A new workflow for improving raw material characterization exponentially

Introduction

With exponential increase in the amount of battery-powered devices – from smartphones to electric cars –high quality characterization of geomaterials becomes increasingly important. This is true for primary raw materials (ores) as well as for recycled materials (batteries). There is a growing need therefore to be able to characterize the economic potential of such materials accurately and comprehensively.

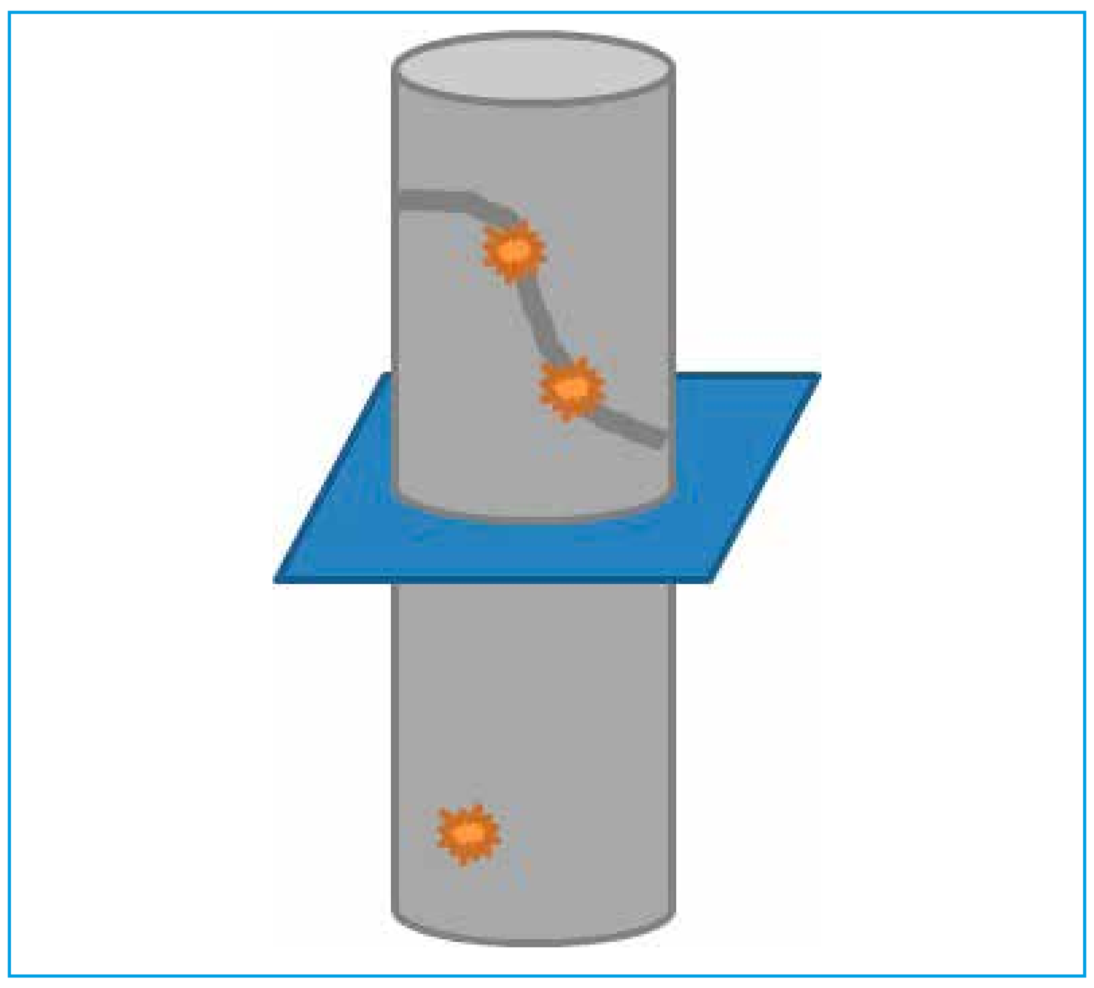

Figure 1. Sketch of a drillcore sample with small amounts of valuable minerals (orange stars), some of which are located in a visible vein (dark grey). A random thin section surface (blue plane) is not likely to contain any valuable minerals.

