INGV (Italian national institute of geophysics and

volcanology) leading tectonics, and Unifi (University of Florence) leading hydrogeology. The wide area mapping task is lead by DLR (German Space Agency). Its services are delivered to civil protection agencies, disaster management organisms, and coastal, rail and motorway authorities to support the process of risk assessment and mitigation. Example case studies in tectonics, flooding and hydrogeology produced during Phase 2 of Terrafirma are presented in the context of the future of the service.

"SubCoast: A GMES Downstream Service on Coastal Subsidence"

L. Bateson[1] and the **SubCoast Team**[2]

1. British Geological Survey.
2. The SubCoast Team consists of C. Bremmer (TNO), S. Marsh (BGS), R. Capes (FNPA), F. Novalli (TRE), F. van Leijen (Hansje Brinker), R. Hanssen (TU-Delft), S. Pedersen (GEUS), M. Graniscki (PGI), J. Cyziene (LGT), M. Corsetto (IG), R. Westerhoff (Deltares), G. Bitelli (Universita di Bologna)

Presented by **Luke Bateson**

Coastal lowland areas are widely recognised as highly vulnerable to the impacts of climate change, particularly sea-level rise, changes in runoff, and stresses imposed by human modification of catchments and delta plain land use. Rates of relative sea-level rise can greatly exceed the global average in many heavily populated coastal lowland areas due to subsidence. This increases the potential for inundation, coastal erosion, habitat disruption and salt water intrusion, especially for the most populated cities on these coastal lowland areas.

SubCoast is a collaborative project under theme FP7-SPACE-2009-1 of the Seventh Framework Programme of the European Commission. SubCoast aims to develop a GMES-downstream service for assessing and monitoring subsidence hazards in coastal lowland areas around Europe. SubCoast develops GMES-downstream services based on satellite data (mainly InSAR), in-situ measurements and geoscientific models. SubCoast builds upon ESA's GMES Service Element Terrafirma which utilises radar interferometry to provide a ground motion hazard information service.

The main objective of *Sub*Coast is to develop a user-centred downstream GMES-service for delivering data and information on extent and impact of subsidence in coastal lowland areas around Europe and demonstrate its viability in various pilot services for a variety of geographical settings and applications.

Services under development in SubCoast include: Wide scale deformation maps, 3D ground motion maps, structural dyke assessments, subsidence assessments, groundwater risk forecasting, relative sea level rise maps, Coastal erosion maps and neo-tectonic maps. All services will be made publically available through a web-based INSPIRE compatible portal enabling the public with an easy portal to view the data to be used in decision support.

These SubCoast services will be developed in four pilot studies at regional, national and European scales. Pilot study areas are the Baltic coast, the Rhine Meuse delta (the Netherlands), Southern Emilia Romagna in Italy and an integration of data around the entire European Coastline. Each pilot service will be explained and examples of the data used to produce the SubCoast services given for each.

Persistent Scatterer Interferometry results for London will be presented as an example of earlier work in a coastal lowland area from which the SubCoast concept has evolved.

"PanGeo: free and open access to geohazard information in support of GMES"

The PanGeo team comprises 13 'core' partners, as well as all 27 EU national geological surveys: Core Team partners are: Fugro NPA Ltd (UK - Project Coordinator), British Geological Survey (UK), Landmark Information Group (UK), TNO (N), SIRS (F), Institute of Geomatics (E), BRGM (F), EuroGeoSurveys* (B), AB Consulting Ltd (UK), European Federation of Geologists (B), Tele-Rilevamento Europa (I), Altamira Information (E), Gamma Remote Sensing (S).

Presented by **Ren Capes**

PanGeo is a service proposed in response to FP7 GMES Downstream Call 3 (released July 2009). The objective of PanGeo is to **enable free and open access to geohazard information in support of GMES.** This will be achieved by the generation of a validated Geohazard Data Layer supported by a Geohazard Summary for 52 of the largest towns listed in the GMES Land Theme's Urban Atlas involving all 27 countries of the EU. Upon user enquiry, a PanGeo web-portal will automatically integrate the geohazard data with the Urban Atlas to highlight the polygons influenced. The datasets will be made discoverable, accessible and useable via a distributed web-map system as built and demonstrated by OneGeology Europe (www.onegeology-europe.eu).

The key users of PanGeo are anticipated as:

- Local Authority planners and regulators who are concerned with managing development risk,
- National geological surveys and geoscience institutes who are obliged to collect geohazard data for public benefit,
- Policy-makers concerned with assessing and comparing European geological risk, much as the Urban Atlas data is used to compare the landcover/use status of European towns.

Products will be made by integrating: a) interpreted InSAR terrain-motion data (derived from existing projects, e.g. ESA GSE Terrafirma plus new processing), b) geological information, and c) the landcover and landuse data contained within the Urban Atlas. The integration and interpretation, plus a validation of key features observed, will be made by the corresponding national Geological Survey for the towns concerned. It is planned to deliver the service for two Urban Atlas towns in each country of the EU (Luxembourg and Cyprus only 1), equalling fifty-two towns in total. The geological survey concerned will choose the towns for processing from the Urban Atlas list using their own knowledge as to where the information will be of most use, probably the largest towns, which, when extrapolated, would equal (13% of total EU urban population). User input to design will be facilitated by the Surveys contracted into the project and initiation of 'Local Authority Feedback Group'.

Terrafirma has shown the potential for the self-sustainability of services providing InSAR-derived terrain-motion data, as 30% of users have gone on to procure further product on a commercial basis. In PanGeo, it is anticipated that, by adding considerably more value as described above, and promoting the clear benefits of such key environmental information, that the local authorities of neighbouring towns will begin to demand similar.

