Report
The planet in Archeology

xplorex

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Introduction

X-ray diffraction is a well-established technique to identify the presence of -polycrystalline- compounds (also referred to as “phases”) in specimens.

Xplorex, develops and manufactures the **planet**; a portable, high-resolution x-ray diffractometer specifically aimed at phase identification. Such a diffractometer can be an enormous time saver in exploration, as well as other types of field work, like the investigation of an archeological site. Please note that the sample needs to be presented in powdered form.

To demonstrate the capabilities of the planet we organized a one-day excursion to a copper quarry from the bronze age.

The **planet** uses para focusing reflection geometry, which yields hitherto unsurpassed resolution for portable XRD. We chose reflection geometry so that the sample thickness is not critical for both heavily absorbing materials and lighter matrices.

Experimental

With a hammer we separated the black part of a piece of rock found on the site.

Figure 1 Piece of Dolomitic rock found on the archeological site in Brixlegg, Austria

The Green part was indicated as Malagite and the bright blue dots were Azurite, both Copper rich minerals. The black pieces were subsequently crushed and ground to a fine powder using a manual pestle and mortar (Agate).

The powder was mounted in the diffractometer and measured. The measurement parameters are summarized in Table 1.

Parameter	Value
Range	
Start Angle (°2θ)	20.15
End Angle (°2θ)	96.51
Step size	Variable; The **planet** has predefined step sizes
Integration time	60s / data point (the measurement comprises 15 times 640 data points)
Total Measurement time	15 minutes
Diffractometer settings	
High Tension	30 kV
Emission Current	0.65 mA
Tube anode	Cu
Focus dimensions	40µm diameter
Take off angle (°)	8
Beam divergence (°)	1.25
Specimen dimensions	7mm diameter; 2mm thickness
Spinning frequency	0.5 Hz
Optical path	Seemann – Bohlin based
Focusing circle radius	160mm
Detector	Dectris' Mythen 1D solid state linear detector
Identification software	Match! From Crystal Impact
Reference database	Crystallographic Open Database (Inorganic)

Table 1 Measurement parameters for black rock sample

The diffractometer settings are constant for the **planet**. The operator can choose the measurement range and the integration time for optimal results and ease-of-use.

Results

Figure 2 shows the recorded diffraction pattern together with the result of the phase identification. The first five candidates in the list were tetrahedrite, and we picked the first one. After accepting this candidate as a match, the recalculated list showed Calcite not as the first matching candidate with a plausible chemistry. We excluded the peaks at 42.6 °2θ and 43.4 ° 2θ as these originate from the sample holder (Brass).

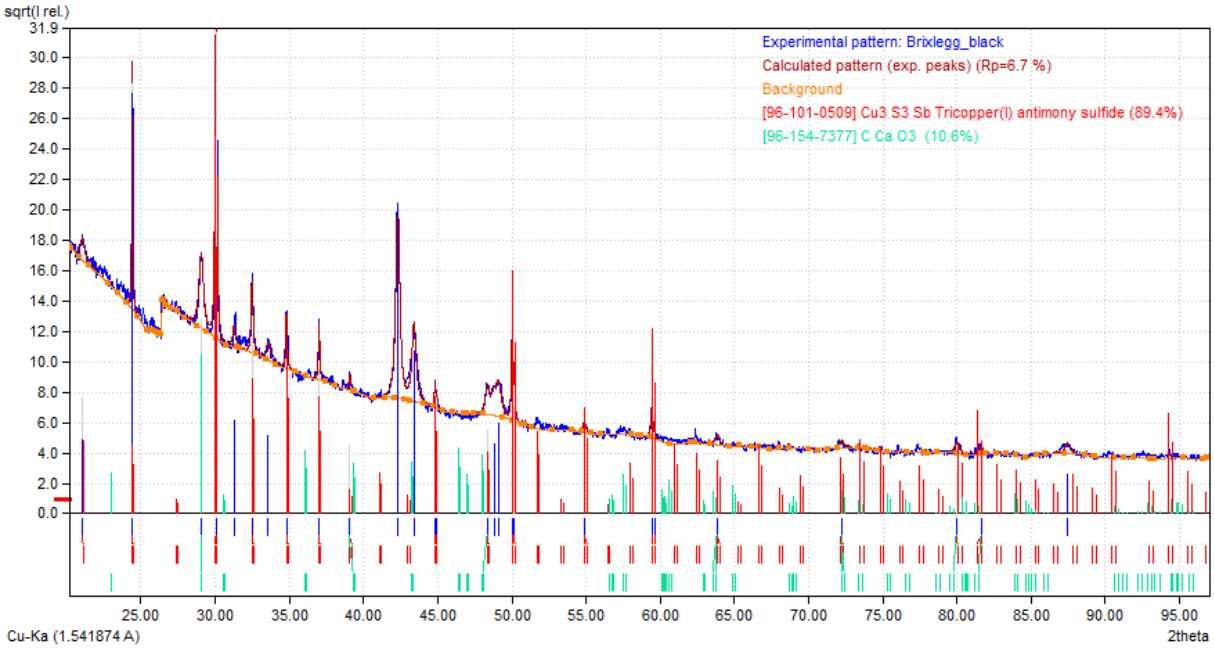

Figure 2 Diffraction pattern of black rock sample; The red lines correspond to the reference pattern for Tetrahedrite, the green lines to Calcite.

Conclusion

The X-ray diffraction measurement we performed with the **planet** clearly identifies the diffraction pattern of two phases: Tetrahedrite and Calcite. No other compounds were detected. Based on the Relative Intensity Ratio the amount of Calcite in the isolated black piece is estimated at approximately 10%.

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