Increased fuel flexibility and performance for boilers with challenging fuels

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Increased fuel flexibility and performance for boilers with challenging fuels

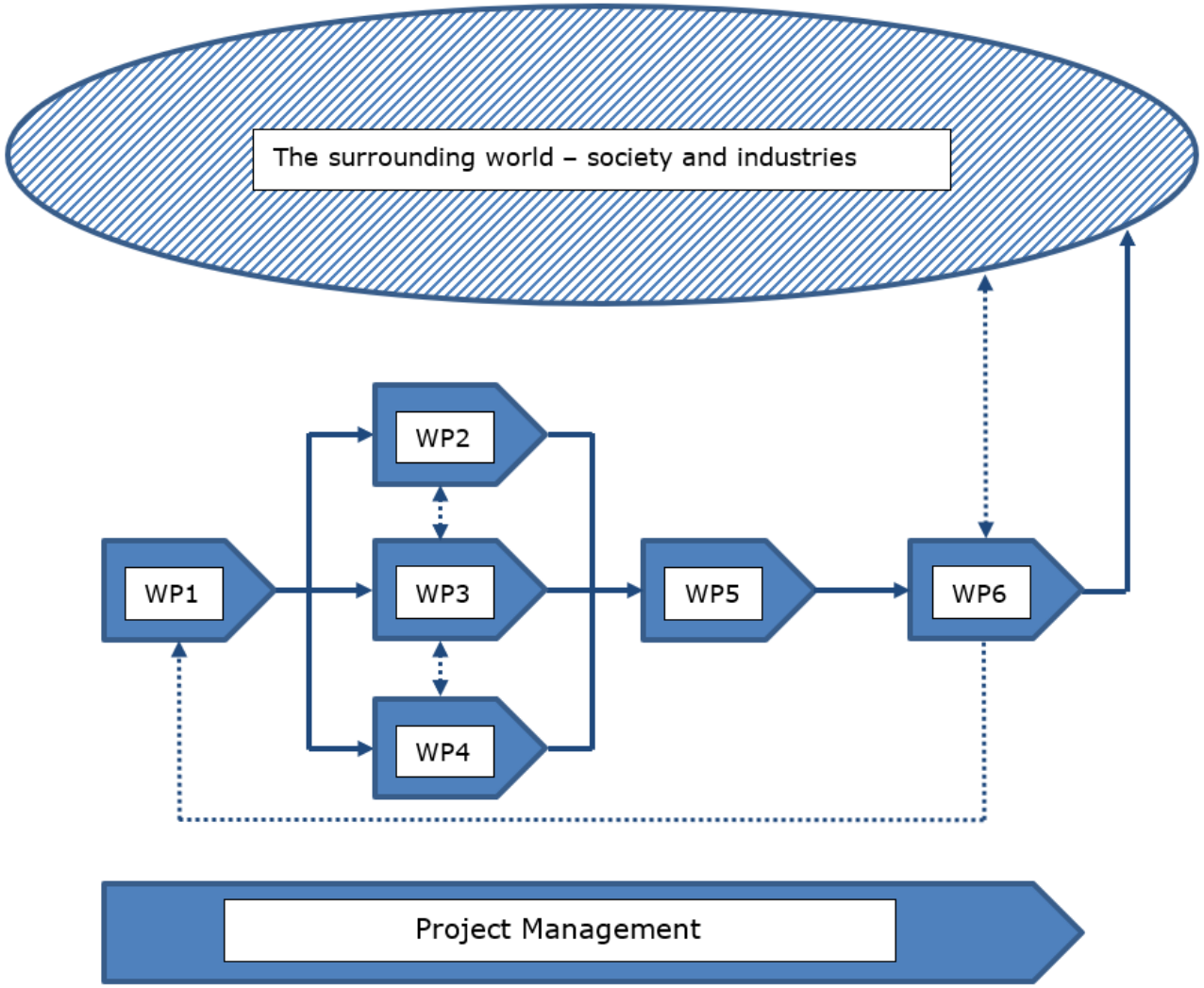
- Calderys
- E.ON
- Energiforsk
- Falu Energi & Vatten
- Högskolan Väst
- Kanthal
- MH Engineering
- Mälarenergi
- Stockholm Exergi
- RISE IVF, RISE KIMAB
- Valmet
- Vattenfall
- *Energimyndigheten*

Background

- Biomass-based fuels often imply an elevated risk of corrosion caused by chlorides and alkali metals
- An additional challenge with recycled wood and waste is their content of paint, plastics and metals
  - This results in high content of heavy metals (e.g. Pb and Zn) and chloride causing increased corrosion

Contents

- WP1 – Challenges and possibilities
- WP2 – Performance of cooled metallic parts
- WP3 – Performance of uncooled metallic parts
- WP4 – Refractories
- WP5 – Excellence in performance
- WP6 – Co-operation and communication



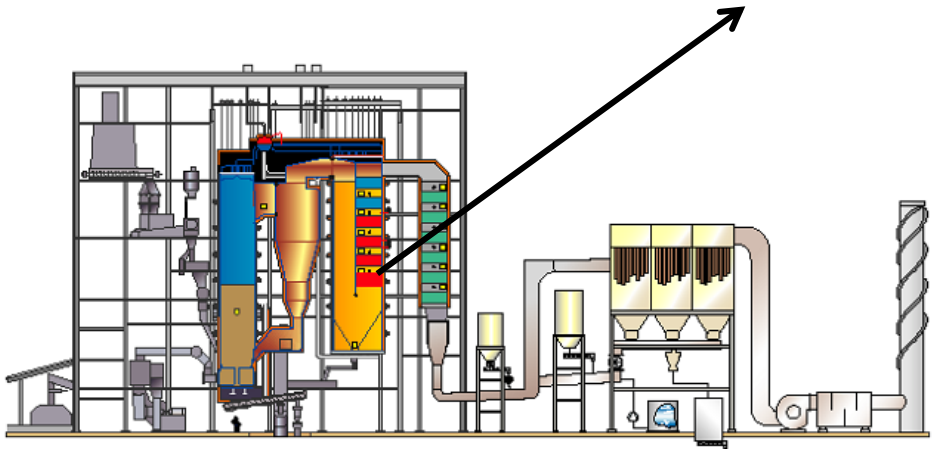
Selection of project goals

- To obtain new knowledge on how heavy metals in deposits influence corrosion of cooled parts
- To identify 1-2 coating candidates with the potential to improve the life performance by 20 %
- To obtain new knowledge on how corrosive fuel components degrade refractories
- To identify 1-2 refractory material candidates with the potential to improve the life performance by 20 %
- To achieve an understanding for when refractories are particularly beneficial to be used for protection of underlying metal and when other corrosion prevention methods may be attractive

Performance of cooled metallic parts

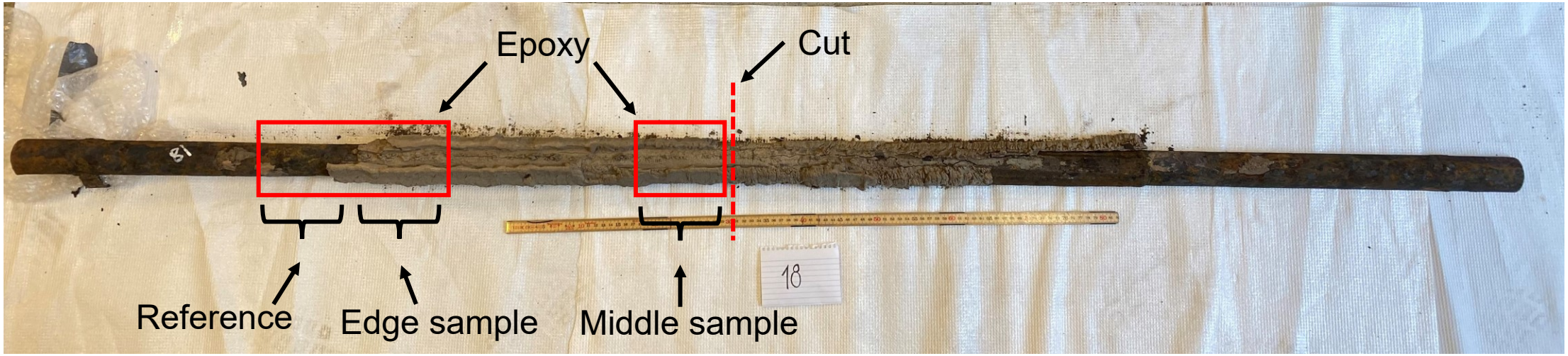
Exposure – Tube shield evaluation

- Collaboration with FeCrAlCLAD- project, which produced the test tube shields and carried out the exposures, as well as some evaluation

