Appendix

Assessment of the Dutch Provisional Restriction on LD and EAF Slags under Article 129 REACH

Analytical data

This appendix provides analytical data on total calcium content, free lime (CaO_{free}) and portlandite ($Ca(OH)_2$) in selected LD and EAF slags. It also describes the analytical methods applied for their determination.

The samples presented do not represent the full range of slags produced across Europe. They are provided as illustrative examples to support the analytical discussion.

Analytical methods used for determination of total calcium, free lime and portlandite:

Calcium in the bulk chemical composition

Major and minor components are analysed by X-ray fluorescence (XRF). XRF determines the elemental composition of the sample. For reporting purposes, the elemental concentrations are conventionally recalculated and expressed in oxide notation (e.g., calcium reported as CaO), as this is standard practice in geochemical and mineralogical analysis. Accordingly, in the tables below, the total calcium content is reported as CaO_{total}.

Oxide notation reflects the conventional way of presenting elemental composition and does not imply that the element is present as the pure oxide phase. In mineral materials such as natural rocks or slags, elements are incorporated into complex mineral phases (e.g., silicates, ferrites), and do not occur as discrete oxides.

The oxygen associated with each element is not measured directly by XRF but is calculated stoichiometrically based on the assumed oxide form. When results are reported in oxide notation, the calculated oxygen is included in the total, resulting in analytical sums typically close to 100%.

DIN EN 1744-1:2009 + A1:2012

According to this method, free lime (CaO_{free}) and portlandite ($Ca(OH)_2$) are determined simultaneously using a conductometric procedure. A dry, finely ground sample (<63 µm) is heated under reflux with ethylene glycol (EG). Under these conditions, free lime and portlandite dissolve in the solvent, while the remaining mineral phases are largely unaffected. The electrical conductivity of the resulting solution is measured, and the combined content of CaO_{free} and $Ca(OH)_2$ is quantified using a calibration curve.

EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

X-ray diffraction (XRD)

With this method, the mineralogical phase composition is determined by powder X-ray diffraction with quantitative phase analysis. The sample material is finely ground in an XRD mill in ethanol suspension together with an internal standard (e.g. 10 wt.% rutile). The diffraction pattern is recorded using cobalt radiation at an accelerating voltage of 40 kV and a tube current of 40 mA over an angular range of approximately 10–115° 2θ. Quantitative phase analysis is performed by Rietveld refinement using appropriate software (e.g. Profex/BGMN). Using this approach, crystalline phases such as free lime (CaO) and portlandite ($Ca(OH)_2$) can be distinguished and quantified individually.

Results:

The following tables present selected analytical results for BOS and EAF carbon steel (EAF C) slags. The data represent a limited set of samples and analyses and are intended to demonstrate that the applied methods are capable of differentiating and quantifying free lime, as well as illustrating the differences between BOS and EAF C slags.

The samples shown do not represent the full range of slags produced across Europe. In particular, the free lime content in BOS slags may vary between steelworks and production conditions. In contrast, the values observed for EAF C can be considered typical, as free lime is usually absent in these slags.

Table 1: Total calcium (reported as cao by convention), free lime and portlandite in selected LD slags from ten different steelworks

Nr.	CaO* (XRF) [wt.%]	Free lime +Portlandite (EN 1744-1) [wt.%]	Free lime (XRD-R) [wt.%]	Portlandite (XRD-R) [wt.%]
1	45,5	7,2	4,0	2,7
2	47,1	8,3	6,4	0,9
3	48,6	8,3	6,1	0,8
4	44,1	9,6	4,9	4,9
5	43,6	3,6	2,4	0,7
6	42,6	7,0	4,1	1,4
7	45,0	1,3	<1	<1
8	48,9	7,4	4,8	0,9
9	35,8	6,5	3,4	1,5
10	40,7	3,4	2,5	1,5

EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

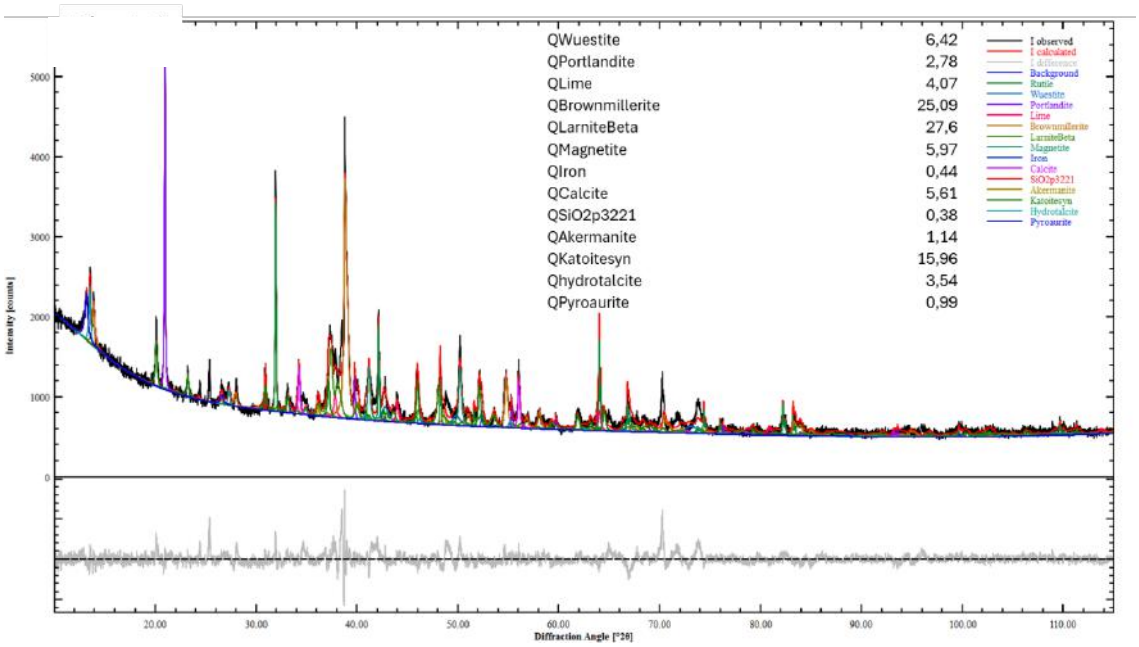
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

Table 2: Total calcium (reported as cao by convention), free lime and portlandite in EAF C slags from ten different steelworks

Nr.	CaO* (XRF) [wt.%]	Free lime +Portlandite (EN 1744-1) [wt.%]	Free lime (XRD-R) [wt.%]	Portlandite (XRD-R) [wt.%]
1	23,4	<0,2	< LOQ	< LOQ
2	23,0	<0,2	< LOQ	< LOQ
3	26,2	<0,2	< LOQ	< LOQ
4	27,2	<0,2	< LOQ	< LOQ
5	28,4	<0,2	< LOQ	< LOQ
6	22,9	<0,2	< LOQ	< LOQ
7	19,3	<0,2	< LOQ	< LOQ
8	18,4	<0,2	< LOQ	< LOQ
9	29,5	<0,2	< LOQ	< LOQ
10	33,1	<0,2	< LOQ	< LOQ

