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A multipronged approach to constraining the timing of emplacement of the Molopo Farms Complex, southern Africa

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The Molopo Farms Complex (MFC) is a 13000 km^2 layered, mafic-ultramafic intrusion that transverses the southern border of Botswana with South Africa. The MFC, which does not outcrop, is believed to intrude sedimentary rocks of the Transvaal Supergroup. The ultramafic sequence is comprised of harzburgites and pyroxenites, and is in turn overlain by amafic sequence comprising norite, gabbro and subordinate pyroxenite [1, 2]. Unlike many other layered intrusions of Southern Africa, the MFC is not well studied, particularly when it comes to the timing of its emplacement [3]. The age of the MFC is considered to be the same as that of the Rustenburg Layered Suite, Bushveld Complex, given the similarities between the geochemical and petrographical characteristics of the units as well as the shared cross-cutting relationship with rocks of the Transvaal Supergroup. At present, the only available age data on the MFC is a poorly constrained Rb-Sr date of 2044 ± 24 Ma [4].

This study aims to re-evaluate the petrography, geochemistry and geochronology of the mafic-ultramafic rocks of the MFC in order to better understand the nature and timing of MFC emplacement. Samples were taken from eight holes from the southern and northern limb drilled by Samancor in the 1970s that intersect both the MFC and host rocks of the Transvaal Supergroup.

This study and published data from the Bushveld Complex show broad petrographical and geochemical similarities [5]. The MFC geochemical signature shows negative anomalies for Eu ($(Eu/Eu^*)_N$ =0.87-1.45), Nb (Ta), P and Ti, and distinct positive anomalies for K, Pb and U, as well as highly enriched LREE.

The geochronology was based on the U-Pb dating of baddeleyite and zircon grains. Baddeleyite grains were separated from the mafic rocks and dated using ID-TIMS, whereas detrital zircon grains from the sedimentary units of the Transvaal Supergroup, in direct contact with the intruded material, were dated using the LA-ICP-MS.

The youngest U-Pb ages of detrital zircon grain populations within 6 analysed samples are dominated by ages between 2018 ± 39 Ma and 2276 ± 19 Ma. Preliminary U-Pb dating of baddeleyite yielded a minimum crystallization age of 2052 ± 8 Ma for the MFC. Our preliminary age for the MFC is therefore within error of the age of Bushveld Complex (2054.4 ± 1.3 Ma [6].The youngest detrital zircon age populations taken in isolation are not able to distinguish characteristic provenance of either the Olifantshoek Group or Transvaal Supergroup. Given the baddeleyite constraints it becomes clear that the sedimentary succession belongs to the Transvaal Supergroup.

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