Methods

Traditionally, such analysis of geological samples is done with bulk or 2D surface methods applied directly to the sample surface or the surface of a carefully prepared thin section. Automated analysis tools, such as QEMSCAN with SEM-EDS, have become quite efficient and convenient, while more interactive tools, such as EPMA or LA-ICP-MS provide unparalleled accuracy on elements covering almost the entire periodic table. The main drawback with 2D surface methods is knowing a priori where to section a 3D sample in order to obtain the best representative analysis. Contextual knowledge of the sample material can help a lot, but an economically significant part of the sample may nevertheless remain unexamined (*Fig. 1*). We have therefore developed a workflow (*Fig. 2*) which takes away most of the subjectivity and chance of preparing 2D slices from 3D objects, such as rocks. The first step of the workflow, XCT, is non-destructive and can later be used as a map for all subsequent analyses. GTK has a unique facility in Finland with XCT and advanced 2D mineralogical, geochemical and isotopic analysis systems in the same laboratory, with the researchers working in close collaboration.

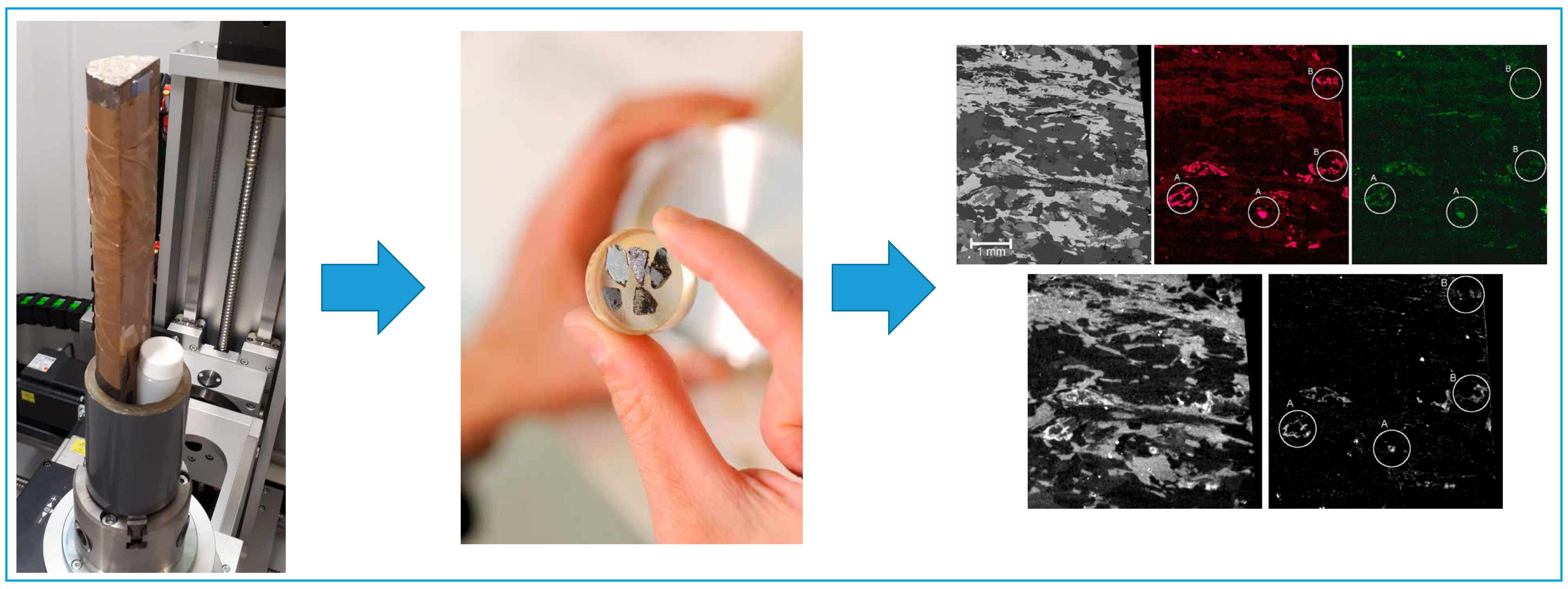

Figure 2. In the new workflow the sample is first scanned with XCT intact (left), then more detailed traditional analysis is done on specified areas (middle), and finally the detailed results (top right) can be combined with corresponding XCT images (bottom right) and extrapolated to the volume.

