Geological, petrophysical, geotechnical and hydromechanical assessment of the Lusatian Granodiorite for the construction of the Einstein Telescope

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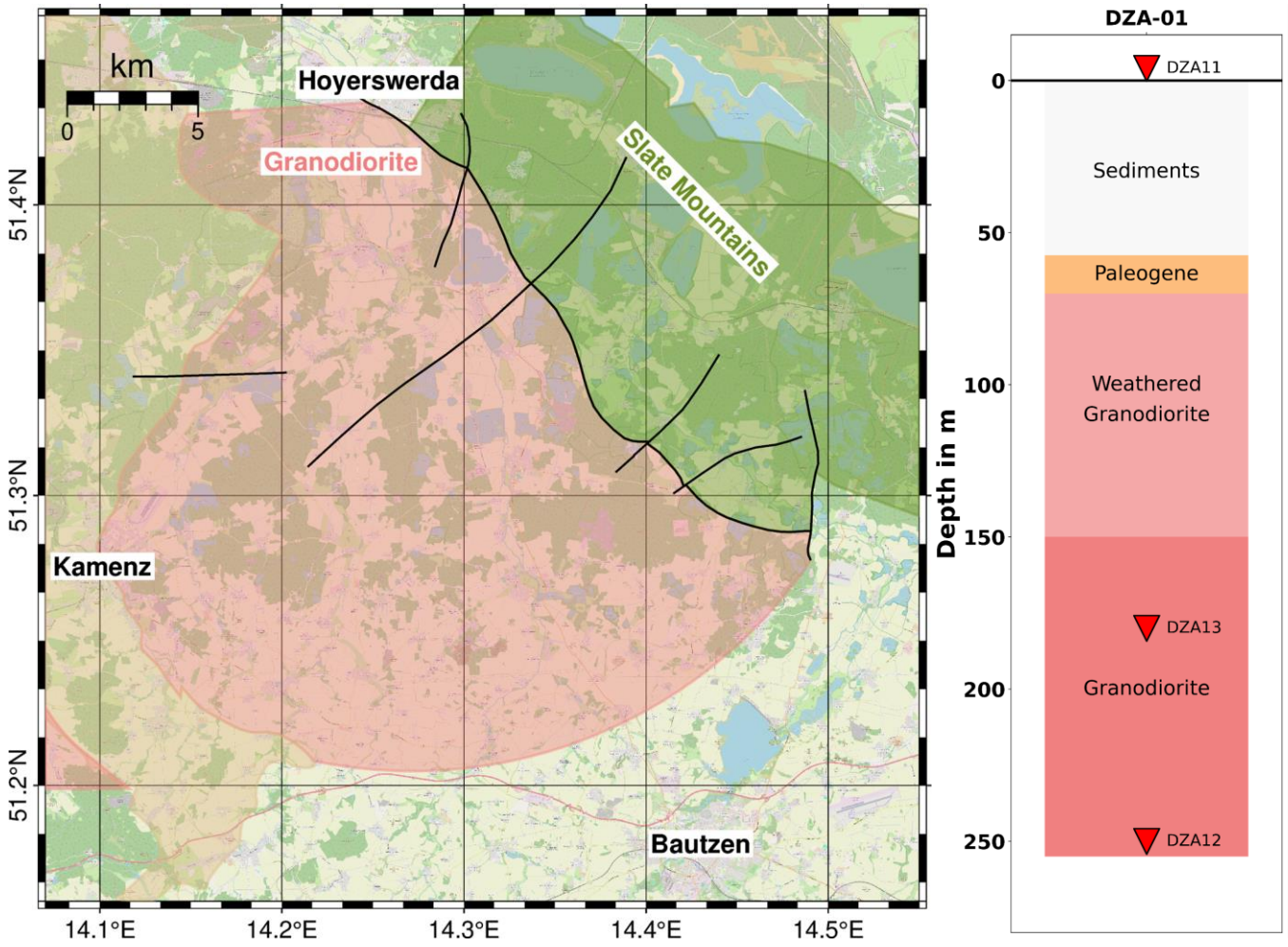
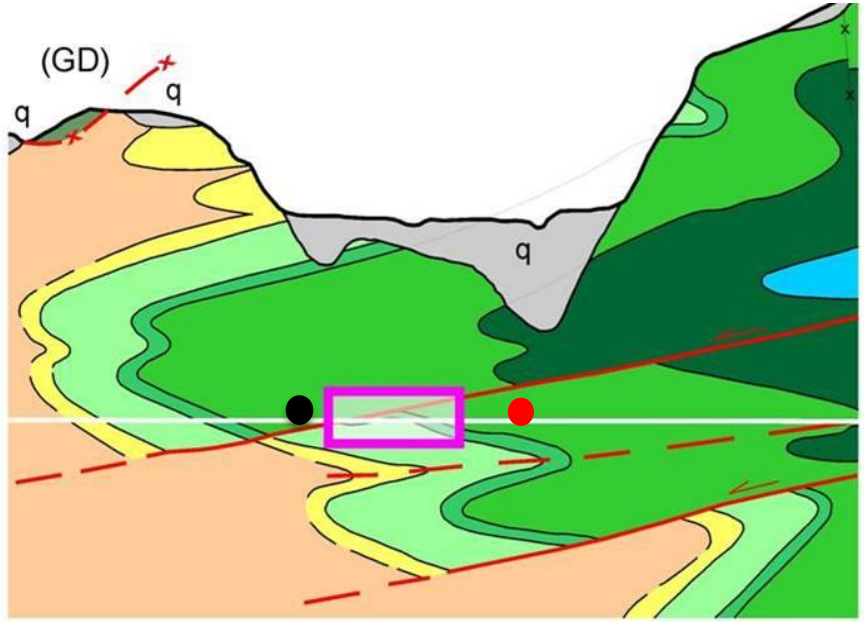
Geology of Lusatian Block



Geomechanical Rock Characterization



Tunnel →

Geological Model

(constitutes geological homogeneous areas)

↓

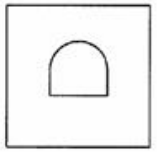
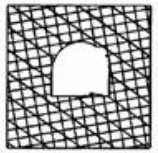
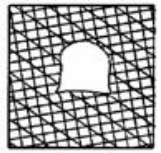
Rock-mechanical Model

(constitutes geomechanical homogeneous areas)

↓

Rock mass behavior Model

(constitutes final rock mass behavior homogeneous areas)

