

living planet symposium | BONN 23–27 May 2022

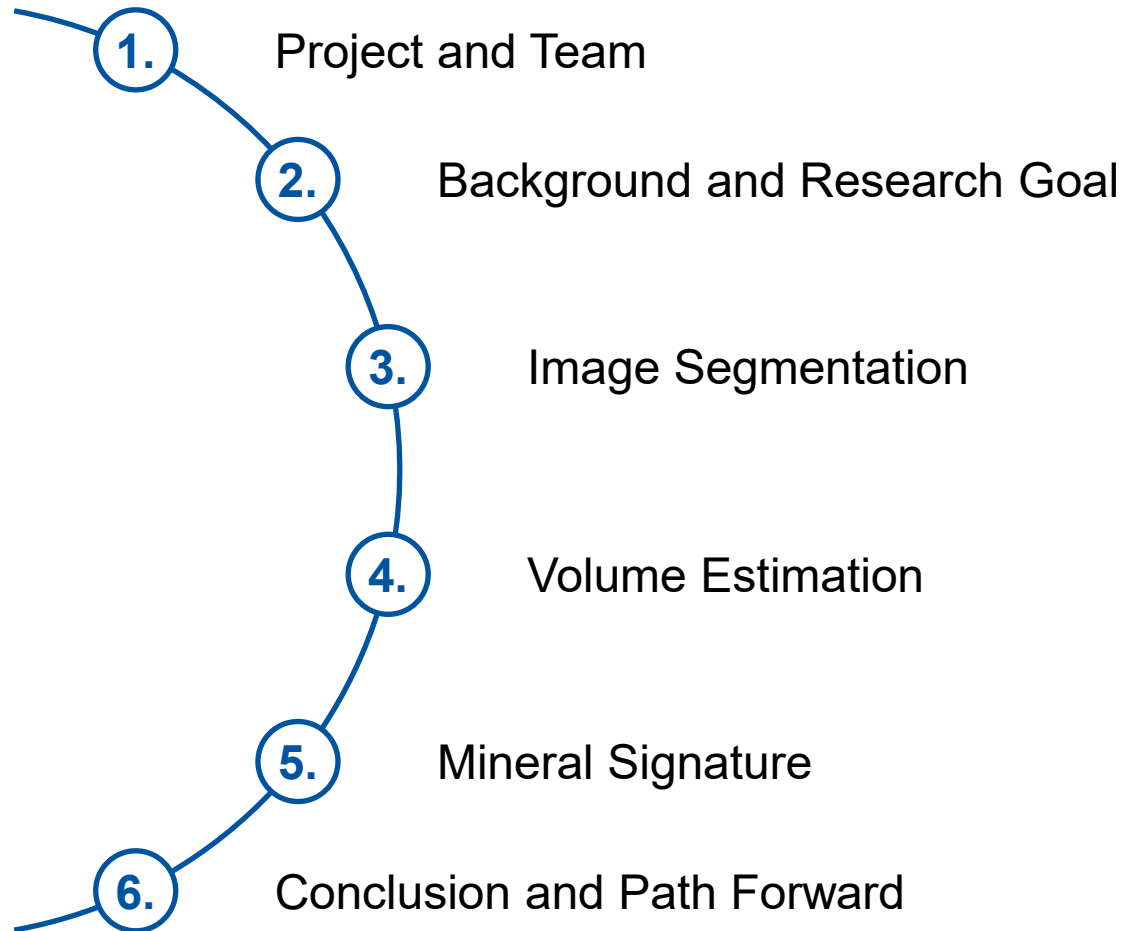
TAKING THE PULSE
OF OUR PLANET FROM SPACE

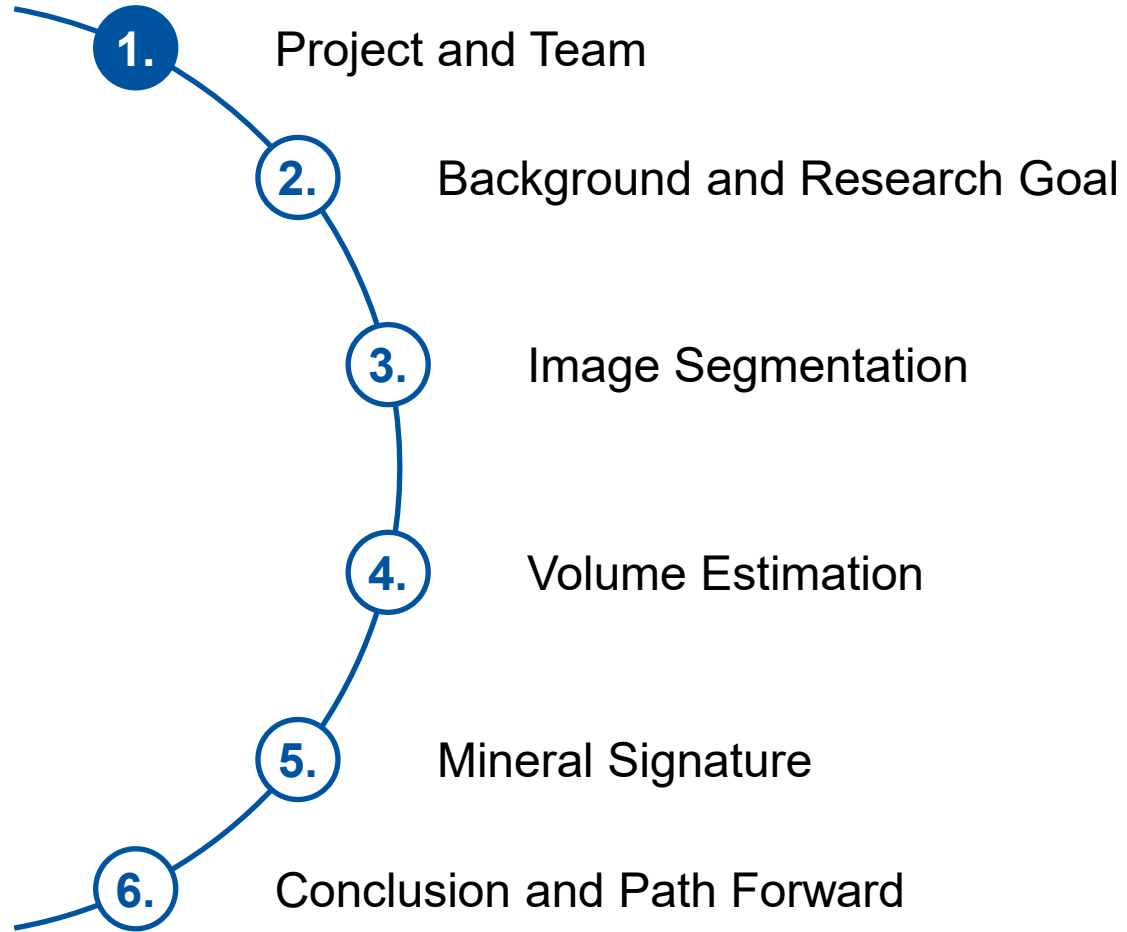


Satellite remote sensing data and artificial intelligence systems to identify, measure and class mine waste piles

Jan-Niklas Sander M.Sc., Nina Küpper M.Sc., Lorenz Richter M.Sc., Justus Freer M.Sc., Prof. Dr. Bernd Lottermoser

25.05.2022





Project and Team



Project title:

Automatisierte Erkennung, Vermessung und mineralogische Klassifizierung von Bergehalden und –teichen mit Satellitenfernerkundung

(Automated detection, surveying and mineralogical classification of heaps and tailings ponds with satellite remote sensing)

