Petrological microscopy data workflow - from field to data

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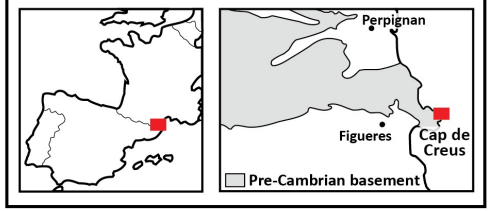
1. Location



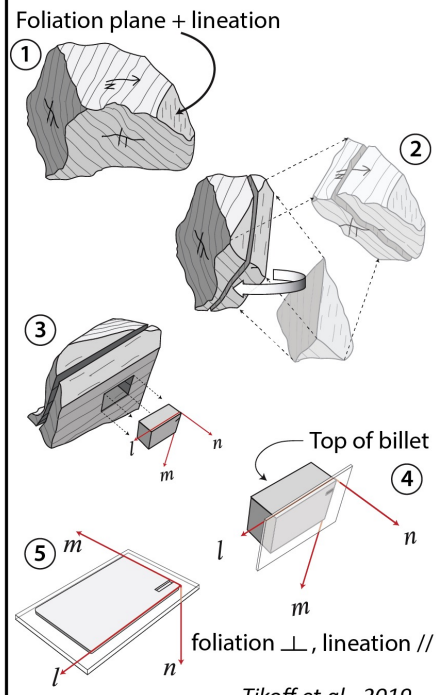
2. Field

Drone-imagery

Field measurements
+
StraboSpot field app

3. Sample

Orientation

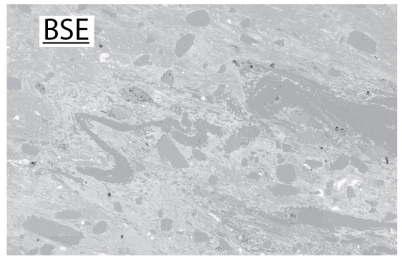


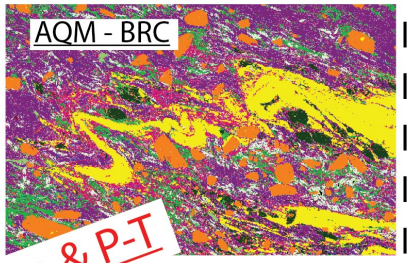
Tikoff et al., 2019

Thin section digitization

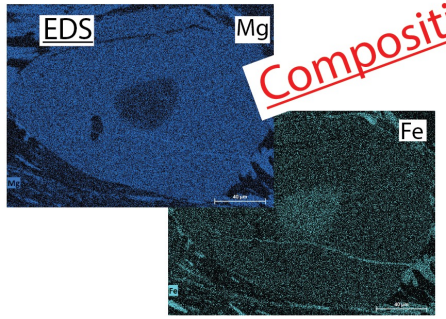
4. Analysis

SEM

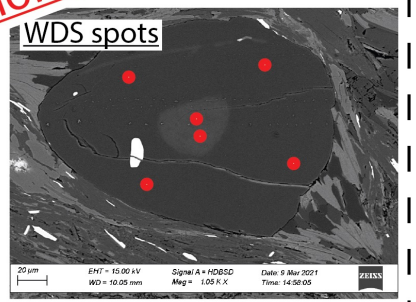




WDS vs EDS

