Relief Mapping and Geomorpholgy

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EXTENDED ABSTRACT

Geomorphology is the study of landforms and the processes that created them. This paper explores the relationship between geomorphology and relief mapping and argues that an understanding of geomorphological processes can help cartographers make better and more meaningful maps.

Aerial photography and satellite imaging have enabled natural features on the earth's surface to be studied from a perspective not previously possible. Many landforms are simply too large to be fully appreciated from the ground, only from above can they be seen in their entirety. Sometimes it is a distinctive vegetative pattern or cover that offers clues to the underlying geology of an area and its probable tectonic history. However more often information can be gleaned from the shape and special characteristics associated with the landform itself, particularly if a digital elevation model is developed from the imagery, stripping away clutter and extraneous information. A digital elevation or terrain model allows us to "fly" over and inspect landforms from the all angles, varying the illumination source position to identify through shadows subtle variations in shape or form.

A number of relief maps are presented (3 in this extended abstract), illustrating different types of landforms and the visual characteristics which give us clues as to how and why they were formed. These relief maps are all from the Geographx archives, though the examples are featured in "Landforms -the Shaping of New Zealand", a book which the writer co-authored (Molloy and Smith, 2002).

Most landforms result from tectonic activity (mountain building or subsidence, vulcanism, earthquakes, faulting) or climate & water (glaciation, erosion & desertification). New Zealand offers a diverse range of spectacular landforms. The country straddles the collision zone of the Indo-Australian and the Pacific plates, and is tectonically very active with crustal deformation of up to 5cm/yr. To cope with this New Zealand has a 3D semi dynamic datum, NZGD 2000 that uses a deformation model that converts survey observations and coordinates to their predicted positions as at 1 Jan 2000.

NZ is also a mountainous, maritime country and our weather is extreme. Erosion rates are high, with rainfall of up to 18,000 mm/year on the main divide of the Southern Alps. It has been estimated that for every 10mm our mountains grow, 9mm is simply washed away.

New Zealand's Alpine Fault (Figure 1) is one of the few places on earth where a plate tectonic boundary lies exposed on land. The dextral strike slip fault is slowly tearing NZ apart with horizontal displacement averaging some 35mm/year. In practice it moves up to 8m horizontally and 2 m vertically every 250 years, the last such event taking place in 1720. Total horizontal displacement to date is around 500km. This is a classic case where aerial photography has opened our eyes – the fault is by any standards a major landform feature yet it was not properly documented until the 1950s. Today geologists are using aerially scanned LiDAR point data to help decipher information on the alpine fault at a local level. This includes offset of features and traces of strike-slip and reverse faulting.

The Taupo Supervolcano (Figure 2) has a logarithmic volcanic explosivity index (VEI) of 8, meaning ejection of a volume in excess of 1000 cu km. This related to the Oruanui eruption 26,500 years ago, the only VEI 8 eruption recorded worldwide in the past 70,000

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Figure 1. New Zealand's Alpine Fault (map by Geographx).