Geo-Environmental Applications II

Abstracts – Day Two, Session Three

"Can vegetation show pH values and heavy metal content in abandoned lignite mine sites?"

C. Gläßer, **C. Salbach** & **C. Götze**

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Presented by **Cornelia Gläßer**

There are numerous large abandoned open pit lignite mine sites all over the world; through the technology we do have an extreme heterogeneous distribution of the former cover material. Compared with this mixture of sediments we do have a large variety in the geochemical properties and hydrological balance inside the dumped material. There is an urgent need to use more precise spatial information to assess the ecological state and to monitor such regions. The test sites are located in the Eocene lignite deposit in Central Germany and the Sokolov Area, CZ (Oligocene and Miocene age). Both sites are characterised by largely effects to heavy metal content and AMD due to the presence of sulphur in the lignite itself and the pyrite content. Ph values vary in short distances between 2.2 and 6-7. The specific characterisation of each mine site showed the distinctive chemical and physical properties as well as hydrological condition. Recent studies show the potential of HRS to detect geochemical properties successful. In relation to natural environments with causal connection between surface and subsurface properties we have to consider: in abandoned mines the type of the technology is influencing the distribution of the former cover sediments and the surface materials are combined un-regular with very different subsurface materials. The pH value is one of the indicators for the sum of the geochemical properties and the water budget in the area. These properties are influencing very intensive the development of pioneer vegetation in the areas. Type and distribution of plants, like lichens, mosses, different grasses are indicator as well as for the pH values and the heavy metal content. The spectral signal of these plants differs largely from other vegetation signals in relation to low content in chlorophyll and the lack of the well defined chlorophyll absorption features in the spectrum. With spectral field measurements of the indicator plants, field and lab analyses of soil condition and heavy metal content in the plants itself we can describe these relation.

Typical for this vegetation is sparse vegetation cover. For this reason we are developing unmixing algorithm for highly heterogeneous sediments and spares vegetation. We are using in both test sites data from the Sensor Hymap. The results show the spatial distribution of the indicator plants and as an additional information for the geochemistry. More over the results of natural succession is very helpful for reclamation processes. These best adapted plants in relation to the physiological condition can also be basic information for cost saving reclamation activities.

"Measuring Rock Dumps from space? How new technology could change the way we measure rock dumps and tailings dams"

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Presented by **Jim Crotty**

The measurement of rock dump's and tailings dam's volumes and tonnages has traditionally been conducted using conventional survey methodology such as manual tacheometry utilizing either theodolites and staffs or more recently total stations, laser reflectors and differential global navigation satellite system (GNSS). New technologies now exist which offer a potentially more cost effective method to obtain this information. These techniques include land and airborne light detection and ranging (LIDAR), digital aerial photography and high resolution stereo satellite imagery. This study will compare the newer methods against the traditional methods using desktop GIS tools and compare the results based on time taken, accuracy, cost and ease of use. The results of the assessment could be used to modify the current practices employed by Anglo Platinum's operations if they can be seen to be fit-for-purpose and prove to be best practice. A test site at Rustenburg Platinum Mines' Khusuleka Mine was identified to conduct these comparisons.

"Airborne infrared-hyperspectral mapping for detection of gaseous and solid targets",

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Presented by **E. Puckrin**

Airborne hyperspectral ground mapping is being used in an ever-increasing extent for numerous applications in the military, geology and environmental fields. The different regions of the electromagnetic spectrum help produce information of differing nature. The visible, near-infrared and short-wave infrared radiation (400 nm to 2.5 µm) has been mostly used to analyze reflected solar light, while the mid-wave (3 to 5 µm) and long-wave (8 to 12 µm or thermal) infrared senses the self-emission of molecules directly, enabling the acquisition of data during night time. The Telops Hyper-Cam is a rugged and compact infrared hyperspectral imager based on the Fourier-transform technology. It has been used on the ground in several field campaigns, including the demonstration of standoff chemical agent detection. More recently, the Hyper-Cam has been integrated into an airplane to provide airborne measurement capabilities. The technology offers fine spectral resolution (up to 0.25 cm^{-1}) and high accuracy radiometric calibration (better than 1 degree Celsius). Furthermore, the spectral resolution, spatial resolution, swath width, integration time and sensitivity are all flexible parameters that can be selected and optimized to best address the specific objectives of each mission. The system performance and a few measurements have been presented in previous publications. This paper focuses on analyzing additional measurements in which detection of fertilizer and Freon gas has been demonstrated.

"Examples of Hyperspectral Solutions for Geoenvironmental Problems"

Conrad Wright, SpecTIR LLC

Geoevironmental problems can involve multiple and disparate issues; some interrelated and some independent. Geological data sets are primary to any geoenvironmental related application; however, as with any environmental related mapping, vegetation and water quality data are also vital to the overall solution. Hyperspectral data, in various forms and collection scenarios, show great promise in providing geoenvironmental solutions towards these various disciplines.

The following examples aim to illustrate efficiencies created through hyperspectral data. With environmental remediation, clean up, and monitoring resources being costly and at times scarce, airborne hyperspectral data, hyperspectral core scanning, and static hyperspectral imaging have great potential for creating efficiencies. These data sources have the potential to provide multiple levels of information in a cohesive Hyperspectral Solution. If this Hyperspectral Solution can be provided in a timely manner, responsible agencies and/or decision makers can subsequently monitor assets and resources more efficiently and effectively.