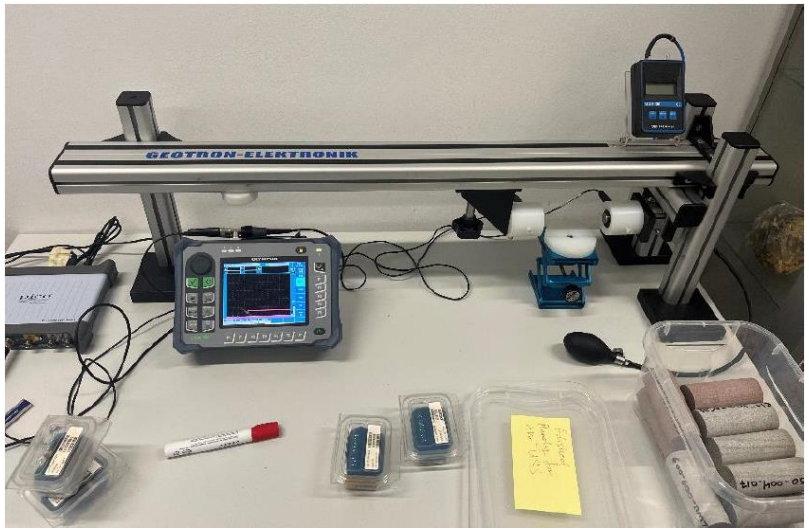
	Low stress levels	High stress levels
Massive rock	 Massive rock subjected to low in situ stress levels. Linear elastic response with little or no rock failure.	 Massive rock subjected to high in situ stress levels. Spalling, slabbing and crushing initiates at high stress concentration points on the boundary and propagates into the surrounding rock mass.
Jointed rock	 Massive rock, with relatively few discontinuities, subjected to low in situ stress conditions. Blocks or wedges, released by intersecting discontinuities, fall or slide due to gravity loading.	 Massive rock, with relatively few discontinuities, subjected to high in situ stress conditions. Failure occurs as a result of sliding on discontinuity surfaces and also by crushing and splitting of rock blocks.
Heavily jointed rock	 Heavily jointed rock subjected to low in situ stress conditions. The opening surface fails as a result of unravelling of small interlocking blocks and wedges. Failure can propagate a long way into the rock mass if it is not controlled.	 Heavily jointed rock subjected to high in situ stress conditions. The rock mass surrounding the opening fails by sliding on discontinuities and crushing of rock pieces. Floor heave and sidewall closure are typical results of this type of failure.

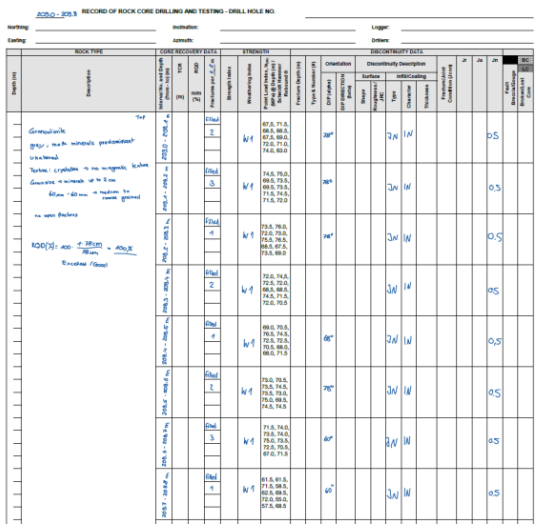
Relevant information for rockmass characterization

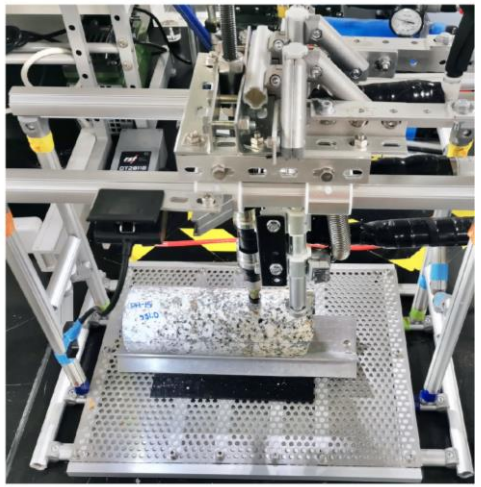
Mechanical Properties ⟷ Hydraulic Properties