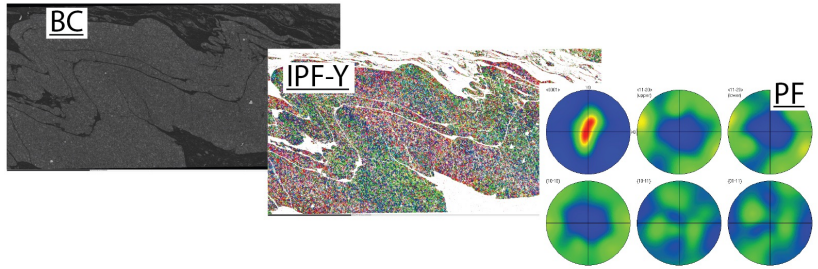


Composition & P-T



Perple_X BRC modeling

EBSD



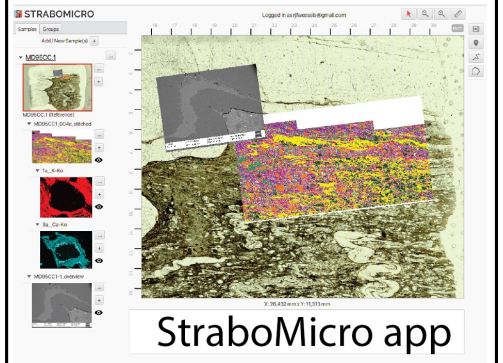
XRF & LA-ICP-MS

SIMS Ti-in-Qtz

WORK IN PROGRESS

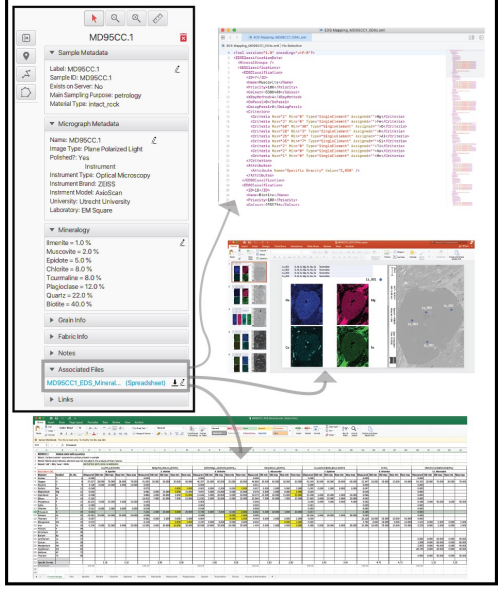
5. Data

Image correlation



StraboMicro app

(Meta)data



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STRABOSPOT
EPOS-NL
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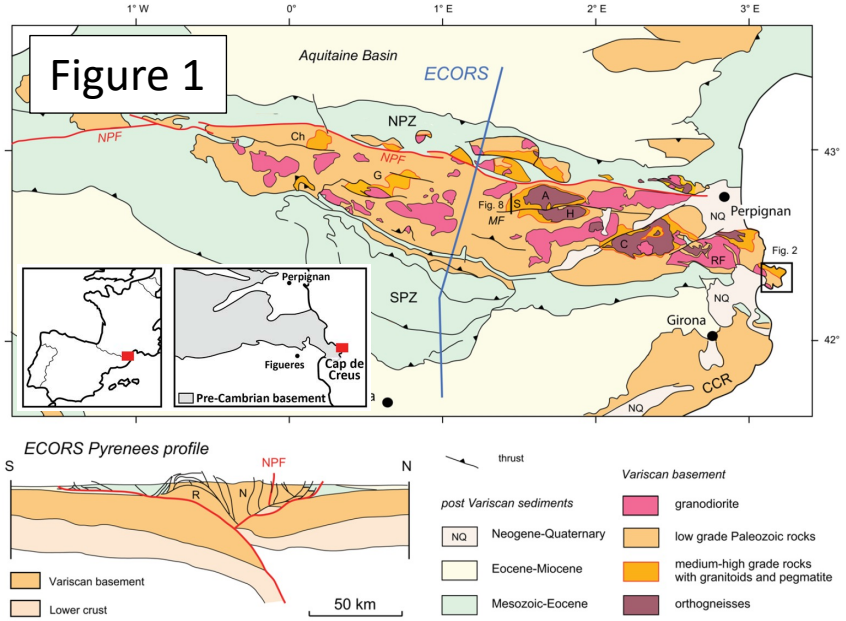
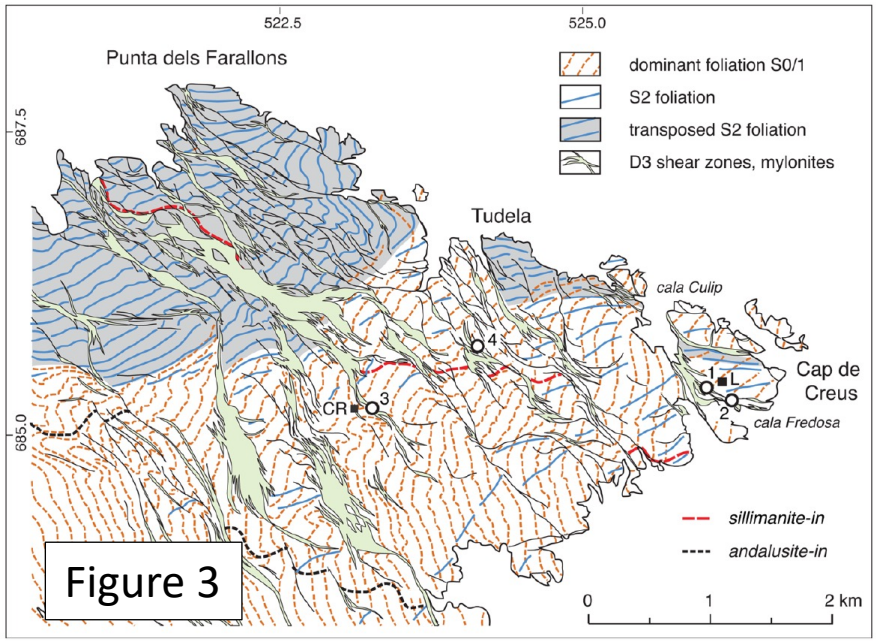
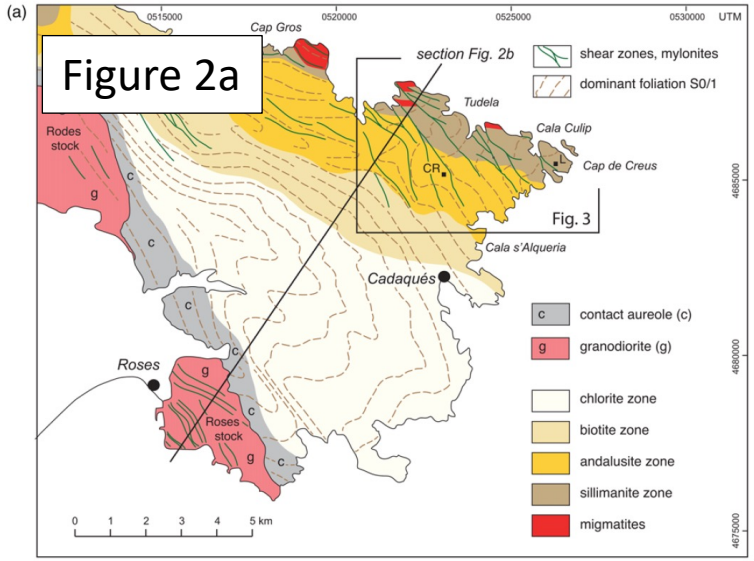
EGU General Assembly 2021
EXCITE

