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Juvenile crust formation in the northeastern Kaapvaal Craton at 2.97 Ga – Implications for Archean crust-mantle evolution, terrane accretion, and the Witwatersrand gold source

A. Zeh (1), J. Jaguin (2), and M. Poujol (3)

(1) Frankfurt, Frankfurt am Main, Germany (a.zeh@em.uni-frankfurt.de), (2) Rennes, Géosciences (justine.jaguin@gmail.com), (3) Rennes, Géosciences (marc.poujol@univ-rennes1.fr)

Combined U-Pb and Lu-Hf isotope data of detrital and magmatic zircons provide evidence that the Murchison Greenstone Belt, NE Kaapvaal Craton, South Africa, hosts an important Archean suture zone, which primarily formed by collision between a primitive arc-island arc system to the north with an older more evolved terrane, the proto-Kaapvaal Craton, to the south at 2.97 Ga. This model is supported by the observations that igneous rocks of the northern terrane, comprising tonalites and quartz-porphyries of the Rooiwater Complex and the Rubbervale Formation, emplaced at about 2.97 Ga and show highly superchondritic εHft of +4.4 to +5.1. In contrast, U-Pb-Hf isotope data of detrital zircons from quartzitic schists of the Murchison Unit and the La France Formation, both forming part of the southern terrane, provide evidence for a southern provenance, which was affected by granitoid intrusions accompanied by crust re-working at 3.53-3.42 Ga (εHft = +1.8 to -4.8), 3.30-3.20 Ga (εHft = +1.8 to -6.3), and 3.13-3.05 Ga (εHft = +1.3 to -5.6); pointing to a connection with the Barberton greenstone belt and Swaziland. A spatial separation of the two Murchison terranes prior to 2.97 Ga, is furthermore supported by the facts that the youngest detrital zircons of the southern terrane, having ages between 2.99 and 2.97 Ga, show subchondritic εHft between -6.5 and -1.5, in contrast to the highly superchondritic εHft obtained from the contemporaneous magmatic rocks of the northern terrane. The juvenile character of the Rooiwater and Rubbervale magmatic rocks, along with the occurrence of VMS deposits, makes them a very potential candidate for the gold-bearing sediments exposed in the adjacent Pietersburg Greenstone Belt and in the Witwatersrand basin. The new U-Pb-Hf isotope datasets, along with data from worldwide sources, furthermore support a model of a steadily evolving “normally” depleted mantle reservoir in response to continuous crust formation during the Archean, starting at about 4.0 Ga.