Geological Mapping II

Abstracts – Day Two, Session Four

"Stereo Satellite Elevation Mapping, Majnoon Project Iraq"

Gerry Mitchell, Photosat

Developments in deriving best-fit thermal inertia and albedo of the surface of Mars

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Presented by **Elliot Sefton-Nash**

Thermal inertia is a thermophysical property equal to the square root of the product of density, thermal conductivity and heat capacity of a material. It is a measure of the resistance of a material to external thermal influence. When used in conjunction with visible and multi-spectral imagery as well as topographic information, thermal inertia is an important new data layer that can assist in the geological interpretation of planetary surfaces. It has been regarded as a proxy for degree of induration, grain size and rock type and can assist in remote planetary mapping to delineate contacts between otherwise ambiguous rock units.

This work comprises ongoing improvements to a method to derive best-fit thermal inertia and albedo that uses day and night infrared imagery, stereo-derived DEMs and a thermal model for the Martian surface.

We introduce higher resolution DEMs to the procedure than were previously available, making the native resolutions of the DEM and infrared images more closely matched. This improves the accuracy of derived thermal inertia in topographically dramatic terrains, which are often of geological interest since they commonly expose extensive stratigraphic sections of the rock record.

We also present results of a consistency study between spatially concurrent thermal inertia retrievals in order to explore the development of a correction procedure in the presence of atmospheric aerosols (water ice and dust).

Finally, the method is employed in an integrated study of enigmatic geologic units on Mars known as light-toned layered deposits (LLDs). These units are of relatively high-albedo and thermal inertia, are layered at a variety of scales and are often enriched in sulphate minerals. Their occurrence is predominantly constrained to the Martian 'chaotic terrains', which are topographically variable regions showing signs of substantial ancient collapse thought to be caused by the catastrophic release of sub-surface water.

We present improvements to and assessment of the thermal inertia derivation methodology and assess its functionality by using it to characterise the thermophysical properties of LLDs in chaotic terrains.

"The study of hydrologic erosion by diachronic imagery and digital elevation models, field survey and soil mechanics, Kinshasa, RDC"

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Presented by **Philippe Trefois**

The high town of Kinshasa city has experienced numerous erosional phenomena, mainly gullies and landslides, within the last decades. More than 300 gullies, representing a total length of 95 km have been mapped on a 2007 SPOT image. Field surveys reveal that most erosions within the study area are to be attributed to man-made factors such as dense habitat, the wrong design or roads regarding water runoff, damaged gutters and water collectors, and deforestation. Heavy tropical rainfall is the principal triggering factor.

The southern part of the city is made of hills belonging to the Kalahari sand formations.

The physical properties of this rather homogeneous formation reveal silty sand with a clay content close to 10%, and triaxial compression tests show a friction angle of 28 ° and low cohesion, whereas the slopes of the walls of the gullies appear to be quite steep.

This can be explained by the "apparent cohesion" due to the consolidation by clay cementation and to capillarity forces in a wet but unsaturated material.

A digital elevation model extracted from a 2006-2007 SPOT stereo pair with a 5m resolution is compared to a DEM interpolated from a 1973 contour map. The dramatic evolution of large gullies is evidenced.

A simple model of slope stability (safety factor for an infinite plane slide) based on the slope map and geotechnical parameters is proposed and compared to the distribution of gullies and landslides observed on the 2007 SPOT orthoimage.

"Day/Night Airborne Hyperspectral Imagery Acquisition Campaign over Cuprite & Yerrington, NV"

Presented by **a member of the ITRES Team**

Day/night pushbroom thermal hyperspectral flights were executed using a TASI (32 spectral bands, 600 spatial pixels) over geological regions of interest in Western Nevada, USA. The mission summary (planning, logistics, mobilization and acquisition) and ortho-rectified spectral radiance mosaic imagery are presented. In addition, comparisons and merits between the day/night are discussed. Imagery examples will include concurrent SASI (shortwave airborne spectrographic imager (100 bands, 600 spatial pixels)) coverage of the Cuprite,NV site as well.

Remote Sensing & Disaster Risk Reduction

Abstracts – Day Three, Session One

"The Geohazards Community of Practice in GEO: A Roadmap for international cooperation"

Stuart Marsh, BGS

Geohazards are a growing cause of disasters. Population growth, concentrated in hazardous areas, is increasing exposure and multiplying the loss of life, livelihoods and property. Mitigation and preparedness are urgent and need accessible, actionable geohazards information. Whilst national and international programs are improving disaster and risk management, links to end users are weak, particularly in developing countries. The GEO Geohazards Community of Practice (GHCP) aims to support efficient geohazard risk management across all phases of the risk management cycle (mitigation and preparedness, early warning, response, and recovery) with actionable information derived from earth observations, by assembling the building blocks required to bring the Global Earth Observing System of Systems' full benefits to end users. The ultimate goal is to increase resilience and reduce disaster impact.

The GHCP brings together national and international organizations concerned with geohazards and their impacts on society, and aims to link these organizations to GEO, to provide coordination, and to facilitate support for relevant GEO Work Plan Tasks. To this end, the GHCP has developed a Roadmap that addresses Earth Observation support for all four phases of the risk management cycle. The roadmap is effectively a pilot initiative for all hazards considered in the Disaster Societal Benefit Area (SBA) of GEO. In order to prepare for the occurrence of hazardous events, to mitigate the danger of these events causing disasters, and to ensure proper response and recovery from unavoidable disasters, humanity urgently needs information about the types of hazards to be expected in a region, their spatio-temporal characteristics, and, in the case of specific hazardous events occurring, timely early warnings. This roadmap sets out a plan to use the Global Earth Observing System of Systems (GEOSS) in a best effort to provide this information to society and the relevant policy and decision makers.