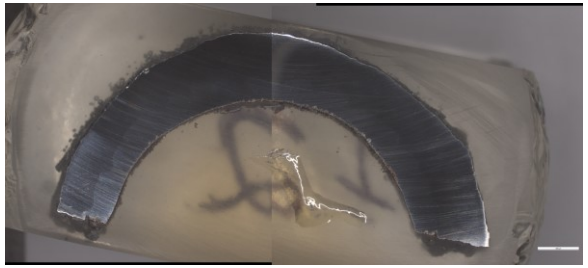
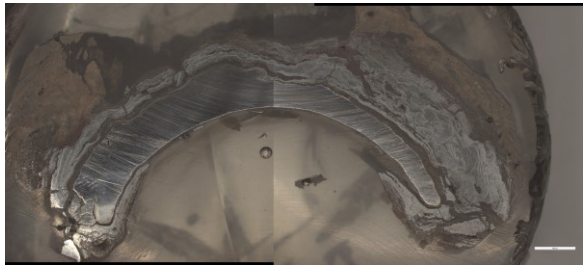
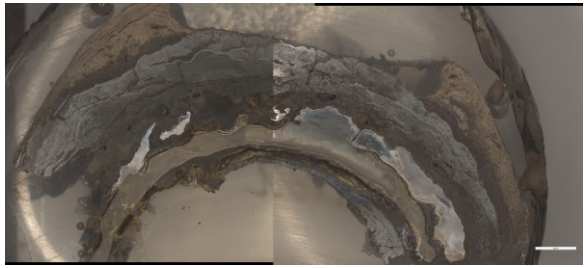


Convection bank 1, "roof"		
Tube	12.	San 60
Tube	13.	EF101 (L197)
Tube	18.	APMT
Tube	21.	EF100 (L198)
Convection bank 0, "floor"		
Tube	6.	San 60
Tube	7.	EF100 (L198)
Tube	8.	EF101 (L197)
Tube	9.	APMT

180 cm

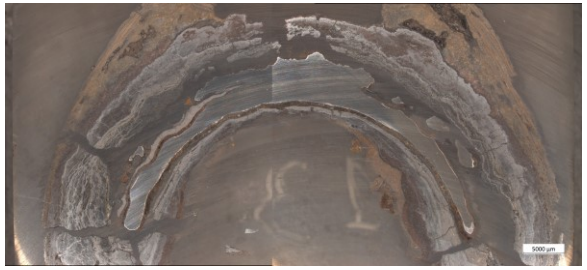
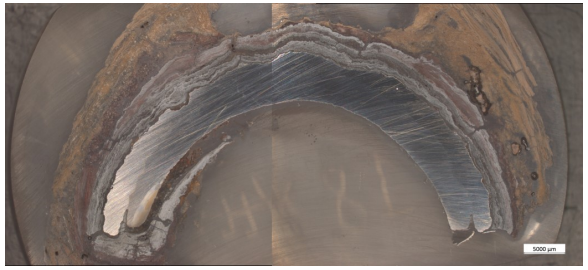


Tube no. 12 – San 60 | Tube no. 21 – EF100 (L198) | Tube no. 13 – EF101 (L197) | Tube no. 18 - APMT | **Roof**

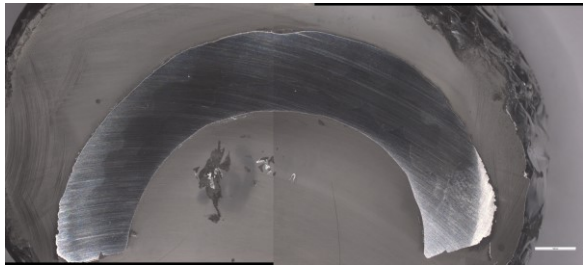
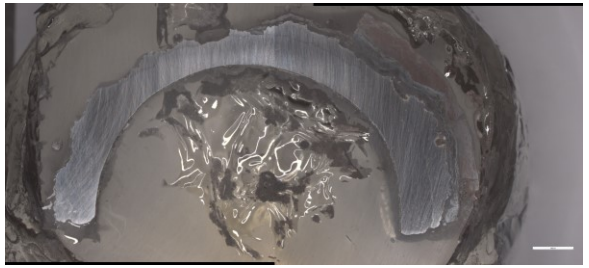
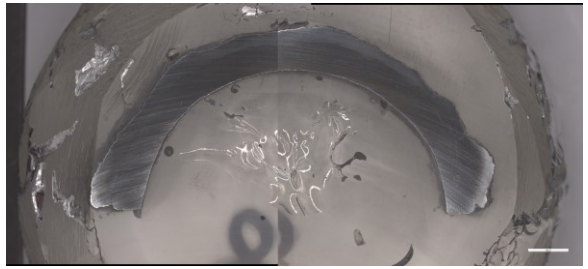
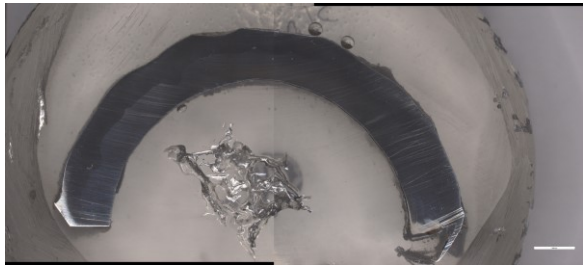

Mid



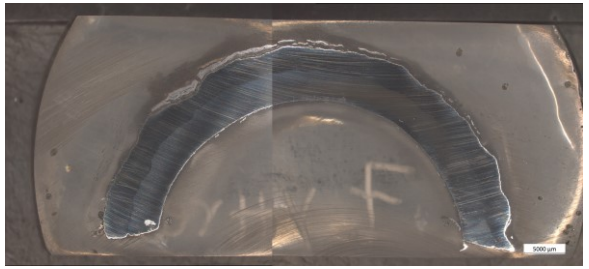
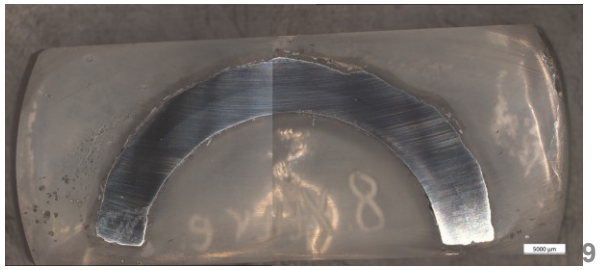



Edge

Tube no. 6 – San 60 | Tube no. 7 – EF100 (L198) | Tube no. 8 – EF101 (L197) | Tube no. 9 - APMT | **Floor**

