A.1 New Zealand Volcanoes Supersite

A.2 Supersite points of Contact

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A.3 Core supersite team and organization

Ian Hamling (InSAR Scientist): Has 6 years experience processing and interpreting InSAR data for a number of tectonic and volcanic processes. After completing his PhD at the University of Leeds investigating post-rifting deformation in the Afar region of Ethiopia, he was a post-doc at the International Centre for Theoretical Physics using InSAR to investigate the deformation filed of North East Italy and Northern Africa. Hamling will coordinate satellite tasking and distribute data as required by agreements with individual space agencies. He will also liaise with Fournier on making available ground-based datasets collected by GNS Science.

Nico Fournier (Senior Volcano Geophysicist): Has 14 years of experience analysing, interpreting and modelling volcano geophysical data, and monitoring active volcanoes. After a PhD at the Open University (UK) and a post-doc at the Universite Blaise Pascal (France), he held a research fellowship at the Seismic Research Centre (UWI, W.I.) and acted as Director of the Montserrat Volcano Observatory. Since 2009, Fournier has been a Scientist at GNS Science, both conducting research on volcanoes and being part of the GeoNet volcano monitoring team. Fournier's main expertise lies in volcano geophysics and geodesy, numerical modelling and physical volcanology. He will be the main point of contact for ground-based monitoring datasets, in conjunction with Hamling.

GNS Science:
GNS Science is the New Zealand Government-owned national earth sciences and isotope technology organisation, New Zealand's leading supplier of earth science research and consultancy services and one of the world's foremost earth science organisations. GNS Science's purpose is to undertake research that drives innovation and economic growth in New Zealand's geologically-based energy and minerals industries, that develops industrial and environmental applications of nuclear science, that increases New Zealand's resilience to natural hazards and that enhances understanding of geological and earth-system processes.

GNS Science operating policies include:

- Representing New Zealand's interests on behalf of the Government through contribution to science diplomacy, international scientific issues and/or bodies as required.
- Developing collaborative relationships with universities and other research institutions (within New Zealand and internationally) to form the best teams to deliver its core purpose
- Develop strong, long-term partnerships with key stakeholders, including industry, civil defence, government and Māori, and work with them to set research priorities that are well linked to the needs and potential of its end-users
- Maintain its databases, collections and infrastructure and manage the scientific and research data it generates in a sustainable manner, providing appropriate access and maximising the reusability of data sets

GNS Science natural hazards research

GNS Science's integrated hazard research is directed toward reducing the economic and social costs of all natural hazards for New Zealand and international communities by developing an understanding of the process that cause earthquakes, volcanoes, landslides and tsunami. With experience, expertise and capability in natural hazards, risk assessment, mapping, creating community resilience, and spatial analysis of hazards using up-to-date technologies and methods, GNS Science staff are recognised internationally for their innovative work.

A.4 Other Supersite Research Teams

A number of research institutes and individuals are currently involved in, or have previously been apart of, research projects related to the volcanoes of New Zealand.

Laura Wallace (University of Texas): Has been actively involved in the analysis and modelling of New Zealand GPS data examining the rotation of the arc and subsequent rifting along the Taupo volcanic zone. She is currently involved with a number of collaborative projects with staff at GNS.

Yosuke Aoki (Earthquake Research Institute, University of Tokyo): Has been appliying InSAR techniques to a monitor a variety of volcanoes around Japan and around the world. His research has included a number ocf callaborative projects investigating magam pathways beneath volcanoes.

Martha Savage (Victoria University Wellington): Has published a number of reseach articles focussed on the structure of the TVZ using a number of seismological methods. Her research group at the university has ongoing collaborative projects with staff at GNS based around the volcanoes of New Zealand.

A.5 Supersite description and justification

Located in the North Island, New Zealand, the Taupo volcanic zone (TVZ) has formed as a result of subduction of the Pacific plate beneath the Australian plate. Extension of between 8 and 15 mm/yr have led to backarc rifting along the 300 km-long, 60 km-wide TVZ. The TVZ is one of the most productive regions of differentiated magma in the world and is home to 6 major caldera complexes in addition to multiple volcanic centres over a relatively small region. A number of eruptions have occurred over the last 50 years. Ruapehu erupted in 1995-96, 2006 and 2007. In 2012, there were eruptions at Tongariro and White Island. The later of which is still ongoing. However, due to restrictions in access to the volcanoes there is little deformation information in the run up to the eruptions. Furthermore, some of TVZ calderas have experienced unrest episodes over the past decades (e.g., Taupo). With regular, high resolution, SAR images we hope that changes at the volcanic centres prior to potential

eruptions can be detected. There have been a number of successful applications of InSAR for monitoring the accumulation of magma in the subsurface prior to eruptions. Eruptions do not always occur, even after observed periods of unrest, but in order to better understand the plumbing system of volcanoes it is vital that we have data to help constrain potential eruption sources.