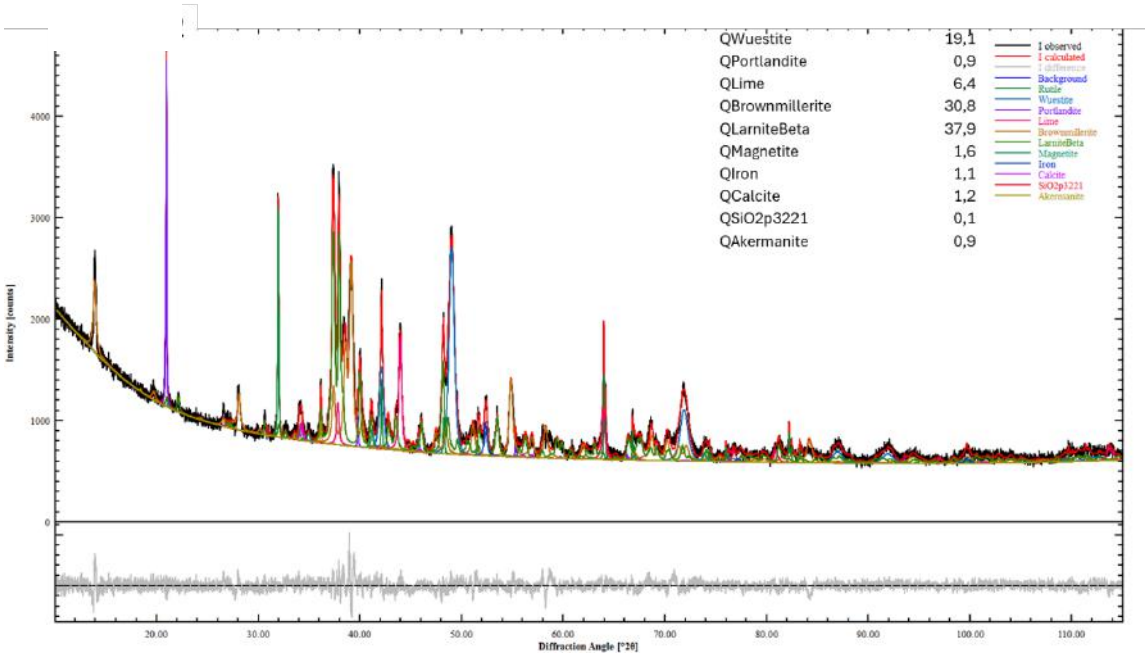
LOQ = *Limit of Quantification*

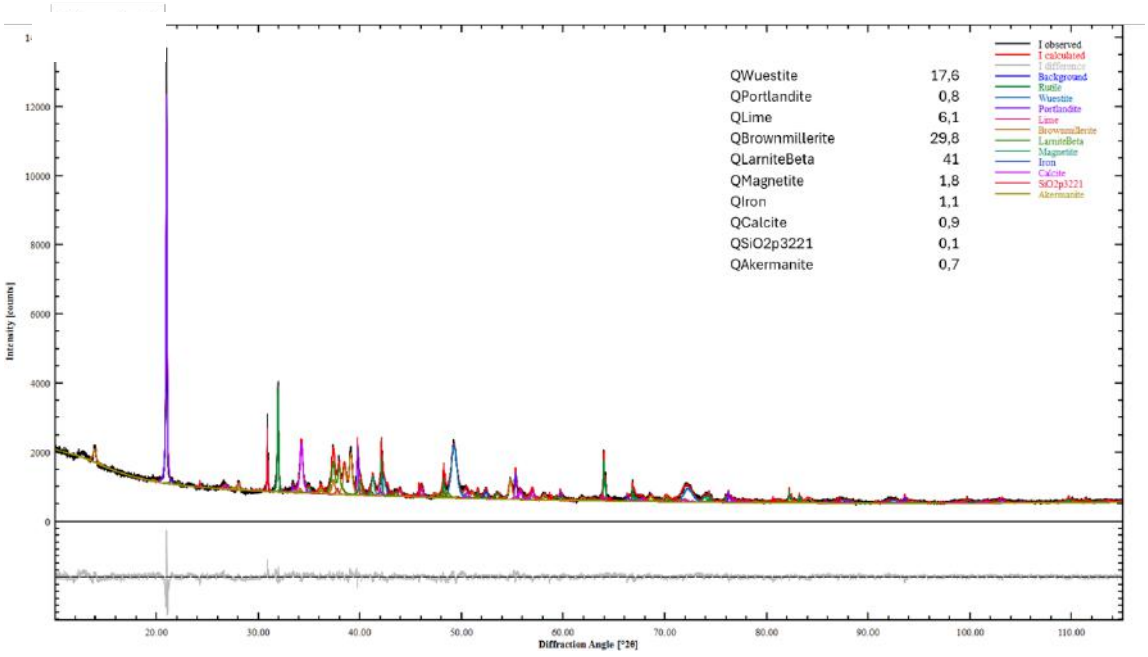
X-Ray Diffraction diagrams – LD slags (BOS)



EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

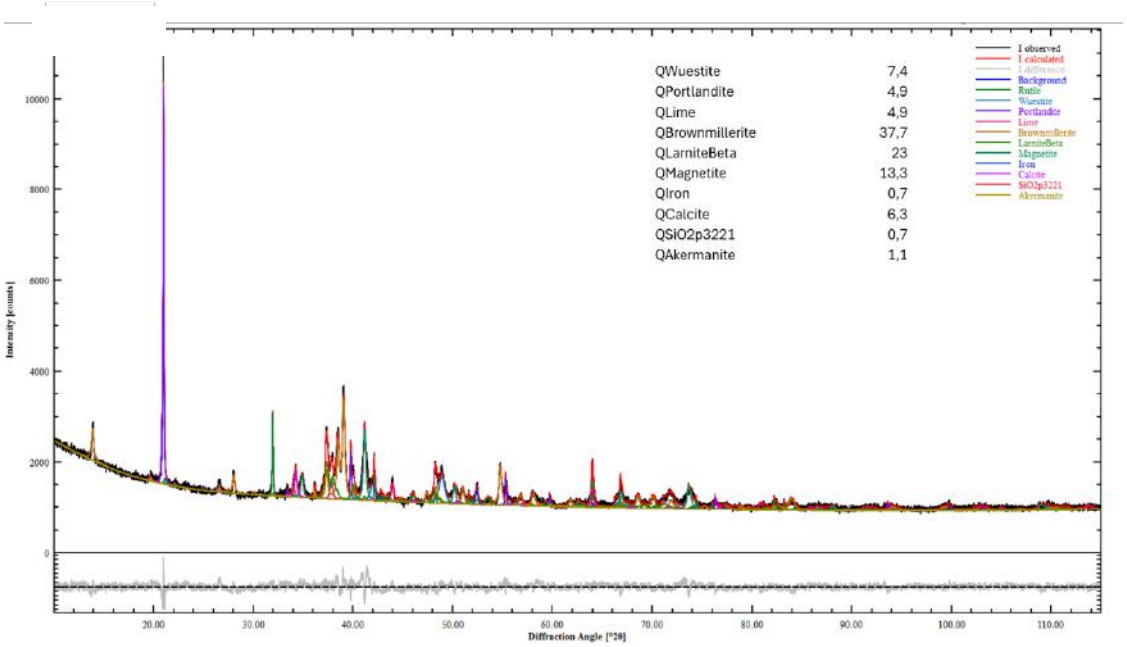
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