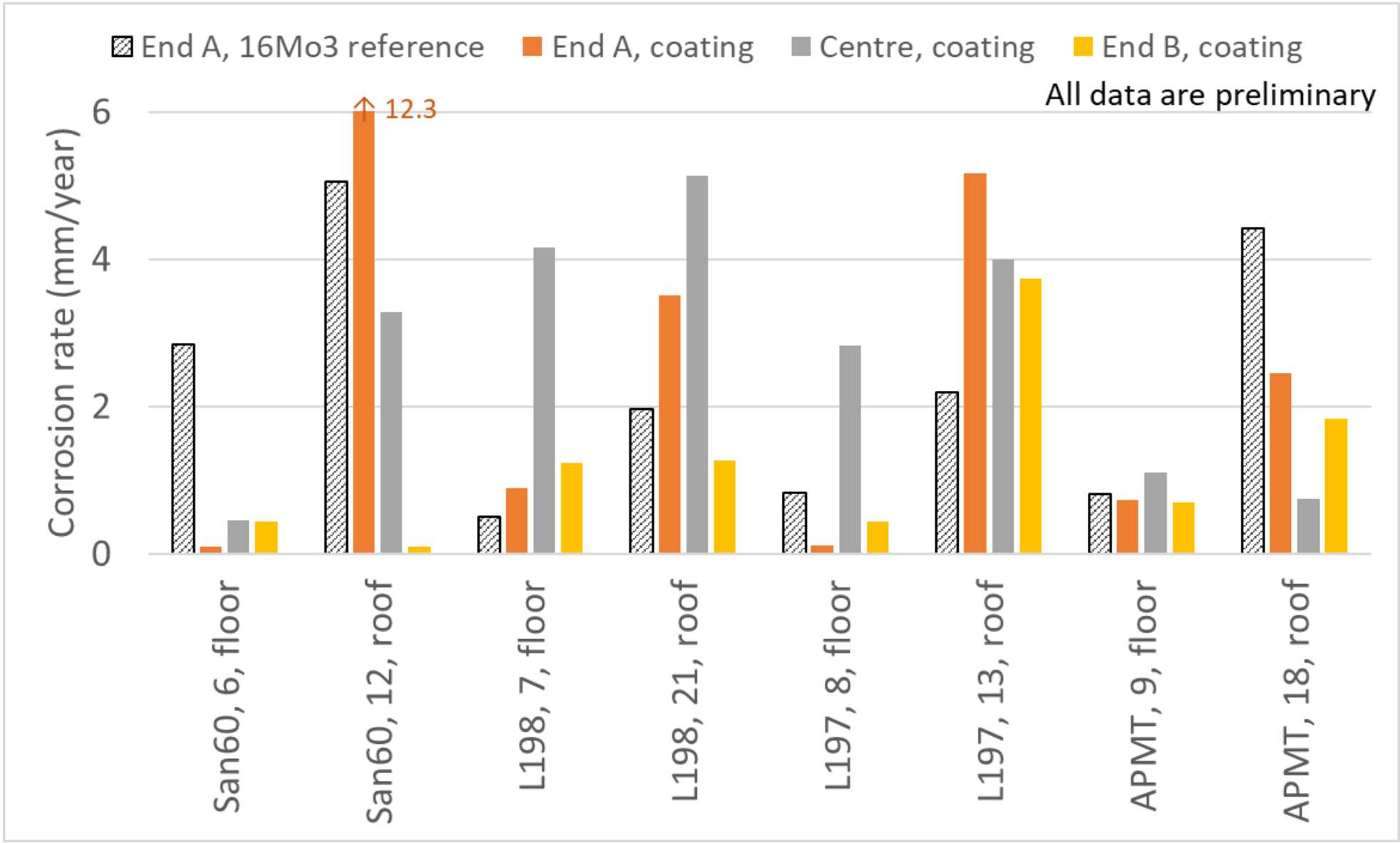





Mid

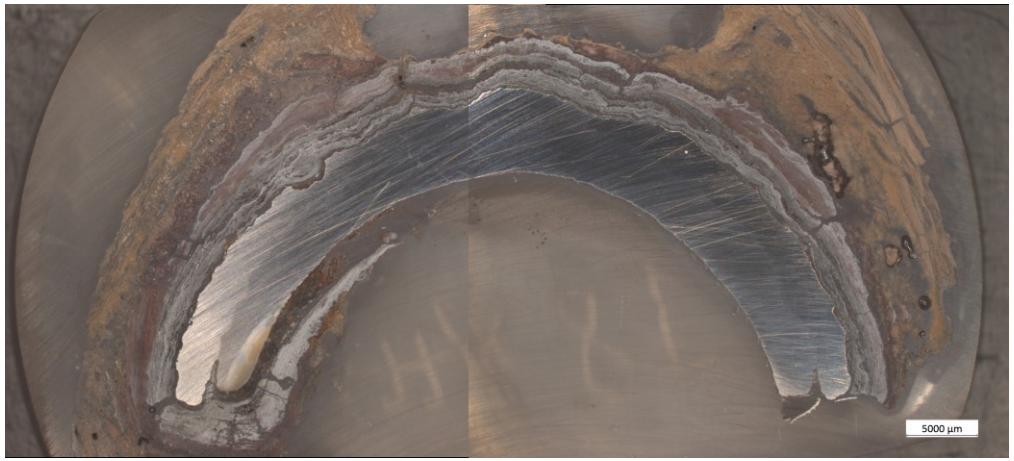

Edge

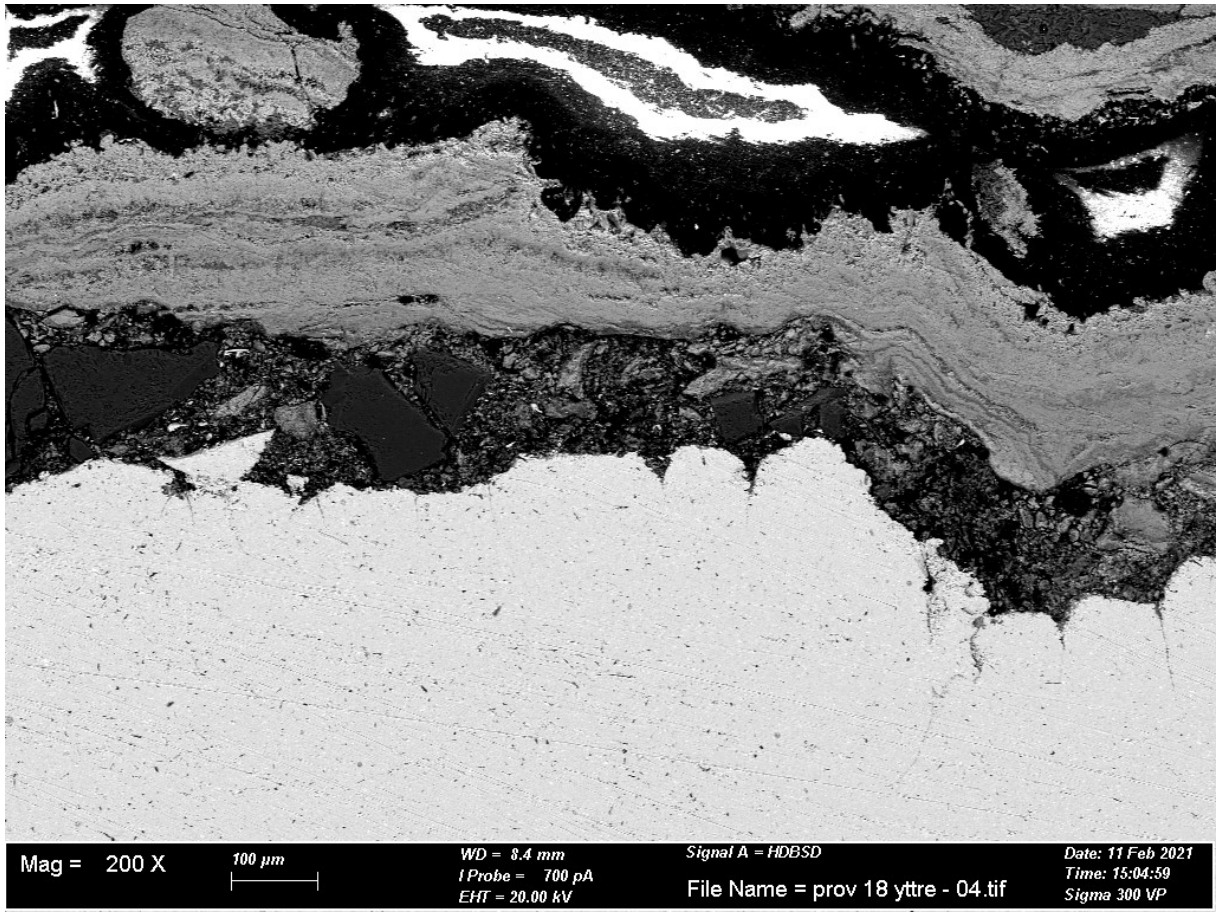
Material losses



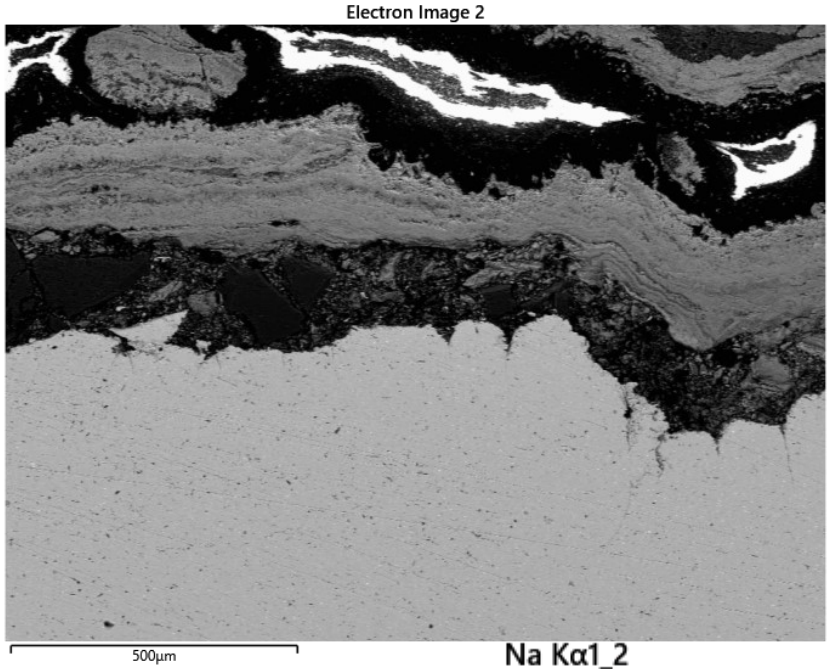
L197 = EF101
L198 = EF100

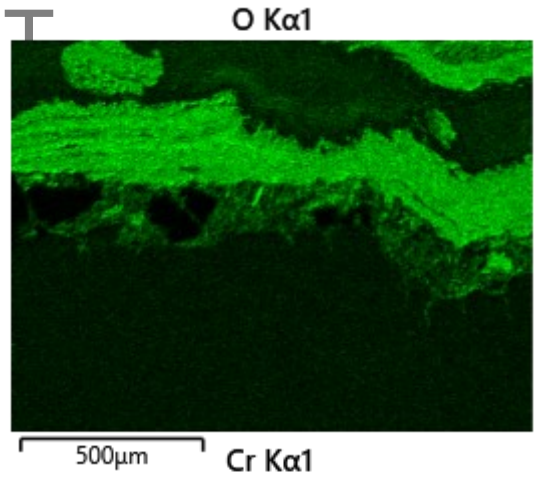
Tube no. 18 Edge - APMT

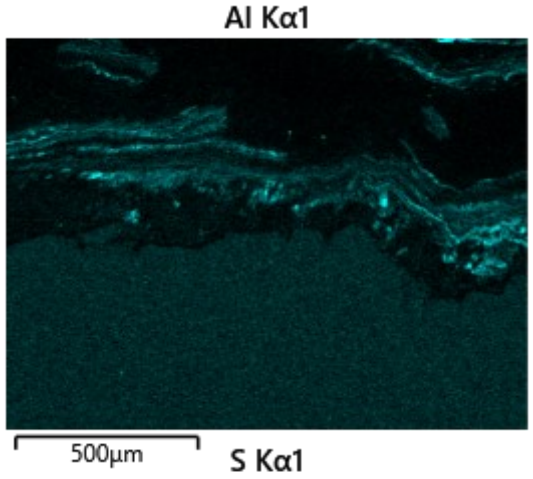


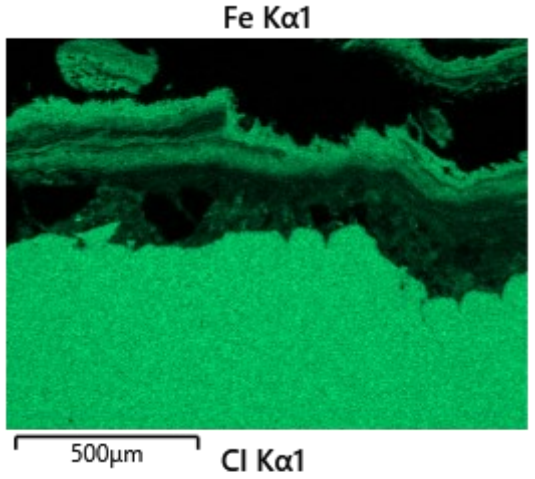


