Implications of vegetation growth and rock weathering rinds associated with periglacial sorted circles and stone-/turf-banked lobes on Mafadi/Njesuthi summits, high Drakensberg, southern Africa

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INTRODUCTION

The High Drakensberg range of southern Africa is known as a marginal periglacial environment with active needle-ice induced landforms, seasonally forming miniature patterned ground & active earth hummocks. Contemporary seasonal freeze may reach ca 60cm depth in places and last 3 months. Large sorted circles and stone-/turf- banked lobes are thought to have formed during colder Neoglacial periods during the Holocene on the high Mafadi-Njesuthi summits (Fig 1). However, their age, periods of likely activity and current status of activity remain uncertain. This study aims to 1) provide a morphological summary of these periglacial features and 2) evaluate their likely relative timing of activity based on an integrated ecogeomorphological approach. In particular, this study focuses on *Helichrysum* shrub ring records and rock surface weathering characteristics (thin section microscope analysis and SEM-EDX analysis) to address knowledge gaps.

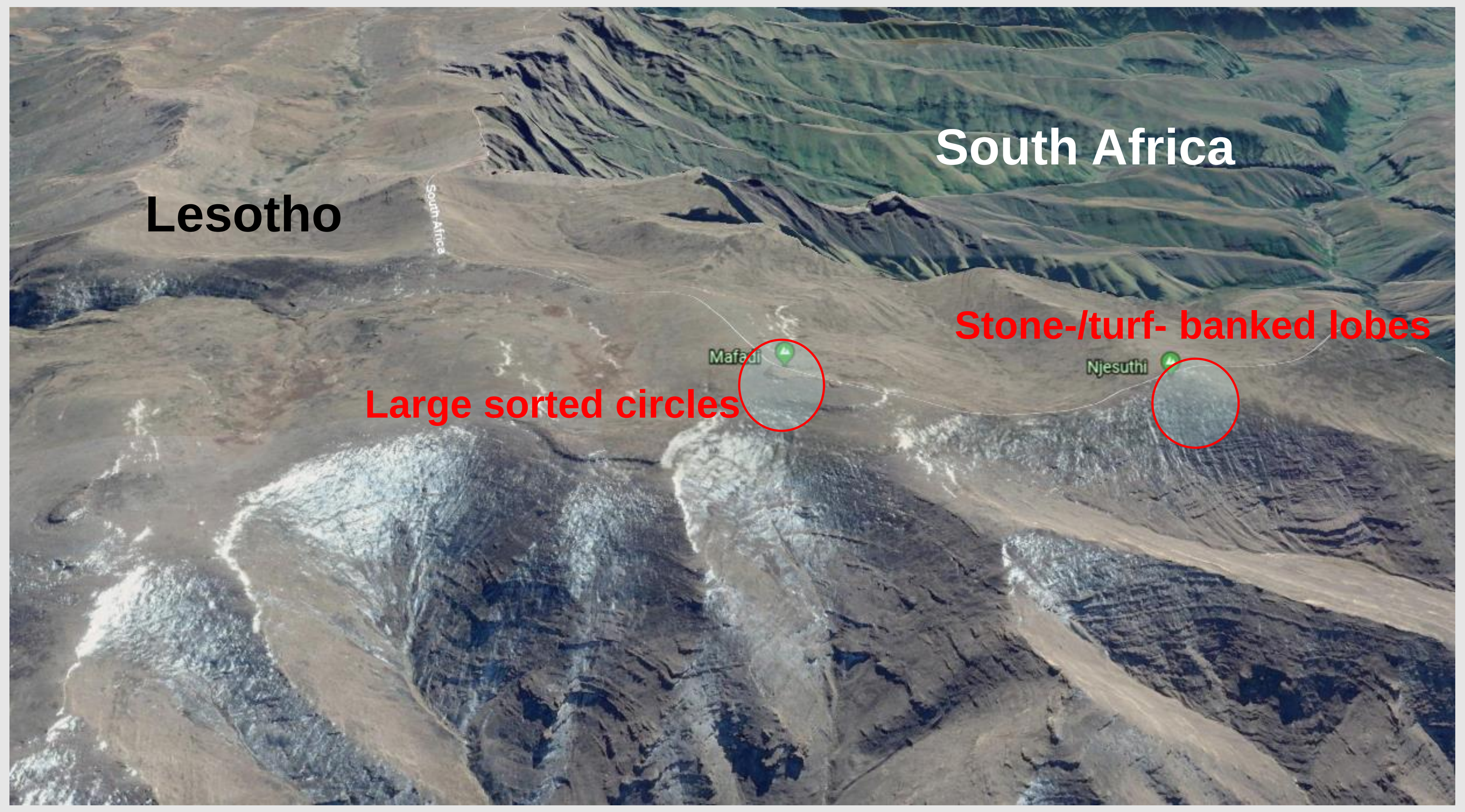
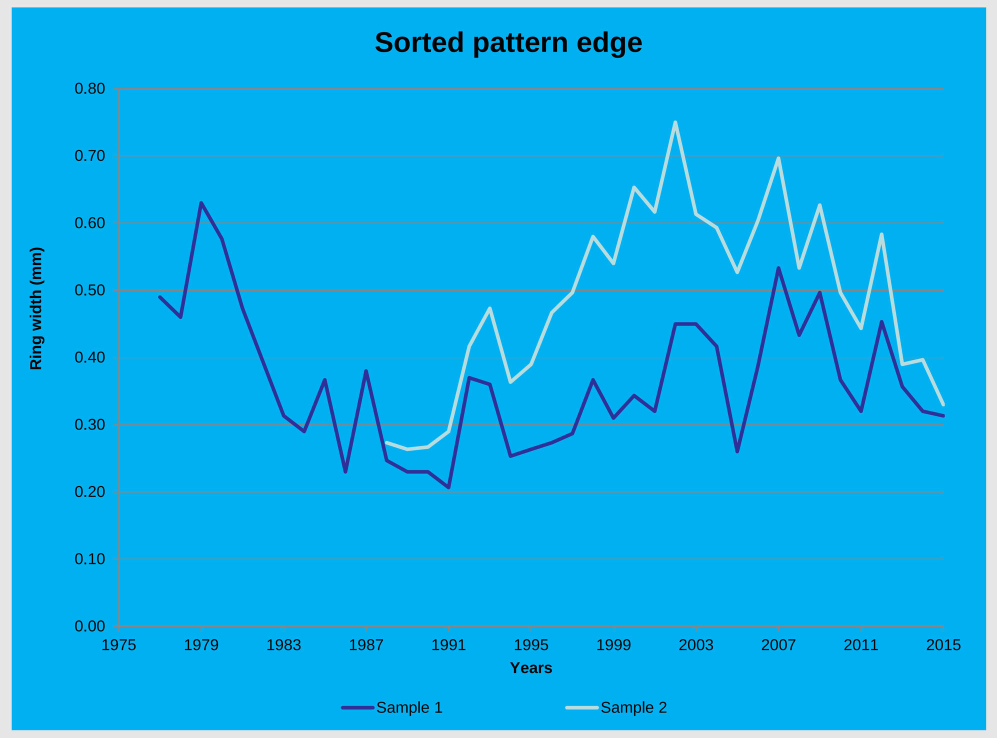