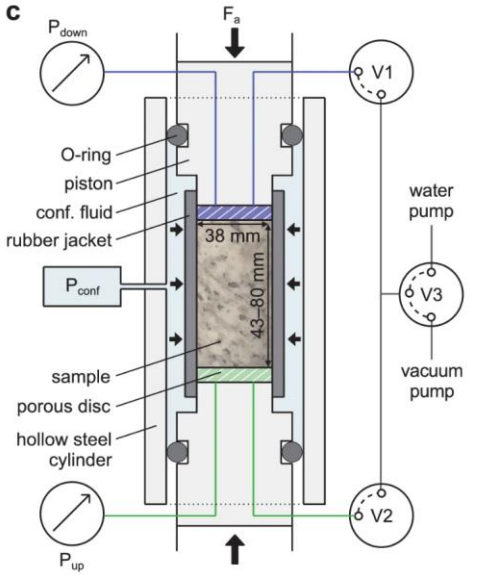
Geology

Destruction Properties



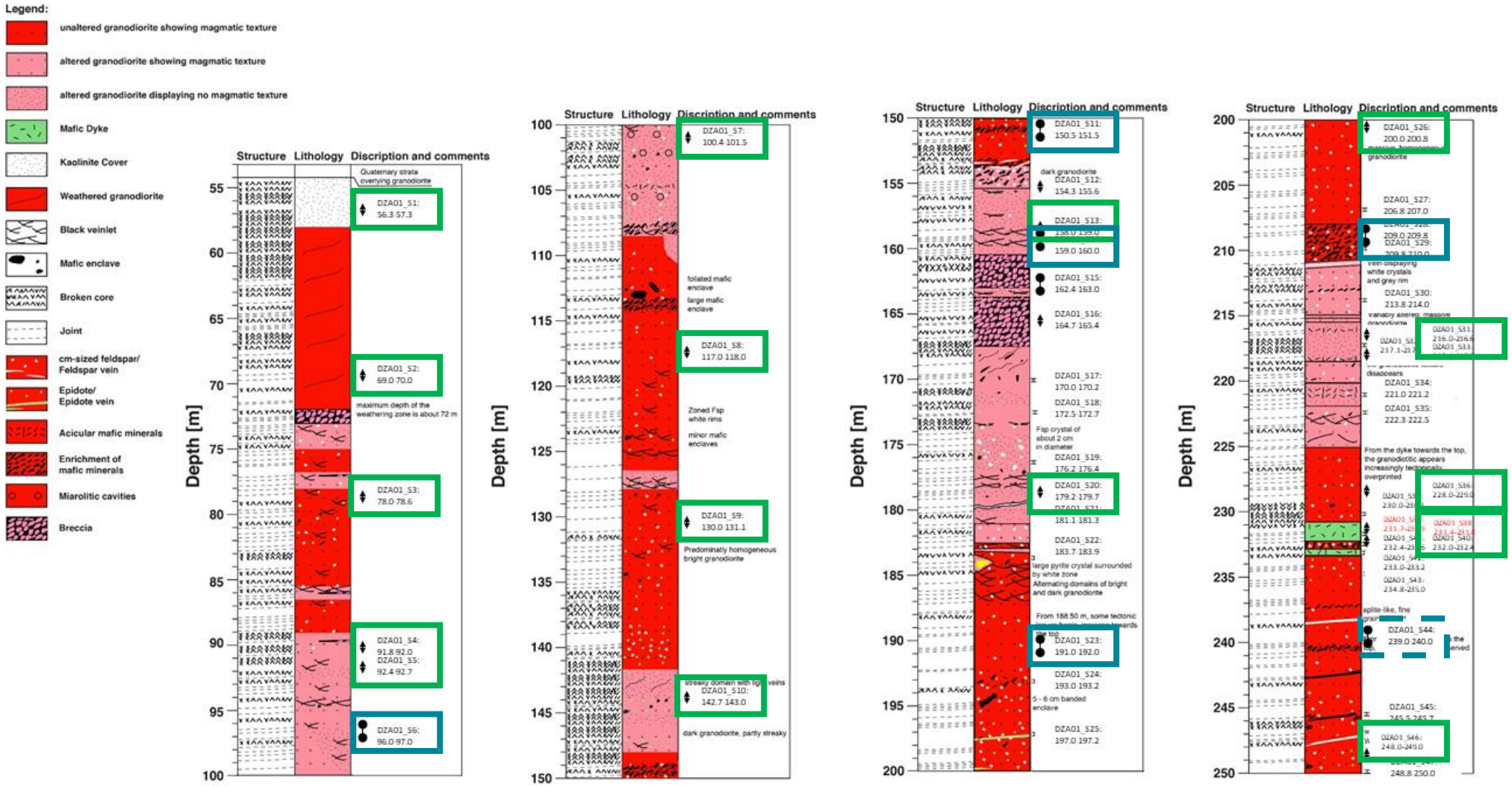






Fraunhofer IEG

Borehole DZA-01/2022

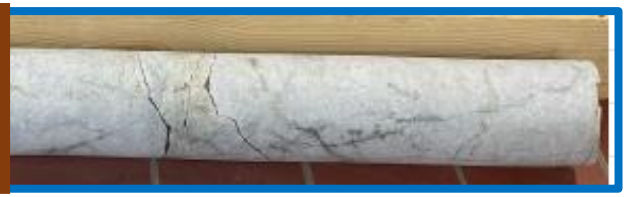


Fraunhofer IEG

Typical lithologies

Altered with magmatic texture

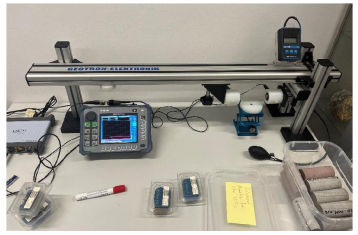
Altered without magmatic texture

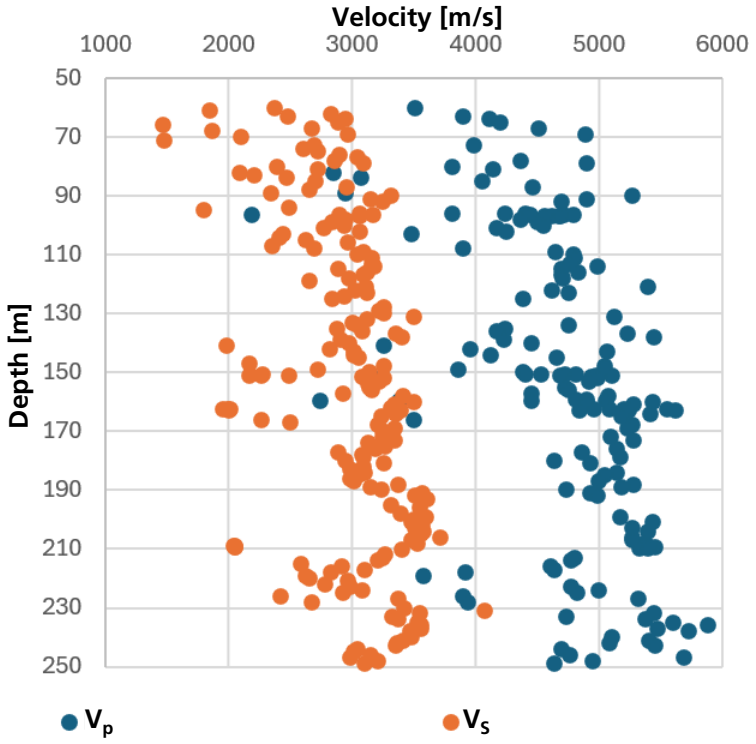


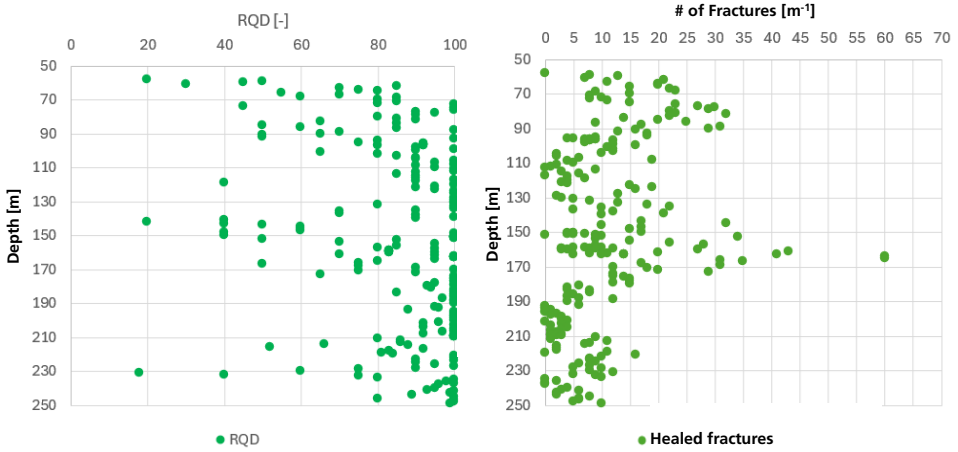
Unaltered with magmatic texture

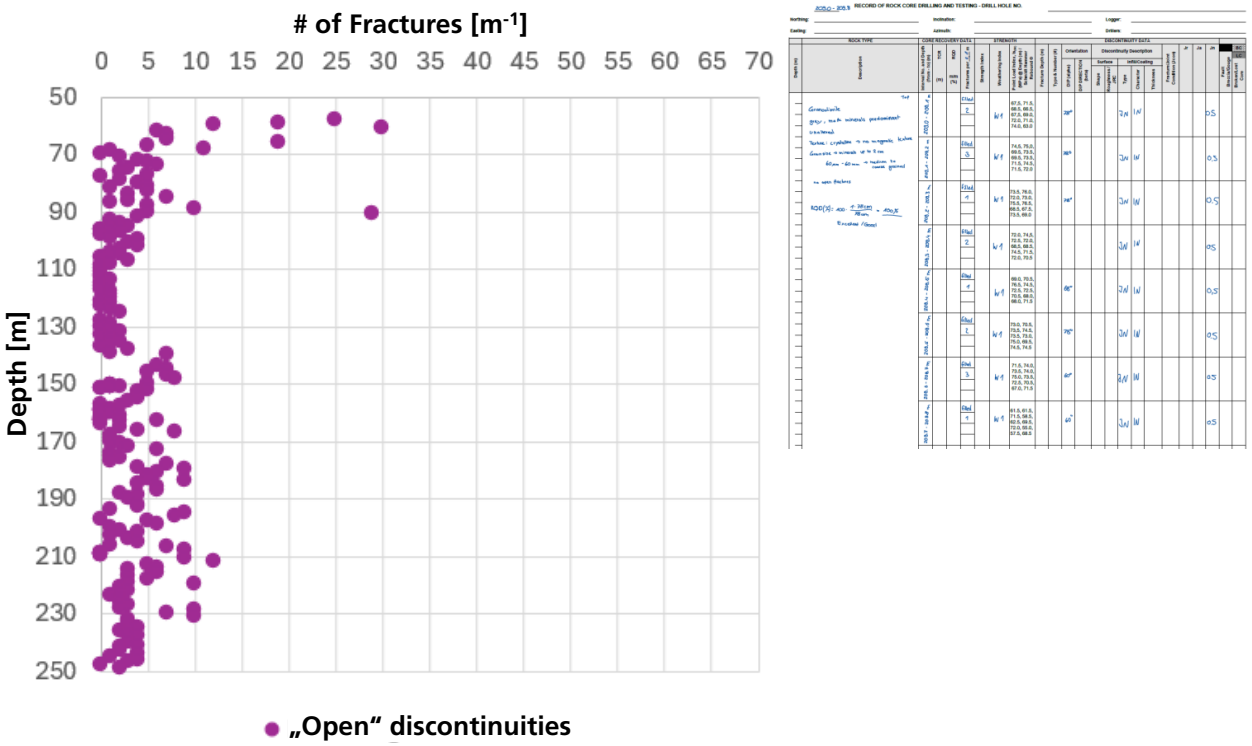
Cataclastic brecciated

Destruction Properties







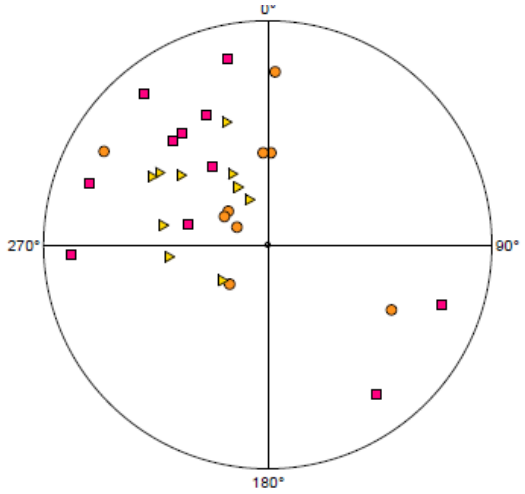


