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Evaluation of Cold Block Digestion for Large-Scale Geochemical Analysis and On-Site Laboratories

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The search for environmentally friendly, safe, and reliable analytical methods in mineral exploration and geochemistry is driving the development of innovative sample preparation and introduction methods for well-established techniques like ICP-OES and ICP-MS. While sampling with laser ablation (LA) shows promise as a future trend, digestion remains the broadly accepted and used technique. It also remains one of the most complex areas in the analytical procedure for high-volume geochemical analysis. This study presents findings from our ongoing evaluation of Cold Block technology for high-volume multi-element analysis of diverse geological samples, including ores, concentrates, and tailings.

Sample preparation and introduction are critical steps in geochemical analysis, directly affecting the quality, reproducibility, and accuracy of results. [1] LA offers potential benefits, such as avoiding digestion steps, reducing contamination, and minimizing waste. However, challenges remain regarding sample homogeneity, matrix effects, and the availability of matrix-matched standards for LA-ICP-MS and LA-ICP-TOF.

Traditional digestion methods, while well-established, often involve strong acids (HCl, HNO3, HClO4, and HF), long digestion times, and high temperatures, posing safety and environmental concerns. Cold Block technology offers a potential solution by utilizing focused short-wavelength infrared radiation for rapid sample heating and a unique top cooling zone to minimize the acid fumes released while providing more efficient digestion of the samples. This eliminates the need for perchloric acid, reduces acid exposure, and accelerates digestion times to 10-45 minutes, compared to hours for conventional methods.

Our evaluation included analysis of certified reference materials (CRMs) and various geological samples. Results from Cold Block digestions were comparable to those obtained using classical four-acid digestion techniques. While the use of boric acid to neutralize remaining HF after digestion may increase some detection limits, they still remain in the low ppm range.

Cold Block technology has the potential to become a new standard in exploration geochemistry and beyond, offering a safer, faster, and more environmentally sound approach. Further development and evaluation of specific methods are ongoing to expand its applicability.

References

[1] W. Zhang, Z. Hu, Recent advances in sample preparation methods for elemental and isotopic analysis of geological samples, Spectrochimica Acta Part B. 160 (2019) 105690.