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Insights from 3-D Structural and Lithological Geomodeling of K.O.V. Mine, Kolwezi Region, Democratic Republic of the Congo: Olistostromes in an Evolving Lufilian Arc Foreland Basin

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Abstract

The Kolwezi area of the Democratic Republic of the Congo hosts world-class stratabound Cu-(Co) and U-(± Cu-Ni-Co-Pb-Zn) mineralization within large fragments (*écaille*) of Lower Roan Group units that are hosted in the regional Roan breccia. Long-debated genetic models for the development of these types of deposits include the development of tectonic mélanges, friction breccias, sedimentary mélanges, olistostromes, and halokinesis or salt tectonics. Compiled historical data and new data at K.O.V. mine, which is an amalgamation of the Kamoto-East, Oliveira, and Virgule mines, situated in the Kolwezi "klippe" or subbasin, has been reanalyzed and used in the construction of a new, fully constrained, implicit 3-D model of lithologies and major structures. This data, which spans approximately 80 years, includes diamond and reverse-circulation drilling, new structural and lithological mapping data, downhole televiewer data, and macrostructural logging. In-pit observations, combined with these new, fully constrained, implicit 3-D models, provide new insights into the geometry and genesis of these deposits and their encompassing volume. The Kolwezi subbasin, characterized by K.O.V. mine, resulted from gravity-driven mass transport processes, concomitant with sedimentary deposition within a progressively folded foreland basin during orogenesis. The final geometry of fragments is due to (1) features that were inherited from the fold-and-thrust belt in the hinterland; (2) features caused by incorporation and dismemberment of fragments throughout a regional Roan breccia, as they were shed into the foreland basin; and (3) large-scale juxtaposition and impingement of fragments, complicated by late-kinematic tightening of the Kolwezi subbasin, further dewatering of the pile, and possibly further remobilization of fluids and metals. Collectively, these features, typified by K.O.V. mine, indicate that the Kolwezi subbasin, the Tombolo subbasin, and other similar regions in the foreland constitute the localized, preserved remnants of an olistostrome that was deposited within a previously much larger foreland basin, ahead of an advancing, thin-skinned fold-and-thrust system, and against the Nzilo block on the western margin of the Lufilian arc.

Introduction

The Lufilian arc

The Lufilian arc, straddling the border between the Democratic Republic of the Congo (DRC) and Zambia (Fig. 1), constitutes the largest global concentration of Cu-(Co) and U-(± Cu-Ni-Co-Pb-Zn) mineralization (e.g., Annels and Simmonds, 1984; Richards et al., 1988a, b; Steven and Armstrong, 2003; Hitzman et al., 2012). The Lufilian arc comprises supracrustal clastic and chemical metasedimentary rocks of the Neoproterozoic Katanga Supergroup (Cailteux, 1994; Cailteux et al., 2005a, b; Batumike et al., 2007; Bull et al., 2011), which record a series of protracted plate margin processes that commenced with rifting and breakup of the Rodina supercontinent, followed by amalgamation of the Kaapvaal and Congo cratons during the Pan-African orogenic cycle (Unrug, 1983; Hanson et al., 1993; Porada and Berhorst, 2000; Armstrong et al., 2005).

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Unrug (1988, 1989) subdivided the Lufilian arc into two zones: (1) tightly folded, thin-skinned thrust sheets of weakly metamorphosed to unmetamorphosed Katangan strata (nominally the "DRC copper belt") that constitute a northward-verging, arcuate fold-and-thrust belt; and (2) an inner zone (the "Zambian copper belt") to the south, showing significantly higher metamorphic grades and late-kinematic exposure of basement granites within the "Domes Region," which exposes the mineralized base of the metasedimentary sequence (e.g., Koegelenberg et al., 2019). Selley et al. (2005) subdivided the Lufilian arc into five regional tectonometamorphic domains that preserve a broad, south-to-north decrease in metamorphic grade, from upper amphibolite to lower greenschist facies: (1) Katangan High, (2) Synclinorial belt, (3) Domes Region or Middle Lufilian, (4) External fold-and-thrust belt or Outer Lufilian, and (5) Kundelungu foreland or Lufilian foreland (Unrug, 1988; Porada, 1989; Cosi et al., 1992; Kampunzu and Cailteux, 1999; John et al., 2004; Selley et al., 2005; Kipata et al., 2013; Torremans et al., 2018; Figs. 1, 2).

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