The roadmap's strategic target for 2020 is to put in place all the building blocks for comprehensive monitoring of geohazards and the provision of timely information on spatio-temporal characteristics, risks, and occurrence of geohazards, in support of all phases of the risk management cycle as a basis for increased resilience and disaster reduction. This will be achieved by developing a global network of very few carefully selected core sites. These core sites will provide focal points for a large geographical region, where all building blocks from observations to end users can be linked together and applied to the phases of the risk management cycle relevant for this region. Thus, these core sites will demonstrate the concept, enable scientific studies and technological developments, provide for capacity building, and inform policy and decision making in the region.

“Abstract GRSG AGM 2010: "Remote sensing in support of geohazards assessment in technical cooperation with developing countries"

Friedrich Kuehn, Federal Institute for Geosciences and Natural Resources (BGR), Remote Sensing Unit, Hannover, Germany, friedrich.kuehn@bgr.de

The German development policy, in general, aims at improving the living conditions of poor people in partner countries. It is governed by the Federal Ministry for Economic Cooperation and Development (BMZ) and carried out by implementing organizations. The BGR serves as a consultant to the BMZ for geological and mining-related issues. At present, the BGR is working on around 35 development projects in Central- and South America, Africa and Asia, in which partner countries and organizations are involved. The project partners are national institutions, associations and companies of the geology, mining, water and environmental sector.

Main thematic areas of the BGR technical cooperation are groundwater management, geological environmental and resource conservation, geohazards assessment, management of georisks, mining consultation, mining environmental protection and resources. Land sliding, seismic hazards, volcanic hazards, land subsidence, instable ground and flooding are most common subjects of activities when dealing with geohazards and management of geological risks. Depending on requirements, remote sensing can be a key component of a project or just a technical part. In most cases, technical focus is on transfer of technology and methodology, on training and education, as well as on support through specialists and equipment for survey and mapping missions.

In the recent past, BGR remote sensing involvement in hazards assessment and risk reduction covered thermal monitoring of volcanoes in Ecuador and in Indonesia, land slide hazards assessment in Thailand, land subsidence and shoreline change detection in Thailand and in Indonesia, building ground instability and flooding in Bangladesh as well as ground instability caused by mining in China.

Indonesia is affected by natural disasters on an almost daily basis. Earthquakes, landslides, volcanic eruptions and flooding pose considerable threat to the population. BGR coordinates and conducts technical cooperation with Indonesia supporting the management of georisks and the reconstruction of areas damaged by natural disasters. The project “Good Local Governance – Mitigation of Georisks” aims at achieving impacts in the field of urban development, i.e. in towns and its border areas, which are mainly affected by georisks. It supports the local government’s services in assessing and evaluating local geological hazards. Remote sensing is a technical component of the project and focuses on capacity building, provision of updated topographic information derived from high-resolution satellite imagery, monitoring of large scale land subsidence caused by over-abstraction of ground water using Persistent Scatterer Interferometry (PSI), and mapping of shore line changes using multitemporal satellite imagery.

Flooding and building ground issues are subjects to technical cooperation with Bangladesh. Rapid population growth in the Greater Dhaka area is embedded into the context of Bangladesh as low-elevation country, whose geography is dominated by a system of very large rivers. These streams drain the whole country heading to the Bay of Bengal. Annual extreme run-off of the rivers has led to the loss of human lives and severe economic damage. Furthermore, the city of Dhaka is subject to land subsidence due to several geological processes and improper building ground treatment. Remote sensing has been used in support of hazard assessment and risk reduction. Airborne laser scanning allowed derivation of high-resolution elevation data supporting flood hazards assessment and regional planning with focus on risk reduction. Time series of aerial photography have been used to identify former parts of natural drainage system now filled. Among other drawbacks, these filled channels may cause building ground instability and blockage of surface water run-off in case of flooding.

This paper gives an overview of BGR’s involvements in hazards and risk assessment in technical cooperation with developing countries. Remote sensing activities and specifics of their implementation will be demonstrated with case studies from Indonesia and Bangladesh.

"GIS Modelling of Earthquake Damage Zones using Satellite Remote Sensing and DEM Data"

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Presented by **Philippa Mason**

The devastating earthquake that occurred in Wenchuan County, Sichuan Province, China, on the 12th May 2008, caused widespread damage and devastation to rural communities and economy, and resulted in at least 68000 deaths; its long-term effects are still being felt today and they are likely to trouble this region for many years to come. The immediate physical effects of the earthquake caused the collapse and destruction of infrastructure in towns and villages all along the Longmenshan fault zone, on which the main rupture occurred. The secondary impact included widespread slope failures throughout the region, which in turn destroyed buildings, bridges and roads, blocked valleys, caused flooding and rendered valuable farmland unusable. The terrain of the entire region has been weakened and is now highly susceptible to long-term slope instability. This earthquake event was categorised as between 6 and 8 on the 12-point Liedu scale, which is the adopted seismic intensity measure in China, yet the actual effects in Beichuan town were observed to be above 11. This suggests that a seismic intensity categorisation alone provides an inadequate representation of the true hazard potential in such a seismically active and populated region, especially when the hazards and risks are likely to be multiple and cascading. This paper describes a GIS based approach to earthquake damage zone modelling, in which co-seismic deformation measures, derived from ALOS PALSAR InSAR data, are combined with a conventional multi-parameter geohazard evaluation which draws on geoscientific parameters such as slope, lithology and structure. The result comprises an earthquake damage map for the Beichuan region, that clearly defines a series of zones of increasing intensity, approximately corresponding to Liedu values 8 to 11, which represents the current damage status as well as the future geohazard potential. We believe that this paper makes an important statement about both the complexity of seismic geohazards and the way they are modelled and described. Certainly, the numerous and disastrous events in this region which occurred during the summer months of 2010 suggest that our conclusions are correct.