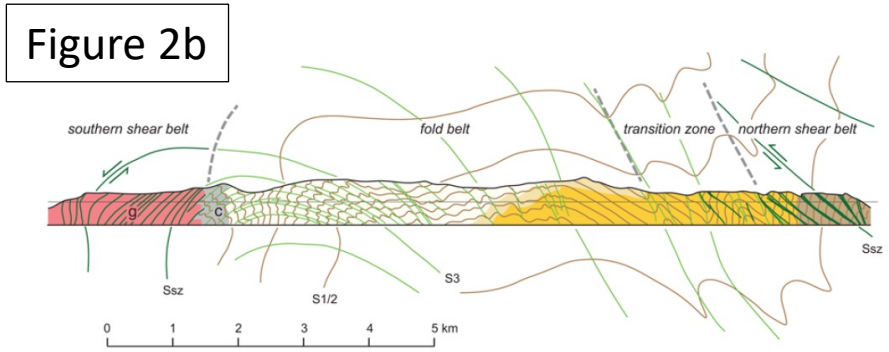
1. Location and geological setting Cap de Creus, NE Spain







Figures from Vissers et al., 2016



Located in the axial zone of the Pyrenees (figure 1), the pre-Cambrian metasediments underwent HT-LP greenschist- to amphibolite-facies metamorphism (figure 2), are intruded by pegmatitic bodies, and overprinted by greenschist-facies shear zones (figure 3).

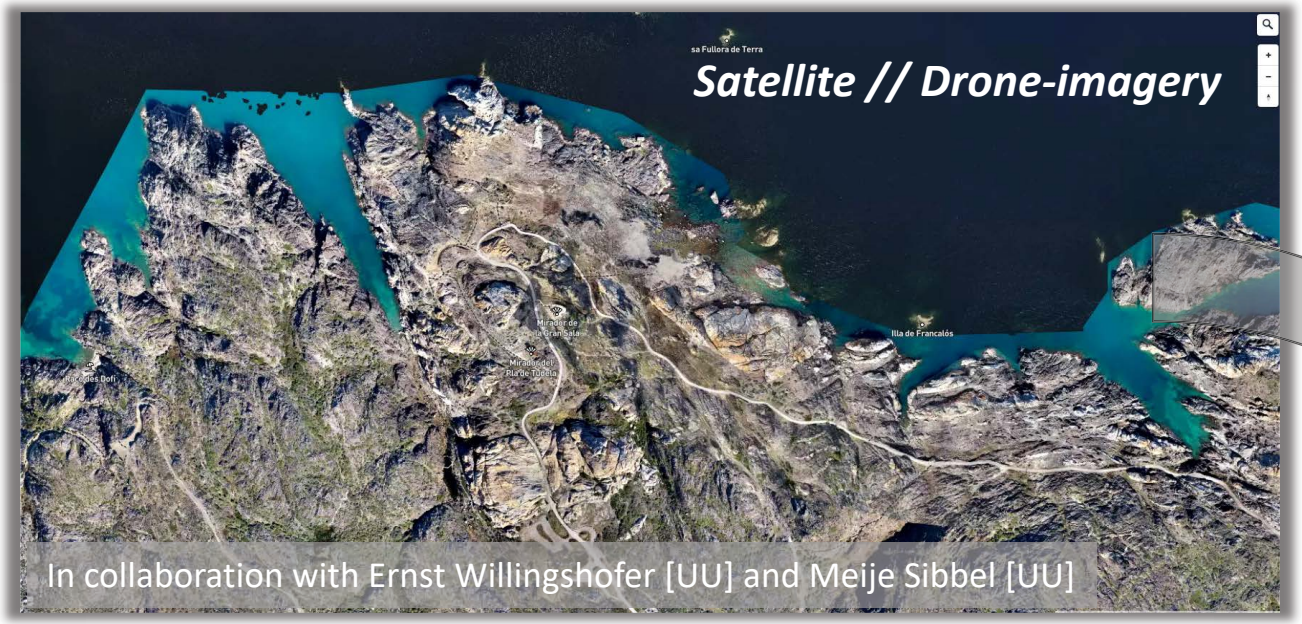
Cap de Creus is a natural laboratory for studying the deformation and metamorphism of crustal rocks, and samples from the region are ideal to test and refine the data workflow.