Fig. 1: The Mafadi-Njesuthi summit study area (between 3350-3450m asl)



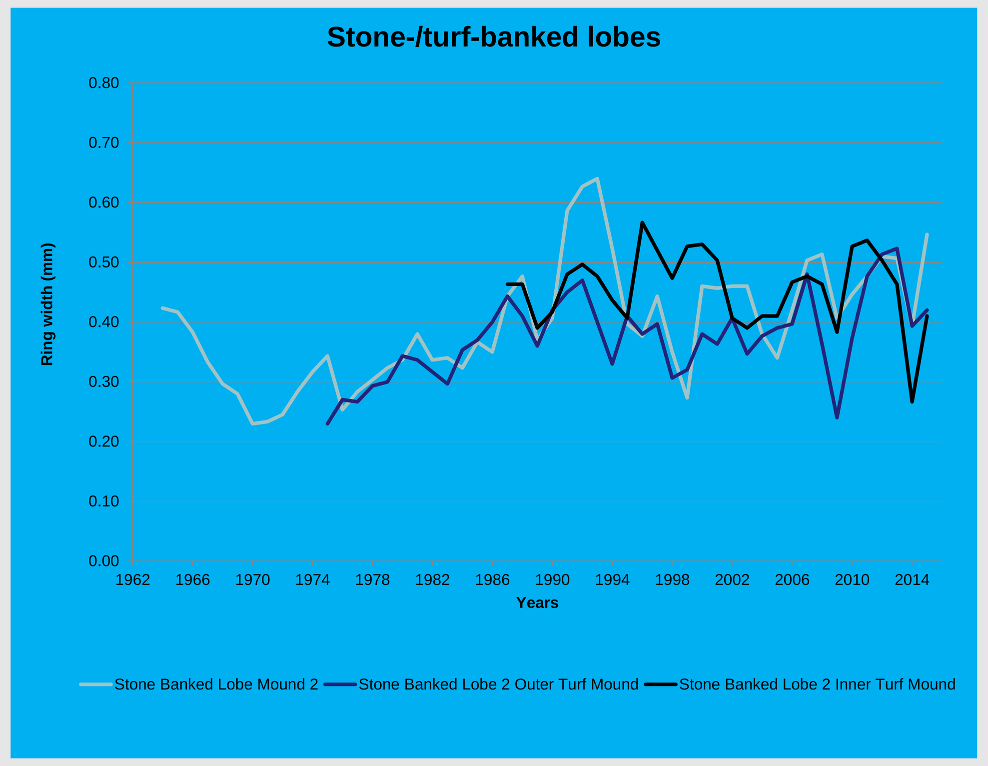


Fig. 4: Annual growth of *Helichrysum* on sorted circles and stone-/turf-banked lobes

Helichrysum shrubs currently grow in some borders and centres of patterned ground, & on stone-banked lobe frontal + peripheral Lobes. Shrubs av ca 37 years (n=18) in age and most date to an establishment in the early 1980s, but some as early as 1962.

