
## Lab Report XRF 148

# S8 TIGER Series 2

- Analysis of the Elemental Distribution in Columbite-Tantalite (Coltan) rocks from Canada with the XRF$^2$ mapping of the S8 TIGER Series 2

Columbite – Tantalite, called Coltan, is one of the most important resource for high-end semiconductor components – Tantalum capacitators are almost used in every electronic product. The mining of Coltan is known as conflict financing resource due to the large mining activities in D.R. Congo and Rwanda, which are owning together about 45% of the market for fresh mined material. Other countries are Brazil (24%) and Canada (9%). Australia has almost exploits it's known resources. The volatile market and the high speculation rate has caused many turbulences at the markets.

Nevertheless the search for new resources is ongoing and the characterization of the element distribution in geological samples for later refining and mineral beneficiation steps is vital to evaluate the value of the resource.

## Instrumentation

The S8 TIGER Series 2 is a high power 4 kW wavelength dispersive X-ray fluorescence spectrometer with unrivalled analytical flexibility. The excitation of elements is done with a voltage ranging from 20 kV for the light elements up to 60 kV for the heaviest elements. The current can be instantly adjusted between 5 – 170 mA to detect trace elements and keep for major elements the count rate in the linear range of the detector. Uniquely for this kind of instrumentation this switch happens instantaneously with our DynaMatch technology. With up to four collimators and up to eight analyzer crystals the S8 TIGER Series 2 provides either optimal resolution and/or high intensity for the analysis of fluorescence lines. With the new HighSense detector technology the intensities of element lines are detected; for light elements with the flow counter and for the heavy elements with the scintillation counter. Based on this advanced WDXRF technology the S8 TIGER Series 2 detects all elements from Be to Am, covering the trace region up to 100%.

Figure 1: S8 TIGER Series 2 for the mapping analysis with the XRF$^2$ functionality

To analyze the element distribution in samples or very small sample amounts down to a single particle the S8 TIGER Series 2 can be equipped with the XRF$^2$ mapping tool . The beam is collimated with the HighSense mask down to either 1.2 mm or even down to 300 µm spot size (FWHM). The surface is than scanned with a step size of 100 µm, providing the best available spatial resolution for this kind of instrumentation. The optimal detection of light and heavy elements is done based on WDXRF technology providing a much better intensity compared to EDXRF for light and heavy elements and maintaining the excellent spectral resolution of WDXRF. This is especially important for this investigation of traces of rare elements, especially avoiding line overlays from major elements. Based on the high intensity setup of the S8 TIGER Series 2 even the detection of these rare elements in the trace region is possible.

## Sample and Measurement

When loading the sample the S8 TIGER automatically takes a high definition picture of the sample mounted in the holder. The Coltan rock is shown as high resolution picture in figure 2. For the measurements now the spots, lines, areas or the entire sample surface can be selected with a mouse "drag and drop" command. After the definition of spot size, step size and measurement parameters the instrument autonomously scans the sample. For the rock we have used two boxes to map flat surfaces in order to record a more accurate image of the element distribution.

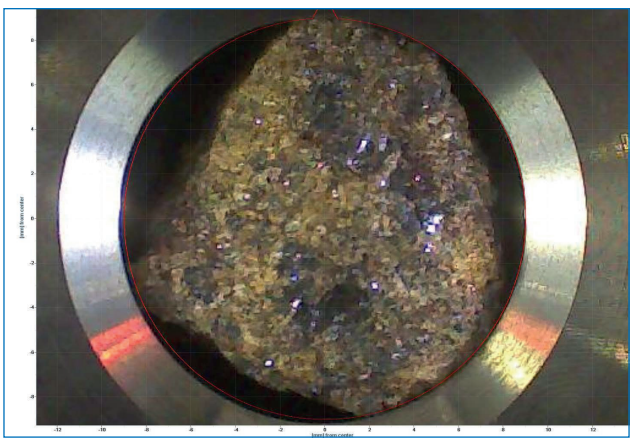


Figure 2: High Res picture taken from the sample in the S8 TIGER Series 2.

## Results

Geologist and metallurgists are interested of the elemental distribution of valuable elements in the Coltan sample from Canada. In this sample clear, brownish and purple grains in the rock can be seen. The brownish part shows high concentration of calcium, mainly the host rock Carbonatite.

