Deciphering element paragenesis, element associations and multi-stage mineralizing processes in orogenic gold deposits with LA-ICP-MS analysis of sulfides

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Quantitative laser ablation inductively coupled plasma-mass spectrometry (LA-ICP-MS) element distribution maps represents a powerful means to investigate both the distribution and relative timing of trace elements capured during sulfide growth. Such data is relevant information for understanding gold mineralizing processes. Althrough there is a trend towards imaging using LA-ICP-MS, we demonstrate that when combined with the compilation of individual time-slice datasets (TSD), LA analyses provide greater potential to understand ore systems. Based on several analyses of gold-bearing sulfides (pyrite, arsenopyrite, pyrrhotite) from a variety of orogenic gold settings (e.g., BIF- and slate-hosted gold deposits), this study introduces new diagrams and application of geostatistical techniques which provide better insight into proceeses of gold deposit formation with possible exploration implications. The proposed protocol of deciphering data follows: 1) use of elemental maps to establish both elemental paragenesis and identify elemental associations; 2) investigate the nature of the mineralizing fluid using Ni:Co ratio variations; and 3) assess upgrading/downgrading and remobilization of gold tenor in the sulfides and by extension in ore deposits using Au versus Ag plots with values grouped by element associations and elemental geochemical affinities. Furthermore, the textural transformation and coupled-dissolution-precipitation (CDP) in pyrite from sedimentary rock-hosted deposits is documented using a new Ag versus Ni plot having defined fields (e.g., diagenetic versus metamorphic). Lastly conventional geostatistical tools are used to confirm element associations through agglomerative hierarchical clustering and factor analyses, whereas a multidimentional scaling approach can identify the geochemical affinity of the mineralizing fluids.