Combined U-Pb-Hf Zircon Geochronology and Pyrite Multiple Sulfur Isotopes of Au-(U)-Bearing Conglomerates of Jacobina Basin, Brazil: New Insights about the Sources of Mineralization

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The Au-(U) and pyrite-bearing conglomerates of the Jacobina Basin, northeastern portion of the São Francisco Craton, Brazil, have several features that resemble the Witwatersrand deposits. There is a debate about the source of mineralization in Jacobina Basin, which includes models of hydrothermal input and paleoplacer, wherein the latter points that the most probable source would be the volcanogenic massive sulfides (VMS) deposits of the 3.3 Ga Mundo Novo Greenstone Belt.

We report the results of combined U-Pb and Lu-Hf isotope analysis of detrital zircon grains from the Jacobina Basin. In addition, we carried out in-situ multiple sulfur isotopes analysis (^{32}S, ^{33}S, ^{34}S, ^{36}S) by SHRIMP-SI on pyrite grains of several minerallized conglomerate beds, as well as two samples of the Mundo Novo VMS pyrites. These analysis were performed in order to evaluate the sedimentary provenance, nature of the source rocks, and to bring further insights about the sources of the Jacobina mineralization, testing the hypothesis of a VMS-derived detrital particles.

The detrital zircon grains of Jacobina Basin (n= 785) yielded Paleoarchean ages between 3.2 and 3.5 Ga, with primary peaks of approximately 3.3 and 3.4 Ga. Most of grains show nearly chondritic compositions with $\varepsilon Hf_{(t)}$ between -5.6 to -0.1, with Hf model ages between 3.5 and 3.8 Ga. Detrital pyrite occur in conglomerates as rounded inclusion-rich and massive grains, which commonly have an euhedral overgrowth of late pyrite. The detrital pyrite grains display a narrow range of $\delta^{34}S$ (-6.2 to +5.6‰), besides Mass-Dependent (MDF-S) and Mass-Independent-Fractionation (MIF-S) signatures, with $\Delta^{33}S$ ranging between -0.14 to +0.70‰ and $\Delta^{36}S$ between -0.83 and +0.50‰. The VMS samples have close to zero $\delta^{34}S$ values (+0.8 to +1.95‰), and show clearly MIF-S anomalies with $\Delta^{33}S$ ranging between -1.2 to -0.90‰, and $\Delta^{36}S$ between -0.50 and +1.50‰.

The U-Pb data set of detrital zircons suggests an exclusive Paleoarchean source for the sediments, most likely derived from a juvenile continental magmatic arc with different proportions of crustal component. According to the sulfur isotope data, the Mundo Novo VMS is not the source for detrital pyrites of Jacobina. The detrital pyrites have grains with MDF-S signatures and also with atmospheric sulfur contributions, which carry small positive MIF-S (S^0 species). Nevertheless, the sulfides from VMS have isotopic compositions compatible with abiotic sulfate reduction, with negative MIF-S values.

The isotopic signatures of detrital pyrites may reflect contributions from magmatic-hydrothermal provenance area, related to the Paleoarchean arc with MDF-S signatures; besides a sedimentary source with positive MIF-S, which could be an external or intrabasinal environment. These data imply in a continental crustal gold endowment during the Paleoarchean and that the Jacobina deposits may have formed between 3.3 to 2.3 Ga, before the Great Oxidation Event (GOE).