Timing Diagenetic Processes in the Zambian Copperbelt: Insights from U-Pb Dating of Detrital Ilmenite and Authigenic Hematite

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The Lubambe-Mingomba (formerly Lubambe Extension) Cu-Co deposit is located in the northern Zambian Copperbelt (ZCB). The basal Mindola Clastics and the overlying mineralized “Ore Shale” of the Neoproterozoic Roan Supergroup were deposited during the mid to late Tonian (~890 to 765 Ma). Detailed petrographic analysis show remnant detrital ilmenite with exsolved hematite and rutile in the basal clastics consistent with early diagenetic breakdown in sedimentary basins. Our study attempts to constrain the timing of ilmenite-hematite breakdown and hence early diagenetic processes preceding complex multi-phased sulfide mineralization in the ZCB.

LA-ICP-MS U-Pb ages from exsolved hematite grains with no remnant ilmenite return post-diagenetic ages between 700-680 Ma suggesting resetting of the U-Pb geochronometer. Rim-core ages from hematite grains with remnant ilmenite record an earlier (~650 Ma) post-depositional age overprinted by a later (~534 Ma) Cambrian event concomitant with the peak of the regional Lufilian Orogeny. In-situ U-Pb dating of ilmenite yielded systematically younger ages (497 to 483 Ma), likely linked to post-Lufilian cooling. Our results produce ilmenite U-Pb ages within uncertainty of other post-orogenic U-Pb ages from apatite and rutile in the same samples.

Our data shows no preserved detrital and diagenetic ages suggesting episodic post-diagenetic alteration of hematite and ilmenite in the ZCB that matches pulsed sulfide (re-)growth models suggested by other workers for the Central African Copperbelt [2]. The episodic breakdown of detrital ilmenite was key to the release of Ti crucial for the formation and stability of abundant rutile and may have increased the Fe budget in metal-laden brines linked to Cu-Co-Fe sulfide mineralization in the ZCB. Furthermore, our study highlights the utility of in-situ ilmenite and hematite U-Pb dating in constraining diagenesis and post-compaction alteration in sedimentary basins.