Fraunhofer IEG

Borehole log – Fracture orientations

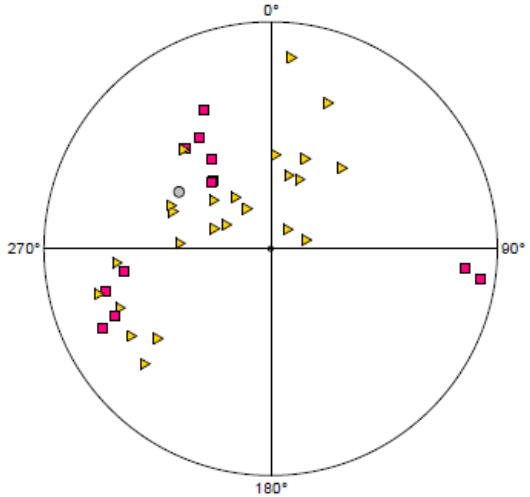
Intermediate dipping NW to WNW

60-80 m



	Counts	Dip[deg]	Azi[deg]
Mean	30	39.48	313.65
■	11	63.47	312.99
●	9	22.65	331.60
▲	10	32.36	305.02

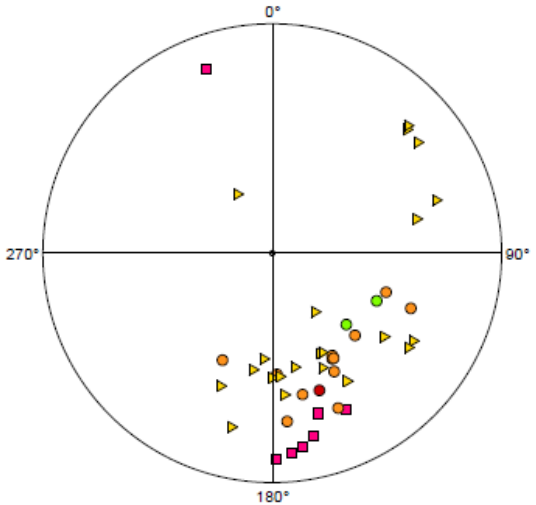
80-100 m



	Counts	Dip[deg]	Azi[deg]
Mean	37	31.91	299.60
▲	24	23.11	309.35
■	12	51.74	289.70
●	1	39.58	301.78

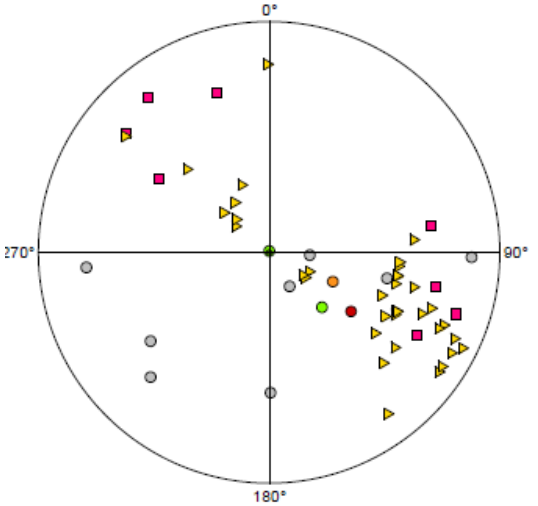
Steeper dipping SE to ESE

140-160 m



	Counts	Dip[deg]	Azi[deg]
Mean	44	48.79	157.70
▲	22	41.57	156.91
■	7	75.28	167.67
●	12	46.20	153.65
●	1	53.40	160.91
●	2	38.93	123.73