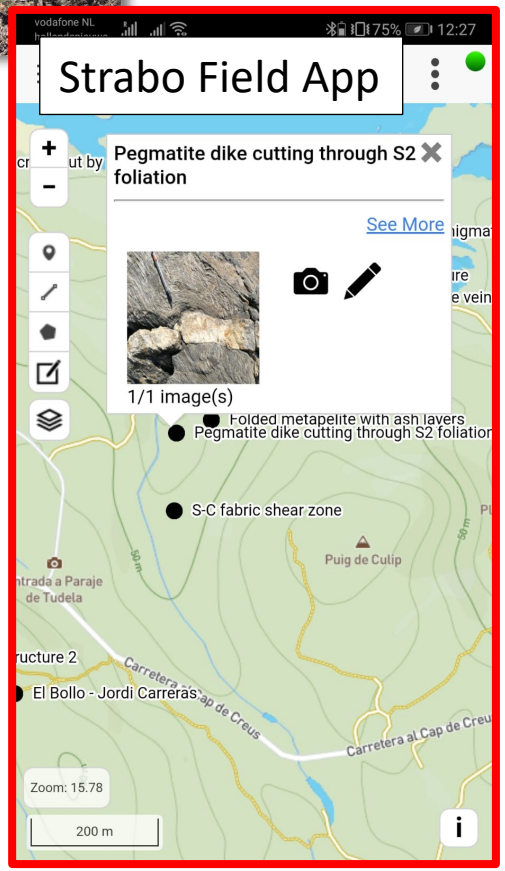
Our approach is to use an active research project as a test case for data and metadata management of petrological microscopy data. Any gaps in metadata schemes are filled along the way.

The Cap de Creus area is a national park, so conservation is important. Sharing and re-use of data can help preserve these wonderful world-class outcrops.

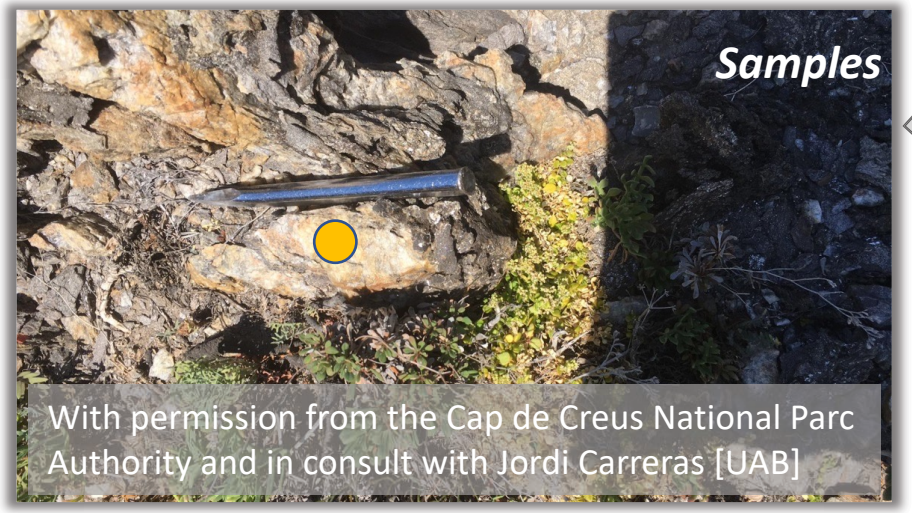
Druguet et al. (1997), Carreras (2001), Fusseis et al. (2006), Druguet et al. (2014)

2. Field data collection





Cap-de-Creus
NE Spain

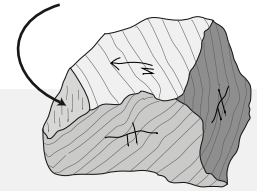


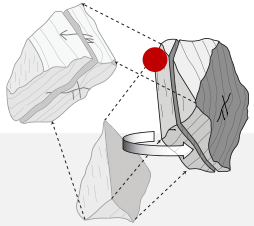
3. Sample orientation and digitization

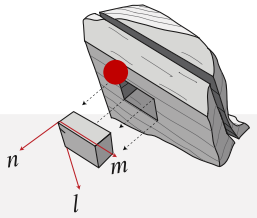
EXAMPLE: XZ thin section – Foliation ⊥, lineation //