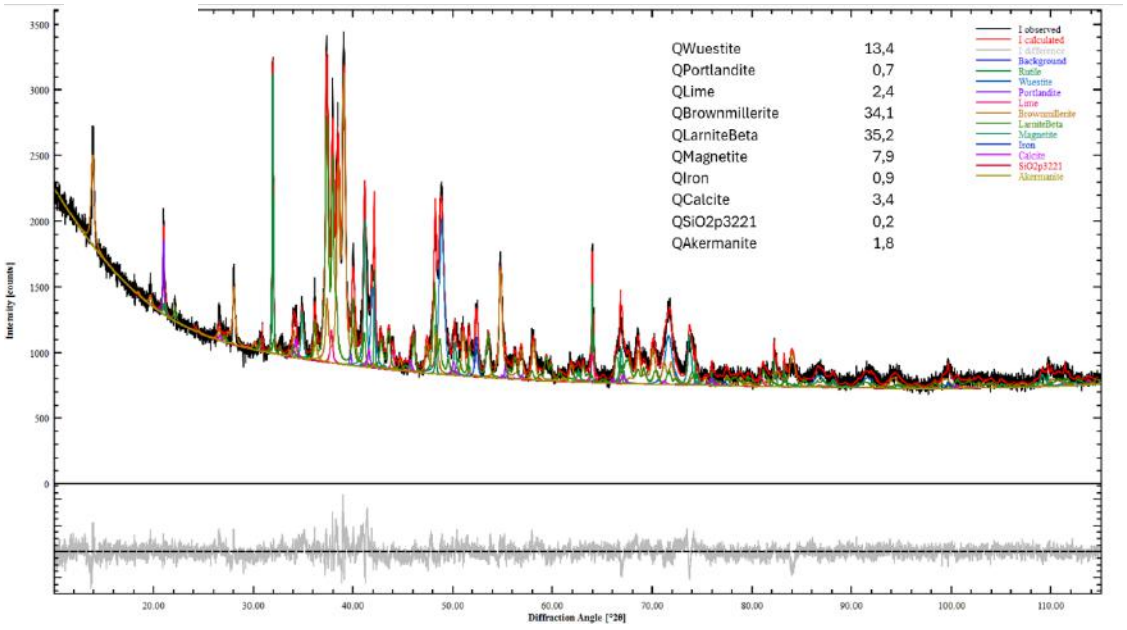




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

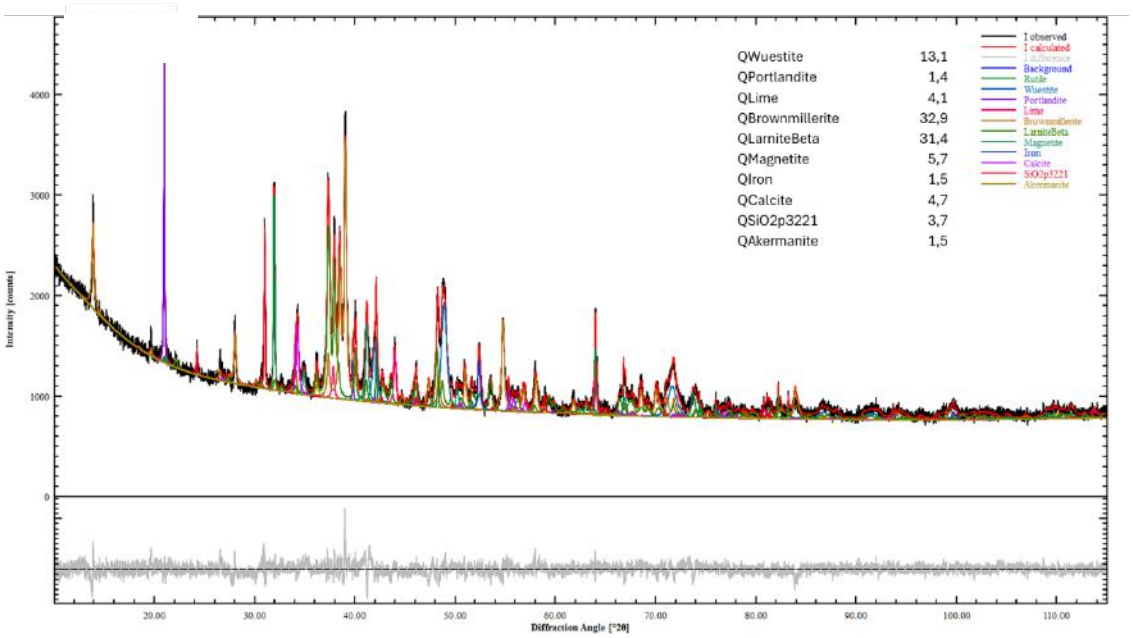
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