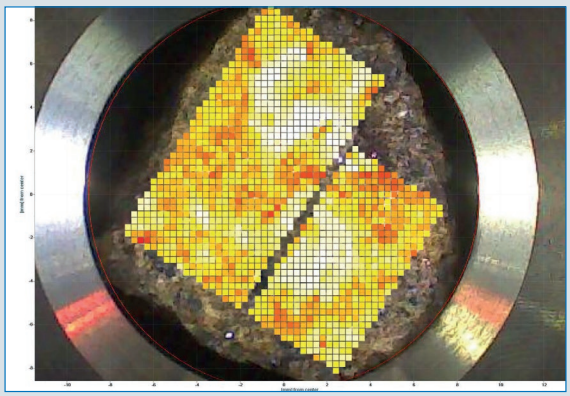


Figure 3: Element map of calcium analyzed with the S8 TIGER Series 2

Figure 4: Element map of iron analyzed with the S8 TIGER Series 2

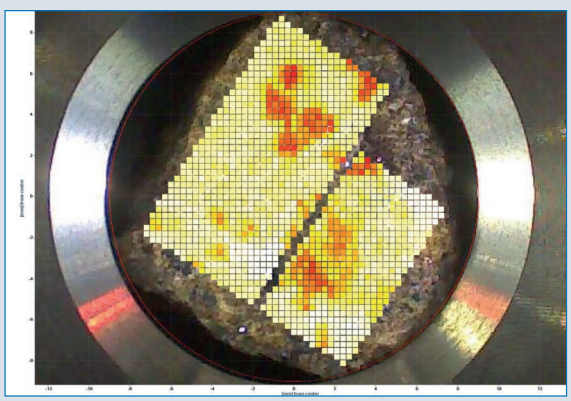


Figure 5: Element map of manganese analyzed with the S8 TIGER Series 2

Figure 6: Element map of titanium analyzed with the S8 TIGER Series 2

Typical base metal elements are occurring at high concentration levels in the purple granules in the rock and are linked to each other. The two main rock phases in Coltan are $((Fe,Mn)Nb_2O_6$ and $(Fe,Mn)Ta_2O_6$, in both phases iron and manganese are linked, the only difference is the third metal Nb or Ta.

Interesting is the spotty distribution of lanthanum in the rock at trace level. We found very small local spots of lanthanum distributed mainly on the host rock.

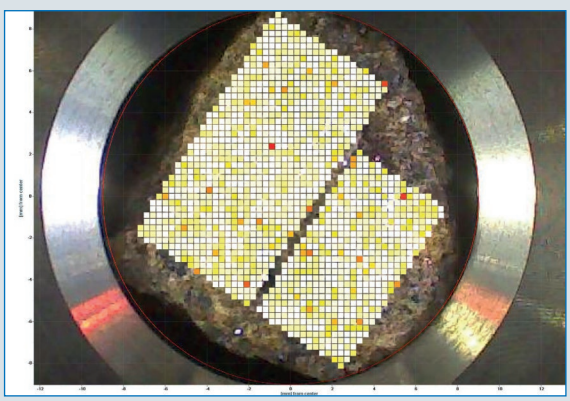
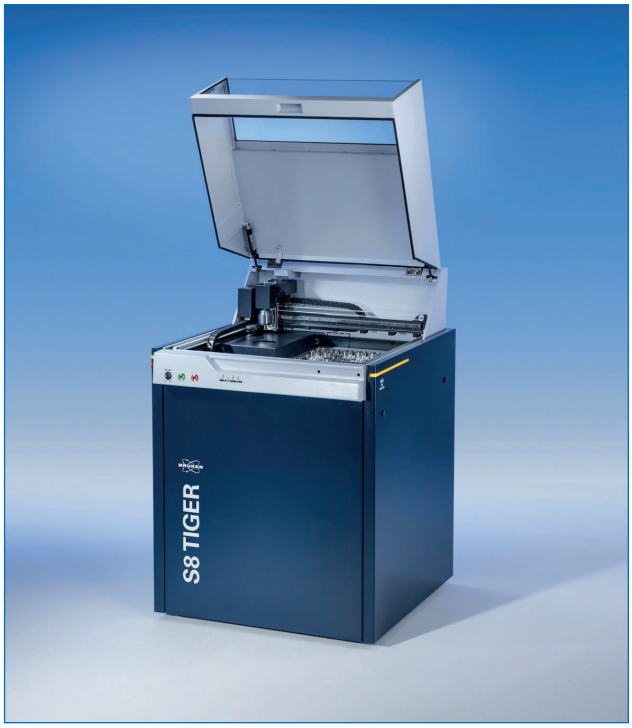


Figure 7: Element map of lanthanum analyzed with the S8 TIGER Series 2

## Conclusion

With the very high local resolution of 300 µm (Spotsize FWHM) and the accurate step size of 100 µm even fine granules in the rock can be analyzed and identified. The high sensitivity of the HighSense beam path of the S8 TIGER Series 2 making even small differences in element concentration visible. The high sensitivity for light elements helped to recognize specific rock types, while the high spectral resolution in combination with the high power excitation of the WDXRF based mapping enabled the analysis of traces of lanthanum in these small spots. With its HighSense beam path the S8 TIGER is providing significantly higher sensitivity compared to any other WDXRF system and maintaining the high resolution of WDXRF at the same time.

For geological classification and the decision of the value of this Coltan resource, Mn and Fe can be used as tracer for fast rock screening, highlighting the valuable minerals in the rock. Beside process control in the production lab, the S8 TIGER Series 2 can be used with the $XRF^2$ mapping tool for process optimization and classification tasks.

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