Project duration: 01.01.2021 - 30.06.2023

Funding volume: 210.000 €

Funded by



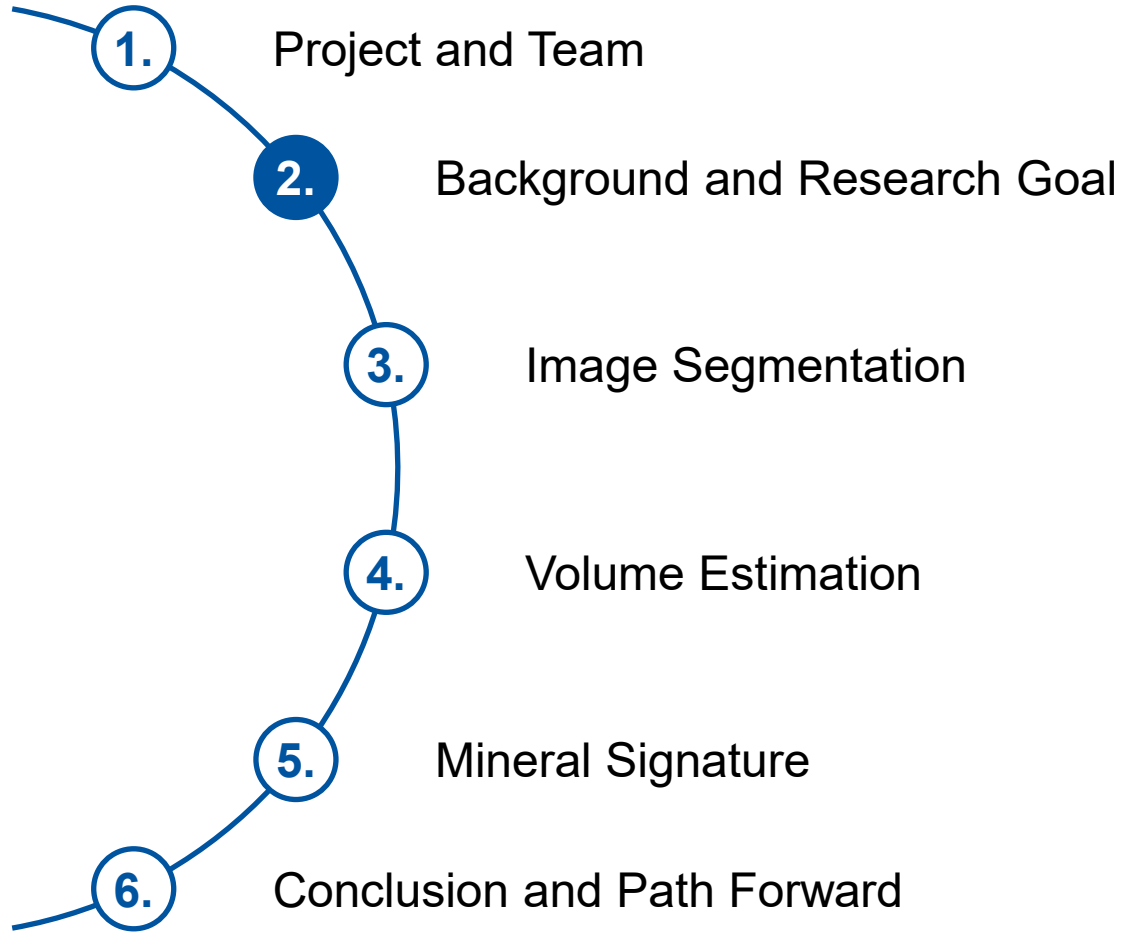
Federal Ministry of Education and Research

Grant number: 3299



Federal Ministry of Education and Research





Background and Research Goal

- Increase in resource demand leads to further exploitation of primary raw material deposits
- Counteracting by focus on secondary deposits like mining heaps and tailings ponds
- Recirculation of already processed and disposed „waste“ into the raw-material cycle

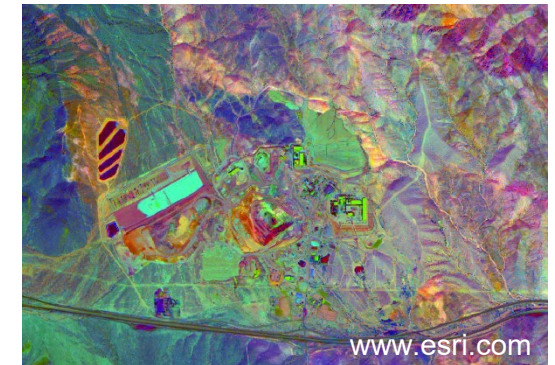
Goal: Providing a global database of mine waste material deposits for economical evaluation and prioritisation



Image Segmentation



Volume Estimation



Mineral Signature

ID	Name	Description	Country	Latitude	Longitude	Estimated Volume (t)	Fe (wt.%)
32	C8I_2021041	paddock tailing	Chile	-33.381835	-71.119005	27,500	3.7
48	C8I_2021041	waste rock	Chile	-34.039115	-70.560448	15,400	8.8
713.1	C8I_2021041	hillside tailing	USA	38.261527	-103.080879	238,700	4.3

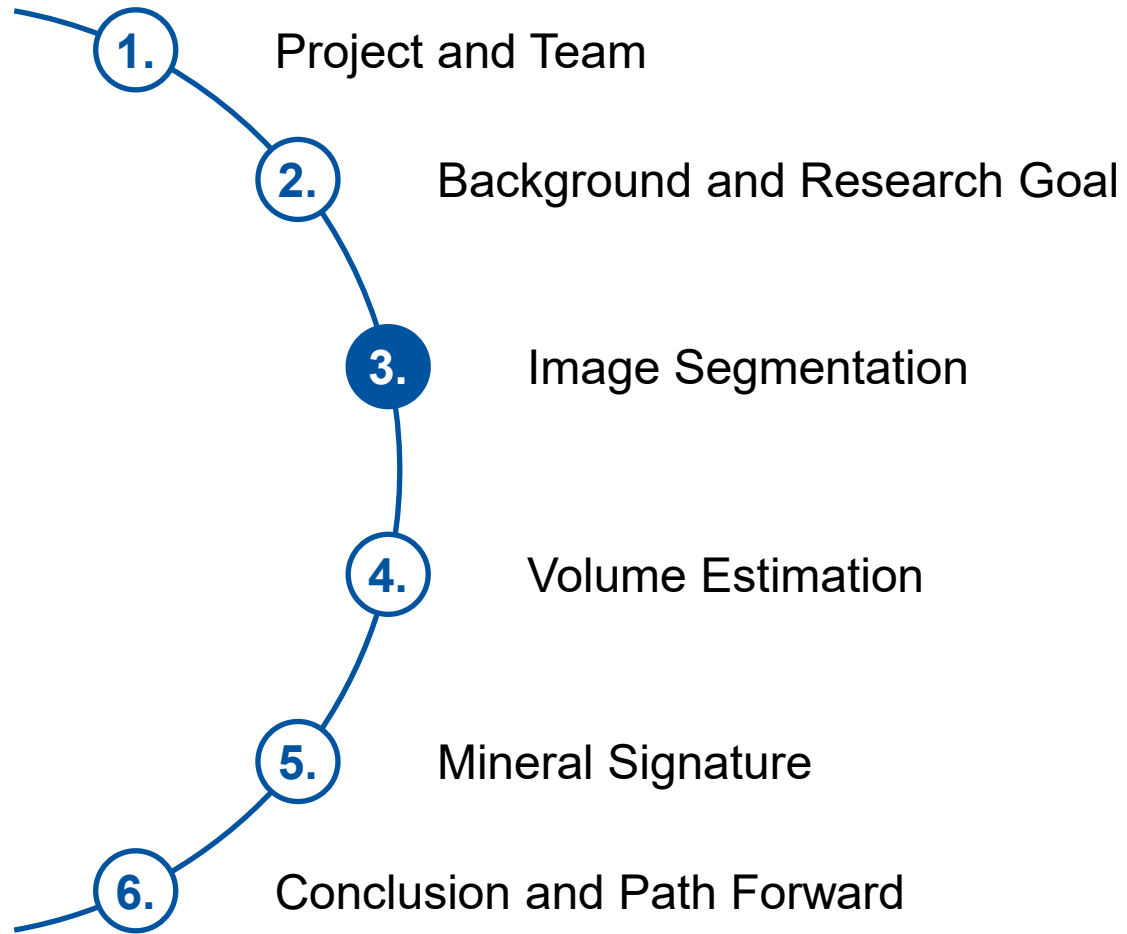
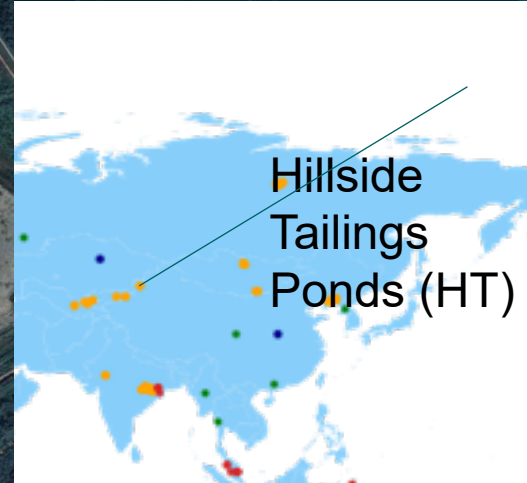