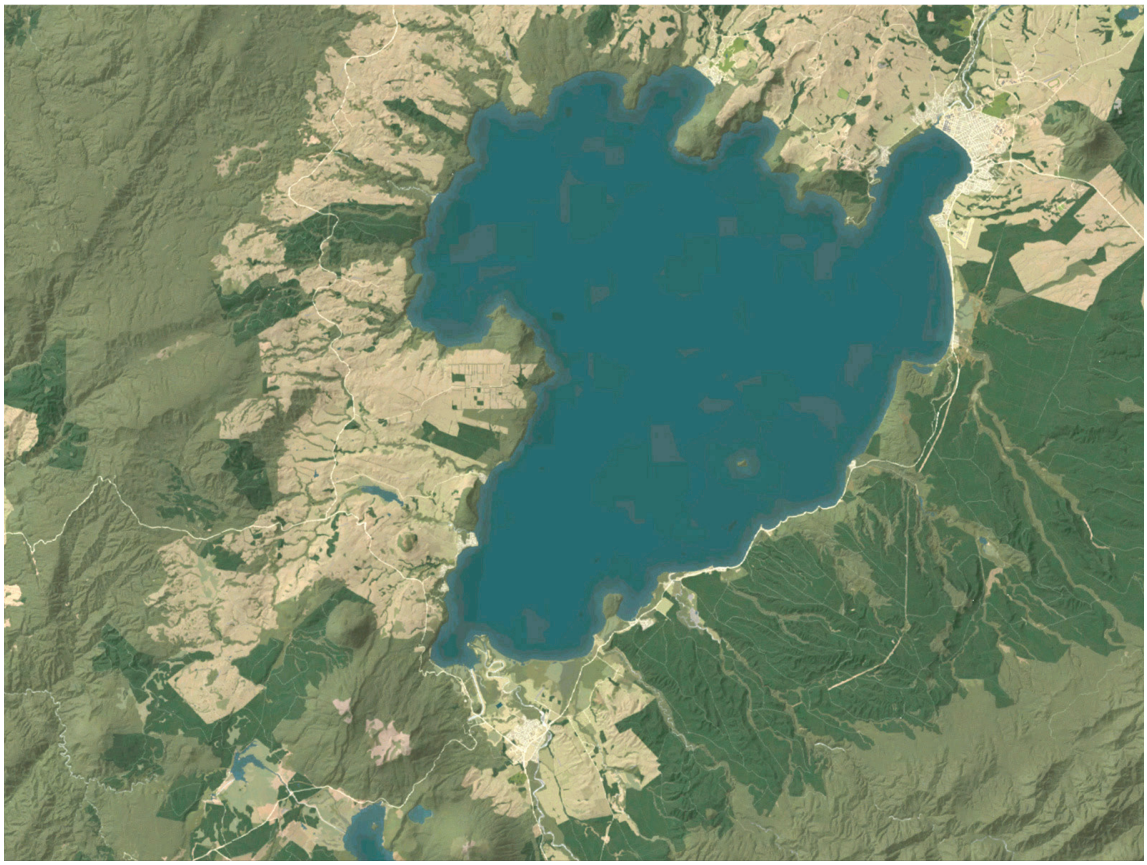

Figure 2. The Taupo Supervolcano (map by Geographx).

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Figure 3. The Green Lake Landslip (map by Geographx).

years. To put this in context Krakatoa was accorded a VEI of 6 with 25 cu km ejected, St Helens rated a VEI of 5 with 1.2 cu km ejected. Evidence of the Oruanui eruption has been partly obliterated by more recent eruptions. However the distinctively shaped lake-filled caldera remains and there are extensive flat sheets of ignimbrite deposits covering surrounding areas.

The Green Lake landslip (Figure 3) lies at the southern end of the Hunter Mountains in Fiordland. About 12,000 years ago, a 10km long section of the mountain range collapsed, displacing 27 cu km 700m down into the Grebe Valley. The landslide coincided with the end of the Otira glaciation, and clues suggest the retreating ice left the steep valley walls unsupported and an earthquake then precipitated the collapse. Tell-tale signs from the terrain include the scarp face and the typical hummocky landslide debris fanning out westwards into the valley floor. Further evidence lies with the landslide lakes and ponds, and the wetland vegetation in the valley floor. Earthquakes are not uncommon in New Zealand, with approximately 15,000 recorded in an average year.

Cartographers, and particularly cartographers undertaking relief mapping, are encouraged to study geomorphology. An ability to understand why relief looks the way it does enables the cartographer to emphasise or better draw out certain characteristics in the data and allow the map to better tell a story. It also helps a cartographer to recognise introduced data faults or artefacts that might contradict or run counter to that story. If we are going to depict natural features in an empathetic manner then it beholds us to try and understand how and why they are there at all.

REFERENCE

Molloy, L and Smith, R. 2002. *Landforms -the Shaping of New Zealand.* Craig Potton Publishing Ltd.