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U-Pb zircon geochronology combining both *in-situ* and bulk-grain techniques in the Transvaal Supergroup, South Africa.

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The Precambrian comprises the vast majority of Earth's history. Preserved archives contain essential information about the first few billion years for planetary evolution of our planet. Despite covering a large part of the history of our planet, these outcrops are not so abundant due to erosion and frequently occur in disparate areas. In order to relate them and to establish a timeline of geological events in a world lacking biochronology, we rely on accurate radio-isotopic age determinations. These are, however, rather scarce and still leave several hundreds of million years long time intervals undated. In this study, we present U-Pb age determinations from volcanic and sedimentary units of the Paleoproterozoic Transvaal Supergroup, South Africa. The Transvaal Supergroup is an exceptionally well preserved sequence and therefore accounts for a very large amount of geochemical data. Due to its capacity to produce large data sets the preferred technique in U-Pb zircon geochronology for ancient sediments is LA-ICP-MS. It allows the aqcuisition of maximum depositional ages (MDA) in a fast way and at a relatively low cost. However, the large analytical uncertainty preclude the temporal resolution to distinguish between different processes in such old rocks. Moreover, the standard dating procedure rarely includes zircon treatment via chemical abrasion to mitigate common problems such as open system behavior due to radioactive decay damage related Pb loss. In consequence, interpreted ages might be severely disturbed and may yield MDA's that are tens to hundreds of million years too young. As an alternative, the much more work-intensive CA-ID-TIMS technique allows the obtention of more accurate and more precise ages, preferably using zircon grains that have previously been screened for their LA-ICP-MS U-Pb age.

Our new combined LA-ICP-MS and CA-ID-TIMS data indicates that the glaciogenic Makganyene Formation has a MDA of ~2.42 Ga. Younger age clusters at around ~2.2 Ga from LA-ICP-MS dating disappear with chemical abrasion and have to be interpreted as artifacts of radiation-damage related Pb loss. These new results have important implications for both environmental evolution during the Neoarchean/Paleoproterozoic, as well as for the regional geology. The Makganyene

diamictites are thought to represent the oldest Paleoproterozoic glaciation in South Africa. The data also corroborate the hypothesis that the directly overlying-to-locally-interfingered mafic volcanic Ongeluk Formation is ~200 Ma older than the volcanic rocks ~2250 Ma Hekpoort Formation in the East Transvaal basin. We therefore reject the long-standing correlation between both units, as previously published.

We demonstrate that LA-ICP-MS is not capable to provide a robust and reliable MDA's in ancient clastic sediments. CA-ID-TIMS analysis provides dates of significantly higher accuracy, because the chemical abrasion is minimizing Pb-loss in the crystal. Therefore, for studies relying on U-Pb zircon geochronology, we encourage the application of CA-ID-TIMS in the youngest populations previously identified with the LA-ICP-MS. This is particularly important for establishing reliable maximum depositional ages in sedimentary rocks.