Potential hazard from New Zealand volcanoes is significant and can impact the population in a variety of ways: local population can be directed affected by volcanic hazards (e.g.,ash fall). Several major national industries can also be dramatically affected even by small eruptions, especially agriculture and tourism. Unrest at one of the larger volcanic systems would also have national and regional impacts (e.g., power grid, aviation sector).

GNS Science currently maintains, collects and processes a dense network of instruments, under the NZ Earthquake Commission (EQC) funded GeoNet project, around the TVZ region (Figure 1). All automatically collected GeoNet data are freely available in near real time. Data includes seismic, geodetic and visual. For a more detailed list see the attached supplementary information. All seismic waveforms and strong motion data collected by GeoNet are archived and available from the GeoNet public data portal in near real time. An earthquakes catalogue is also available and searchable through web services. All GPS raw data are freely available through the GeoNet public data portal. GeoNet also provides processed daily positions. In addition, volcano webcam images are available from the GeoNet website in near real-time. Given the large number and variety of historically active volcanoes in a relatively small area, and the extensive monitoring already being conducted, the TVZ provides an excellent location as a volcano supersite.

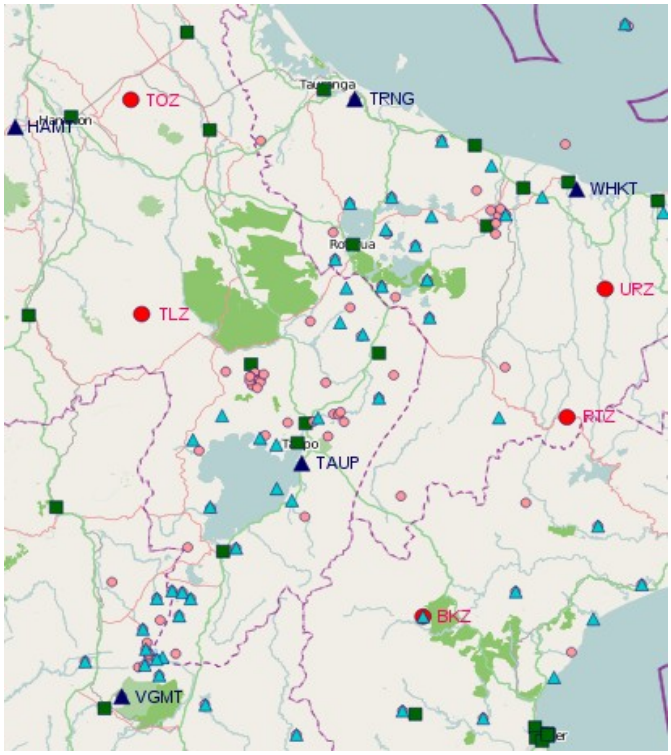

Figure 1. Distribution of Geonet instruments around the TVZ. Dark and light blue triangles show the location of continuous GPS stations, red and pink circles show the location of seismographs and the green squares show the location of strong motion seismographs.

A.6 Current or future use of requested data

Given the recent eruptions at Tongariro and White Island, space based measurements are crucial for

monitoring ongoing, and future, activity at these volcanic centres where ground based monitoring is becoming increasingly difficult. Although there is a good archive of Envisat and ALOS data covering the TVZ, there has been limited SAR data available since 2011 when ALOS stopped operating. However, if selected as a supersite location, access to the data of TerraSAR-X, Radarsat-2 and COSMOS-SkyMed, as well as access to data from the soon to be launched Sentinel-1 and ALOS-2, will be critical for future monitoring of theses volcanoes with unprecedented spatial resolution.

A.7 Schedule

If selected, we would hope that acquisitions from TerraSAR-X, Radarsat-2 and Cosmos-SkyMed would follow shortly after. Other data, including GPS and seismicity, are already available through the Geonet project at GNS Science (http://www.geonet.org.nz/).