Image Segmentation

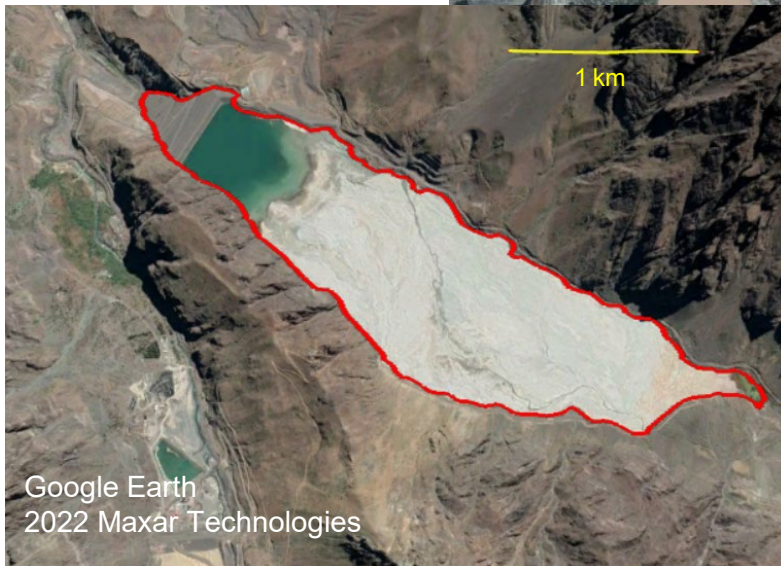
Paddock
Tailings
Ponds (PT)



Hillside
Tailings
Ponds (HT)

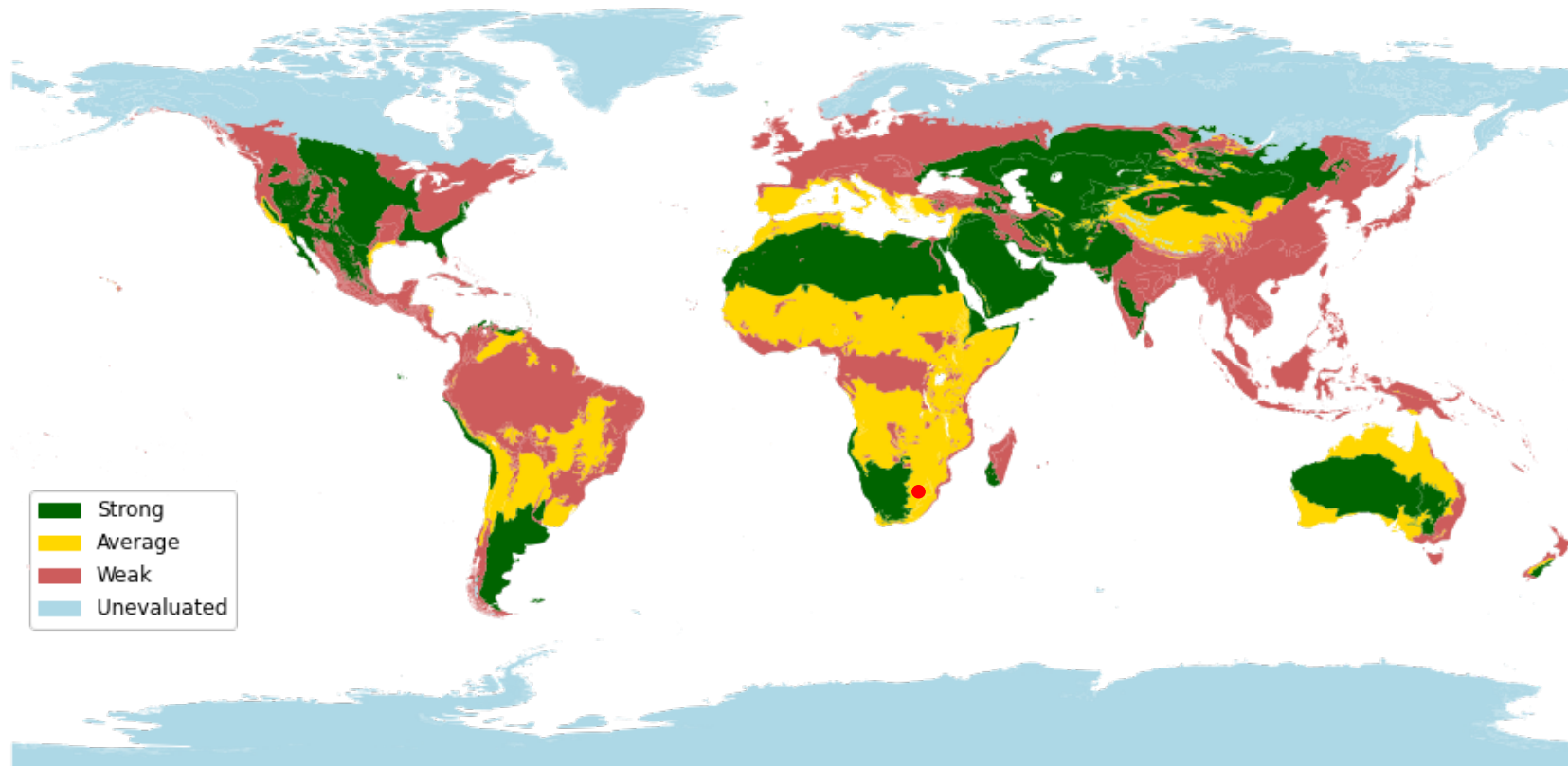


Crossvalley
Tailings Ponds
(CT)