Mapping Seismic and Volcanic Hazard with InSAR

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Satellite radar interferometry (InSAR) is a tool that enables surface deformation to be measured in remote parts of the world with no requirement for ground-based instrumentation. By using multiple interferograms acquired over extended time periods, deformation rates can be recovered with a precision comparable to that of GPS. In many areas of the world, InSAR data offer the only means of monitoring active volcanoes or mapping strain building up around faults. In this presentation I will review the latest developments in the use of InSAR for mapping seismic and volcanic hazard. These include time series methods, which are particularly valuable at active volcanoes, and methods for measuring slow rates of deformation around active faults. I will show examples from the Afar region of Ethiopia, at the northern end of the East African Rift, where a series of dyke intrusions and eruptions have occurred on the plate boundary in the last 5 years, and from Tibet, where we have been developing methods for mapping strain over very large areas. I will conclude by discussing likely future developments for InSAR in the next years to decades, including the planned launch of ESA's Sentinel-1 in 2012/13 – the first dedicated mission designed for routine InSAR work. I will also discuss the SuperSAR mission concept, proposed to ESA's Earth Explorer 8 call in June 2010. The SuperSAR mission would be a dedicated InSAR satellite designed to produce a 3D global strain map at high resolution. It would be unique in simultaneously imaging the ground with two different radar beams separated by around 50 degrees, enabling instantaneous 2D deformation to be measured, along with 3D deformation from the combination of ascending and descending data.

Remote Sensing & Disaster Risk Reduction

Abstracts – Day Three, Session Two

Detecting zones of neotectonic activity using freely-available DEMs

N. Argyriou, **R. Teeuw** & **D. Rust**, Centre for Applied Geosciences, University of Portsmouth, UK.

Presented by **Nasos Argyriou**

This study examines how Digital Elevation Models (DEMs), such as those from the ASTER G-DEM and the Shuttle Radar Topography Mission (SRTM) can be used to highlight zones of neotectonic deformation, via morphometric analyses of drainage basins and lineaments.

The test region for this study is the island of Crete, located in the outer forearc of the Hellenic subduction zone, associated with collision of the African plate and the Eurasian plate. This tectonic setting affects the island's landscape, with mountainous relief and geomorphological processes that are strongly influenced by neotectonic deformation of the ground surface.

Morphotectonic analysis, using several indices that highlight active tectonics, provided important information concerning the relative tectonic activity. Areas characterised by lateral stream migration, vertical movements and tilting associated with recent tectonic activity, were determined by various geomorphic indices.

VLF geophysical surveys were used to verify predicted fault zones. ArcGIS was used for the manipulation and analysis of the diverse geoinformatic datasets, leading to the identification of tectonically active zones in the study region. The methodology developed in this study provides a low-cost reconnaissance tool to locate areas of neotectonic deformation.

"The British Geological Survey Remote Sensing of Geohazards"

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http://www.bgs.ac.uk/research/technologies_epo.html

Presented by **Colm Jordan**

The British Geological Survey (BGS) conducts an extensive combination of research and applied projects for a wide range of geohazard applications. Many of these make extensive use of Earth Observation (EO), under the remit of the Earth & Planetary Observation & Monitoring Team. A small selection of the BGS contributions to remote sensing of geohazards is described here.

The "International Charter; Space and Major Disasters" is an agreement among Space Agencies to support emergency efforts caused by major disasters by supplying EO datasets. Two BGS staff have now been trained as Project Managers for disaster response following geohazards, to ensure fast data, information and services delivery to the appropriate body. Before receiving that training, BGS responded to an activation of the Charter following a volcanic event at the Soufrière Hills Volcano on the island of Montserrat in July 2008. Data were received from suppliers and passed to colleagues at the University of Reading for their use in disaster management on-the-ground in Montserrat.

Responsive work was also undertaken by BGS following the Haiti earthquake in January 2010. The 7.0M_w event (and at least 52 aftershocks) affected three million people, and damaged approximately 250,000 residences and 30,000 commercial buildings. A Building Damage Assessment Report was compiled using a network of volunteer scientists GEO CAN (Global Earth Observation Catastrophe Assessment Network). Manual image interpretation was used to delineate destroyed and heavily damaged buildings as part of the Post Disaster Needs Assessment and Recovery Framework. BGS donated staff time and expertise to the GEO CAN endeavour.

The GEO CAN post earthquake damage assessment clearly illustrated the contribution that a desk based interpretation can provide. The Global Earthquake Model Foundation have further realised the part that EO data can play on the ground and they have awarded a project to a consortium, which includes BGS, to develop Inventory Data Capture Tools. BGS is leading the task to develop an OpenSource digital field mapping system and we expect this will enable imagery to be used by experts in an earthquake-affected area and for data to be collected systematically prior to use in GEM databases. This project is due to start in mid December 2010.

Whilst the projects above are mainly responsive, i.e. mapping post event system, BGS is also involved in projects developing long term monitoring systems. The EU FP7 European Volcano Observatory Space Services (EVOSS) project is coordinated by IPGP, France and has 12 partners who are working to develop services within the framework of GMES to detect precursors to eruptions and monitor the products of ongoing volcanic activity. The services will include near-real-time atmospheric and thermal products, along with delayed-time deformation maps.

