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Orogenic gold deposits span a spectrum in regards to setting and style of mineralization, nature of gold (e.g., invisible, coarse) and favourable host rock. In addition, deposit formation is often attributed to protracted multi-stage hydrothermal processes. That gold mineralization also depends on a variety of features, such as metal-source reservoirs, metal-transport processes and wall-rock stratigraphy, which add to the challenge of investigating origin of paleo-mineralized settings. Recent work using quantitative laser ablation inductively coupled plasma-mass spectrometry (LA ICP-MS) element distribution maps/profiles and their corresponding time slice datasets (TSD) provides new insight into identifying and assessing elemental paragenesis, multi-dimensional element coupling/decoupling processes, and corresponding mineralizing events. To further assess complexities of mineralization, application of geostatistical tools (e.g., multidimensional scaling, principal component analysis, linear discriminant analysis) and various innovative multi-element binary plots (e.g., Ag versus Au, Ni versus Co) is advised.

To illustrate the application of this methodology, the results LA ICP-MS mapping and data processing for Fe sulphides from several metasedimentary-rock-hosted Canadian gold systems are presented: three Archean Algoma-type BIF-hosted gold deposits (~ 4 Moz Au Meadowbank, ≥ 2.8 Moz Au Meliadine district, ~ 6 Moz Au Musselwhite) and eight slate-belt style vein gold deposits from the Paleozoic Meguma terrane (Nova Scotia). The maps and derived elemental plots generated from the various settings demonstrate that: 1) the gold mineralization present is the product of multi-stage processes; 2) elemental associations vary as mineralization progresses, such as the early growth history of sulphides versus later coupled dissolution-precipitation reactions; and 3) different metal-source reservoirs and stratigraphy influence the fluid signature. These results contribute to better deciphering the complex processes involved in the protracted evolution of these and other orogenic-type gold systems (e.g., remobilization of invisible gold from early sulphide, precipitation of visible gold in later sites, increase of Au fineness).