under review	1,800
and negative	5,000

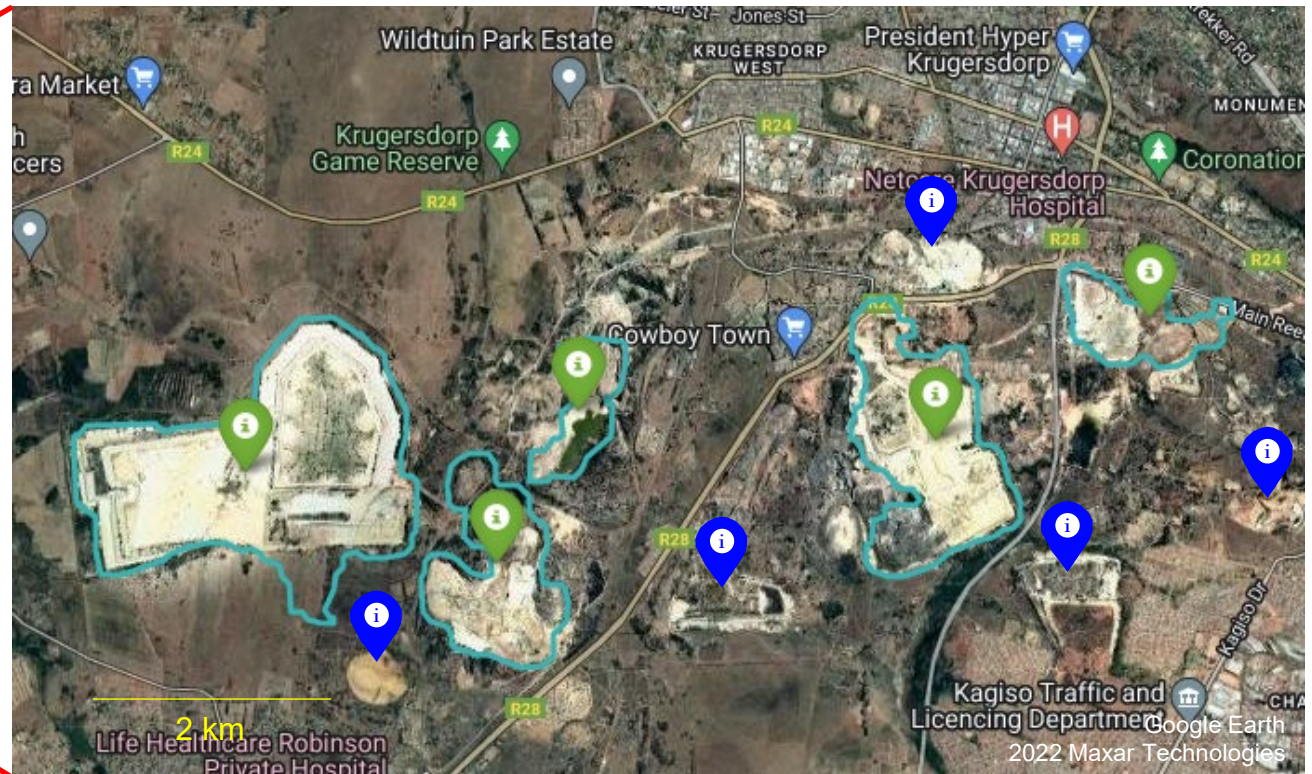
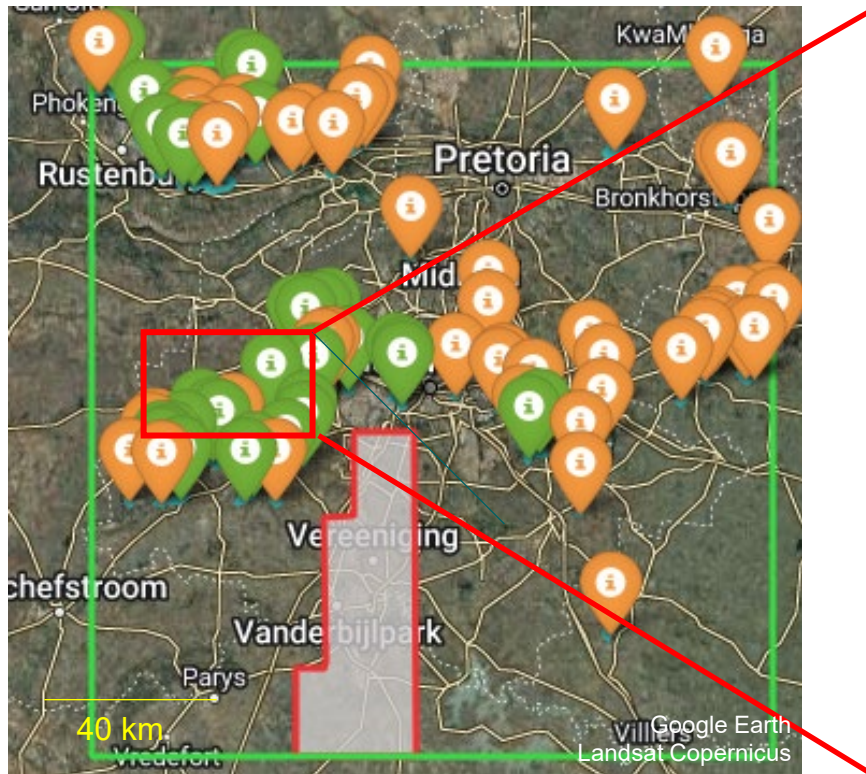
Waste Rock
Dump (WR)

