Mapping and modelling lava flow dynamics and hazards at mount Cameroon volcano

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Destruction of human property and agro-allied plantations by lava flow invasion is a significant volcanic hazard at Mount Cameroon volcano (Cameroon), where reliable hazard and risk maps are required for risk mitigation. This thesis is dedicated to the study of lava flows at Mount Cameroon, a volcano situated in a densely populated region with over 450000 inhabitants on its flanks.

Mount Cameroon (MC) is the largest (~4095 m a.s.l.) active continental volcano in West Africa based on its recorded historic eruptions for the 20th and 21st century (1909, 1922, 1925?, 1954, 1959, 1982, 1999 and 2000). This volcano is subject to a variety of hazards: volcanic eruptions, earthquakes and lahars. Although records of eruptions at MC are found back to 2500 BC, few of its eruptions have been documented. This is in great contrast to other volcanoes like Mount Etna whose documented eruption history dates back more than 2500 years. Previous work carried out for eruptions resulting from MC mostly centred on its seismicity, tectonics, petrology and geochemistry. Recently, focus on lava flow studies at Mount Cameroon has shifted towards morphological and lava flow hazard assessment.

This thesis is the first to assess lava flow hazard and risk at MC through a combination of a systematic field approach supplemented with remote sensing observation and lava flow modelling techniques. It illustrates the systematic use of a field-based approach to describe lava flow surface morphology for the 2000 lava flow field and structure to retrieve the flow's deformation history.

The 1982 lava flow field was also investigated for its channel geometry and its lava rheology. This information together with petrographic and channel geometrical data collected were used to model these flows with the FLOWGO model in a first phase. This model's performance was evaluated based on its ability to reproduce the total length and the internal channel geometry observed for these lava channels. In the last part of this thesis, the spatial distribution of lava flow hazard was evaluated through the use of the VORIS stochastic model in combination to FLOWGO.

Using a combination of free/low-cost multispectral datasets, pre-historical lava flows and lava flows from the last century were mapped at MC. This map showed that lava flows that issued at elevations of < 1500 m a.s.l. along the NE and SW flanks could represent a hazard for settlement and infrastructure.

From MODVOLC data, direct eruption observation, seismic data, field observations and optical RS datasets, the 2000 eruption duration was estimated at ~ 52 days. Other facts revealed that at some places eruptions previously thought to have produced only pyroclastics emplaced an 850 m-long lava flow field. At some some sites aa lava was the dominant flow morphology while pahoehoe lava dominated at other sites. For this 2000 eruption, we realised that it was the slow-moving pahoehoe lava that covered a more extensive area and attained a longer length than the fast-moving aa lava flow. Calibrating the 1982 and the 2000 lava flows using FLOWGO produced satisfactory results for the former flow (1982) with slight mismatches for the latter (2000) flow. Lava flow hazard maps produced emphasised the vulnerability of coastal and the NE habitats from lava flow invasion from MC eruptions.