Method: Tikoff et al., 2019

Foliation plane and lineation

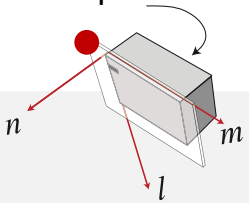


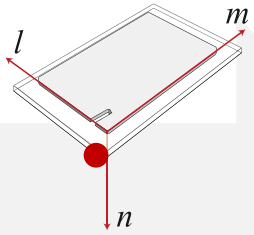


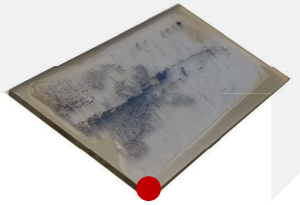


● = reference corner

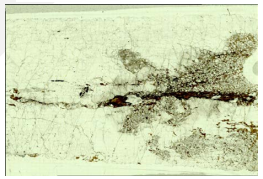
Top of billet





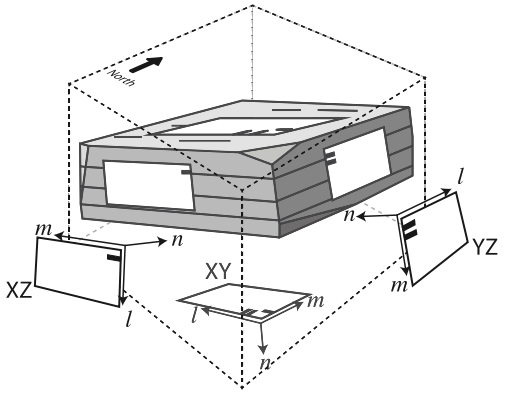


Digitization



ZEISS AxioScan Z1

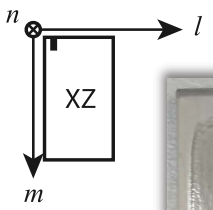
EXAMPLE: Three mutually perpendicular thin sections – 3D representation of a sample



Single notch: X-direction: Notch lineation parallel, in the foliation plane

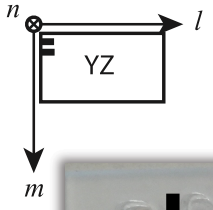
Double notch: Y-direction: Notches lineation perpendicular, in the foliation plane

No notch: Z-direction: Lineation perpendicular, perpendicular to the foliation plane

