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

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Large sorted circles (>30 cm in diameter and consisting of pebble centres and cobble to boulder borders, commonly vertically aligned) and stone banked lobes are thought to have formed during colder Neoglacial periods during the Holocene, but their age, periods of likely activity and current status of activity remain uncertain on the highest summits of the Drakensberg, southern Africa. This study aims to 1) provide a morphological summary of these periglacial features and 2) evaluate their likely ages and dynamics based on an integrated ecogeomorphological approach. In particular, this study focuses on Helichrysum shrub ring records and rock surface weathering characteristics (thin section microscope and SEM-EDX analysis) to address knowledge gaps.
Shrubs of the genera Helichrysum, and less occasionally Erica, currently grow in some borders and centres of patterned ground, as also on stone-banked lobe frontal and peripheral lobes, and occasionally lobe treads. Based on ring counts, Helichrysum shrubs average ca 37 years (n=18) in age, suggesting establishment in the early 1980s, with some as early as 1962. This may suggest declining frost action intensity since the 1980s, allowing for land surface stabilization and colonisation by shrubs and other growth forms. Multiple regression indicates that shrubs had a considerably stronger correlation with climate parameters (temperature and precipitation) before 1990, and a weaker correlation with these parameters after this date. This can be interpreted as the climate regime now changing to a point where more stable features of the landscape can be colonised by shrubs. The growth season also seems to have shifted earlier in the austral summer over time, from Dec-March (before 1990) to Nov-Feb (after 1990). Plant growth rates also differ on an interannual basis according to their micro-topographic locations and with respect to their positions on periglacial landforms, suggesting that periglacial features influence plant growth rates.

Rock surface weathering results indicate that the investigated patterned ground features have deteriorated noticeably; thin section analysis shows that plagioclase minerals were altered into amorphous silicates throughout the sample. SEM-EDX analysis of these samples indicates that this silicate is subsequently removed from the surface, resulting in pitting. This weathering behaviour is observed on all sides of the rock samples, suggesting that these rock fragments are still mobile. In contrast, samples from a larger 'fossil' pattern site shows increased alteration of plagioclase towards the exposed surface, indicating that these samples are less mobile and have been stationary for quite some time. Rock samples from the lobes were relatively little altered, and show concentrated deterioration around vulnerable edges such as relatively sharp corners. Physical weathering of the stone samples has resulted in crack formation throughout the stone. Results indicate that 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, resulting in differential weathering across the samples. All data suggest accelerated warming, particularly in the last 30 – 50 years.