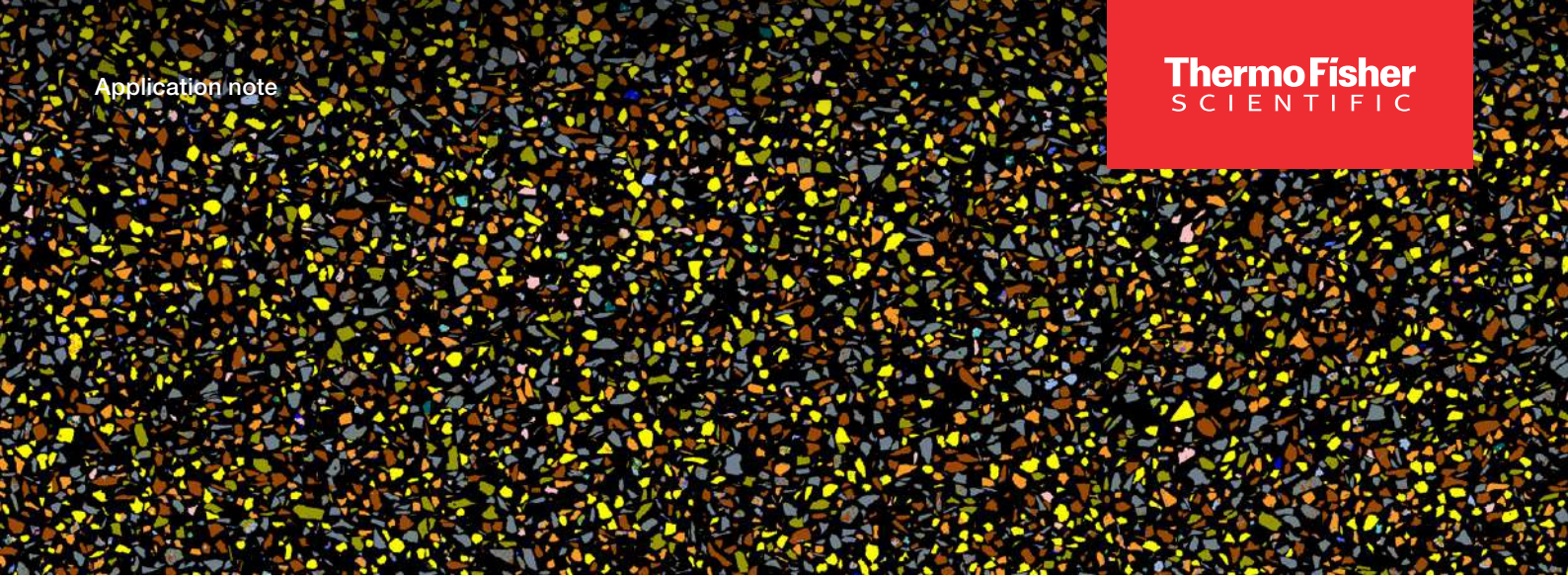
Application note



# Enhancing copper recovery with advanced mineral analysis in Maps Min Software

By 2050, the demand for copper is projected to surge by 70%.[1] This growth trajectory underscores the necessity for advanced geometallurgical strategies that tackle the challenges posed by modern copper deposits, which often feature lower grades and complex textures. Reliable, quantitative mineralogical data is critical for comprehensive ore characterization and copper recovery optimization.

## Comprehensive ore characterization

Thermo Scientific™ Maps Min Automated Mineralogy Software offers effective characterization of complex ores through the analysis of multiple particle size fractions from various processing plant streams. This approach captures statistically robust geometallurgical data on the mineralogy and textures of the samples, ensuring representative results for liberation and locking data, as well as mineral associations within micro-textures.

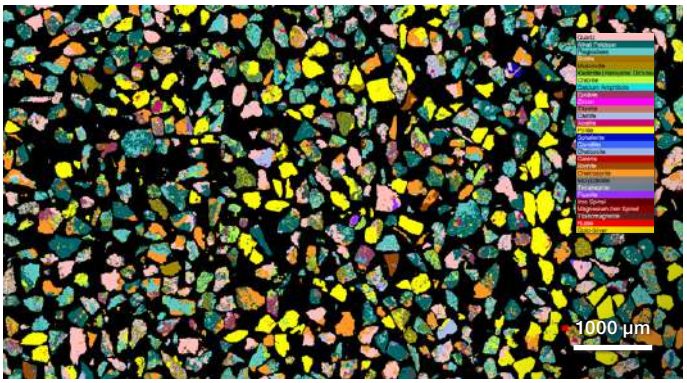



Figure 1. Mineral map generated with Maps Min Software, showing the complex textures found in copper sulfide ore particles.