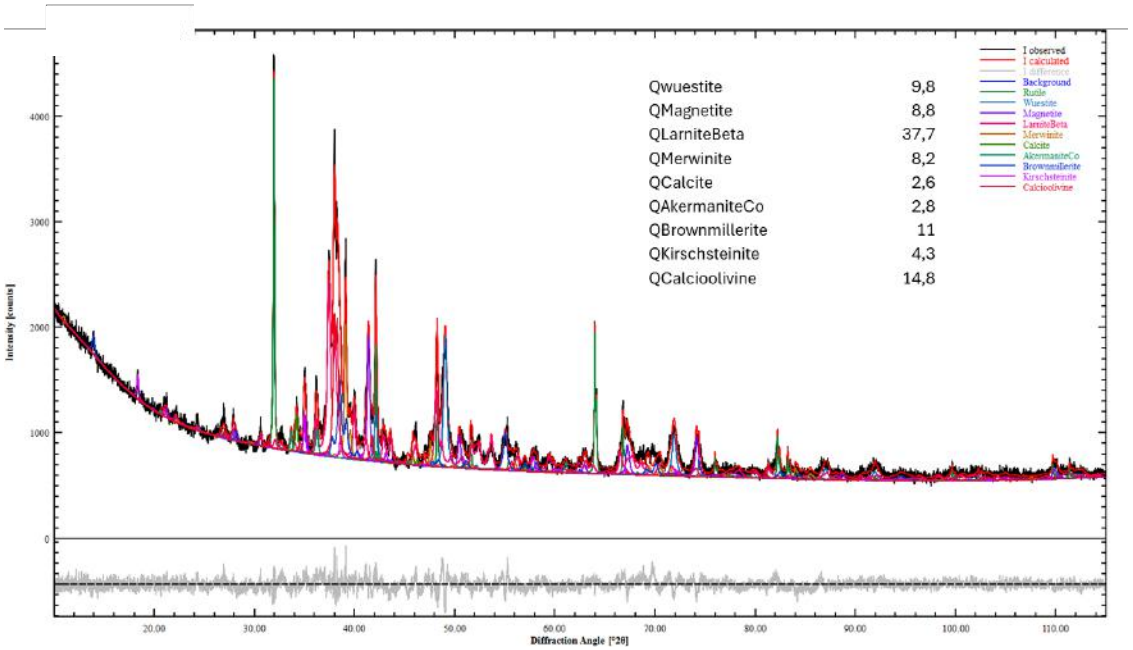




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

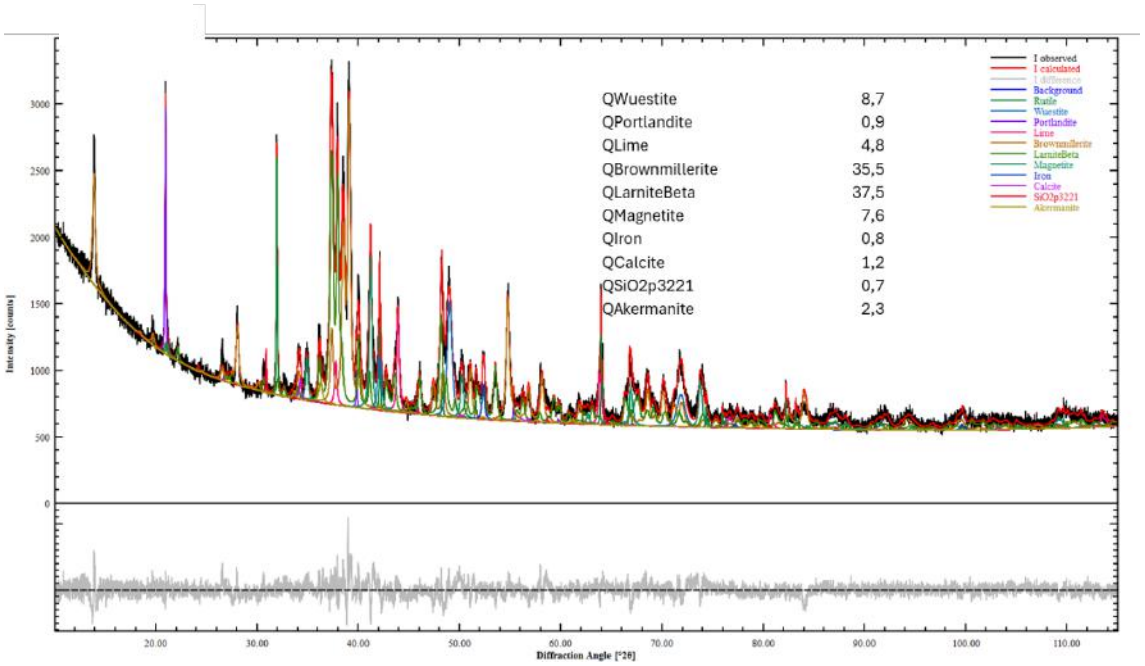
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