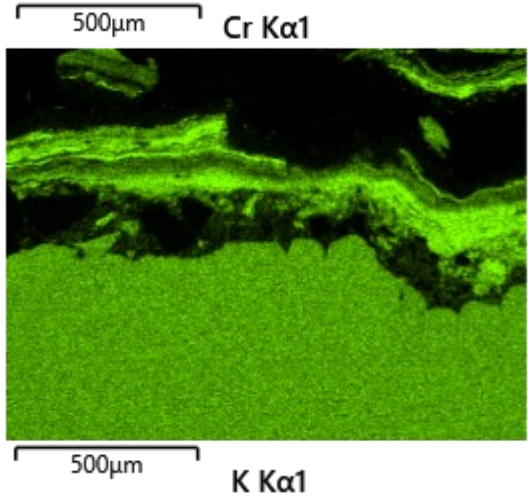
Tube no. 18 Edge - APMT

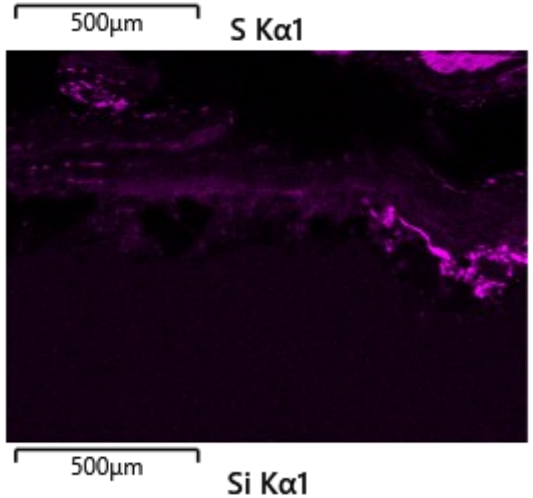


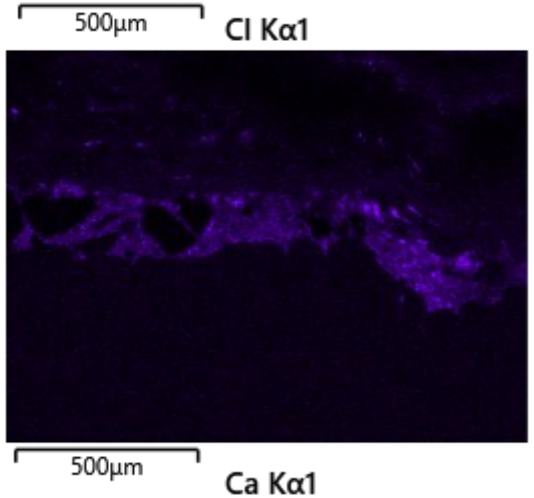


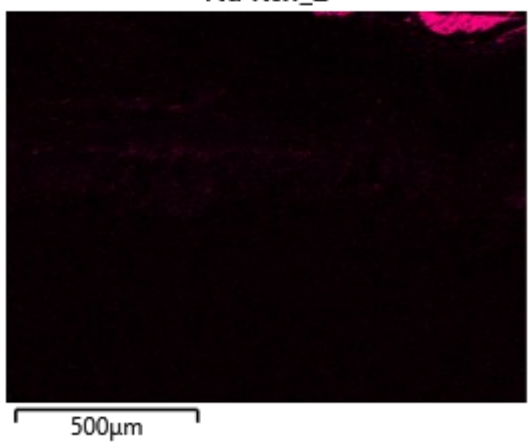


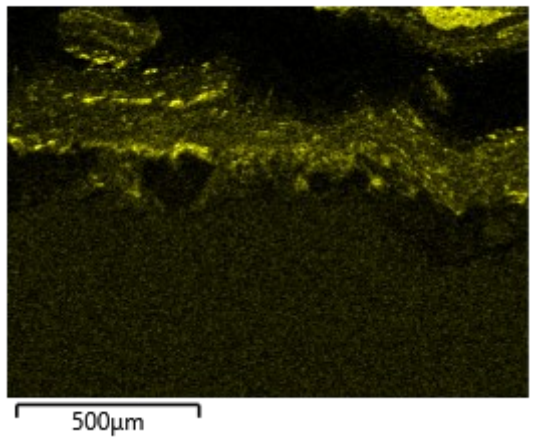


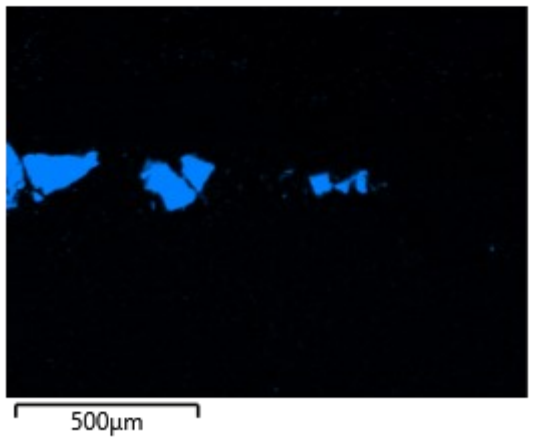


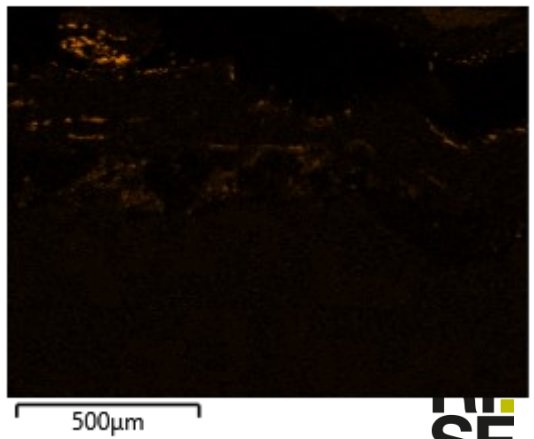










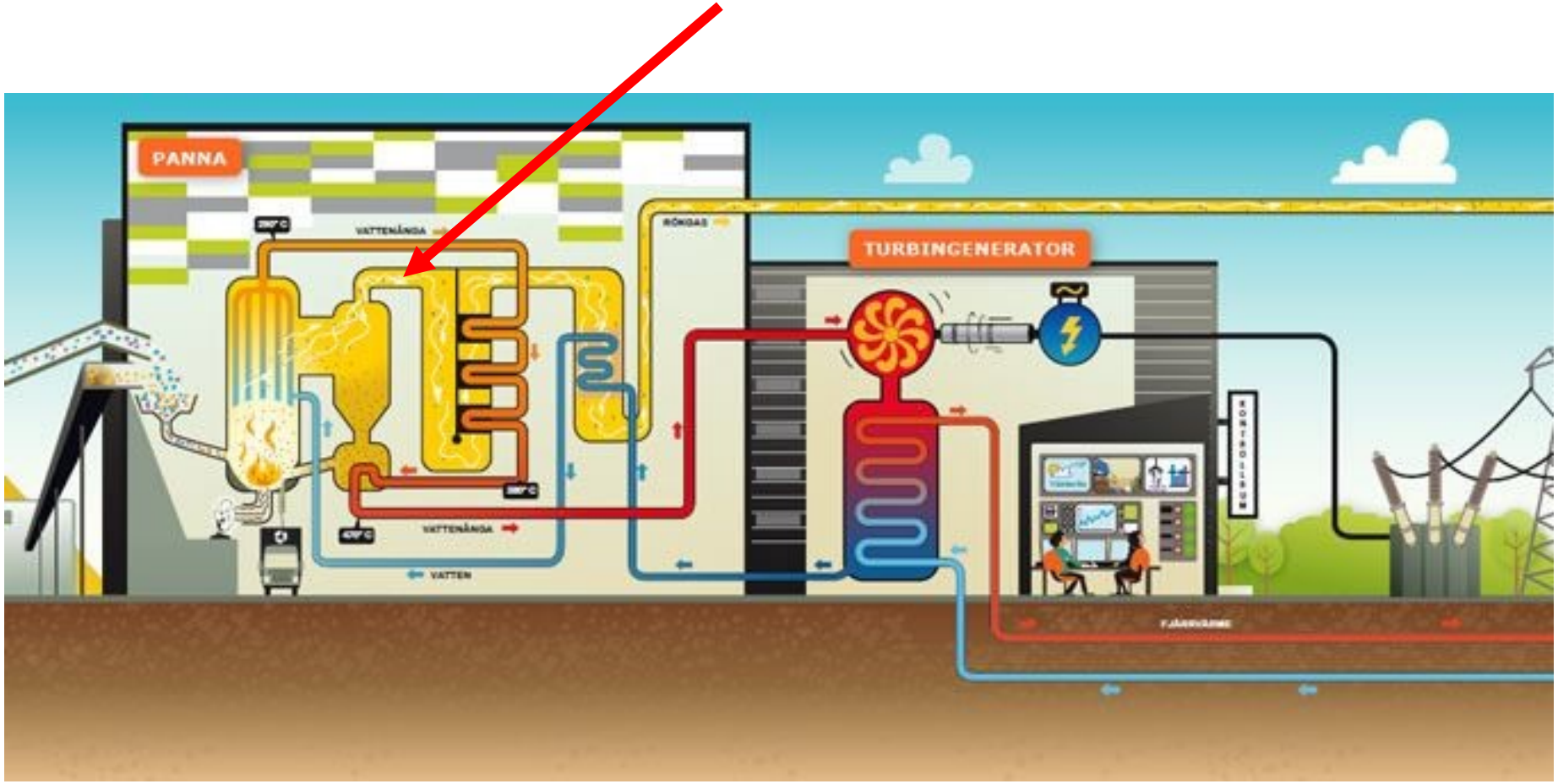


Performance of uncooled metallic parts

- Many components other than tubing, and that are mostly uncooled, such as cyclone vortex finder, supports, hangers, plates, refractory anchors and nozzles, frequently experience short life.
- Being uncooled these parts operate at a high temperatures giving intrinsically different challenges compared to cooled parts, as e.g. condensed phases in the deposits are expected to be different.