Polished thin sections or rock slabs can also be analyzed using Maps Min Software to provide insights into an ore body's potential, including valuable mineral content along with deleterious mineral and element data. Mineral identification in Maps Min Software is highly accurate thanks to a proprietary full-spectrum, best-match phase-identification algorithm with mixed-spectrum deconvolution. The easy-to-use interface makes it fast and straightforward to set up mineral libraries for a range of commodities and rock types.

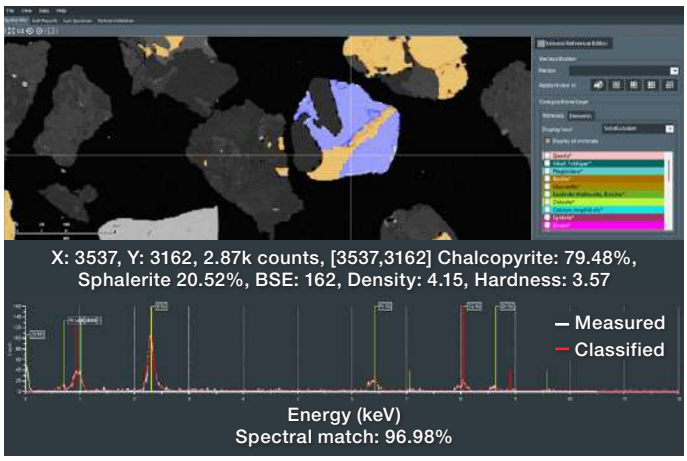



Figure 2. A mixed spectrum at the boundary of chalcopyrite and sphalerite grains, which is correctly classified as a mixture, or mixel, of both minerals through the proprietary identification algorithm.

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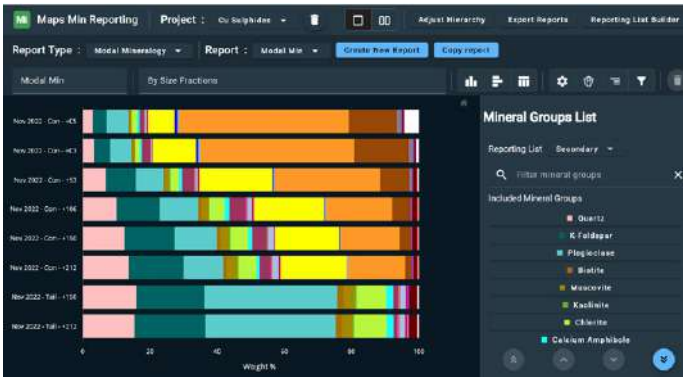


**Figure 3. Maps Min Software reporting interface showing a modal mineralogy bar chart of bulk copper ore concentrate and tailings samples. Results from multiple replicates are combined for the +150 and +212 µm size fractions in both samples.**

## Processing challenges for copper deposits

Copper deposits often contain arsenic-bearing enargite and fluorine-containing gangue, such as sericite or clays, which present processing challenges. Maps Min Software delivers quantitative data on the locking and association of copper sulfides and non-sulfide gangue, as well as on the deportment of copper among floatable (sulfides) and non-floatable (oxides and silicates) minerals. Unique standards-based elemental quantification provides true elemental abundances for each measurement, which is crucial for determining potential dilution in the flotation concentrate and for understanding copper losses to tailings.

For example, a high proportion of free chalcopyrite surface area indicates high floatability, while significant amounts of locked chalcopyrite associated with silicates may reduce concentrate grade or recovery. Liberation data can identify whether unliberated particles or poor flotation cell mechanics and reagent performance are causing separation inefficiency.

## Leaching of low-grade copper sulfide and oxide ores

Analysis with Maps Min Software also provides the information needed to enhance the efficiency of hydro-metallurgical and bacterial leaching of low-grade copper ores. High-precision modal mineralogy data on all minerals affecting acid consumption and heat generation are used to calculate the impact on leaching effectiveness. Free surface area and locking information on acid consumers, for instance, indicates leaching efficiency, while similar data on acid generators, such as pyrite, informs acid consumption rates. Mineral association tables from Maps Min analysis also quantify textural associations between the phases, which aids in the assessment of general ore leachability.

