Geophysical Research Abstracts, Vol. 9, 10295, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10295

DEM-aided volcanic reconstruction and collapse recognition of degraded Miocene volcanic edifices: a case history of Lyttelton Volcano, New Zealand

B. Székely (1), S. J. Hampton (2)

(1) Space Research Group, Institute of Geography and Earth Sciences, Eötvös University, Budapest, Hungary (2) Department of Geological Sciences, University of Canterbury, Christchurch, New Zealand (balazs.szekely@elte.hu / Fax: +36 1-372-2927/ Phone: +36 1-2090555 ext. 6651)

Reconstruction of highly degraded volcanic edifices often needs a multimethod approach to reveal all possible volcanological, petrological and topographic features that still can be recognized despite the long-term activity of the destructing forces. The actual ridges can be considered as the least degraded surfaces of an original, hypothetical volcanic cone. If it is feasible to assume that the original form had central symmetry, a possible technique is the polar coordinate transformation (PCT) analysis (Székely and Karátson, 2004) of the digital elevation model.(DEM).

Banks Peninsula (New Zealand) is the highly eroded remnants of two large Miocene stratovolcanoes, Lyttelton (11.0-10.4 Ma) and Akaroa (9.1-8 Ma). The morphology of Lyttelton and Akaroa Volcanoes is highly debated with two main models proposed: the Hawaiian shield morphology (i.e. Sewell et al 1992), or the Mt Etna stratovolcano morphology (i.e. Shelley, 1992). Through GIS based analysis the morphology of Lyttelton Volcano can be assessed, with preliminary recognition of eruption centres and collapse features.

DEM-based morphometry is used as a method for reconstructing volcanic relief. Using ridge line patterns, slope angles, lava flow dips, volcanic extent below Canterbury Plains, degradation rates, cone sectors of these volcanoes can be established, and linked to original volcano elements. The PCT map, derived from the original DEM, has been used to analyze the ridges to reveal possible eruption/symmetry centers. The point of rotation is located on the intersection of ridgeline orientations of the volcano,

providing a point which would be directly below the summit. The image produced highlights concentric and radial features, which can be classified as sectors. The variation in sectors relates to exposure of basement lithologies in collapse regions, steep sided collapse walls, infilled collapse regions, primary volcanic slopes, volcanic slopes modified by later volcanism.

It is proposed that the large harbours of Lyttelton and Akaroa are the result of catastrophic collapses. Further proposed collapses of Lyttelton Volcano are highlighted in digital terrain analysis, including the region of the Mt Herbert Volcanics and Gebbies Pass. Correlating collapse regions from digital terrain analysis and mapping of localised fieldwork areas enabled recognition of collapse related features, including exposure of basement lithologies, infilling deposits dipping in direction of collapse, and steep headwall scarps.

Periods of volcanism modified the symmetrical Lyttelton 1 Volcano, with a shift in volcanic activity, down Lyttelton Harbour (Lyttelton 2 Volcano). Resulting in the sectors of modified volcanics identified in the PCT image, in the northeast sector of the volcano. The evolution of multiple eruption centres can be identified, through changes in the radial valley pattern, as well as volcanic collapse features.

Financial help of the Hungarian National Scientific Fund (OTKA) and Békésy György Postdoctoral Fellowship (to BSz) is gratefully acknowledged.

Sewell, R.J., Weaver, S.D., Reay, M.B. (1992). Geology of Banks Peninsula. Scale 1:100,000. Inst. Geol.Nucl. Sciences Map 3. Lower Hutt, Inst.Geol.Nucl. Sci. Ltd.

Shelley, D. (1987) New Zealand J. Geol.Geoph., 30(2):159-168.

Székely B, Karátson D (2004) Geomorphology, 63(1-2):25-37