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The chemical stratigraphy and palaeoenvironmental significance of the Kalkkop Impact Crater Lake deposits, Eastern Cape, South Africa.

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Since the accretion stage of planets, impact cratering has played a major role in the geological and biological evolution of our planet. In South Africa both cosmic impact and endogenic Crater Lake deposits of various ages occur and these craters include the Palaeoproterozoic Vredefort, Early Cretaceous Morokweng crater, and Middle Pleistocene Tswaing and Kalkkop craters. Studies show that only a few craters in South Africa have been identified as impact craters, and Kalkkop crater has been found to be of impact origin.

The 650 m wide Kalkkop meteorite impact crater crater (32^0 42'30"S and 24^0 26' 00"E) is situated ~51 km southwest of the town of Graaff-Reinet on a low relief plain, in the semi-arid Karoo biome of southern South Africa. A core drilled through the centre of the crater passes through 89 m of variously laminated and massive, carbonates that overlie brecciated sandstone and shale. Kalkkop has been previously dated at ~250 Ka using the U-Th method, similar in age to the Tswaing Crater, 40 km NW of Pretoria. However, the crater rim at Kalkkop has been almost entirely eroded and, given the low regional erosion rates (< 4 m/million years), would appear to be much older than Tswaing. The carbonates are dominated by dolomite in the upper 35 m and by calcite below 35 m. Carbonate $\delta^{18}O$ value vary between -3.85 and 6.64 ‰ (relative to PDB), and generally increases upwards. These data are consistent with precipitation from water ranging in $\delta^{18}O$ between -3 ‰ (typical of meteoric water) at the base, and ~+5 ‰ (typical of highly evaporated water) in the upper part of the succession. The lower part of the succession shows a strong correlation between $\delta^{13}C$ and $\delta^{18}O$ values, suggesting non–equilibrium precipitation during periods of high evaporation rate. The upper part shows no correlation between $\delta^{13}C$ and $\delta^{18}O$ which is consistent with equilibrium between the carbonates and the lake water, suggesting that recharge of water became more continuous. Detailed dating studies are required before the Kalkkop Crater carbonates can be used as a proxy for past climate.