"From Capacity building to Capacity development or from Building Capacity to Building on Capacity?"

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Our world is facing the effects of global change and the ongoing growth of its population. Globalization continues to transform our world into an ever more interdependent system, linking developed and developing countries more than ever. Development is increasingly dominated by the interference of global and local transitions. In developing countries, as well as in developed countries, local transitions are not always contributing to sustainable development. This is also reflected in capacity building in developing countries where the trend is moving towards innovation and transition management. Innovation is organized in the Netherlands in so-called knowledge or innovation platforms where different players representing different stakeholder groups collaborate. Key partners for capacity building are (1) knowledge institutions, (2) entrepreneurs and business partners, (3) non-governmental or civil society organizations, and (4) government bodies; the so-called KENGi partners where the I stands for innovation. The Faculty of Geo-Information Science and Earth Observation (ITC) (recently merged into the University of Twente) has 60 years of experience in education, research and project services in the field of geo-information science and earth observation using remote sensing and GIS aimed at international exchange of knowledge, focusing on capacity building and institutional development in developing countries and emerging economies. In this playfield in the early days capacity building was synonymous to training in the Netherlands. This shifted to training in the Netherlands and local refresher courses in the home country in the 1990's. The past decades the modus of operandi changed to joint education programmes and academic partnerships, from training of individuals to institutional development and with the advent of e-learning the location-basis has gradually disappeared. In the playfield of capacity building new agendas, new actors (Developing economies) and new thinking (GLP, 2005; WOTRO, 2010) emerge presenting new possibilities to continue capacity building missions. A main shift of new thinking is the call for more business-like approach with emphasis on return of investment, whereby a larger role for the private sector is advocated.

Earth science geoinformation organisations, in their core activities, increasingly emphasize the development of a broad understanding of the interactions between humans and the Earth. This emphasis necessitates an increased focus on understanding active processes and events, from the commonplace to the catastrophic, and the use of models both to predict their frequency and effects in the future, and to support the conception and implementation of appropriate policy responses at various scales from global to local. The past decade in the field of earth observation and geo-information science can be characterized by a gradual change of focus from the "inventory" type of science (mapping, databases, what is where?) to the understanding of processes that play a role in shaping our environment, predicting their effects in future and providing improved information support support for planning and policy making. Some of the 'big questions' on system Earth are that prevail are 'How is the global earth system changing? ', 'What are the primary forces of the Earth system?',' How does the earth system respond to natural and human-induced changes?', 'What are the consequences of change in the earth system for human civilization?', 'What are the consequences of processes such as urbanization and global economic development for system Earth?' and 'How will the Earth system change in the future?'. Clearly these earth science questions have a global dimension but seek local solutions. The overarching structure for both earth observation development as well as capacity building is the GEOSS 10-Year Implementation Plan that expires in 2015 and focuses on nine "Societal Benefit Areas" that are in line with the UN Millennium Development goals but more targeted to areas that benefit from spatial information such as disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity.

Within this framework of shifting plates the talk will address capacity building from a geosciences perspective: the present is the key to the past but is the present also the key to the future?

Remote Sensing & Disaster Risk Reduction

Abstracts – Day Three, Session Three

"Current status in the remote monitoring of volcanic phenomena"

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Presented by **Matthew Blackett**

The remote sensing of volcanic phenomena using satellite sensors has been undertaken since 1960s. Since this time there have been remarkable developments in the field, with the launch of high resolution, multi-spectral sensors capable of imaging all manner of volcanic phenomena; from heat, ash and gas emissions to ground deformation and slope angle. Significantly however, despite the numerous possible applications of remote sensing to the monitoring of volcanism, no one satellite sensor has been launched with this as its primary role. This paper summarises the key issues of spatial and temporal resolution, and of band availability, leading to a summary of current volcanic-remote sensing capabilities. Some of the most recent developments in the field of volcanic remote sensing are presented, both in terms of a review of some previous / current sensors and a discussion of some of the most recent studies conducted in the field. In terms of sensors, particular focus is on an assessment of ASTER and its infrared imaging capabilities; while providing very useful data in many aspects, the sensor (and the data derived from it) have some shortcomings which will hopefully be considered in the design of new sensors. In terms of recent work, focus is largely general, although the topical issue of volcanic ash cloud detection features prominently. The paper concludes with a summary of the 'current state of the art' and a discussion about the exciting prospects for the future.

"Rapid topographic change measured by high-resolution satellite radar at Soufriere Hills Volcano, Montserrat, 2008-2010"

G. Wadge[1], **P. Cole**[2,4], **A. Stinton**[2,4] , **J-C. Komorowski**[3,2], **R. Stewart**[4,2], **A.C. Toombs**[1] & **Y. Legendre**[3]

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4. Seismic Research Centre, University of the West Indies, Trinidad and Tobago

Presented by **Geoff Wadge**

High-resolution satellite radar observations of erupting volcanoes can yield valuable information on rapidly changing deposits and geomorphology. Using the TerraSAR-X (TSX) radar with a spatial resolution of about 2 m and a repeat interval of 11-days, we show how a variety of techniques were used to record some of the eruptive history of the Soufriere Hills Volcano, Montserrat between July 2008 and February 2010. After a 15-month pause in lava dome growth, a vulcanian explosion occurred on 28 July 2008 whose vent was hidden by dense cloud. We were able to show the civil authorities using TSX change difference images that this explosion had not disrupted the dome sufficient to warrant continued evacuation. Change difference images also proved to be valuable in mapping new pyroclastic flow deposits: the valley-occupying block-and-ash component tending to increase backscatter and the marginal surge deposits reducing it, with the pattern reversing after the event. By comparing east- and west-looking images acquired 12 hours apart, the deposition of some individual pyroclastic flows can be inferred from change differences. Some of the narrow upper sections of valleys draining the volcano received many tens of metres of rockfall and pyroclastic flow deposits over periods of a few weeks. By measuring the changing shadows cast by these valleys in TSX images the changing depth of infill by deposits could be estimated. In addition to using the amplitude data from the radar images we also used their phase information within the InSAR technique to calculate the topography during a period of no surface activity. This enabled areas of transient topography, crucial for directing future flows, to be captured.

