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The Timing of Mineralization in the Mina Justa IOCG System, Peru: Insights from In Situ U-Pb MC-ICP-MS Ages for Apatite, Magnetite, and Titanite

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Iron oxide copper-gold (IOCG) deposits are major sources of Fe (in magnetite), Cu, and Au (in sulfides). They are also usually enriched in Ag, Mo, Co, As, U, and Rare Earth Elements (REE), which are critical metals for developing renewable energy technologies. In Peru, the Mina Justa IOCG deposit consists of two mineralization styles: manto and hydrothermal breccia. Magnetite is present in both styles, but Cu mineralization is concentrated in the latter.

Constraining the timing of Fe and Cu mineralization at Mina Justa is fundamental to understanding the duration and type of processes that generated this mineral deposit and ultimately to test the hypothesis of a genetic link with other deposits in the area. Previous workers used Ar/Ar geochronology to date alteration minerals (actinolite and microcline) from Mina Justa. The samples yielded ages ranging between 157 and 95 Ma, and the authors interpreted magnetite to have formed at around 110 Ma and Cu sulfides at around 100 Ma, suggesting two separate mineralization events in the deposit. However, the relationships between the alteration minerals and the mineralization stages are poorly constrained; hence, the proposed ages do not provide direct information about the timing of mineralization.

We characterized samples from the manto and breccia units at Mina Justa via scanning electron microscopy and identified magnetite, apatite, and titanite grains for U-Pb isotope measurements via in situ multicollector-inductively coupled plasma-mass spectrometry (MC-ICP-MS). This innovative technique allows us to perform spot analyses for detailed geochronological studies. Additionally, its application for dating magnetite opens the door to date mineralization in ore deposits that lack “traditional datable minerals” like molybdenite.

Our preliminary results (Fig. 1) are the first to date ore minerals at Mina Justa and indicate that magnetite, titanite, and apatite in the deposit are older than previously published, inferred ages of mineralization. Further work will focus on directly dating the sulfide minerals to assess the timing of Cu mineralization.

The results of this project will contribute to understanding the timescales of Fe and Cu mineralization at Mina Justa and clarify the time framework in which this deposit formed. This knowledge will help to identify the tectonic setting propitious for the occurrence of IOCG deposits in the Andes and elsewhere, allowing for the refinement of geophysical and geochemical exploration techniques to find new prospects that will optimize the exploration process and maintain the supply of resources for future generations.

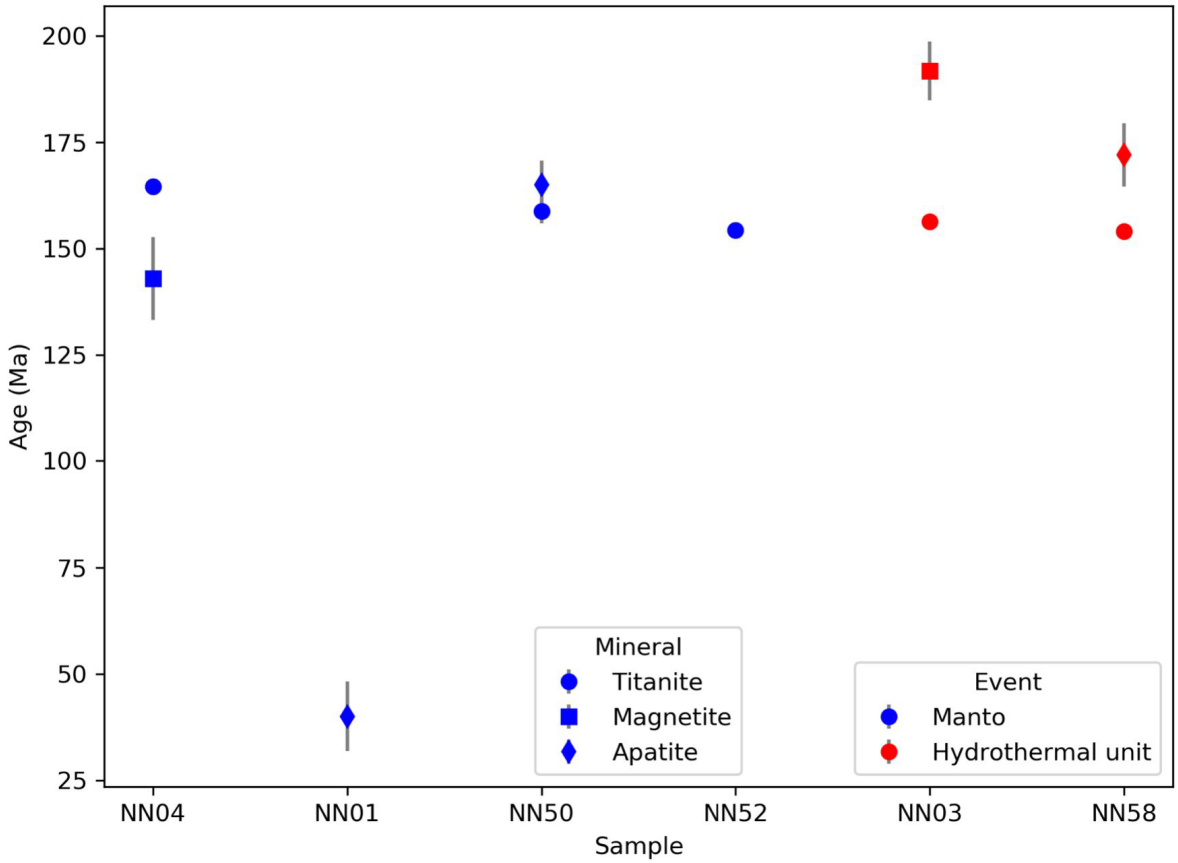

Fig. 1: Compilation of ages obtained for the Mina Justa IOCG deposit in Peru. All but one sample indicate that apatite, magnetite, and titanite at Mina Justa formed before 140 Ma. The different symbols represent the mineral analized and the colors correspond to the mineralization style. Error bars correspond to 2 standard deviations and might not be visible if the uncertainty is less that the size of the marker.