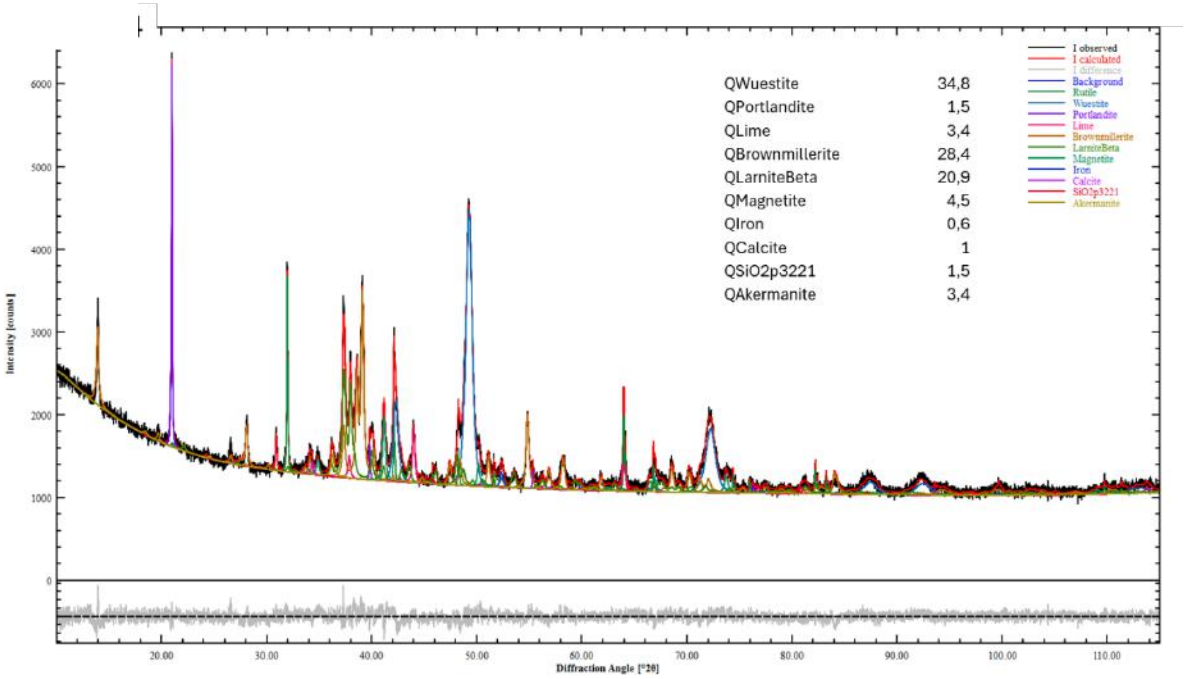




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

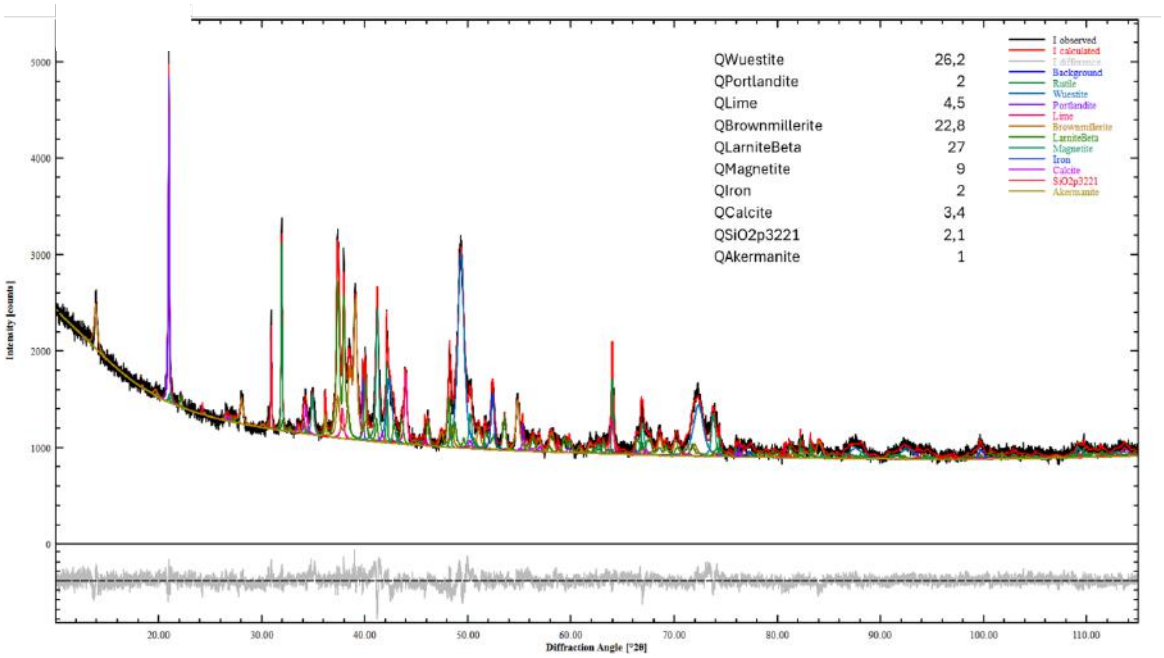
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles





EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

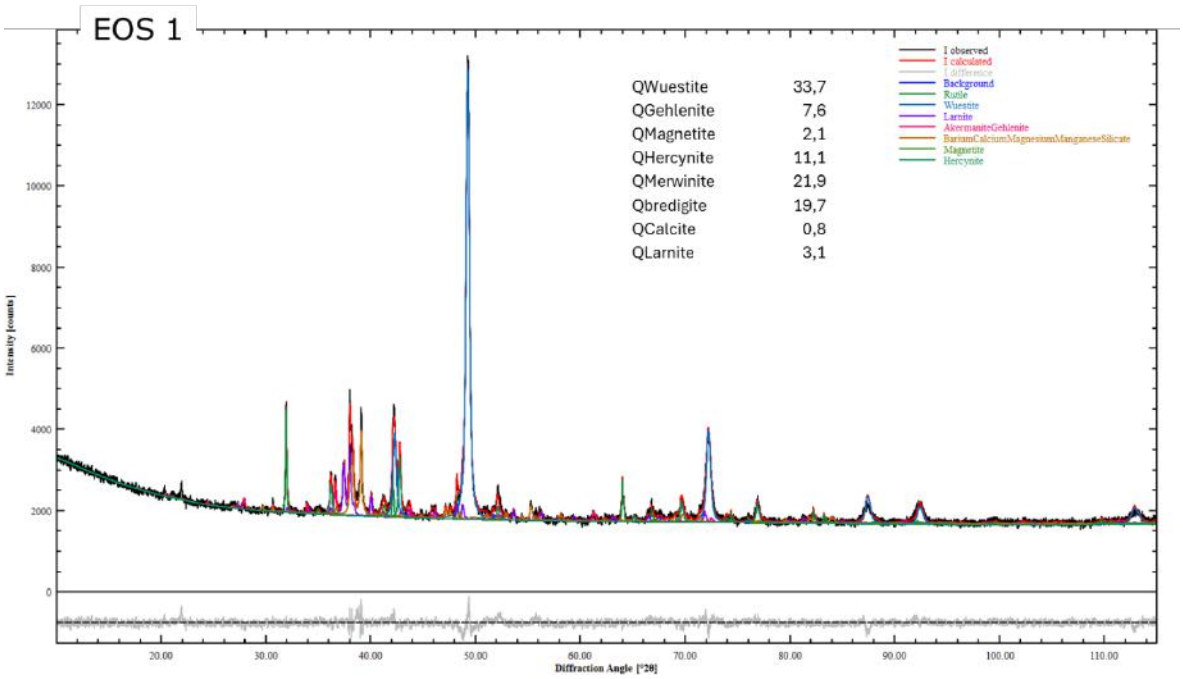
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