"Assessment of Landslide Susceptibility in Paphos District, Cyprus"

A.B. Hart[1], **M.E. Ruse**[2], **P.R.N. Hobbs**[3], **M. Efthymiou**[4] & **K. Hadjicharalambous**[4]

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2. Consulting Engineering Geomorphologist, Hong Kong, P.R.C.
3. British Geological Survey, Keyworth, Nottinghamshire, UK
4. Geological Survey Department, Nicosia, Cyprus

Presented by **A. B. Hart**

The Paphos District is one of the most landslide-prone areas of Cyprus, with landslides impacting villages and roads, occasionally necessitating their relocation. With expansion of development in recent years, the Cypriot authorities are investigating ways to assess landslide susceptibility, hazard and risk, and then be able to use these assessments in the planning process. An ongoing project has used a combination of aerial photography and QuickBird satellite imagery, supported by field verification and Terrain Classification mapping, to identify and map 1,842 landslides, cataloging them within a GIS-based landslide inventory. This has shown that shown that landslides cover approximately 24 % of the 546 km^2 project study area, with the largest (compound) landslides reaching almost 3 km width and 4.5 km length, comprising spreads of calcareous cap-rock, block slides and substantial earth flows. In particular, the landslide inventory records a number of landslide types that are strongly related to local topography and geology.

Located on the western margin of the Troodos Mountains, the terrain is characterised by a sequence of weak to very weak rocks, comprising bentonitic clays, mudstones, and tuffaceous sandstones, clay-rich melange with interbeds, and a sedimentary melange derived by the erosion of the underlying rocks as a series of submarine debris flows. The uppermost units, forming high level plateaux in many areas, are a range of chalks and limestones. Where these formations outcrop in the highlands of the region, the relatively steep slopes, intense winter rainfall, and periodic earthquakes have combined to form a highly landslide-prone area.

Statistical and GIS-based spatial analysis of the landslide inventory data, as well as other relevant and available information collected by the project allowed for relationships between the mapped landslide distribution and factors such as the geology (and in particular the presence of bentonitic clays), slope angle, the mapped terrain units, rainfall and seismicity to be determined which were then used to assess the landslide susceptibility and hazard across the Project area. The intention of the Client is that such outputs will then be used to identify areas of significant landslide risk, allow for more effective management of landsldie prone areas and be used as part of the planning process.

The Client also intends to maintain the landslide inventory and the other outputs from the project. Therefore, the techniques and methodology used had to be sustainable and repeatable. For example, the landslide inventory has been designed to be expandable as new landslide information becomes available. The Consultant team has therefore also produced guidelines on how to use the project outputs and how to maintain them going forward.

This paper presents the methodology, the landslide inventory, some of the data analysis results and some of the final output mapping.

Remote Sensing & Disaster Risk Reduction

Abstracts – Day Three, Session Four

"AguAAndes and WaterWorld: fusing geospatial data and process models to support water and food policy"

Mark Mulligan, King's College London

The CGIAR Challenge Programme on Water and Food has the goal of increasing "the productivity of water used for agriculture, leaving more water for other users and the environment". The CPWF commissioned a series of basin focal projects (BFPs) to tackle water- productivity at the mega-basin scale for 10 basins which make up some 9% of the global land surface. The Basin Focal Project for the Andes (BFP-ANDES) brought together scientists at King's College London and throughout the Andes to engage in bio-physical, socio-economic and institutional analysis to identify and analyse major links between water and poverty throughout the Andes and investigate interventions to improve water productivity.

The Andes is a large and complex "basin", both bio-physically and socio-economically, so understanding the impact of scenarios for change and interventions for development require sophisticated basin-wide but locally relevant tools. A questionnaire of 80 water professionals in the Andes at the start of the BFP-ANDES found that many (47% of respondents) did not use the results of scientific research in the decision-making process. This was largely because of institutional lack of capacity, training or knowledge of the available tools and partly because of lack of or high cost associated with the types of data required to use these tools. To help address this, as part of the BFP-ANDES we have developed the AguAAndes Policy Support System (http://www.policysupport.org/links/aguaandes). AguAAndes is a means of bringing together the best available data and science in a system that better enables project partners and next users to apply the knowledge obtained during the project in a locally meaningful and dynamic way. The system has a series of key attributes that make this possible:

- Batteries included! -all data supplied for running the system anywhere in the Andes (in fact globally) so models are self-parameterising
- Simple to use with separate interfaces to the same tools for scientists (detailed) and non-scientists (less detailed)
- Web based so little local computing capacity and no GIS capability required, with frequent, immediate updates and continuous user engagement in system development
- Models developed specifically for tropical mountain environments

Having an online system helps overcome some of the considerable barriers to the use of policy support tools by next users including NGOs, advocacy groups and other organisations who connect with policy but may have low technical capacity and little funding to support complex spatial modelling applications.