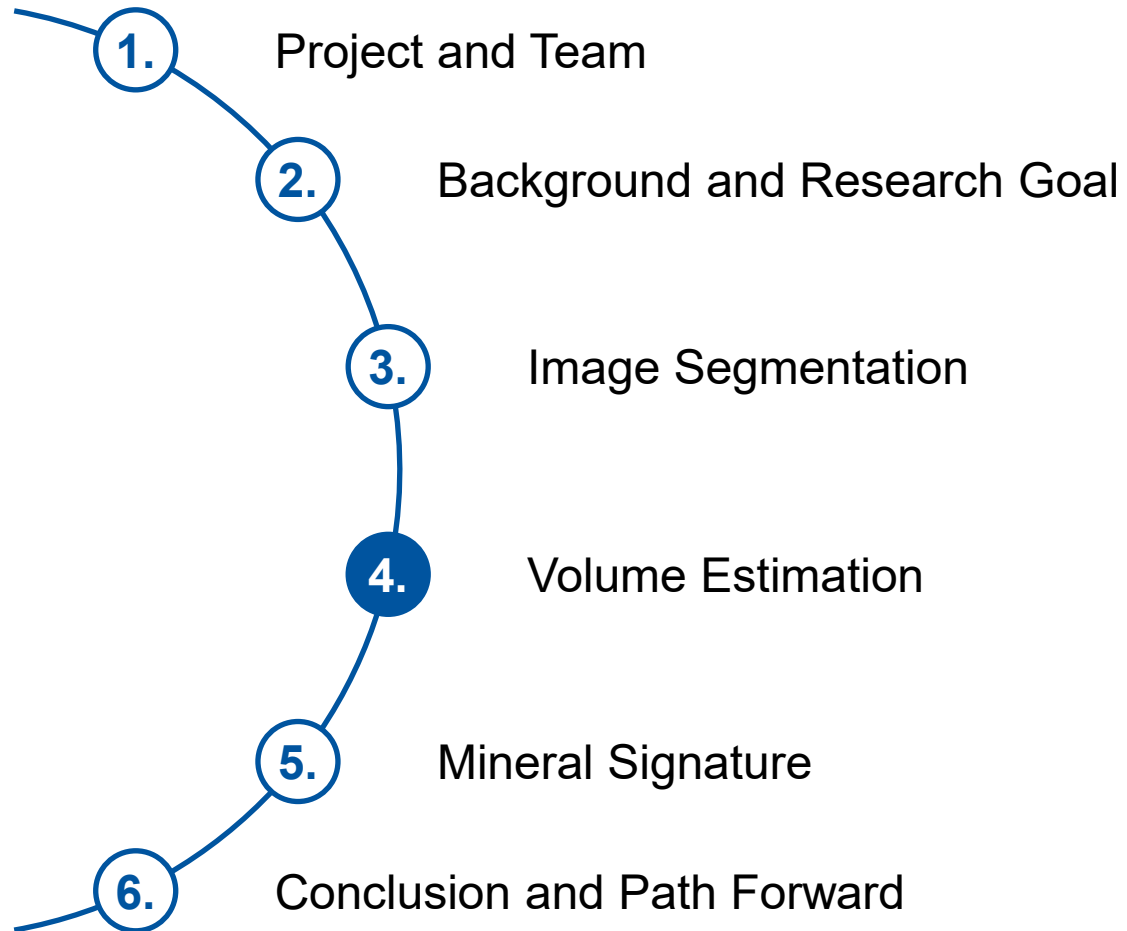


Currently expected performance by ecoregions

Strong	25%
Average	20%
Weak	28%
Unevaluated	26%

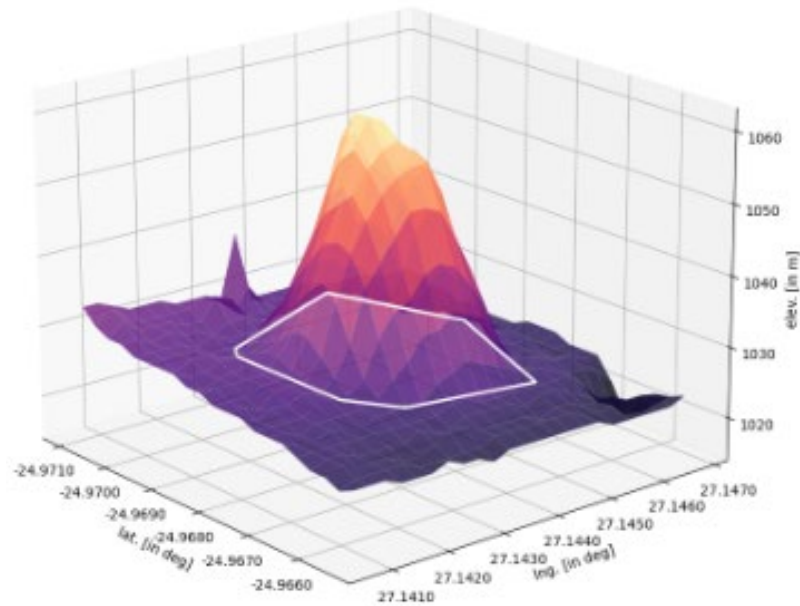
Region Example: OOS Eval – South Africa



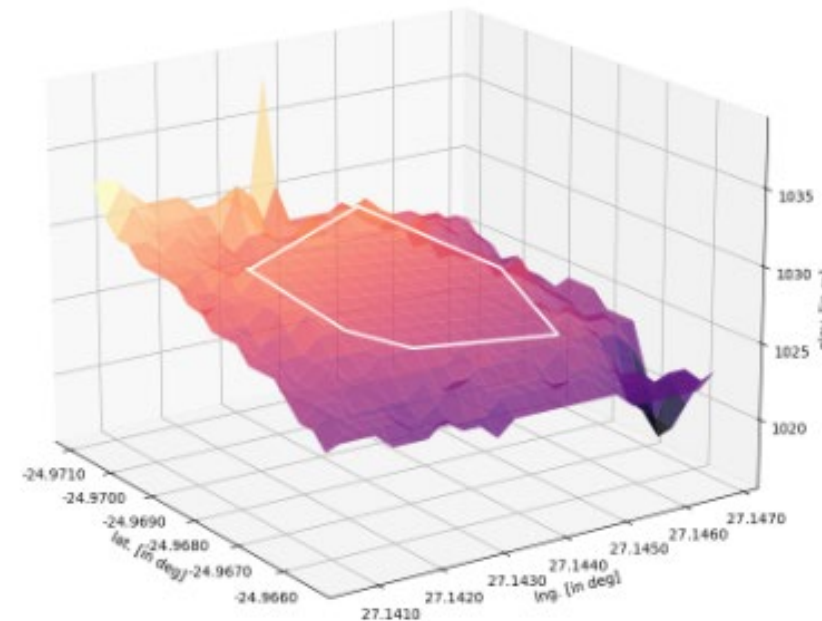


For pile-like mine waste deposits we use the **plane method**, which fits a plane through the boundary points of the object.