Fig. 2: Large sorted patterned ground (compass for scale)

Fig 3: Stone-/turf-banked lobes

FEATURES

1. Large sorted patterned ground: inner vegetated centres av = ca 1.5m in diam. Pattern borders ('Gutters') av ca 0.9m in diam & consist of rocks/pebbles (Fig 2).
2. Large sorted circles (>0.3m diameter pebble centres, and cobble to boulder borders which are commonly vertically aligned)
3. Stone-/turf- banked lobes: 3-6m in downslope length; 2-4m in width (across slope); frontal lobes average 0.5m in ht; U-shaped in plan form; lateral turf lobes and frontal lobes suggest 'bulldozing' through solifluction (Fig 3).

Figure 5A: Sorted patterned ground surface

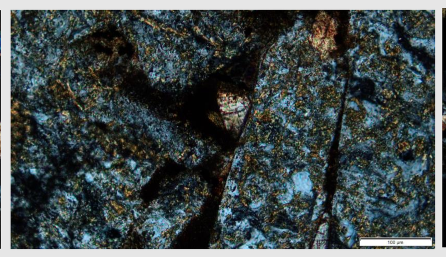


Figure 5B: Plagioclase alteration

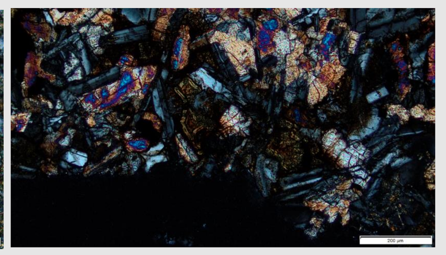


Figure 5C: Frontal lobe thin section

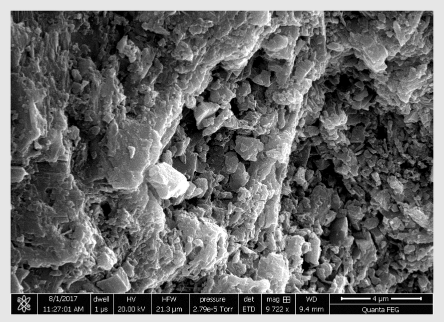


Figure 5D: Pitting on surface

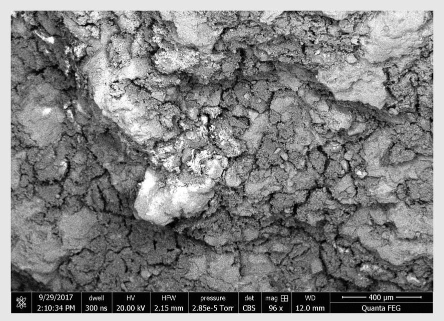


Figure 5E: Relatively intact surface

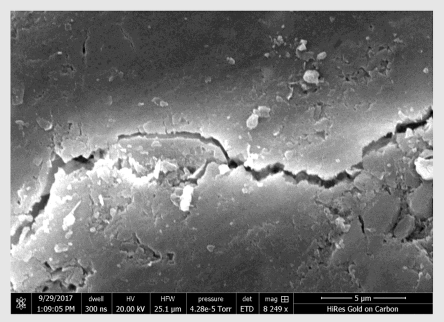


Figure 5F: Crack formation within sample

Rock surface weathering results indicate that the investigated patterned ground features have deteriorated noticeably- plagioclase minerals altered into amorphous silicates (Fig. 5A), pitting at the surface (Fig. 5D). Weathering is observed on all sides of the rock samples, suggesting rock fragments are still mobile. In contrast, samples from a larger 'fossil' pattern shows increased alteration of plagioclase towards the exposed surface (Fig. 5B), suggesting low mobility/stationarity for some time. Rock samples from lobes = relatively little altered (Fig. 5C; 5E), but show concentrated deterioration around vulnerable edges.

KEY FINDINGS

Patterned ground features on the mountain interfluve (plateau) experience higher chemical weathering rates, likely connected to their ability to retain water, and are still active, whereas the lobes and 'fossil' patterns have been stationary for a prolonged period of time (possibly since the Little Ice Age), resulting in differential weathering across the samples. Further declining frost action associated with 20th C warming has likely reduced frost intensity during the past half century, allowing for land surface stabilization and colonisation by plants on periglacial landforms. Ground conditions have changed to a point where more stable features of the landscape can be colonized by plants. Plant growth rates differ on an inter-annual basis according to their micro-topographic locations and with respect to their positions on periglacial landforms, suggesting that periglacial features influence micro-scale soil hydrology, ground thermal conditions and consequently plant growth rates.