220-250 m

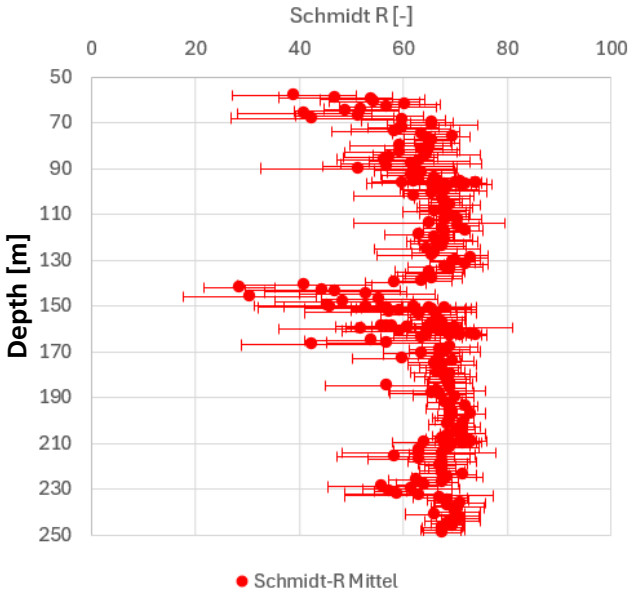


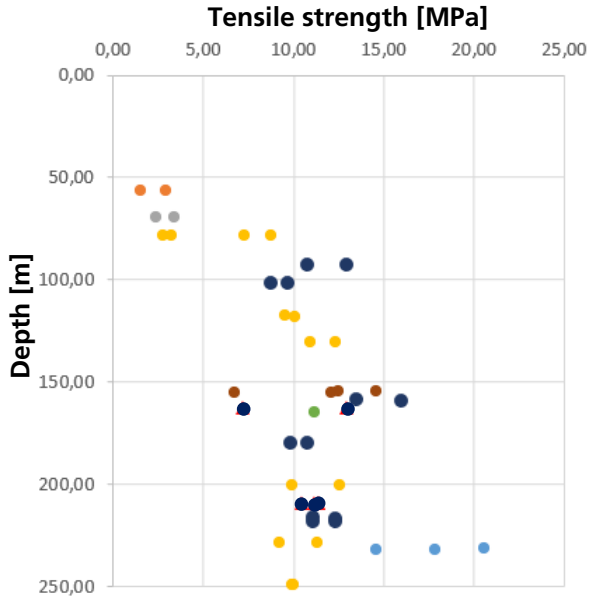
	Counts	Dip[deg]	Azi[deg]
Mean	56	50.78	114.18
▲	36	51.99	114.13
●	8	30.01	202.61
■	8	89.96	301.10
●	2	13.22	135.34
●	1	36.16	125.55
●	1	24.85	114.64

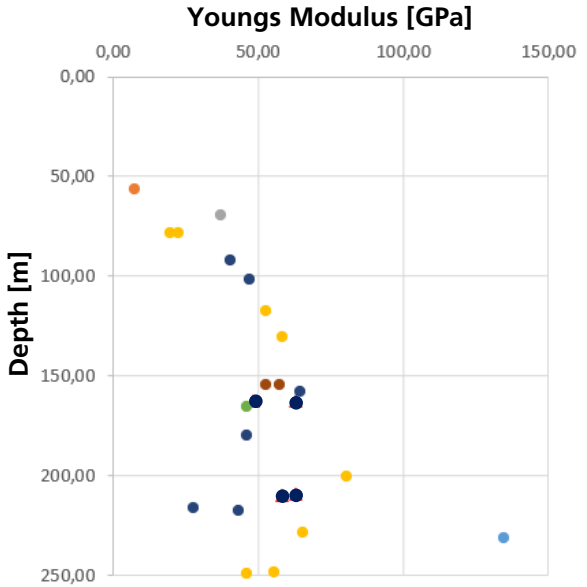
- Open fracture
- Fracture, partially open
- Fracture, finely branched
- Healed/mineralized fracture
- Discontinuity
- Unclear structure