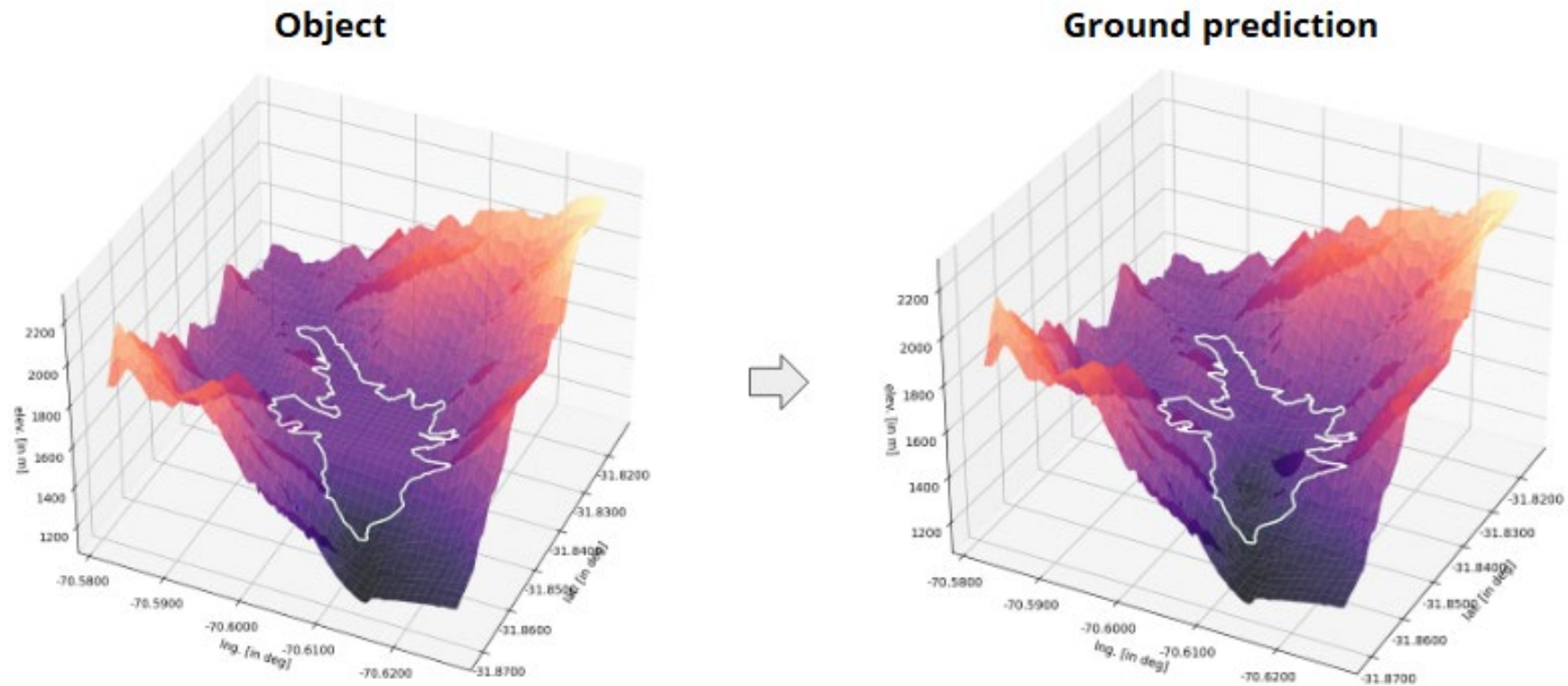
Object

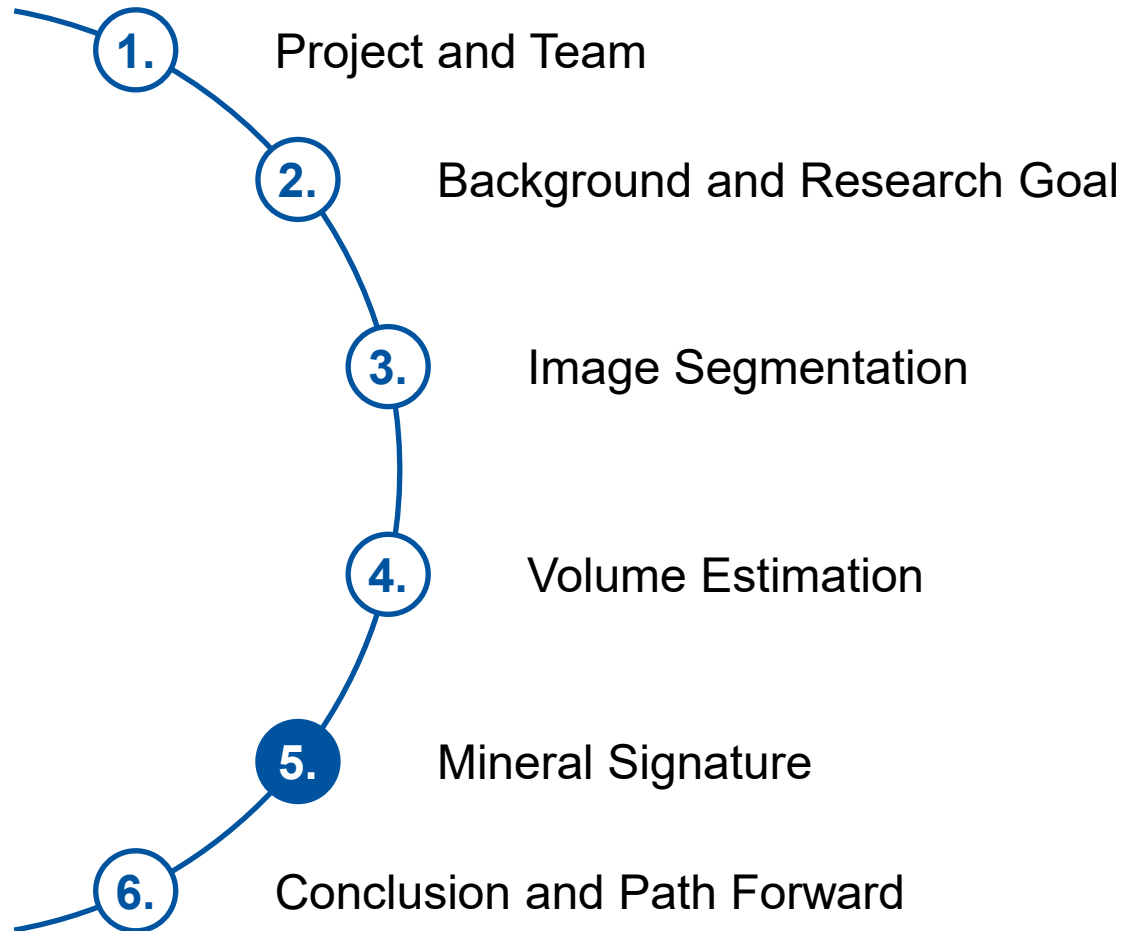


Ground prediction



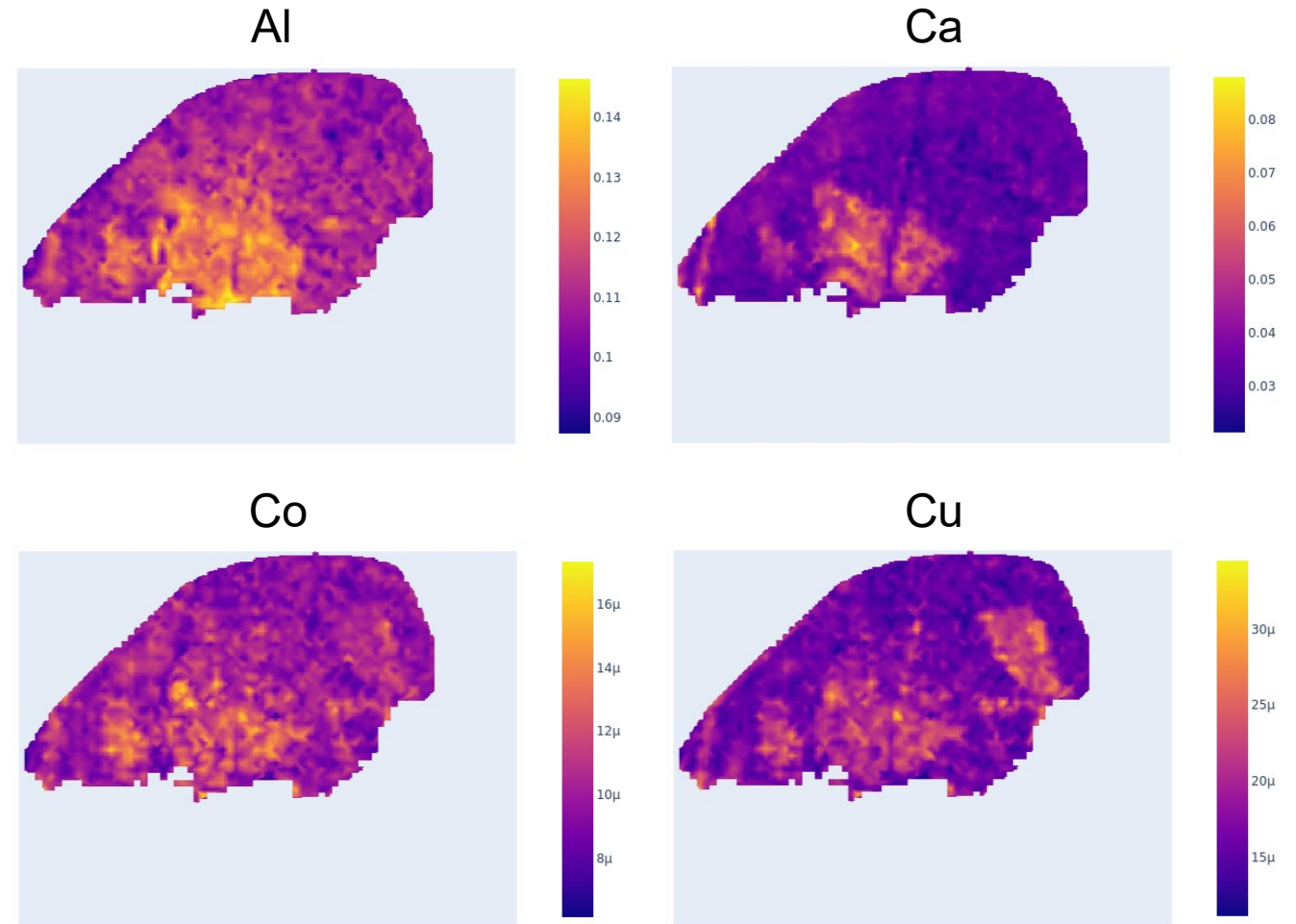
For more complex structures, like cross valley or hillside tailings ponds, we use a method based on spline interpolation, the **spline method**.



