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A mineralogical-geochemical study of Mesoarchaean quartz-pebble conglomerates from the Pongola Supergroup and implications for U/Au placer deposits

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The Witwatersrand Basin in the central Kaapvaal Craton of South Africa contains one of the largest gold reserves on Earth [1]. It includes a number of stratigraphic units which are mineralized to different degrees. The Pongola Supergroup, exposed along the eastern craton margin, is very similar in lithology and age to Wits Basin strata, but so far no metal enrichments of economic interest have been found. In both groups, quartz-pebble conglomerates (QPC) form thin beds intercalated with coarse-grained sandstones and are enriched in a suite of heavy minerals. The present study focuses on petrography, provenance, bulk geochemistry and single zircon age data of QPCs situated at the base of the Pongola Supergroup, in order to investigate Au and U mineralization potential.

The Pongola Supergroup is exposed in southern Swaziland, eastern Mpumalanga, and northern KwaZulu-Natal [2]. Palaeoarchaean granitoid-greenstone basement is unconformably overlain by the Nsuze Group [3], which commences with sandstones including QPC. This study is based on QPC's and sandstone host rocks from the Buffalo River Gorge (BRG) and the White Umfolozi Inlier (WUI). In addition, two conglomerate samples from the long abandoned Danny Dalton Mine (Mozaan Group) were obtained for comparison. Thin sections and heavy mineral concentrates were investigated by Raman spectroscopy, scanning electron microscopy (SEM), cathodoluminescence (CL), laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), X-ray fluorescence (XRF) and ICP-MS. The youngest age component isolated in the 60 most concordant (±5%) U-Pb zircon ages of 3241 ± 5 Ma sets the maximum age for the sedimentation of the BRG QPCs. This new constraints is ca. 140 My older than it was determined in the WUI (3102 ± 15 Ma).

In general, the mineralogically mature (average SiO_2 of c. 90 wt. %) QPCs show enrichment in U and Th compared to sand- and gritstone, associated with secondary REE-rich phosphate phases, recording a hydrothermal overprint. However, WUI conglomerates are less mature than those from the BRG area, indicating a shorter transport distance. According to this, the amount of gold detected in the QPCs is generally very low (0-28 ppb). Higher concentrations (> 20 ppb) are restricted to the more mature QPCs from the BRG and related to relatively high ferromagnesian elements (e.g. V) and especially Zr concentrations, indicating a recycled, possibly greenstone belt source. Especially one QPC sample from WUI shows distinct enrichment of uranium (780 ppm) and thorium (1,620 ppm). CL imaging provided evidence of former U/Th mineralization in some QPCs by luminescing quartz damage, induced by α-radiation. The most abundant heavy mineral phases in the Nsuze basal QPCs are rutile/leucoxene, zircon, pyrite, monazite and tourmaline, and, as supergene minerals, jarosite and Fe-hydroxides. Micron-scale (<5μm) REE- (Ce, La) and Nb, U, Th -rich inclusions are observed in leucoxene aggregates, but U and Th are predominantly linked to phosphate aggregates, exhibiting either (1) La-Ce, (2) U-Th or (3) U-Th and La-Ce rich inclusions. The observations indicate that a fluid impregnated the material and led to precipitation of REE- and U, Th, Nd -bearing mineral phases.

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