Geophysical Research Abstracts, Vol. 8, 09648, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09648

Amphitheatre valleys on volcanoes: characterization, evolution, Surface Processes Modelling

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Amphitheatre valleys are large, steep-sided landforms, mostly with flat floors, described and termed first by Hinds (1925). Their role in degrading volcanic landforms was evaluated by Cotton (1952) and recently by Karátson et al. (1999). Cotton (1952) emphasized that amphitheater valleys develop under extremely heavy rainfall and that rapid tropical-subtropical weathering is also essential. In volcanic terrains, amphitheatre valleys can be found under climates commonly with >2000-2500 mm/yr precipitation (Karátson et al. 1999) and in areas where valley downcutting is initiated or enhanced by rainstorms. Amphitheater valleys can develop on any volcano type, but due to the aforementioned climatic circumstances they are present preferably in oceanic islands. Most commonly, the basaltic shield volcanoes of the tropical-subtropical belt are included (i. e., Hawaii, Réunion, Tahiti, Mauritius, Galápagos), and subduction-related composite volcanoes/lava domes can also exhibit amphitheatre valleys (The Philippines, Japan: Ollier 1988; Karátson et al. 1999). Formation of such valleys are determined by tectonic control (e. g., fault systems and rift zones typical of ocean-island volcanoes: Duffield 1982; Fornari 1987; Carracedo 1994) and alternate beds of more and less resistant and/or permeable volcanic material (Ollier 1988; Join et al. 2005). The softer/permeable beds are characterized by steep valley floor (rapidly retreating valley section often with waterfalls), whereas more resistant beds by flatter floor.

Special attention should be given to the differently permeable layers of large volcanic islands/edifices. Current works have shown that aquifers can reach a high level in the centre of such volcanoes (Join et al. 2005) and water-saturated zones have serious

implications on amphitheatre valley evolution (Saint Ange et al. 2004). These results call attention that, along with the initial structure and typical climate (precipication), contrasting erodibility is a key factor in determining surface processes and long-term topography changes. In our work, we have modeled the possible role of contrasting erodibility in conical volcanic edifices. Our results show that huge amphitheatres can form merely by headward erosion if alternate layers with contrasting erodibility are present. Moreover, with respect to the existence of huge 'cirques' e.g. on Réunion, our simulation argues for the formation of caldera-like depressions by simple erosion processes.

These studies were carried out in the framework of projects T43644 and T47104 (contribution No. 06) of the Hungarian National Scientific Fund (OTKA). BSz also received financial support from University of Tübingen (Germany).

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