Future work - Field exposure Mälarenergi P6

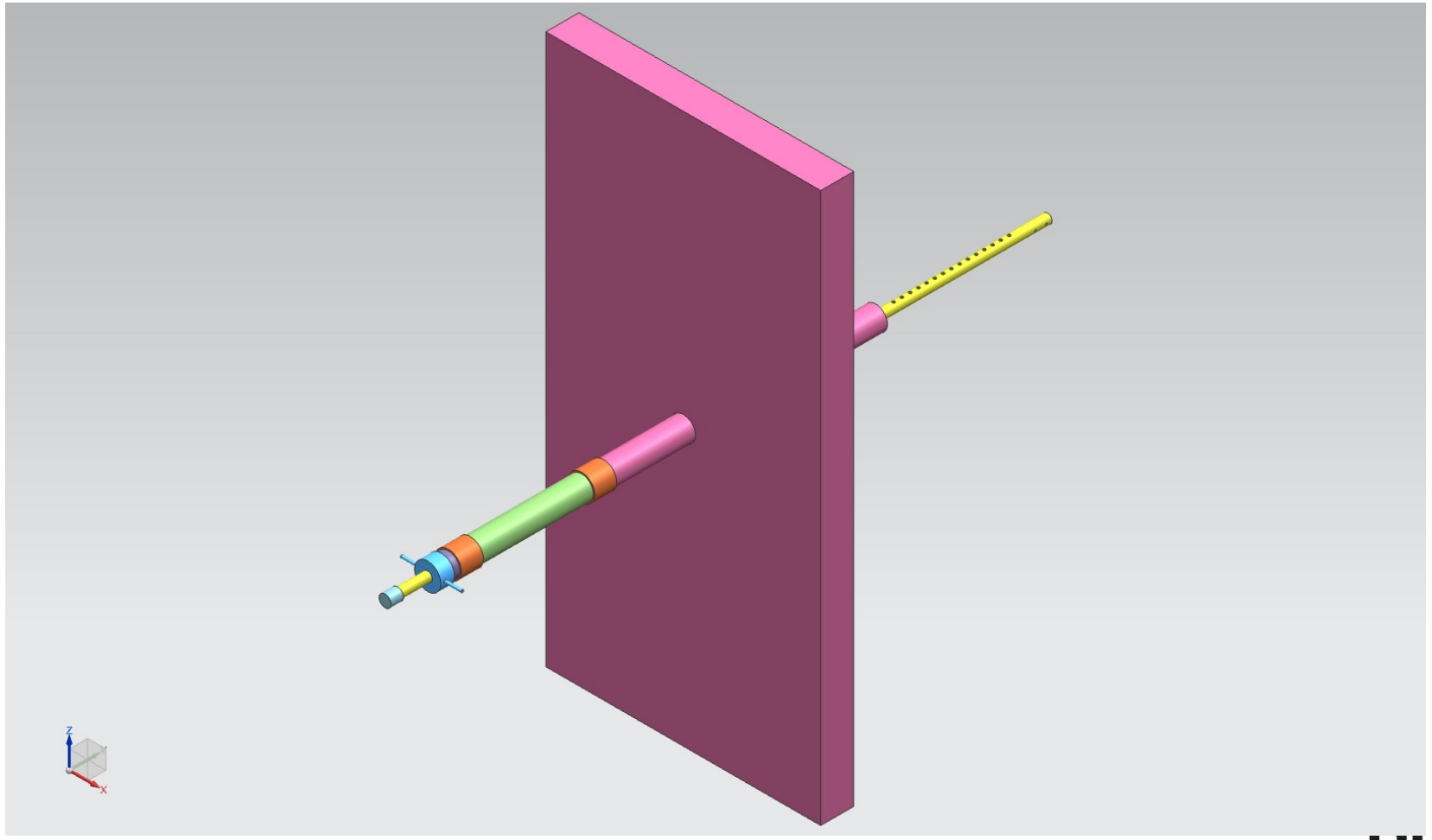
Horisontal manifold duct just before vertical empty pass



Field exposure Mälarenergi P6

New design – developed to allow high probe temperature, since it is uncooled

Outside Manifold duct



Field exposure Mälarenergi P6

- WP3: Study performance of uncooled metallic parts
- Probe built at RISE KIMAB
- 12 samples

- Estimated temperature 950 °C

- Selected test materials:
  - Solid 625 (1x)
  - 253 MA (reference, 2x)
  - Solid APMT (2x)
  - Welded APMT (1x)
  - Welded FeCrAl test alloy EF101 (1x)
  - Welded FeCrAl test alloy EF100 (1x)
  - Thermal Spray coatings
    - CorrEr (1x)
    - Fe24Cr8Al0.5Y (1x)
    - Ni23Co17Cr12Al0.5Y (1x)
    - Ni22Cr10Al1Y (1x)

EF101 = L197
EF100 = L198

Refractories

- Example of challenges encountered

Calderys is acknowledged for providing the image

Test material

Three test materials are chosen for the analysis:

- CALDE STIX PB 85 CG
- CALDE CAST LM 74 A
- CALDE SPRAYCAST SIC 70

Reference bulk specimens prepared by Calderys for comparison (unexposed)

Summary of analyzed materials

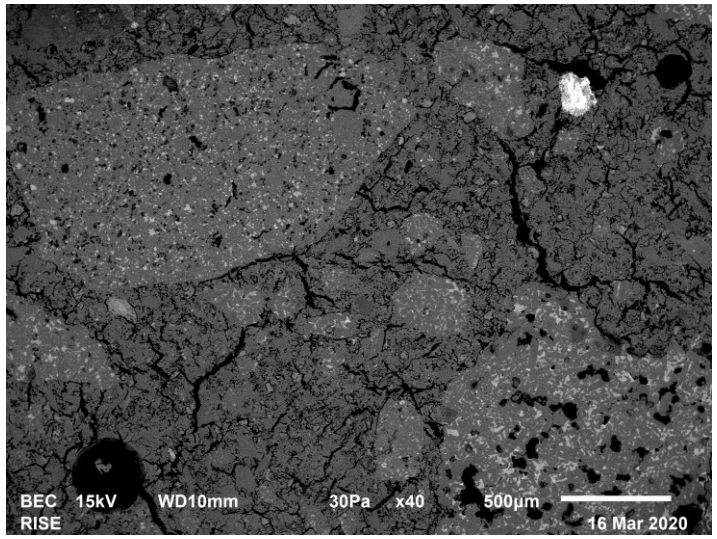
	Unexposed	6-7 months	1 year	2 years	6 years
CALDE STIX PB 85 CG	Calderys REF	EON Exp 6m	-	-	-
CALDE CAST LM 74 A	Calderys REF	**EON Exp 7m**	-	*EON Oct 2021*	-
CALDE SPRAYCAST SIC 70	Calderys REF	EON Exp 6m	**EON Exp 1y**	*EON Oct 2021*	**ME Exp 6y***

Bold text = new specimens since last meeting (Sept 2020)
Italic text = planned specimen extractions
EON = E.ON. Händelö P14 or P15
ME = Mälarenergi Västerås

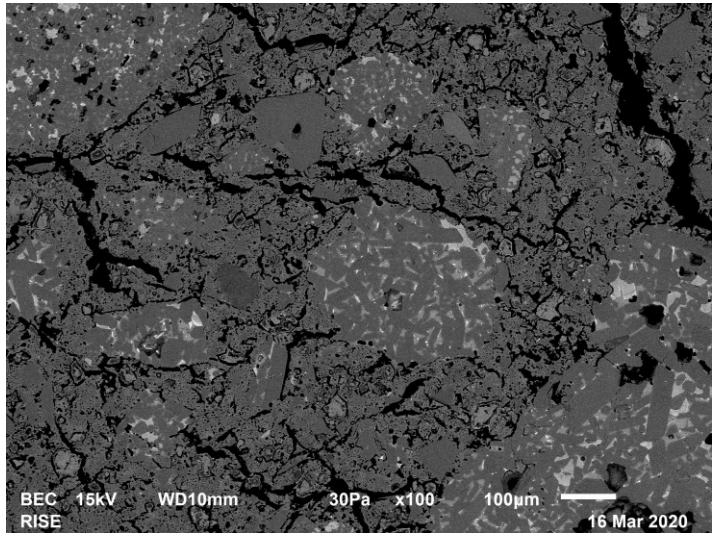
*Notice that the material extracted from Mälarenergi (exposed 6 years) is from a different material batch compared to Calderys REF SiC and the exposed specimens from E.ON

REF: CALDE STIX PB 85 CG – microstructure (bulk)