AguaAndes is used to support analyses around the development of payments for environmental services schemes (Nature Conservancy), potential impacts of planting biofuels (Conservation International), the provision of baseline hydrological information (WWF), examining the impacts of conservation strategies for REDD (Inter-American Development Bank) and others. All of these applications are focused on reducing environmental risks and community vulnerability.

"Crisis and disaster response: Is there time for remote sensing? "

Anna Mason, MapAction, UK, amason@mapaction.org

Every picture tells a story, but what is the interval between a disaster and the story remote sensing can tell to emergency workers?

Image based mapping products are useful as a proxy indicator of impact in the early stages of an emergency. Whilst remotely sensed data cannot determine the exact extent to which individuals have been affected, or provide guidance regarding their specific needs, it can be useful for preliminary damage analysis that can lead to rough estimates of the affected population. Such estimates can be critical in the early stages of a relief effort, for identifying the likely scale of the required relief effort, and to feed into requests for donor funding - until such time when the results of field assessments can be used to obtain directly observed data.

The window of opportunity in which such estimates are useful is limited. The utility depends directly upon the timeliness with which satellite data is captured, processed and products made available to key players in a position to quickly instigate such an analysis. Organisations directly involved in the information flow at a field level are in a unique position to facilitate this process, and ensure that results are disseminated to all relevant actors within the relief response.

This talk will present a view of the value of remote sensing in crisis and disaster response, referring to experiences gained from the field over the past year, including mega disasters such as the 2010 Haiti Earthquake and the 2010 Pakistan Floods. The discussion is set in the context of: (i) the immediate aftermath of sudden-onset disasters, typically over one to three weeks; (ii) supporting the response of the humanitarian community, involving local/national authorities, UN agencies and NGOs; (iii) a focus on remotely sensed data and derived vector products.

Mapping Solutions Workshop

Council Room, Burlington House

MAPPING Solutions
The Power of Hyperspectra

Workshop 1: Optical hyperspectral imaging using HySpex

Introduction to Hyperspectral imaging

Hyperspectral camera technology

Calibration of Hyperspectral instruments

Applications of Hyperspectral imaging

Hands-on demonstration of HySpex Hyperspectral cameras

Workshop 2: Thermal multiband and hyperspectral imaging

Introduction to up-to-date with multiband and hyperspectral cameras

Thermal cameras family produced by Telops

Applications of thermal imaging

The Mapping Solutions workshop will be held during the lunch and coffee breaks in the Council Room at Burlington House on day's 1 and 2 of the meeting.

If you are interested in attending please contact Amer at Mapping Solutions at info@mapping-solutions.co.uk

masala zone

street food starter

each guest chooses individually one of these dishes (starter portion)
bhel **-** crunchy salad with chutney & peanuts
chicken or vegetable samosas - with curried chick peas
aloo tikki chaat - spiced mash cake with yoghurt & chutney
pau bhaji - spicy potato mash & veg with warm bread
shikampuri kebab - melt in the mouth lamb patties stuffed with herbs

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deluxe main course- grand thali

this is the way meals are traditionally eaten in indian homes. it is served on a platter, with several little bowls of different dishes, giving nutrition, flavour, & texture. just choose one of the slow-cooked curries listed below as a centre piece & the grand thali will come with:

- *an indian canapé (changes daily)*
- *two vegetables(changes daily)*
- *dal (lentil) (changes daily)*
- *raita (changes daily)*
- *whole wheat chapatti (traditional indian bread) (changes daily)*
- *kachumber (indian salsa) (changes daily)*
- *papadum & chutney*
- *rice (changes daily)*

each guest chooses individually one of the following curries:

shahi patiala veg curry - rich and flavourful
paneer makhanwalla - indian cottage cheese in a tangy tomato based sauce
masala chilli paneer
vegetable undhiyo - a mix of vegetables - sweet potato, raw banana, baby aubergine, snow peas, purple yam, val dal cooked with greens (a celebratory gujarati dish)
chicken saffron korma - zero chilli dish with turmeric & cardamom
butter chicken - chicken tikka in a tangy tomato based sauce
chicken mangalore - zesty with coconut & tomato flavours
malabar green chicken - kerala recipe with fresh coriander, curry leaf & cloves
badami lamb korma - with crushed almonds, star anise & cardamom
dhaaba roghan josh - classic lamb curry with intense robust flavours
mutton kolhapuri - pungent with black cardamom, pepper & star anise
prawn malai - gently spiced & flavoured with coconut
goa prawn curry - konkan coastal recipe of coconut, red chilli & tamarind

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dessert - *choose one of the following*:

mango, caramel or pistachio kulfi - home made indian ice creams; or **gulab jamun with ice cream**; or **rasmalai** - milk patties in a creamy milk sauce with saffron

a discretionary service charge of 10% will be added; all dishes may contain traces of nuts

medium spice **more spice**

covent garden	soho	islington	earls court	camden town	bayswater	fulham
48 floral st wc2e 9da	9 marshall st w1f 7er	80 upper st n1 0nu	147 earls court rd sw5 9rq	25 parkway nw1 7pg	75 bishops bridge rd w2 6bg	583 fulham rd sw6 5ua
t: 020 7379 0101 f: 020 7836 0202	t: 020 7287 9966 f: 020 7287 8555	t: 020 7359 3399 f: 020 7359 6560	t: 020 7373 0220 f: 020 7373 0990	t: 020 7267 4422 f: 020 7267 8833	t: 020 7221 0055 f: 020 7221 6620	t: 020 7386 5500 f: 020 7386 0088

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