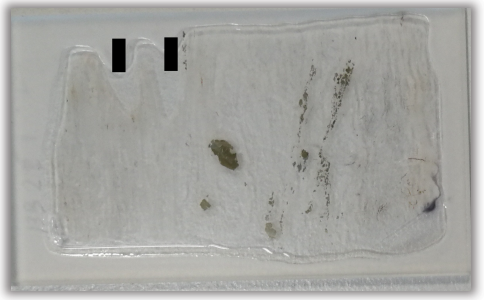


XZ thin section

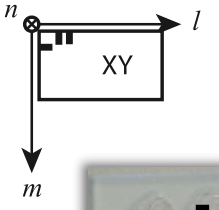
Foliation ⊥, lineation //



YZ thin section



Foliation ⊥, lineation ⊥

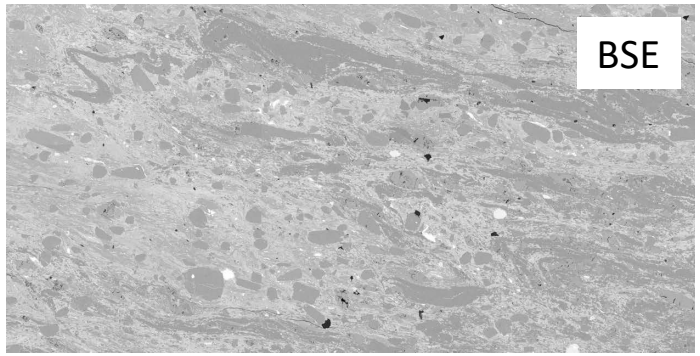


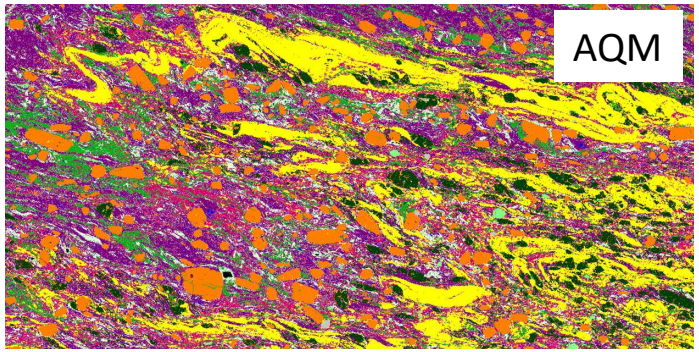
XY thin section

Foliation //, lineation //

4. Analytical techniques – Preliminary results (1)

SEM – EDS – AQM



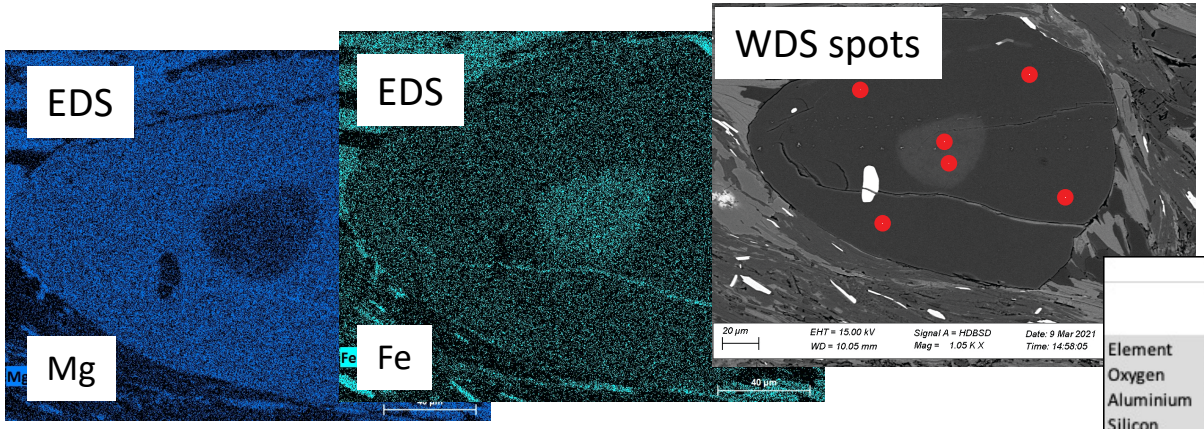


Area% minerals

21.9%	Quartz	8.4%	Tourmaline	<0.5%	Apatite
17.9%	Muscovite	8.1%	Chlorite	<0.5%	Albite
14.2%	Biotite	5.3%	Epidote	<0.5%	Anorthite
11.6%	Plagioclase	1.1%	Ilmenite	<0.05%	Zircon
9.9%	Unclassified			<0.05%	Monazite

EDS spot measurements (Zeiss EVO 15 with Bruker XFlash 6160 EDS detectors) are used to determine the average elemental composition of the phases in the thin section. Automated Quantitative Mineralogy (AQM – Zeiss Mineralogic software) is used to determine the area percentage of each phase. These result, together with the density of the phases, are used as input for a Python script in calculating the Bulk Rock Composition (BRC).

SEM-EDS // EPMA-WDS



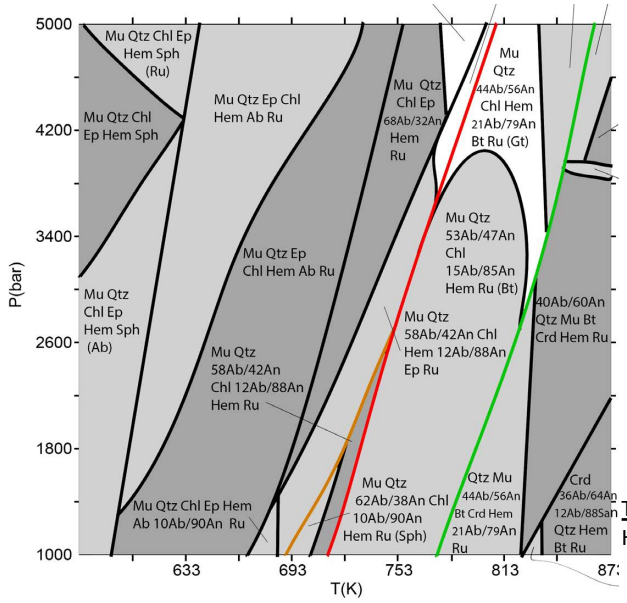
Also interesting: note difference in composition of core w.r.t. rim of tourmaline

		EDS EVO Mass Norm.[%]	WDS EPMA Mass Norm.[%]	
Element	At. No.	MEAN	MEAN	%RSD
Oxygen	8	50.65	52.28	1.6%
Aluminium	13	19.68	19.08	1.5%
Silicon	14	17.37	16.55	2.4%
Iron	26	5.80	6.00	1.7%
Magnesium	12	3.93	3.63	3.9%
Sodium	11	1.36	1.19	6.8%
Calcium	20	0.71	0.73	1.6%
Titanium	22	0.48	0.47	0.7%
Potassium	19	0.02	0.04	40.5%
	SUM	100	100.0	

<u>QC EDS results:</u>

Comparison between EDS and WDS spots indicates that EDS differs <5% RDS for normalized mean mass concentration >5%, and <10% RDS for values <5% normalized mean mass

Perple_X modeling



MnCKFMASHT

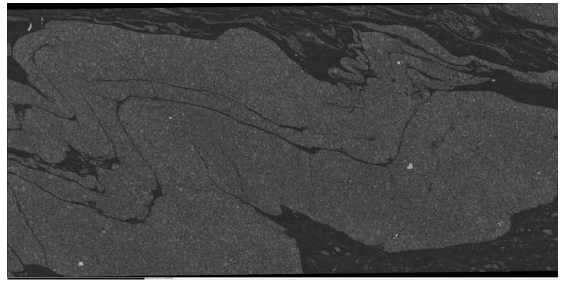
H_2O saturated

<u>Thermodynamic database:</u>
Holland and Powel (2011)

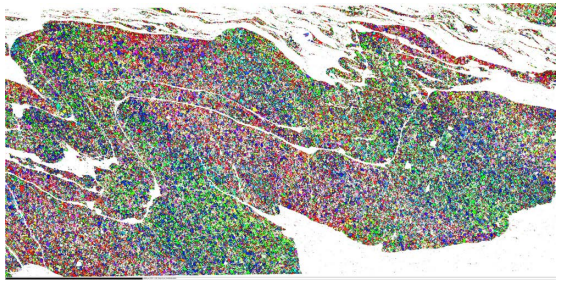
4. Analytical techniques – Preliminary results (2)

