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THE ORIGIN OF SLOPE DEPOSITS IN THE SOUTHERN DRAKENSBERG, EASTERN LESOTHO

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Submitted in fulfilment of the academic requirements for the degree of Doctor of Philosophy

School of Geography, Archaeology and Environmental Studies

University of the Witwatersrand, Johannesburg

Johannesburg
July 2006

This thesis is dedicated to the memory of my father, Ken Mills (1946-2004).

Declaration

I declare that this thesis is my own, unaided work, except where otherwise acknowledged. It is being submitted for the degree of PhD to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.



(Stephanie Mills)

14th day of July 2006

Abstract

The high Drakensberg of southern Africa has received considerable geomorphological interest during recent decades. In particular, there has been an ongoing debate concerning the accuracy of landform interpretations which propagate past glaciation and permafrost. This research examines the macro and micro-sedimentology of various deposits found in eastern Lesotho and compares them with possible geomorphological process origins such as debris flows, debris avalanches, mudflows, mudslides, landslides, solifluction deposits, rock glaciers, pronival ramparts, glacial moraines and fluvial deposits. The results support the contention that four of the deposits are moraines, formed by small glaciers, and one is a debris flow which was initiated by a small glacier. However, two further deposits indicate that localities in close proximity to the linear deposits experienced mass wasting, associated with past periglacial conditions. With the assistance of applying glacier reconstruction methods, modelling hillshade, the provision of new palaeoclimatic extrapolations, and correlation of deposits with contemporary snow patch distribution, it is demonstrated that the valley slope deposits are determined by a past climate that was within the glacial/periglacial equilibrium zone, and was influenced by specific topographic and associated micro-climatic thresholds. It is shown that macro-topographic factors (e.g. slope gradient, aspect etc) and summit altitude are critical factors determining whether slopes were influenced by periglacial (mass wasting) or glacial processes (small niche/cirque glaciers) in adjacent valleys.

Preface

This work stems from the discovery of debris deposits in eastern Lesotho, which display unique morphological characteristics. No work has previously been undertaken on such deposits in the area, which thus offers a great opportunity to add understanding to the Quaternary history of southern Africa. Having lived and been educated all my life in the northern hemisphere, I was unaware of the controversial debate regarding the Quaternary history of southern Africa. This has helped offer a fresh perspective, without any preconceived ideas as to the processes which formed these deposits. The process origins considered for the formation of these deposits were chosen based on the morphology of such process origins and their role in the alpine environment. The initial aim of this research was to ascertain which processes could have formed the deposits located in eastern Lesotho, however through the use of sedimentological analysis and AMS dating, it soon became clear that a serious contender was that of past glacial processes. Given the controversy surrounding such a claim, it was necessary to investigate this further through the use of glacier reconstruction techniques and the influence of solar radiation. These techniques helped further reinforce that small glaciers had been present in the past, however the lack of further deposits on adjacent slopes indicates that glaciers were restricted to only a few areas. Given the recent prolific production of periglacial-related literature for Lesotho, it is hoped that this research will reawaken the interest into past glacial processes, which were first suggested five decades ago.

Sections of this work have been presented at the *SASQUA* conference in Johannesburg, South Africa in 2003, the *Sixth International Conference on Geomorphology* in Zaragoza, Spain in 2005 and the *Geomorphology and Earth System Science* (BGRG) conference in Loughborough, England in 2006. Sections of this work have also been published in *Quaternary International*, 2005.

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Scientific advice on the various aspects of my thesis has been provided by several people. I would first like to thank Simon Carr for all his help and advice regarding the glacier reconstruction work. Simon gave up his time to take me through the process step by step, along with his postgraduate student, Chris Coleman. Thanks also for checking that I had undertaken the process correctly and also on the advice regarding several aspects of my PhD. Thanks also to Jim Rose for all his advice regarding the Sehonghong deposits. Jaap Van der Meer gave up time for discussion and looked through my thin sections and advised me on references I should look at. Correspondence by email was also invaluable and I would like to thank Colin Thorn for his advice regarding snow patches, Richard Shakesby for his advice regarding pronival ramparts, Wishart Mitchell for his advice regarding snow blow and Pascal Bertran and John Menzies for their advice on the micromorphology of debris flows. Thank you also to Colin Lewis for his advice regarding the Sehonghong deposits and Richard Washington for his advice regarding past climatic processes.

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