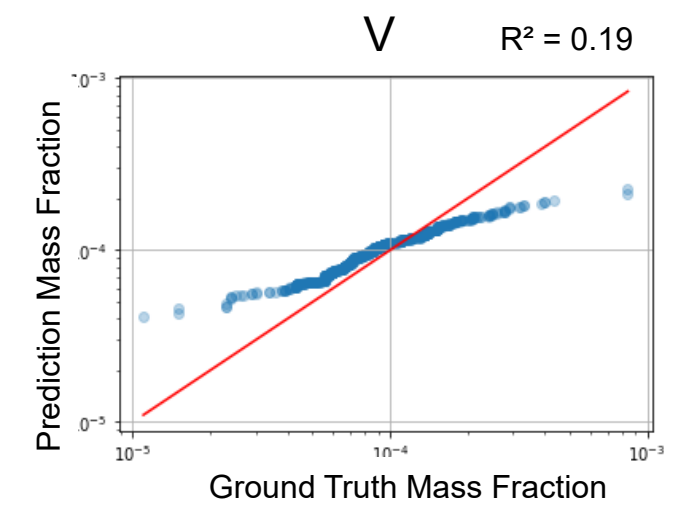
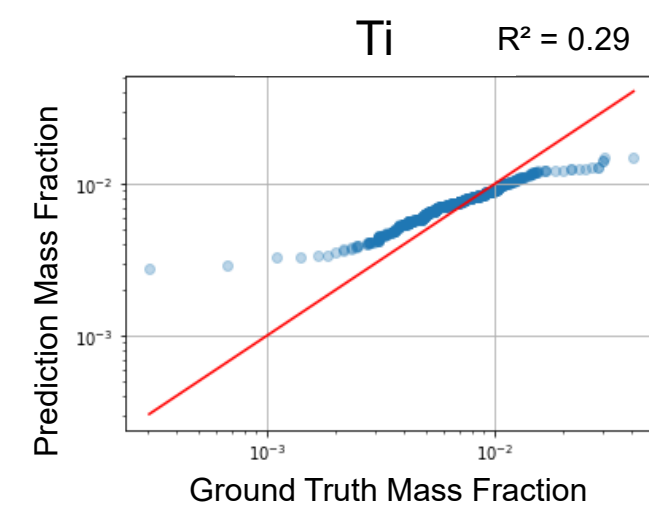
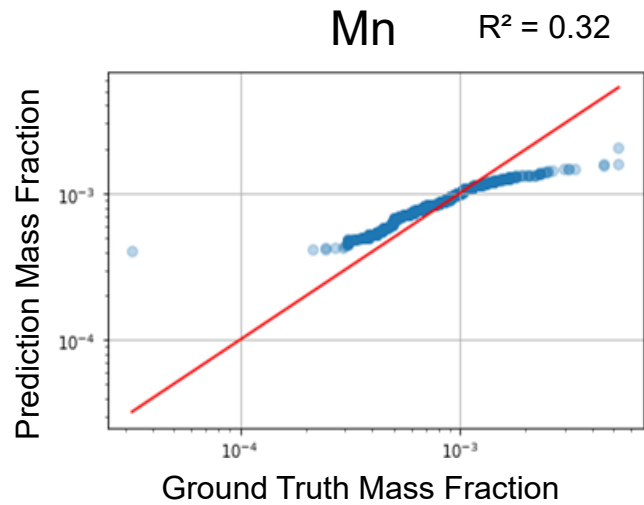
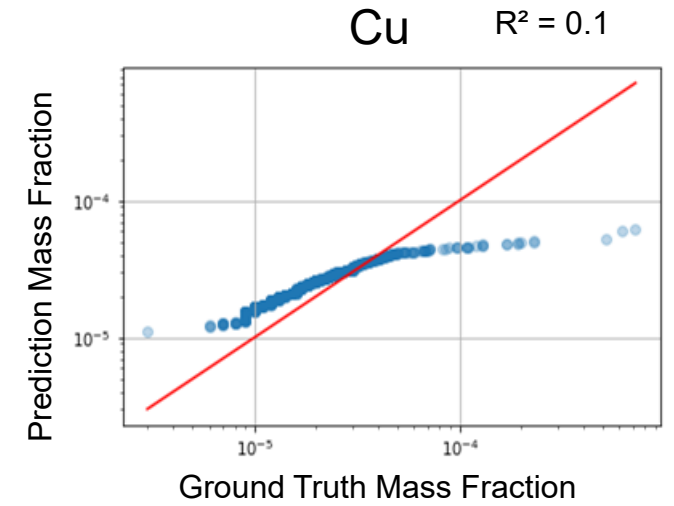
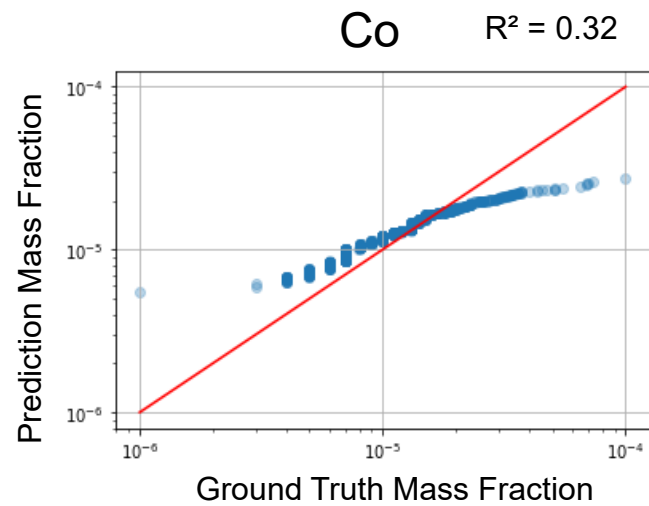
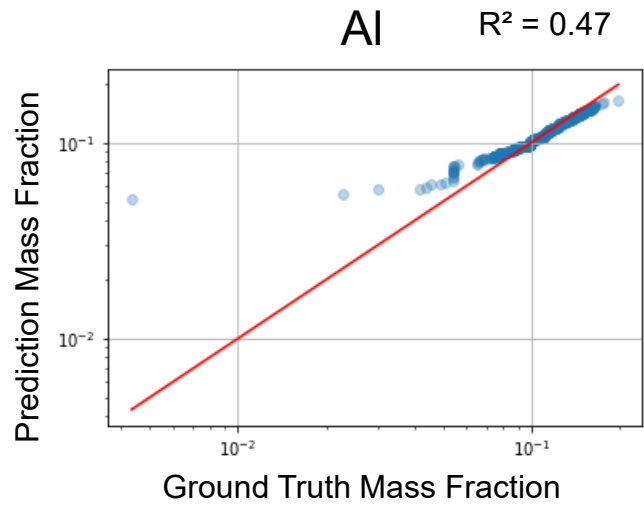


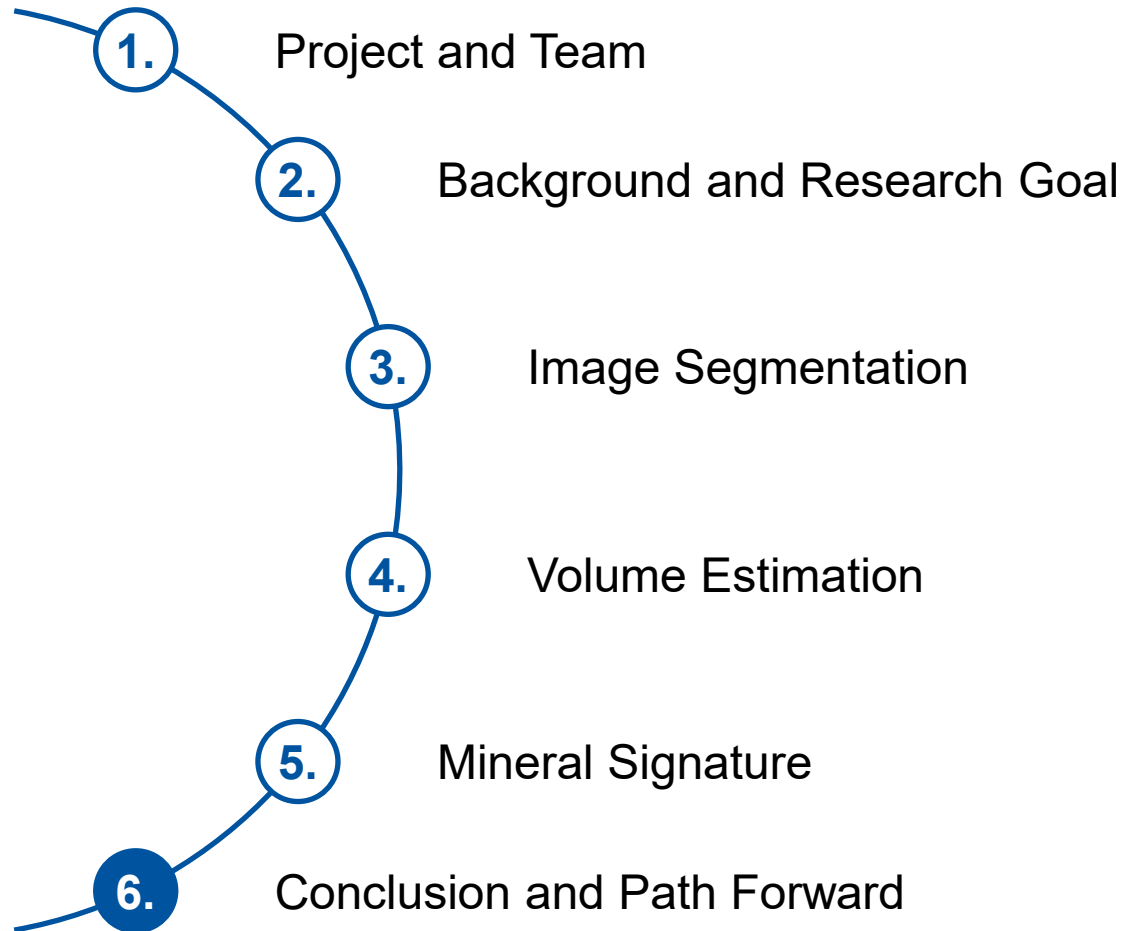
- 1-75,000 PRISMA pixels per object (30 x 30 m spatial resolution)
- Mineral spectra library: > 6,000 entries
- Two current methods focusing either on mineralogical or chemical composition
- Mine waste material is not homogenous
- Surficial information