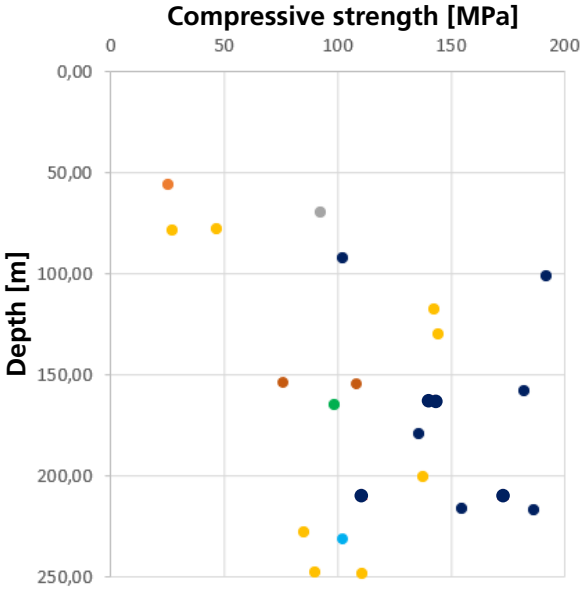
pole projection in upper half sphere

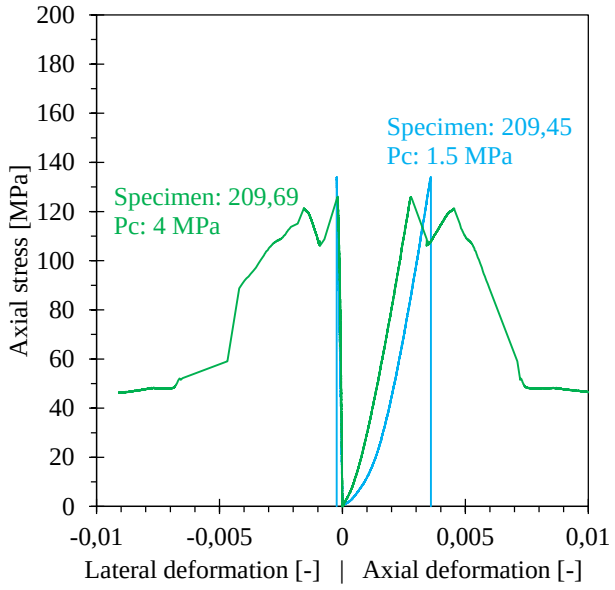
Mechanical Properties







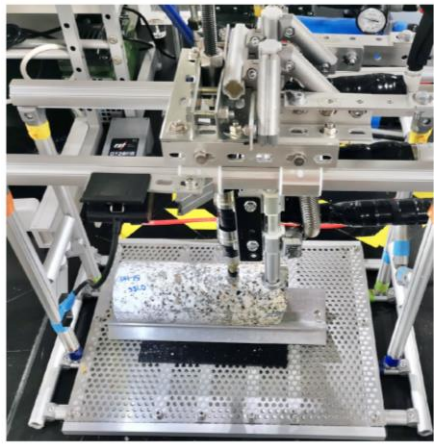


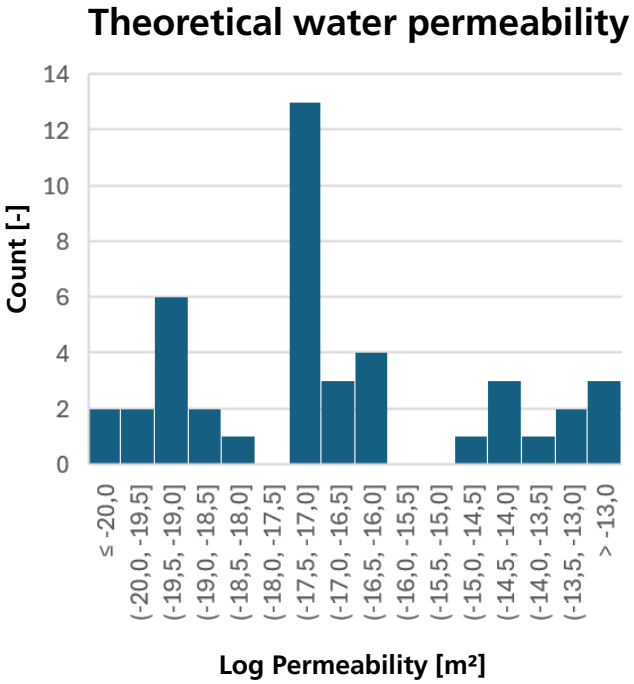


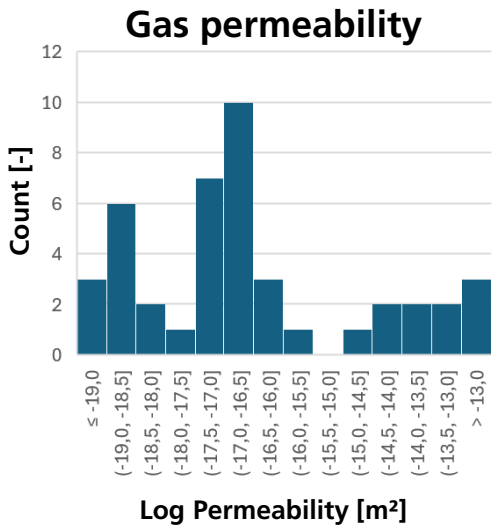
- Kaolinite
- Weathered
- Unaltered with magmatic structures
- Mafic dyke
- Cataclastic, brecciated
- Altered without magmatic structures
- Altered with magmatic structures

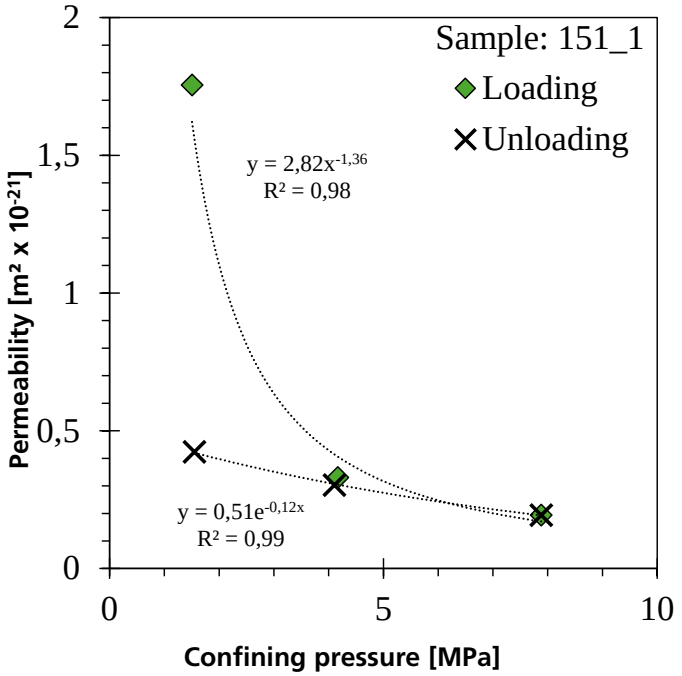
Fraunhofer IEG

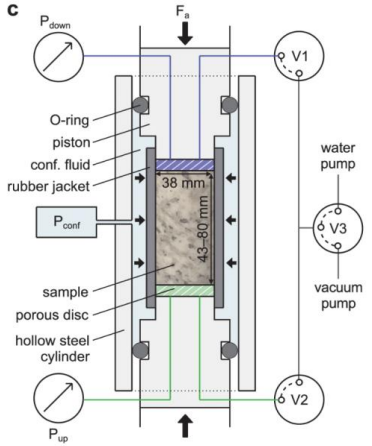
Hydraulic Properties

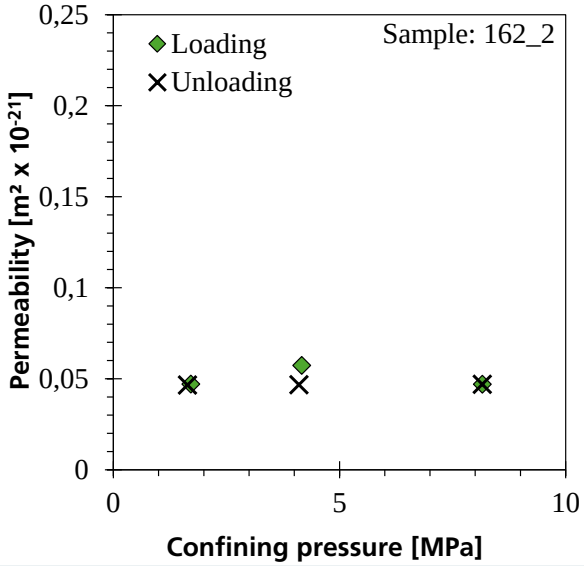






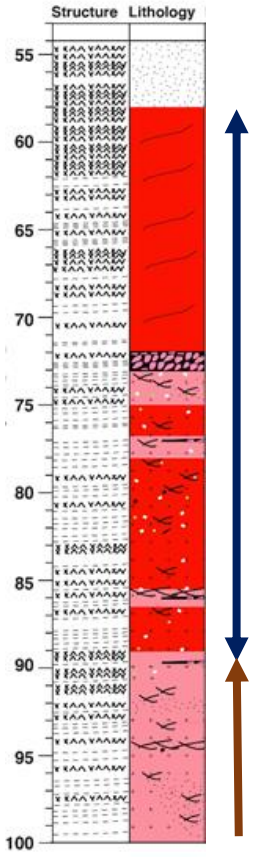






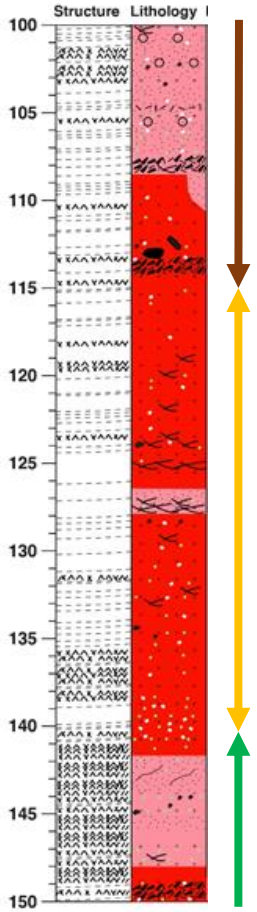
Fraunhofer IEG

Geotechnical homogeneous volumes



Group I
altered, discolored and possibly faulted granodiorite of the paleosurface with increased fracturing and secondary porosity, which cause reduced seismic velocities and lower mechanical strengths