A.8 Detailed geographic region of interest

The New Zealand Volcanoes (NZVolc) supersite, covers the volcanoes of Ruapehu (175.615, -39.219), Ngauruhoe (175.63, -39.219), Tongariro (175.659, -39.126) and White Island (177.18,-37.52). In addition, the region covering Taupo caldera is also required and is bounded by -38.5 to -39 South and 175.6 to 176.3 East (Figure 2). Occasional requests for data may be considered should any of the less active volcanic centres in the North Island experience unrest. These volcanoes include the Auckland Volcanic Field, Taranaki, the Okataina caldera and Tarawera.

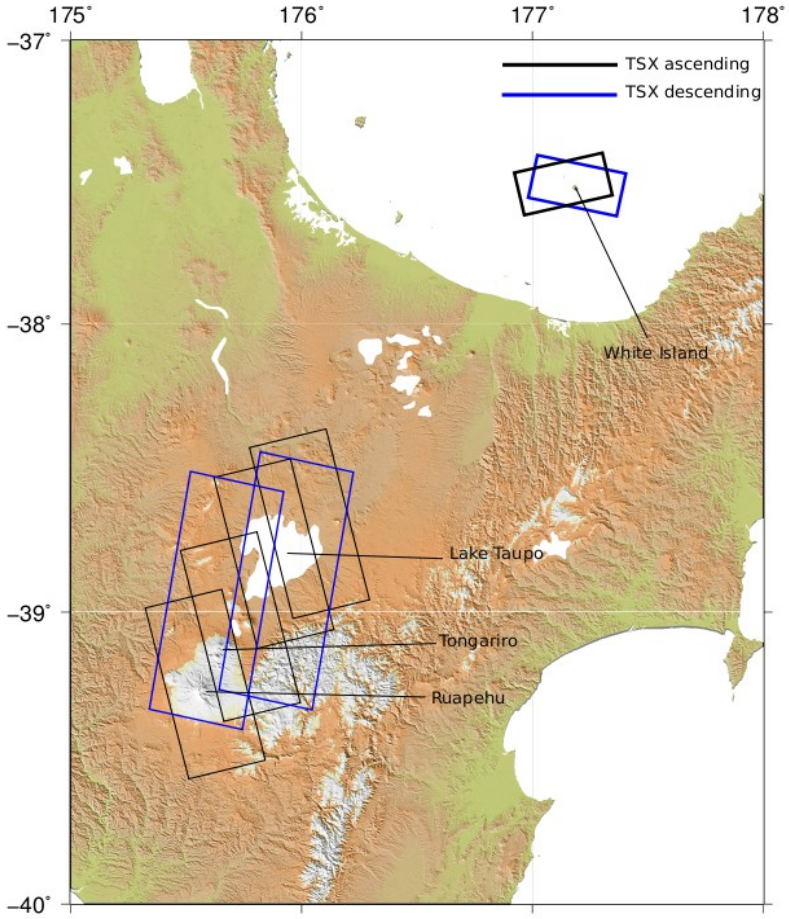

Figure 2. Map showing the location of the volcanic centres covered under tthe supersites proposal and the approximate location of ascending (black) and descending (black) Terrasar-X stripmap tracks.

A.9 Data requirements

For Ruapehu, Ngauruhoe and Tongariro volcanoes, where, during the southern hemispheres winter, significant accumulations of snow are deposited we would request that SAR images were acquired in both ascending and descending modes, every 11 days for TerraSAR-X and every 16 days for Cosmos-SkyMed, during the summer months (December – May). Due to the small size of White Island (~2 x 1 km) we would request high resolution strip map data to be acquired in both ascending and descending modes on each pass (11 and 16 days respectively). Similarly, we would ask that the region around Lake Taupo be acquired as frequently as possible. Figure 2 shows the approximate location of ascending and descending tracks for TerraSAR-X, details on individual tracks and frames will be finalised after acceptance of the supersite.

A.10 Available resources

Research involving the TVZ supersite will be carried out using resources provided by both GNS Science (Crown Research Institute) and universities. Funding sources include the New Zealand Natural Hazards Platform, the Earthquake Commission (EQC) and contestable grants (e.g., Marsden funds). This funding will primarily support New Zealand scientists to investigate volcano and tectonic processes in the TVZ and other volcanic regions in New Zealand.