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Towards understanding the giant Kibali orogenic gold deposit, northeast DRC

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The Kibali gold project is a giant orogenic gold deposit located in northeast Democratic Republic of Congo operated by Randgold Resources Ltd. The project is centered around the Kagaraba-Chaffeur-Durba (KCD) deposit which has an inferred resource of 17 Moz Au (Dec. 2013) with significant additional resource in an array of satellite deposits, the principle of which are the Pakaka (1.2 Moz) Mengu (0.7 Moz), and Pamao (0.7 Moz) orebodies, bringing the total resource to 22 Moz.

The Kibali study area straddles three major hitherto unexplored geological terranes. The Kibali Granite - Greenstone belt (KGGB) is an east-west trending elongate belt, consisting of greenschist to low amphibolite facies volcano-sedimentary units, carbonaceous shales, banded iron formations, and subaerial basalts. The units are intruded by multiple igneous bodies ranging in composition from granitic to gabbroic. These rocks sit to the north of, and are stratigraphically above, the Upper Zaire Granite Massif (UZGM). This complex contains plutonic rocks that range from gabbro through tonalite to granodiorite The West Nile Gneiss, which is thrust southward over the Kibali granite-greenstone terrane along its northern edge, is largely comprised of biotite granite gneisses.

The KCD deposit consists of disseminated sulfides hosted in microscopic quartz veinlets. Pyrite, arsenopyrite, chalcopyrite, and pyrrhotite are the dominant phases, with multiple generations of each identified. The orebodies are developed in a south-vergent thrust stack, with mineralization located along NNE-dipping, WSW-striking ductile shears linked by steeply dipping NNE-striking lateral ramps and transfer faults that likely acted as fluid conduits. The deposits show a range in $\delta^{34}S$ data, from -2 to +8 per mil and with a mean of +4.4 per mil.

Igneous zircons and hydrothermal monazites were dated using LA-ICP-MS techniques. Intrusive units from both the KBBG and UZGM yield ages that range from 2643 to 2629 Ma. All analysis yielded discordant lower intercepts recording a region wide Pb loss event during the period 500-400 Ma. Zircons from the West Nile Gneiss show no Archean signature and yield ages that range from 1003 to 983 Ma. This implies that if emplacement of the WNG caused the development of the thrust stack that hosts the mineralization, this cannot be of Archean age. Monazites from the orebodies yielded ages of 530±30 Ma at KCD, 545±19 Ma at Pakaka, and 556±38 Ma at Pamao. These ages, when combined with geochemical data, indicate that the Kibali Granite-Greenstone belt and Upper Zaire Granitoid formed during an arc accretionary event at approximately 2.63 Ga. Although the gold may initially have been Neoarchean in age, the monazite data potentially place the main phase of mineralization as a product of the Pan African event along the northern margin of the Congo Craton. We suggest the large size of the Kibali Au deposit reflects reworking of Achean gold during repeated fluid and deformation events that spanned the Proterozoic and culminated during the Pan African orogeny.