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Mineralogical composition, weathering products and sinkhole formation of two different karst units in South Africa

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The two main karst lithological units in South Africa represent the areas underlain by dolomite in the Gauteng Province and the Northern Cape Province. In South Africa, land underlain by dolomite rocks is susceptible to sinkhole and subsidence formation. This study attempts to identify main differences between the dolomites of the Malmani Subgroup (mainly situated in Gauteng Province) and the Ghaap Plateau Group (Northern Cape Province), both forming part of the Transvaal Supergroup.

The Transvaal Supergroup is an end-Archaean/earliest Proterozoic platform succession developed on the Kaapvaal Craton, spanning the approximate period of 2650 to 2050 Ma. The Ghaap Group is subdivided, in stratigraphic order, into the Schmidtsdrif, Campbell Rand, Asbestos Hills and Koegas Subgroups. The Chuniespoort Group comprises three main stratigraphic units with the Malmani Subgroup at the base, the Penge Formation in the middle and the Duitschland Formation at the top. The Malmani Subgroup is up to 2 000 m thick and is subdivided into five formations, based on chert content, stromatolite morphology, intercalated shales and erosion.

Considering that some 3000 sinkholes have occurred in the dolomites of the Malmani Subgroup and less than 10 have occurred in the Northern Cape, this study aims to investigate the main differences between the dolomites of the Malmani Subgroup and those of the Ghaap Plateau Group. The mineralogical, geomorphological and climatic variations between the two occurrences could be fundamental in explaining the anomalous karst development.

In order to investigate the mineralogical composition of the dolomites of the Malmani Subgroup and the Ghaap Plateau Group, twelve selected dolomite rock samples were submitted for mineralogical testing. XRD and XRF testing were conducted. The XRD testing revealed that the Malmani Group dolomites have a higher content of magnesium rich minerals and the dolomite mineral percentage higher. The Ghaap Plateau dolomite samples have a higher content of quartz. The XRF testing revealed that the average percentage silicon dioxide (SiO_2) for the samples from the Ghaap Plateau is higher (39,03%) compared to the Malmani Subgroup (10,84%).

One of the most significant differences between the two units is the difference in climatic region. The climate in the Gauteng Province is mostly moderately dry subtropical, specifically a humid subtropical climate, with long hot and wet summers and short cool and dry winters. The climate in the Northern Cape Province is mostly hot and dry. The Malmani Subgroup is situated in an area where the Weinert 'N' is classified as N<5 (predominantly chemical weathering) and the Ghaap Plateau dolomite area is present in the area where N>5 (predominantly physical weathering).

The Ghaap Plateau dolomite has been known to have very little to no wad (weathered altered dolomite) occurrence. It is believed that the main reason is the fact that the dolomite of this area is exposed to physical weathering, i.e. disintegration and not a change in composition which is the result of chemical

weathering. On the Malmani dolomites, the narrow weathering features, referred to as grykes or slots are filled with wad. The dolomite of the Ghaap Plateau is generally not so extremely pinnacled and usually has a more undulated profile.

The higher presence of silicon dioxide in the samples from the Ghaap Plateau could have a direct correlation with why the dolomites from this region are quite resistant and do not easily weather to form wad, as silicon is chemically a very stable element. Although dolomite from the Malmani Subgroup more commonly forms wad as a weathering product, there is no direct correlation between the manganese content of the Malmani and Ghaap dolomites.