Cu:	19.3 ± 1.6 ppm
Co:	13.4 ± 1.4 ppm
Al:	12.3 ± 0.8 %
Ca:	4.3 ± 0.3 %
...	



Values as mass fractions of the given elements.





Feasibility

...for identification, volume estimation and mineralogical characterization given

Fundament

...for **economical evaluations** and reuse in **raw-material cycle**

„Smart exploration“

Innovative interweaving of mining and machine learning algorithms

Future-oriented

General increase in remote sensing data availability and improvement in machine learning expectable

What's next?



Ongoing expansion of data base, especially in humid regions



Further evaluation and development of spectral analysis models



Upscaling and usability improvement of software

Thank you for your attention!

Jan-Niklas Sander, M.Sc.

MRE – Institute of Mineral Resources Engineering
RWTH Aachen University

Tel: +49 241 80-95685
sander@mre.rwth-aachen.de

www.mre.rwth-aachen.de

Nina Küpper, M.Sc.

MRE – Institute of Mineral Resources Engineering
RWTH Aachen University

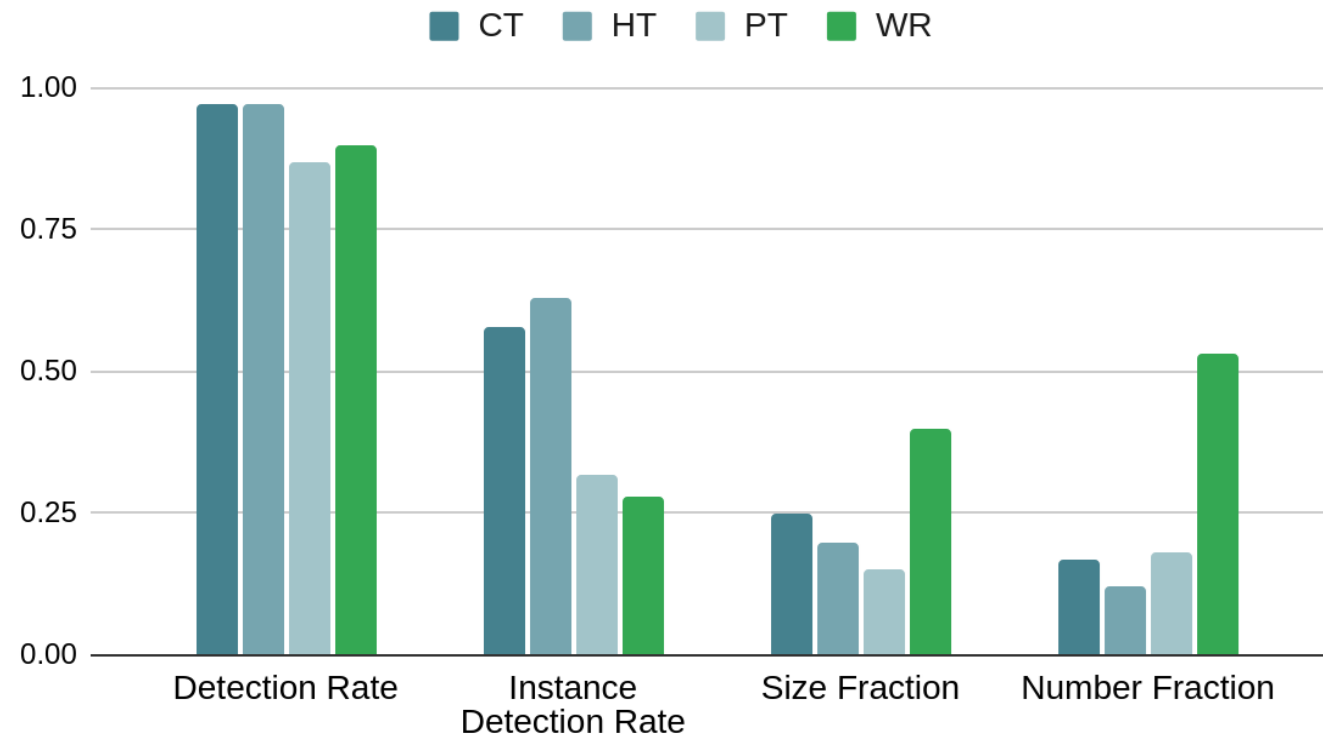
Tel: +49 241 80-95670
kuepper@mre.rwth-aachen.de

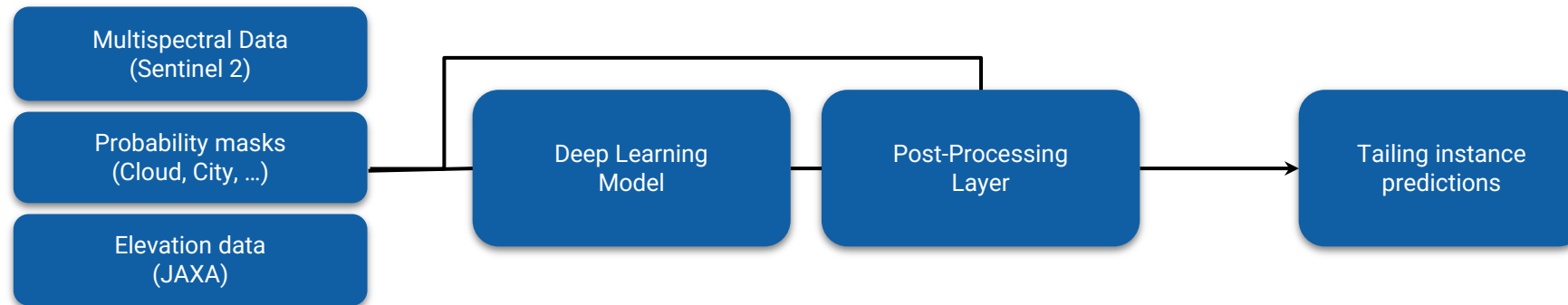
www.mre.rwth-aachen.de

- Esri: Mineral Exploration from Space. <https://www.esri.com/about/newsroom/arcwatch/mineral-exploration-in-the-hyperspectral-zone/> Retrieved 10 May 2021.

Current performance

Detection metrics by tailing type - Larger 0.5 sq-km





In current training dataset

Type	Total	Mediterranean	Desert	Temperate	Tropics	Boreal
Tailings	830	415	133	221	60	0
Dumps	2271	558	364	617	731	0

Under review

Type	Total	Mediterranean	Desert	Temperate	Tropics	Boreal
Tailings	313	1	13	119	175	5
Dumps	1388	23	372	591	355	47