Advances in Applications of LA-ICPMS to Minerals in Ores and Black Shales

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Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) is a powerful analytical tool in ore genesis and Earth evolution research. We have focused on pyrite, the most common sulphide, because it adsorbs a large range of trace elements during growth, shows excellent growth zoning and is fairly robust to metamorphic recrystallization. A combination of laser spot analysis with laser mapping of texturally characterised pyrite enables a metal paragenesis to be developed for any given ore system up to middle greenschist facies of metamorphism. This approach is particularly important for determining the timing of gold in a mineral paragenesis.

Just as hydrothermal pyrite adsorbs metals from ore fluids, marine pyrite adsorbs trace elements from seawater. This enables us to produce seawater trace element time series for over 25 trace elements from deep time to modern oceans. Gold for example was enriched in the Archean ocean, but depleted in the Proterozoic ocean, which helps to explain the lack of major gold deposits in the Boring Billion period.

Some important trace elements are not adsorbed into marine pyrite, and LA-ICPMS analysis has shown they concentrate in the organic-clay matrix of black shales (e.g V, U, Cr, Th, Sn and REE). This means that a combination of laser spot analysis on marine pyrite and the pelagic matrix in black shales enables all significant trace elements to be successfully tracked through time, providing proxies for ocean nutrients, atmosphere oxygenation and upper-most crustal composition. These factors are shown to control the cycles of basin-hosted ore deposits through time.