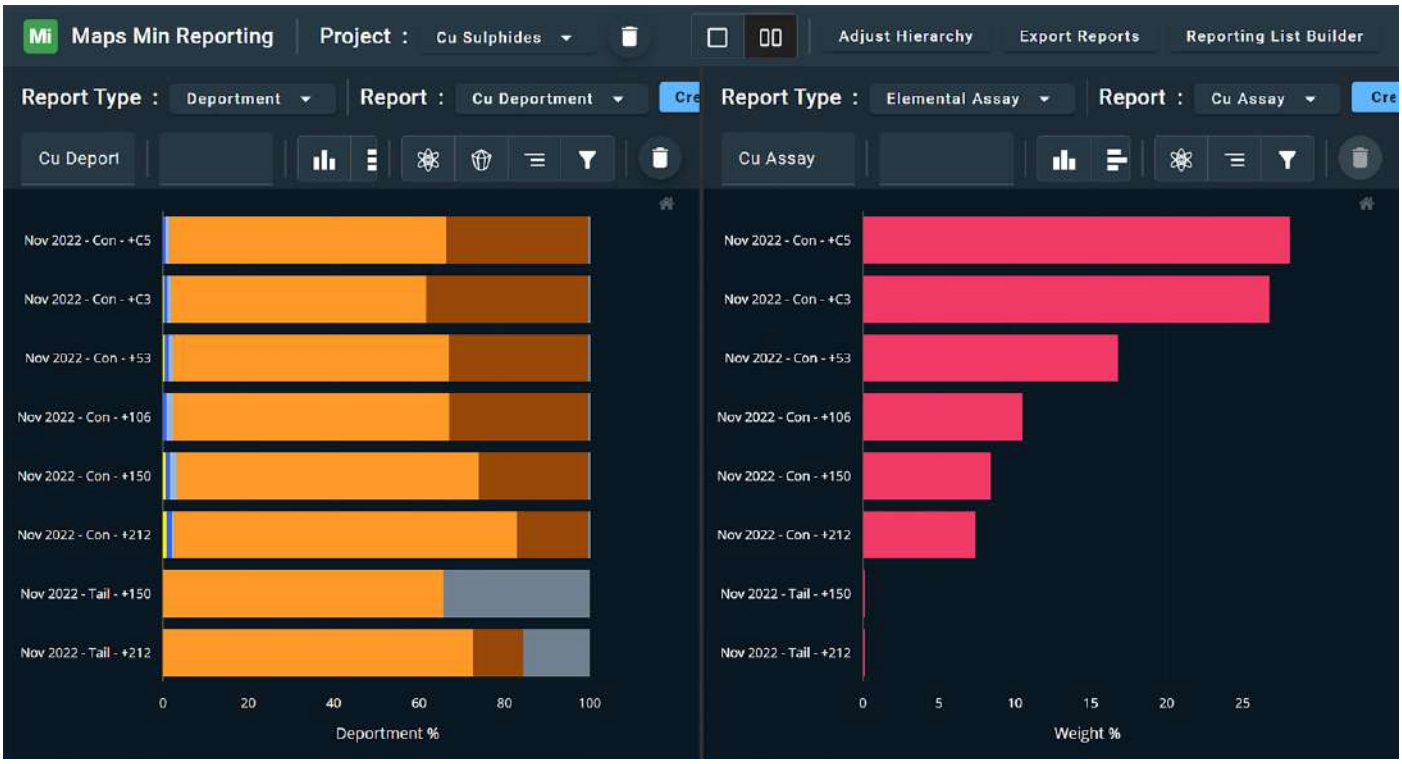


**Figure 4. Side-by-side reports displaying the deportment (left) and elemental assay (right) of copper in concentrate and tailings samples. Yellow – pyrite, blue – covellite, light blue – chalcocite, orange – chalcopyrite, brown – bornite, and grey – tetrahedrite.**