SEM – EBSD

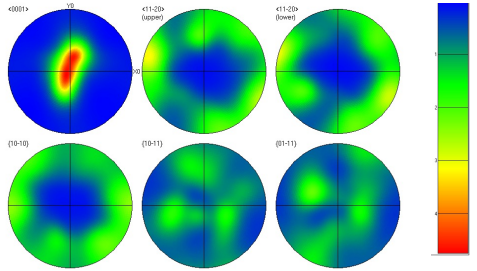
In collaboration with Maartje Hamers [UU]



BC

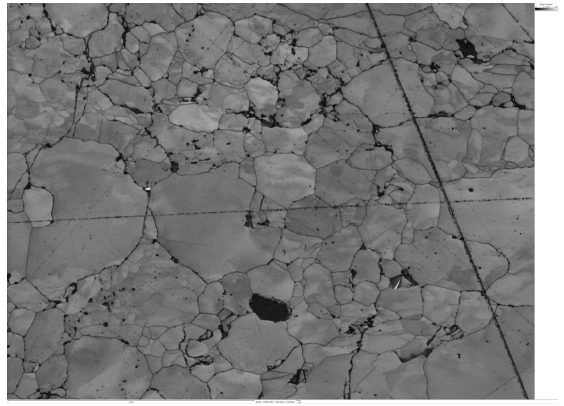


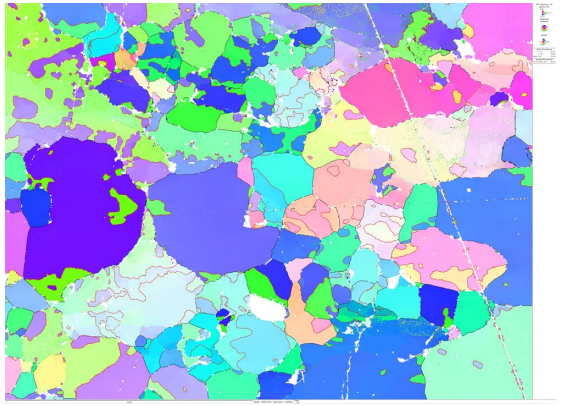
IPF-Y

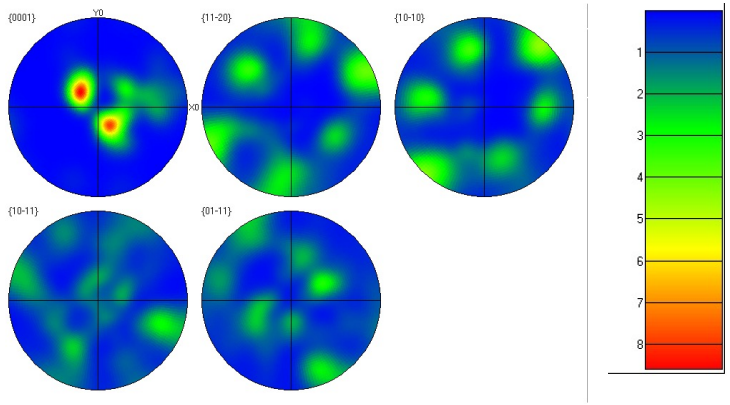


Pole figures

Folded quartz mylonite from Greenschist facies shear zone







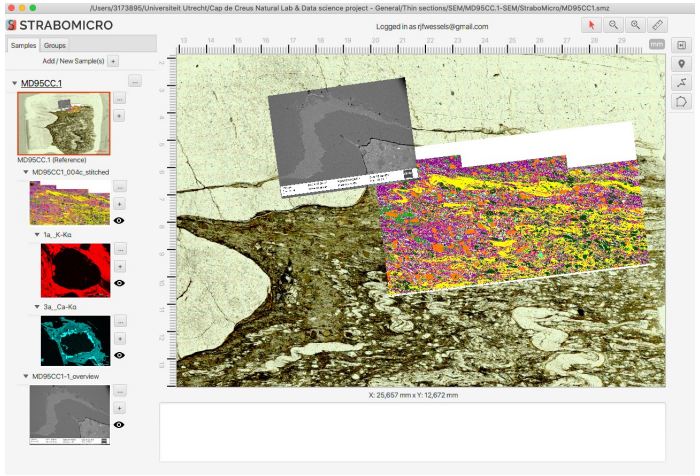
Quartz tectonite from high-strain shear zone in Amphibolite shists

BC: band contrast maps, IPF-Y: map showing crystal orientation parallel to Y axis. Pole figures showing quartz crystal directions in stereographic projection.

- Oriented sample workflow links crystallographic preferred orientation of quartz directly to field.
- EBSD data and metadata described by scheme developed with Strabomicro team in 2020.
- Providing raw data and derived data products, enables data to be re-used using different processing and calibrations.