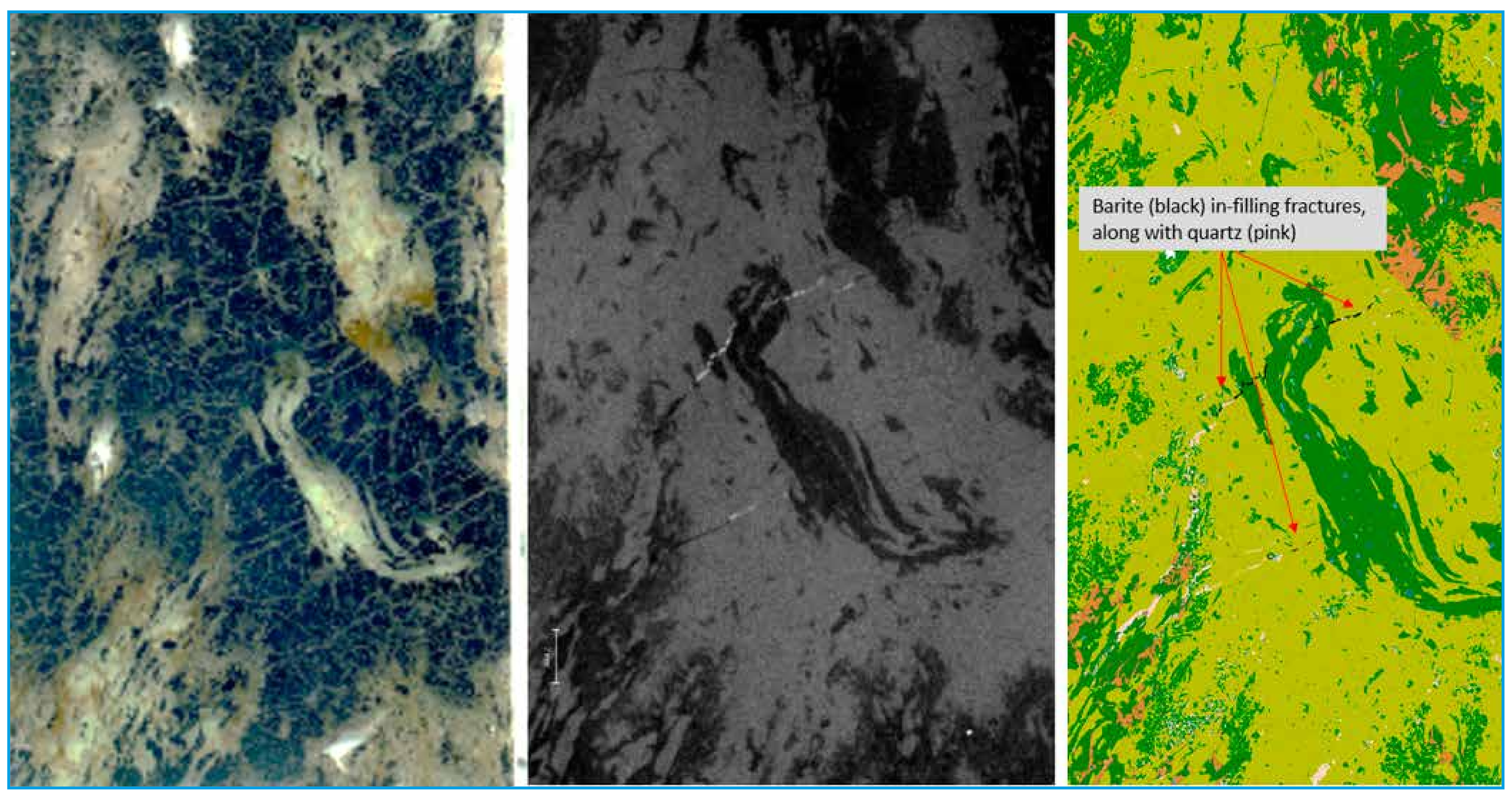

Figure 3. X-ray tomographic cross-section from a mineral exploration drillcore (middle) contained a high density fracture filling (bright color means high density). A thin section was made from the same feature (left) and analyzed with QEMSCAN (right) to identify the mineral inside the fracture.