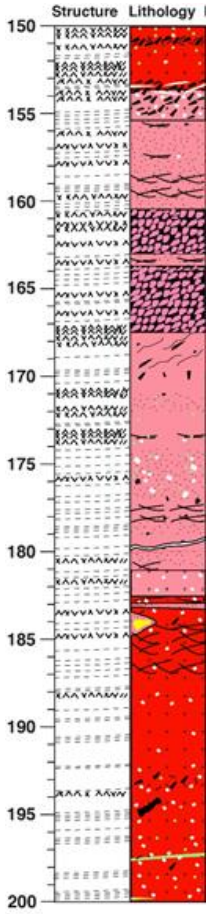
Group II
altered and partially bleached granodiorite, partly enriched with dark mafic minerals and dark



fissure fillings, but very low fracturing, intermediate porosity, high density, intermediate seismic velocities and high mechanical strength

Group III
massive, gray single-mica (and possibly two-mica) granodiorite, partly enriched with dark mafic minerals and dark fissure fillings, very low to low fracturing, low porosity, high density, high seismic velocities and high mechanical strength

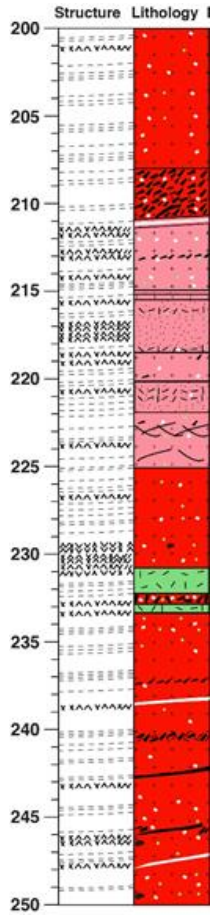
Group IV



Group IV
fault zones with increased fracturing and secondary porosity as well as reduced density, reduced seismic velocities and lower mechanical strength

BUT
Due to intense remineralization a better than average construction rock

Group III



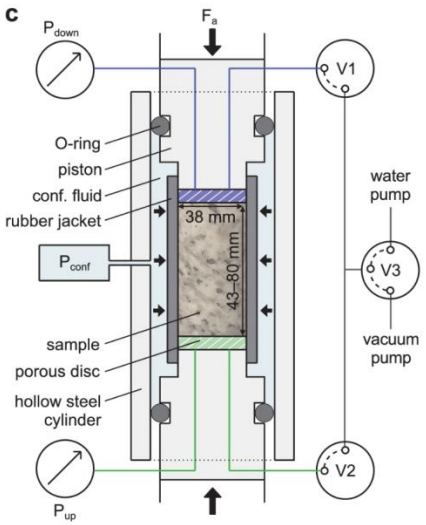
Group III

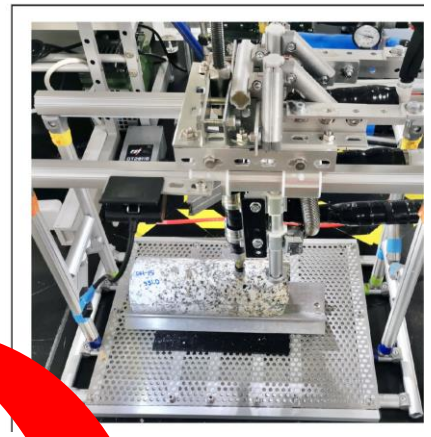
Group IV

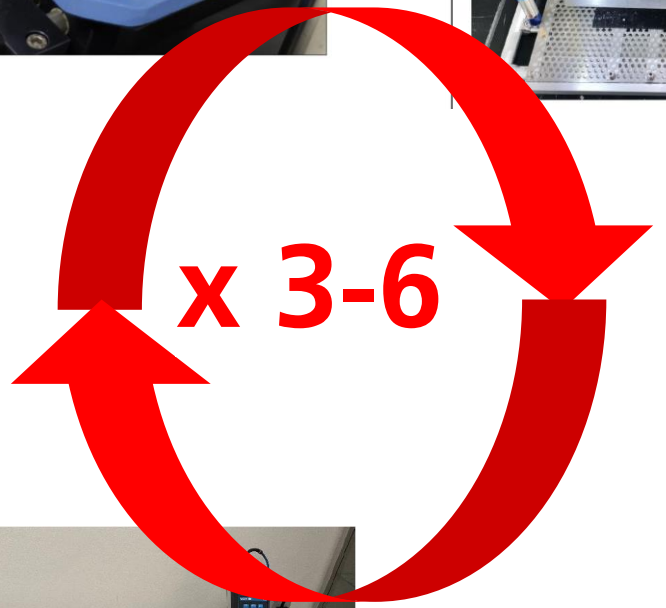
Group V
Mafic dykes

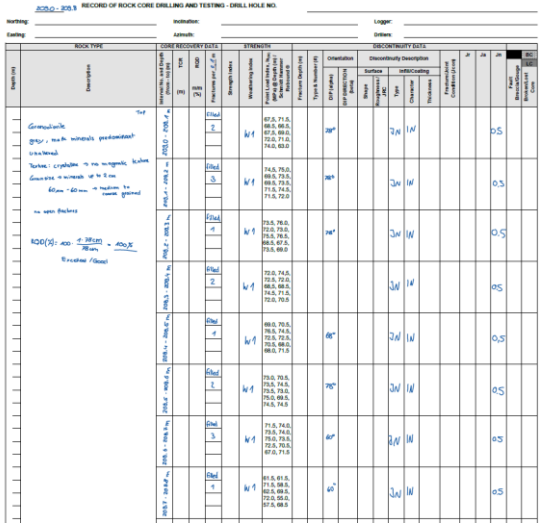
Group III

And repeat...







