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Reconstructing the extent of past glaciation in eastern Lesotho during the LGM

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Geomorphic evidence for past glaciation in the high Drakensberg has been the subject of much debate over recent decades, provoking a glacial versus non-glacial interpretation of many landforms. Although the summits of the high Drakensberg escarpment of eastern Lesotho attain heights of up to 3482 m a.s.l., there has historically been an absence of unequivocal geomorphic evidence indicating Quaternary glaciation in southern Africa. Recent published work has applied a geomorphological, micromorphological and glaciological approach to demonstrate a glacial origin for various 'moraine like' deposits in south-eastern Lesotho. However, Quaternary glaciation at these sites implies that specific climatic conditions would have been required to sustain active glaciers. This paper presents results for four sites in the Lesotho highlands, which host linear ridges interpreted as glacial moraines. The application of a glacier reconstruction technique to determine whether these sites could have supported glaciers permits the calculation of palaeoglacier mass balance, total velocity and basal slip, which in turn may be compared to modern analogues. Reconstructed equilibrium line altitudes (ELAs) for the sites range from 3081 to 3173 m a.s.l. and palaeotemperatures during the summer months ranged between 2.4ºC and 2.9˚C, whilst palaeoprecipitation would have approximated 1500 mm per annum. The results indicate that the mass balance characteristics for the four palaeoglaciers are comparable with modern analogues and hence reflect areas of marginal glaciation. Additional evidence is presented from insolation mapping to identify areas with significant topographic shading. The

potential impact of this shading on glacier mass balance is quantified from energy balance model calculations. The climate history of Lesotho is still uncertain due to an absence of any palaeoclimatological data from this region, in particular for the period spanning the LGM. The occurrence of glaciation in the Drakensberg suggests that precipitation was greater than at present, despite the general consensus that the summer rainfall region of southern Africa was drier during that time. With the use of insolation maps and energy balance models and the correlation of deposits with contemporary snow patch distribution, we demonstrate that the variable distribution of moraines is determined by a past climate that was within the glacial/periglacial equilibrium zone, but controlled by specific topographic and associated micro-climatic thresholds.