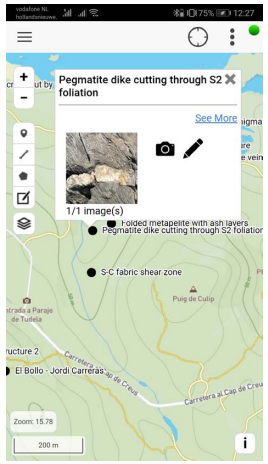
5. Data and Metadata

Image correlation

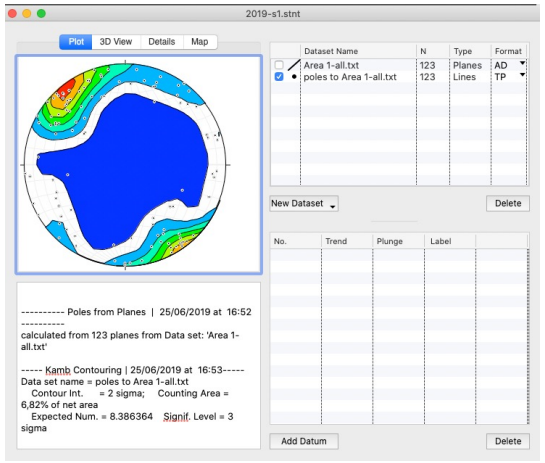


StraboMicro

Data correlation

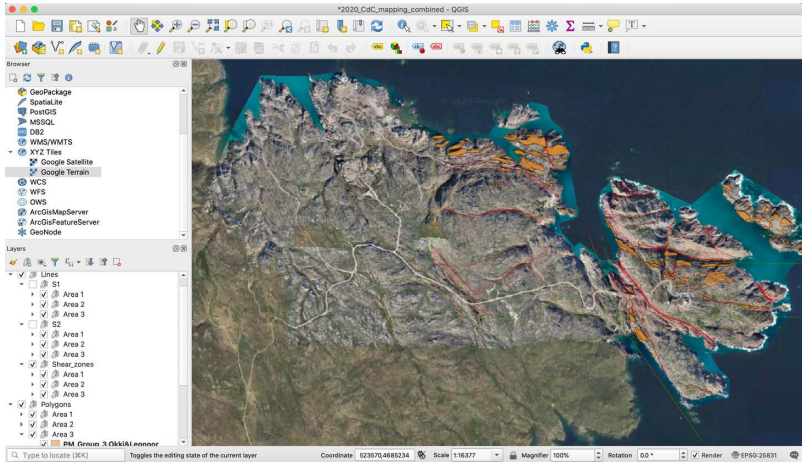


StraboSpot Field app



Stereonet software (Allmendinger)

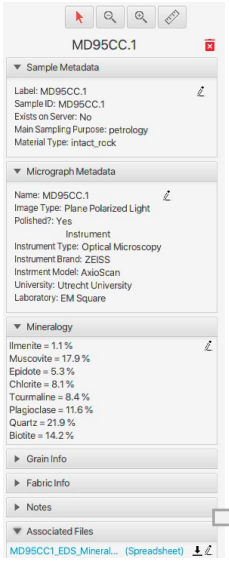
Spatial correlation



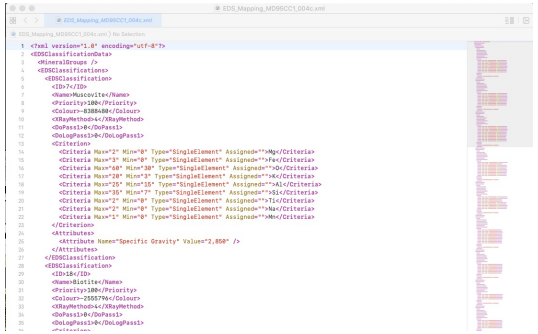
QGIS

Data and metadata - data will be published as data publications in the EPOS framework and in the StraboSpot data repository

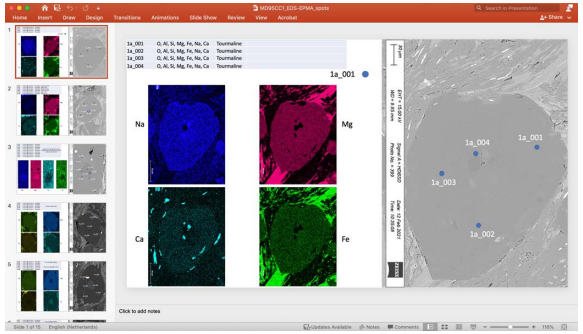
StraboMicro



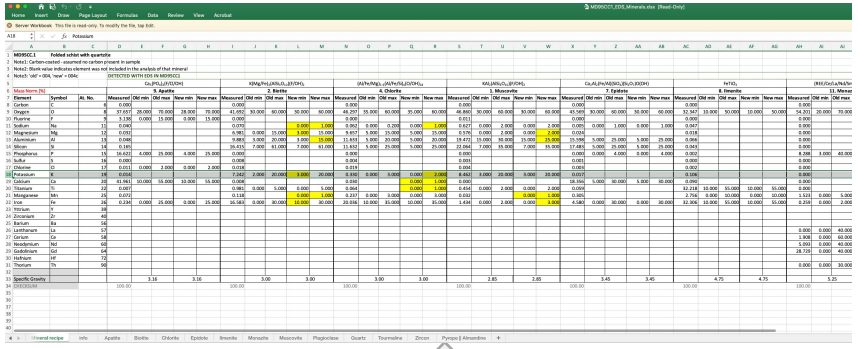
e.g. mineral recipe as input for the AQM software



e.g. additional point and sample info in ppt



e.g. compositional and location data on EDS spots and BRC



Addition of linked files to the dataset