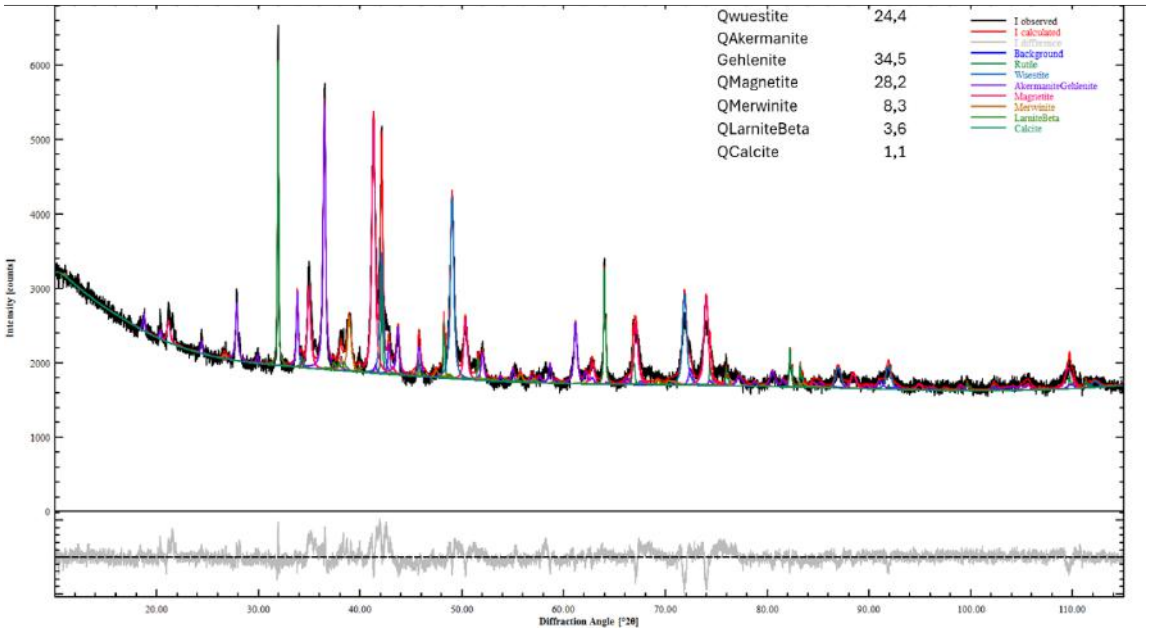


EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

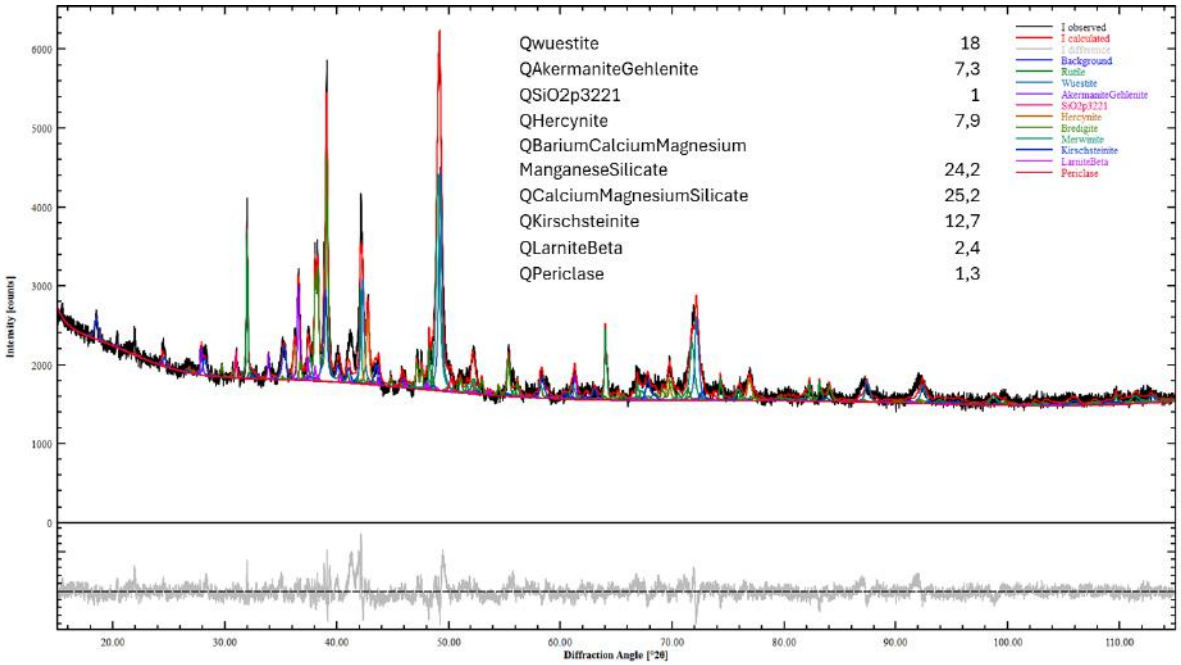
X-Ray Diffraction diagrams - EOS

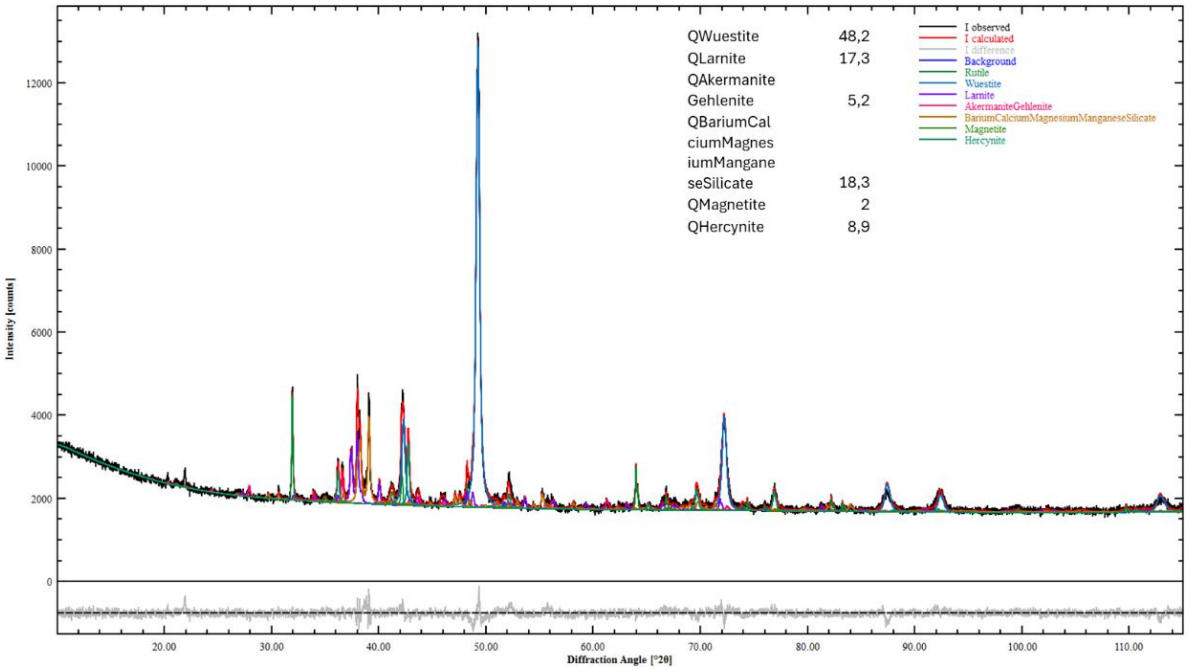




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

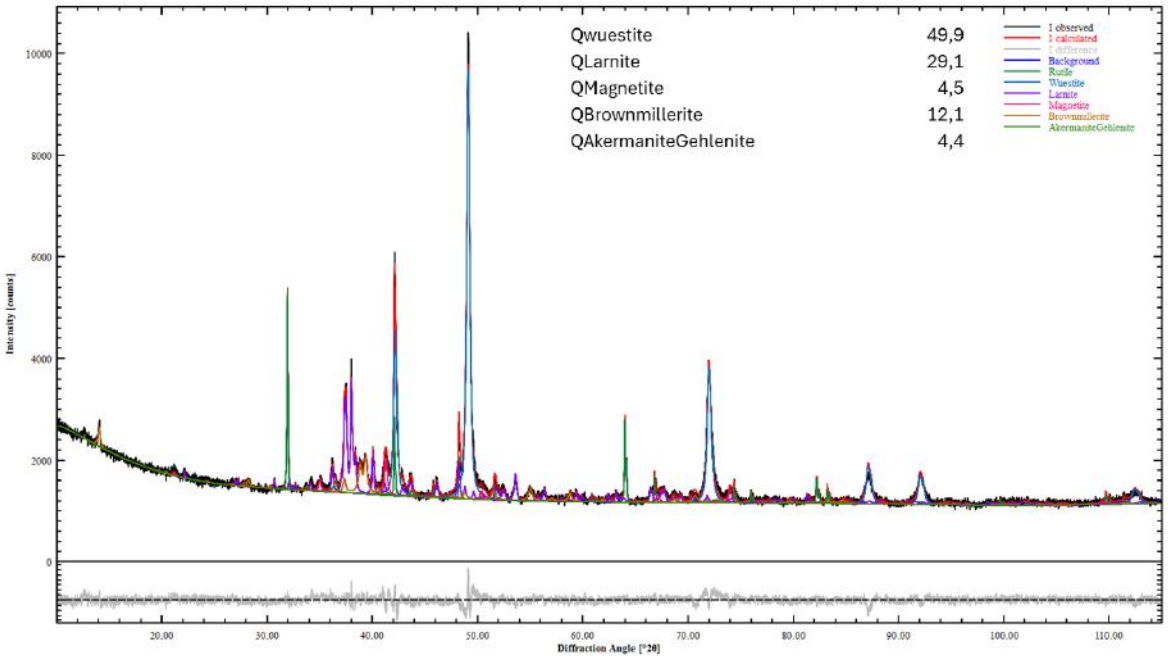
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