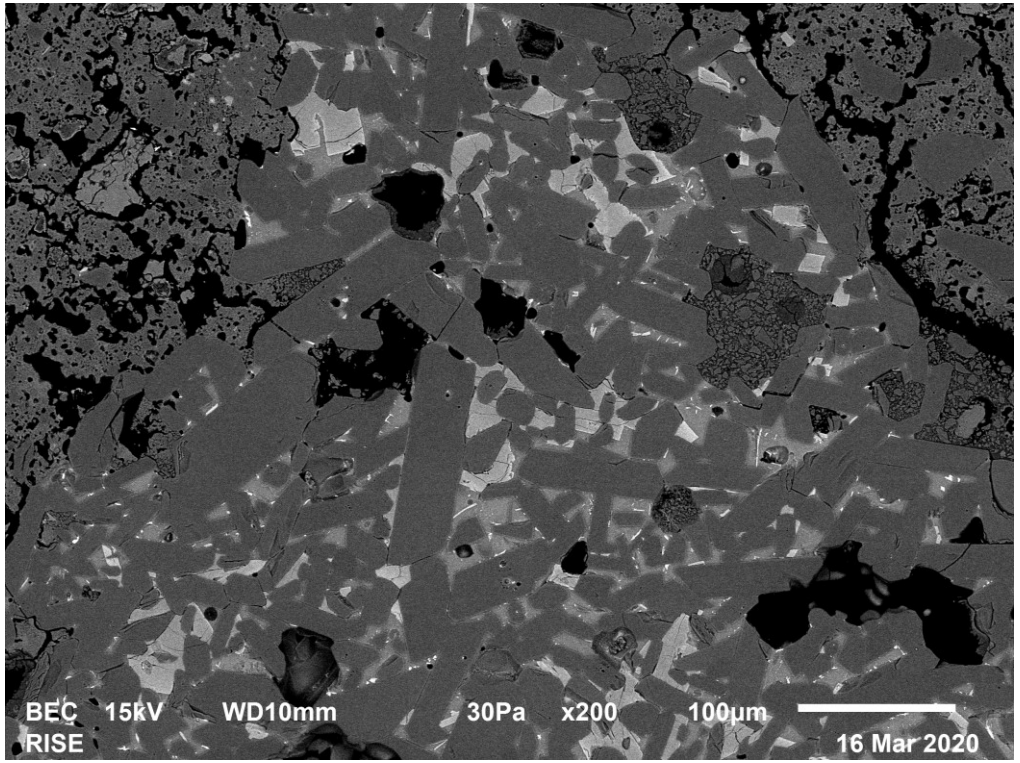
x40



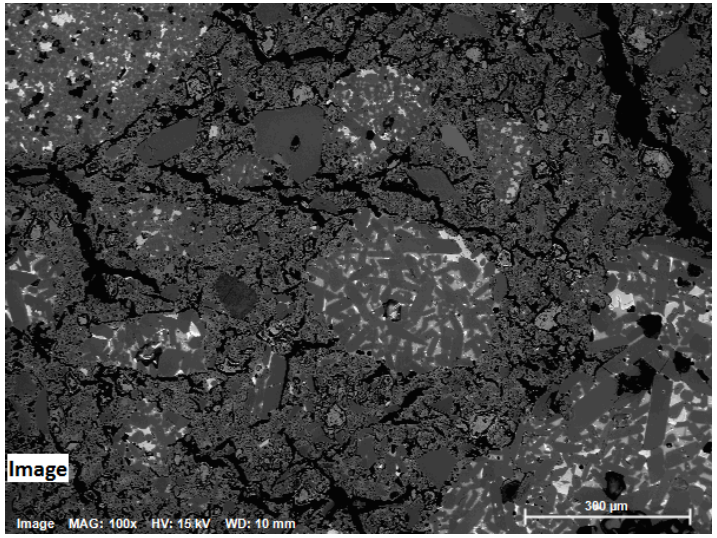
x100

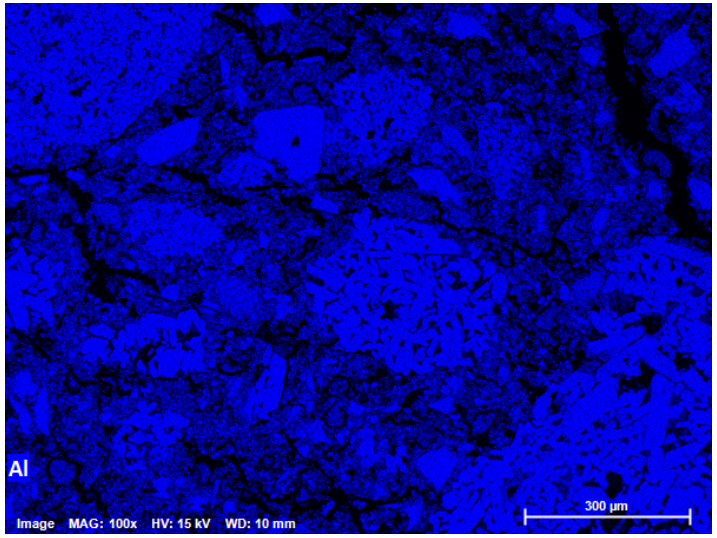


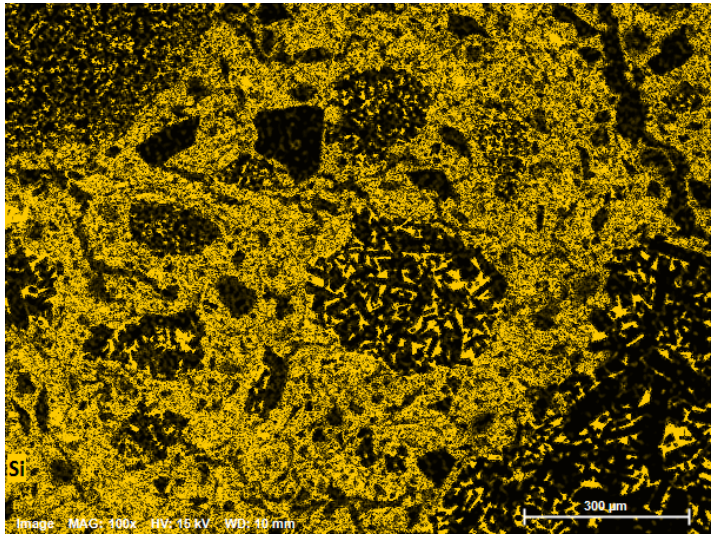
x200



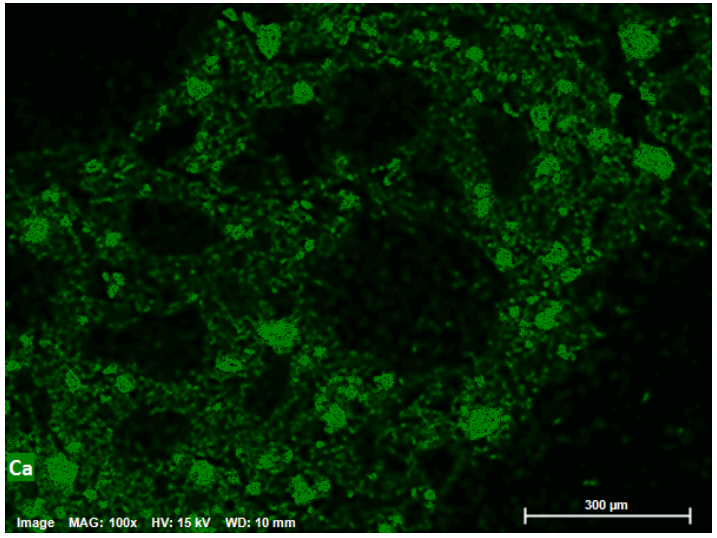
REF: CALDE STIX PB 85 CG – EDS-mapping (bulk)