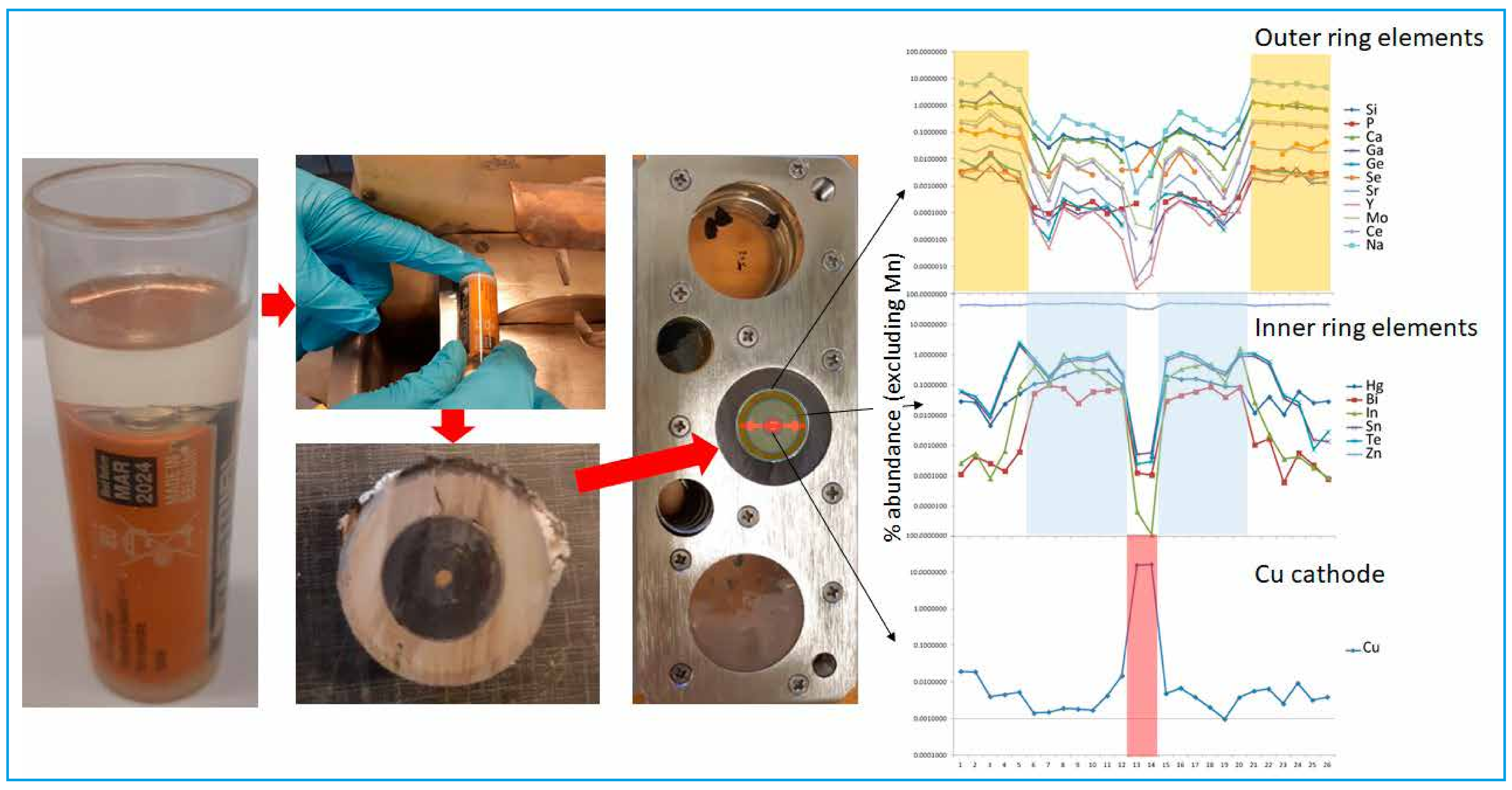

Figure 4. For LA-ICP-MS analysis a battery is mounted in epoxy (left), cut (middle top), polished (middle bottom) and mounted (right). A profile of elemental composition from one end of the battery to another can then be obtained (graphs on the right).

Results and conclusions

The workflow has been successfully used with mineral exploration samples (Fig. 3) and batteries (Fig. 4) to find important features in the sample for more detailed analysis. This workflow will be used increasingly in the future, as it allows more economical sample preparation and enables the discovery of interesting features that would be very unlikely with traditional methods. It also makes the traditional analysis results exponentially more valuable, when they can be extrapolated from a surface to the whole volume.

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