Carbonate U-Pb Geochronology: A Novel Tool for Directly Dating Fluid Flow Events in Mineral Deposits

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Carbonate veins are ubiquitous in many ore deposits and often are interpreted as a late stage in the ore deposit history. Dating both veins and brittle fault material has been notoriously difficult because of a lack of “datable” material. Using innovative techniques, it is now possible to date carbonate in veins, breccias, and faults with the U-Pb isotope system.

This presentation gives an overview of advances in U-Pb carbonate geochronology and explores the effectiveness of the U-Pb calcite dating technique for providing timing constraints for faulting, fluid-flow, and mineralization events. In similarity with other unconventional geochronometers that have low U content and incorporate common Pb into their structures (such as titanite), calcite is not always straightforward to date and results can therefore be ambiguous to interpret. This method has, however, been successfully applied to a variety of ore deposits, including porphyry, orogenic gold, Carlin-type, and Pb-Zn mineralization.

In a fault-controlled Cu-Au-Mo porphyry system in the central Yukon, Canadian Cordillera, U-Pb carbonate dating has been used to analyze a variety of fault and vein material. Over 50 samples have been dated, revealing a long history of faulting and fluid flow in the deposit spreading over tens of millions of years between ~75 and <20 Ma. The results show the carbonate veins crystallized during the main ore-forming event at ~75 Ma. Subsequently, there was a prolonged period of fault-controlled fluid pulsing that likely concentrated metallic minerals in the deposit. The findings show that carbonate veins are not always late features within ore deposits and are an underutilized resource for understanding the full temporal and fluid evolution of a system. Carbonate U-Pb geochronology is therefore potentially incredibly useful for telling the previously untold and long history of fluid flow in a variety of deposits.