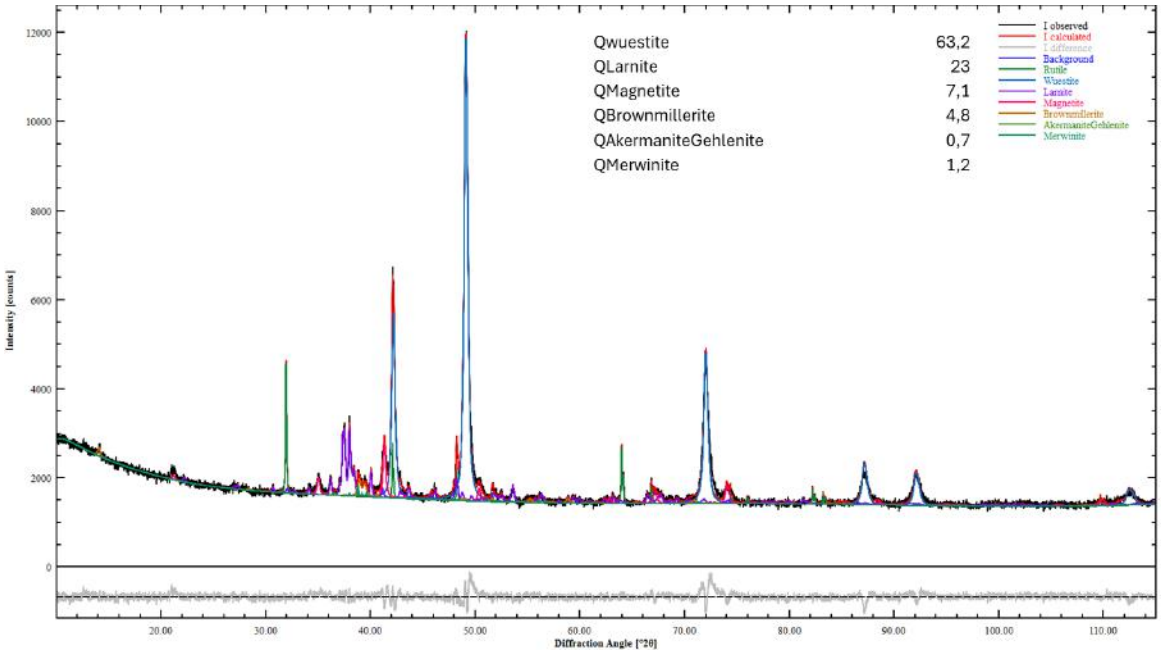




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

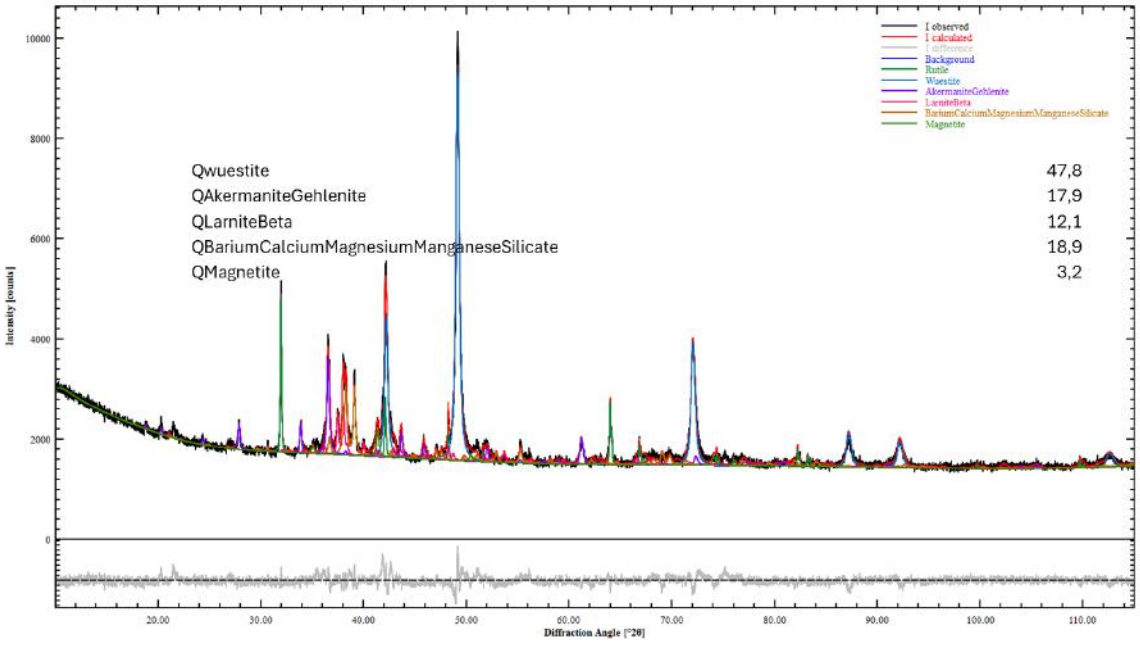
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

