The Source of Gold for the Witwatersrand from Re-Os and U-Pb Detrital Zircon Geochronology

J. RUIZ¹, V.A. VALENCIA¹, J.T. CHESLEY¹, J. KIRK, G. GEHRELS¹ AND H. FRIMMEL²

¹ University of Arizona, Tucson Arizona. 85750 USA jruiz@geo.arizona.edu; victorv @ geo.arizona.edu jchesley@geo.arizona.edu, jkirk@geo.arizona.edu; ggehrels@geo.arizona.edu

² University of Würzburg, Am Hubland, D-97074 Würzburg, GERMANY; hartwig.frimmel@mail.uni-wuerzburg.de

The Witwatersrand basin in South Africa, which hosts the largest concentration of gold on Earth, is an Archean system that contains gold and rounded pyrite. The basin has been the focal point of studies devoted to the evolution of the atmosphere and gold mineralization because of the large accumulation of gold and the presence of uraninite and sulfides in the sediments of this Archean basin. Understanding if the gold, uranium and sulfides are detrital or were introduced to the basin by hydrothermal fluids has been at the center of debates for ~100 year.

Kirk et al [Science, 2004] obtained Re-Os isochrons for gold with an age of 3033 ± 21 Ma (${}^{187}\text{Os}/{}^{188}\text{Os}_i = 0.1079 \pm 0.0001$), and for gold and pyrite combined with an age of 3016 ± 110 Ma (${}^{187}\text{Os}/{}^{188}\text{Os}_i = 0.1090 \pm 0.0013$). Both Os isotopic initials are in agreement with estimates of the mantle at that time. Questions remained, however, about the relationship between detrital and authigenic pyrite and the ultimate source of the detritus.

Here we present new Re-Os data that show that authigenic pyrite with low Os concentrations overgrow detrital cores with high Os. The pyrite cores also yield a Re/Os age of 3067 ± 45 Ma. We also analyzed more than 1200 zircons from throughout the basin that included samples from the Black Reef, the Val Reef, the Kalkoerkans Reef, the Kimberly Reef, and the Ventersdorp Contact Reef. The data yield a histogram for footwall and hanging-wall zircons with frequency distribution peaks with ages at 2955, 2907 and 2826 Ma, whereas the reefs have zircons with peaks at 3047 and 3089 Ma. Comparing these data with possible sources for the sediments, which include the Barberton, Murchison, Amalia-Kraippan greenstones, the Johanesburg and Vredeforth domes show a unique correlation with the Murchison Greenstone for the reef sediments. In its totality, our data demonstrate that the the sediments in the gold bearing reefs, have zircons that are the same age as the gold providing further indication that gold is sedimentary, and with a unique source distinct from other sediments of the basin.