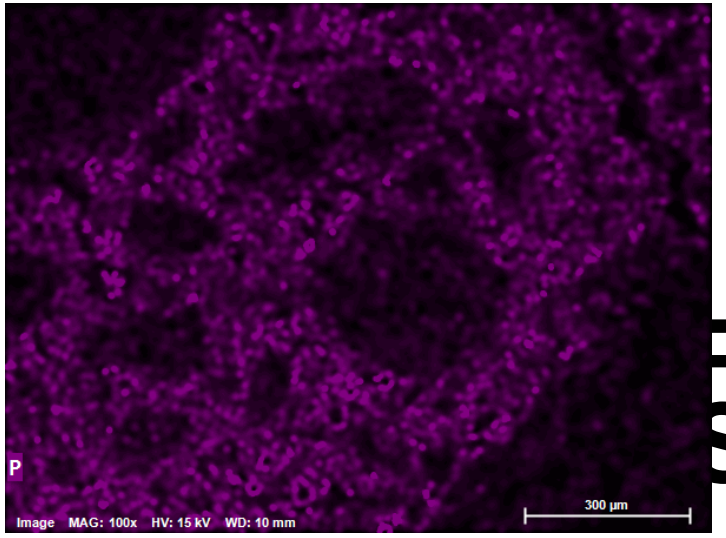




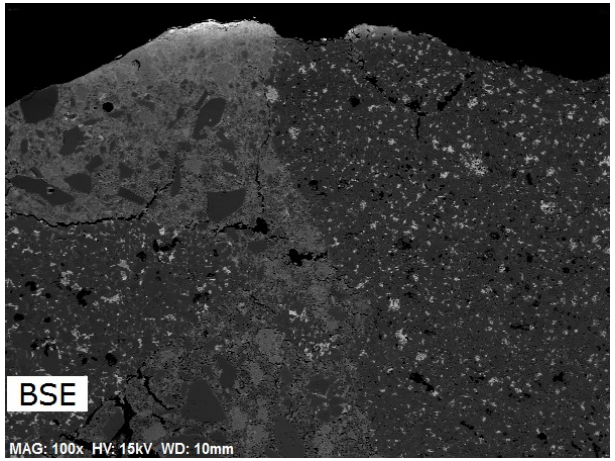


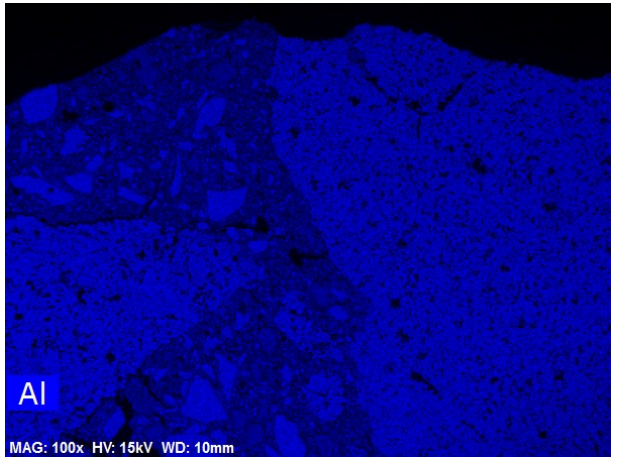
CALDE STIX PB 85 CG	
Al_2O_3	84 %
SiO_2	8 %
CaO	2,3 %
P_2O_5	1,0 %

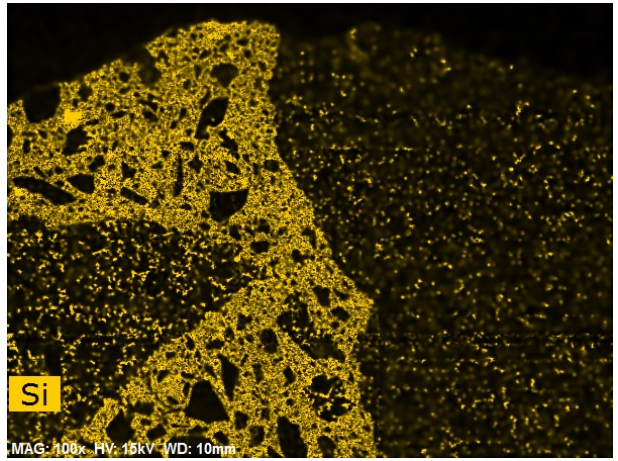


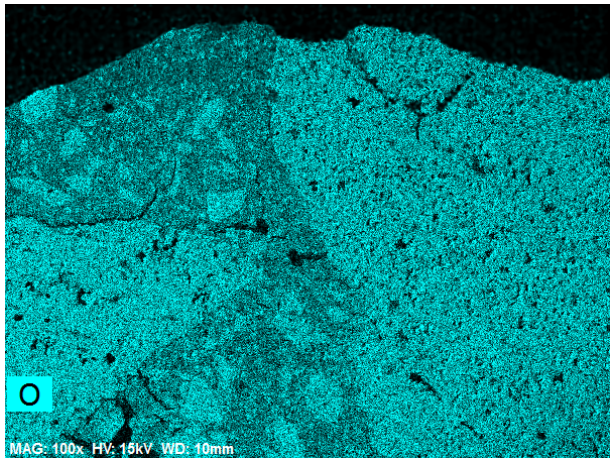


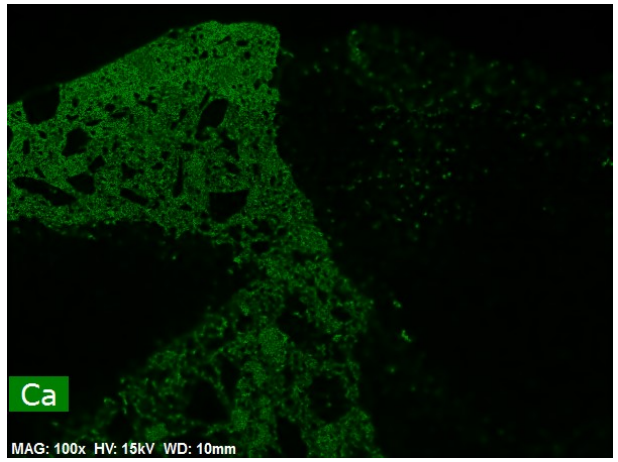
EON Exp 6m: CALDE STIX PB 85 CG – EDS mapping

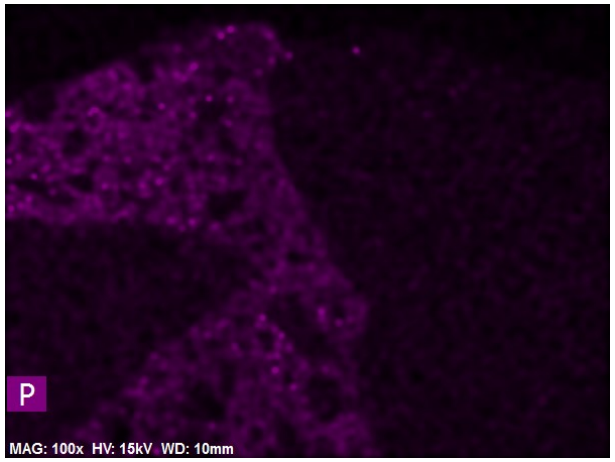












Area: surface (wall)

CALDE STIX PB 85 CG – EDS results

CALDE STIX PB 85 CG DATA SHEET		REF (bulk)	EON Exp 6m (bulk)
Al_2O_3	84 %	74 %	75 %
SiO_2	8 %	15 %	14 %
CaO	2,3 %	5,0 %	4,4 %
P_2O_5	1,0 %	2,1 %	1,6 %
Na_2O	-	0,6 %	1,1 %
K_2O	-	0,5 %	0,9 %
TiO_2	-	1,9 %	2,1 %
FeO	-	0,9 %	0,9 %

Semi quantitative results (norm. wt%)

Composition results from EDS analysis are semi quantitative, and should be evaluated relative to each other to determine trends (increasing/decreasing composition after exposure compared to reference)

Thank you for listening!