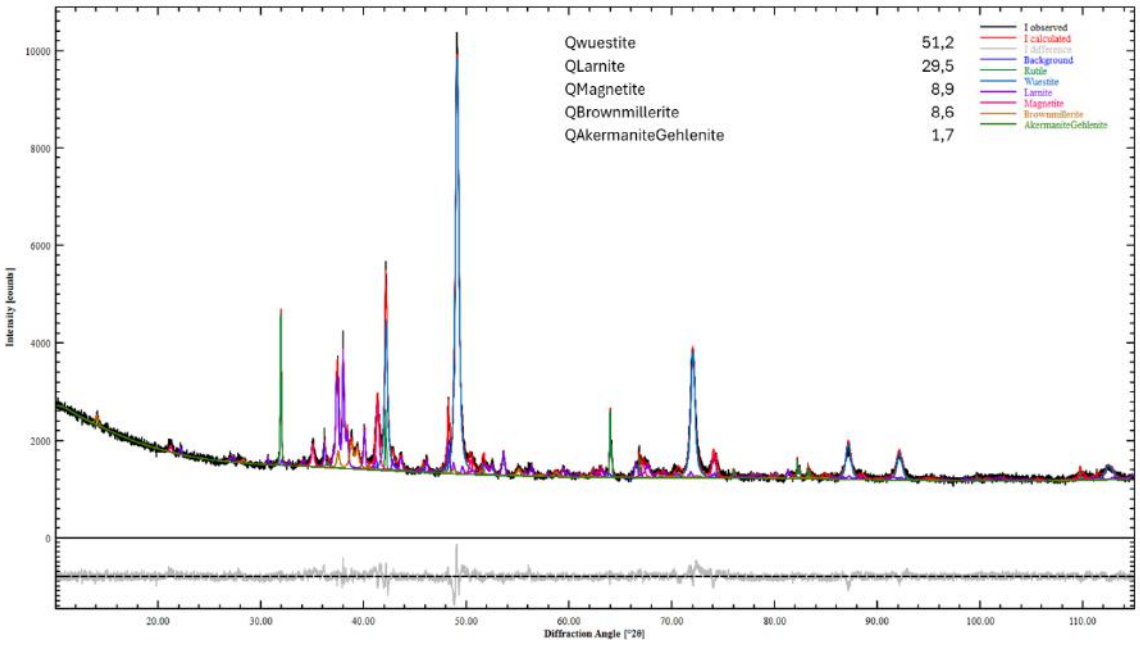




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

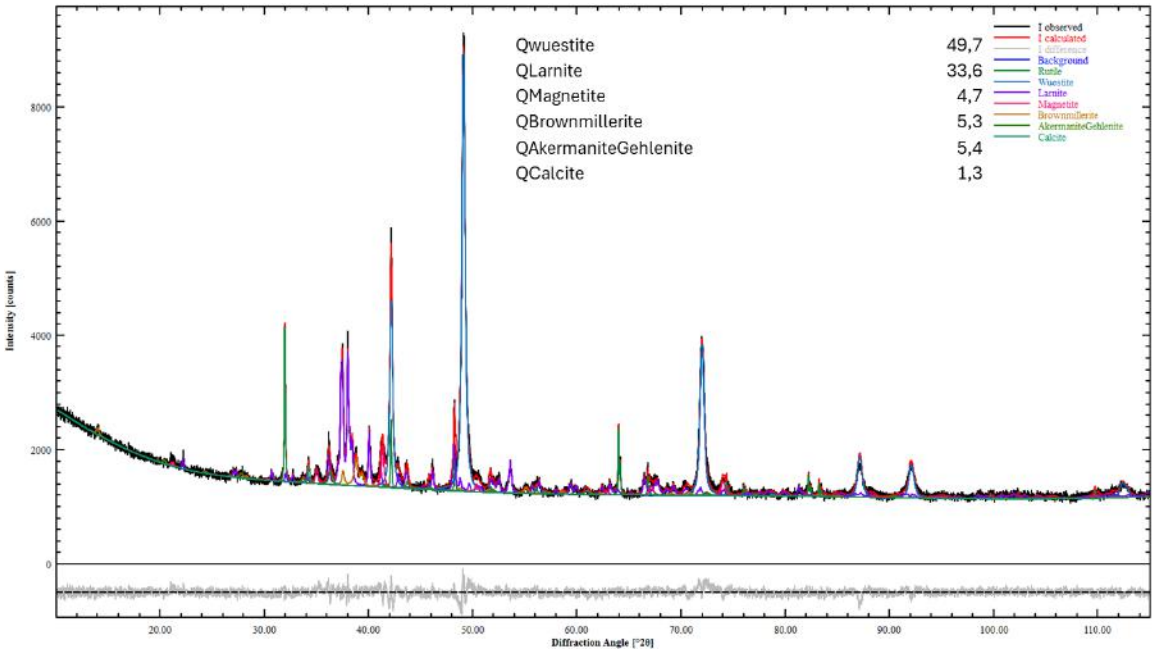
EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles

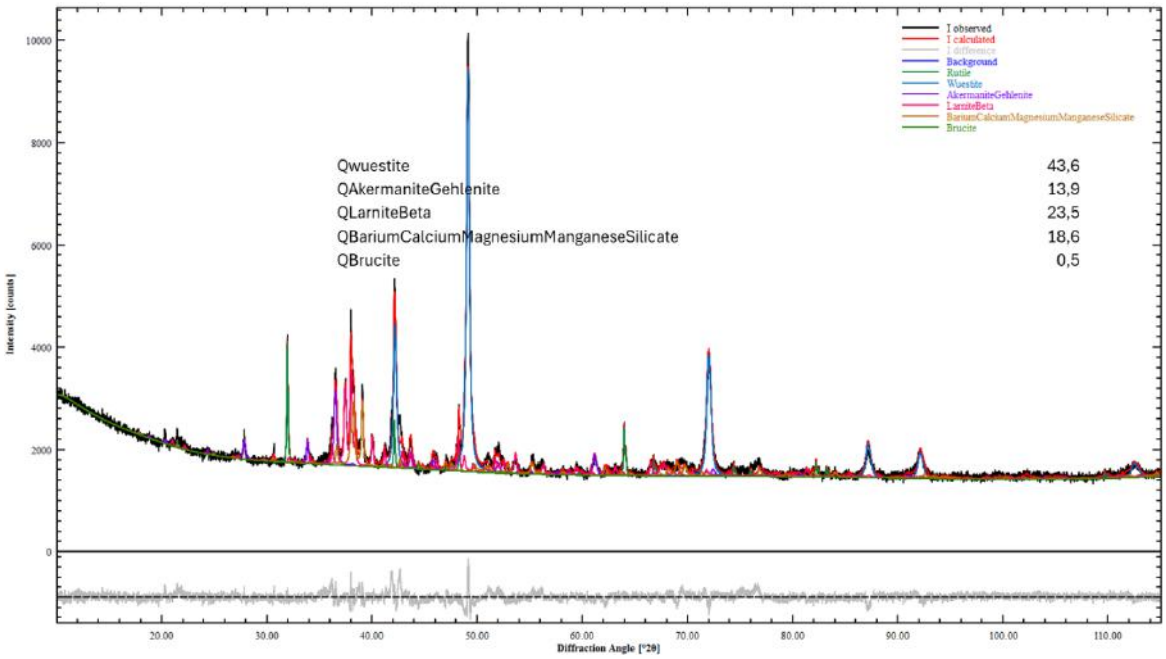




EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles





EUROSLAG / RFSC
Bliersheimer Straße 62, 47229 Duisburg

EUROFER
Avenue de Cortenbergh, 172, 1000 Bruxelles