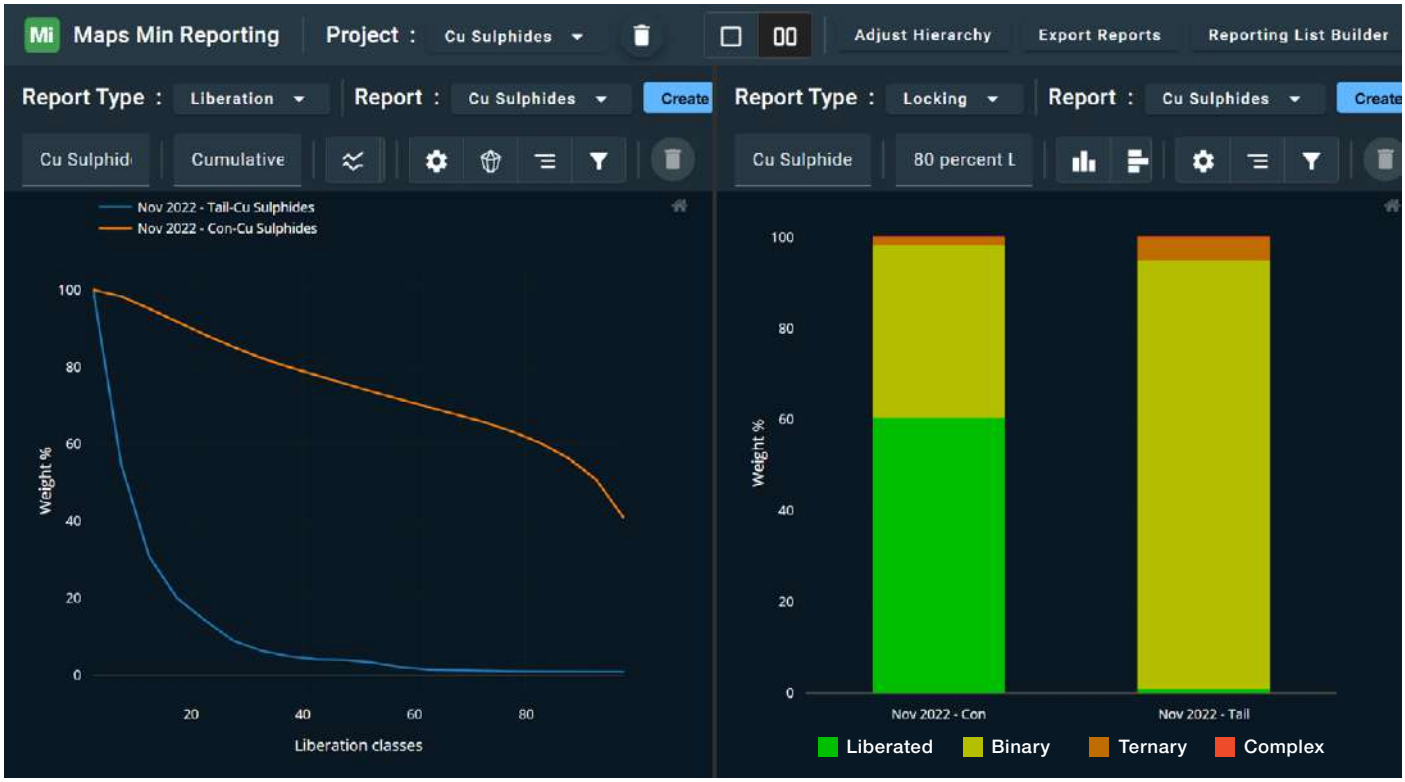


**Figure 5. Liberation graph of combined copper sulfides (left), along with a bar chart showing locking characteristics for the concentrate and tailings samples (right).**

## Advanced analysis modes

Full X-ray grid mapping precisely captures chemical variations within grains, while a centroid mode offers faster acquisition. Both modes can be used to target specific minerals through a trigger, which expedites analysis. This search mode is particularly useful for analyzing feed or tailings samples where ore mineral concentrations are lower, thus optimizing acquisition times to efficiently measure the textural characteristics of key minerals in low-grade samples. This generates higher statistical results on important ore-mineral properties (e.g., grain size, liberation, and associations) in less time than it would take to run a normal grid or centroid measurement, as these analyze all particles in a sample.

## Conclusions

Quantitative evaluation of copper distribution throughout all copper-bearing minerals, together with the characterization of the textural occurrences in an ore, facilitates the formulation of processing strategies to maximize copper recovery at optimum grades. Leveraging the highly accurate mineralogical data provided by advanced Maps Min Software enables the copper industry to effectively address the geometallurgical challenges of modern deposits, ensuring sustainable growth and efficient resource utilization.

### References

1. Farrel, S and Whitton, L. **BHP Insights: how copper will shape our future.** (2024) URL: https://www.bhp.com/news/bhp-insights/2024/09/how-copper-will-shape-our-future

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