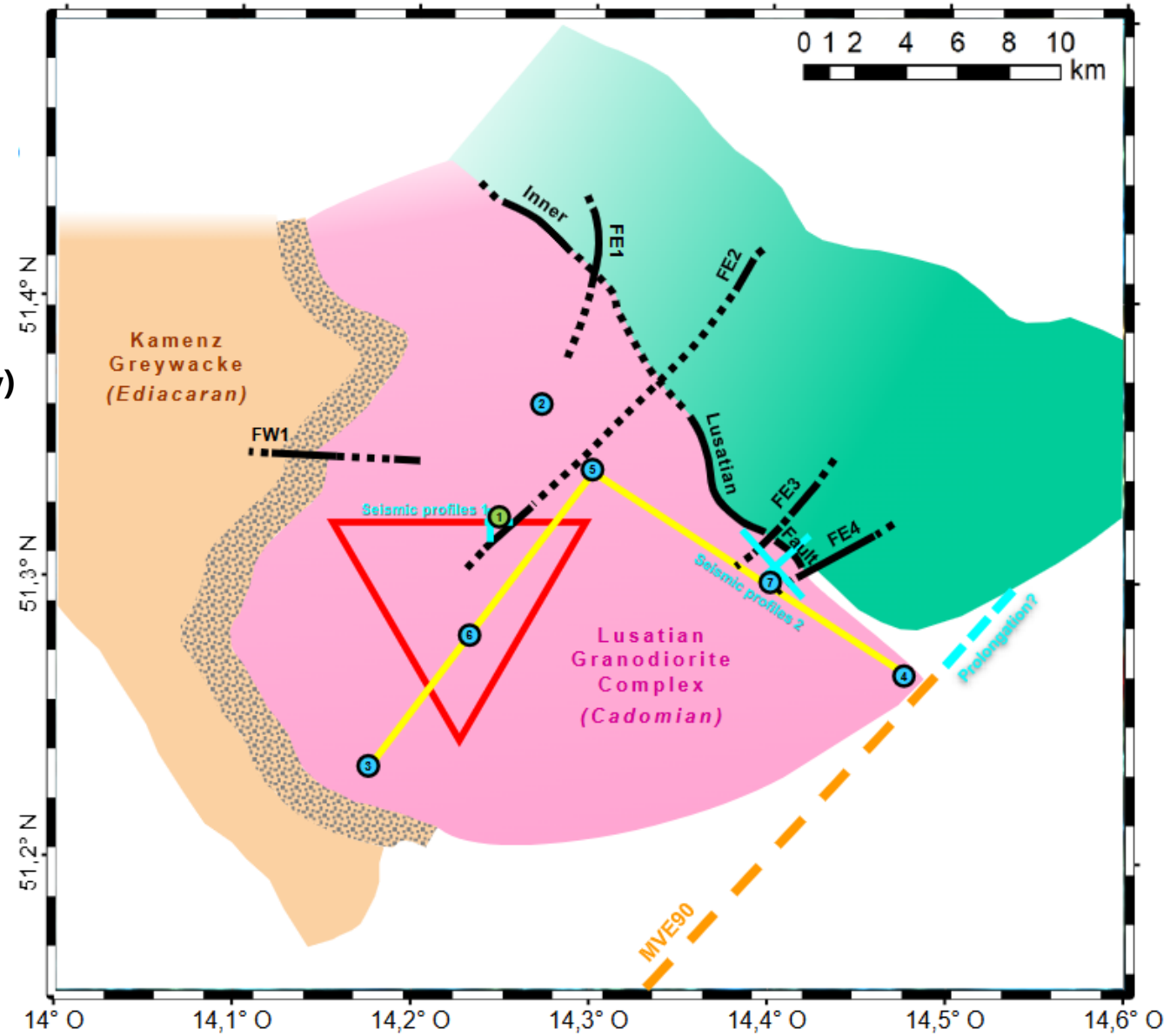


Fraunhofer IEG

Continuity of structures

certain faults
(from drillholes or gravimetry)

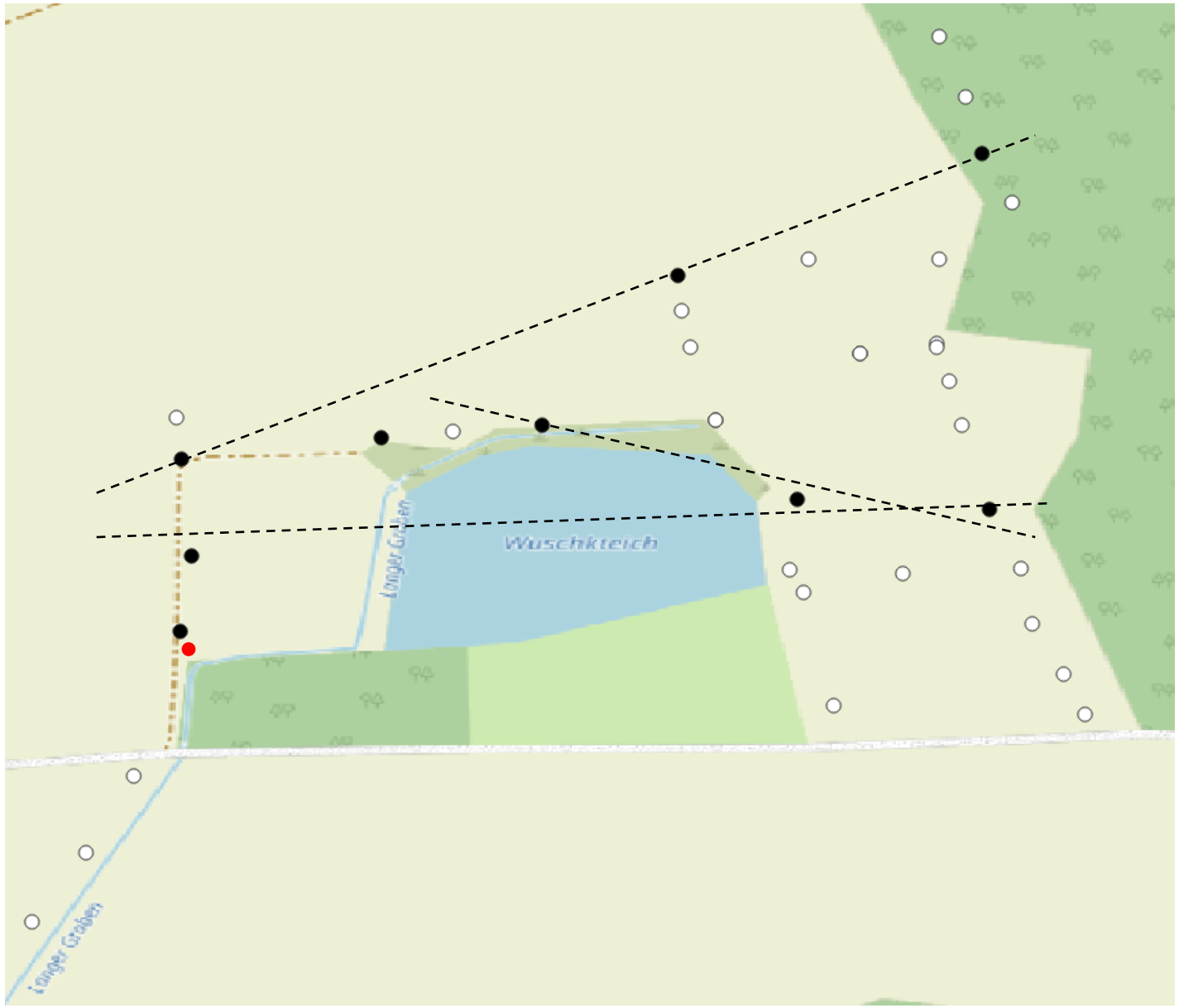
uncertain faults



Fraunhofer IEG

Soil gas probing

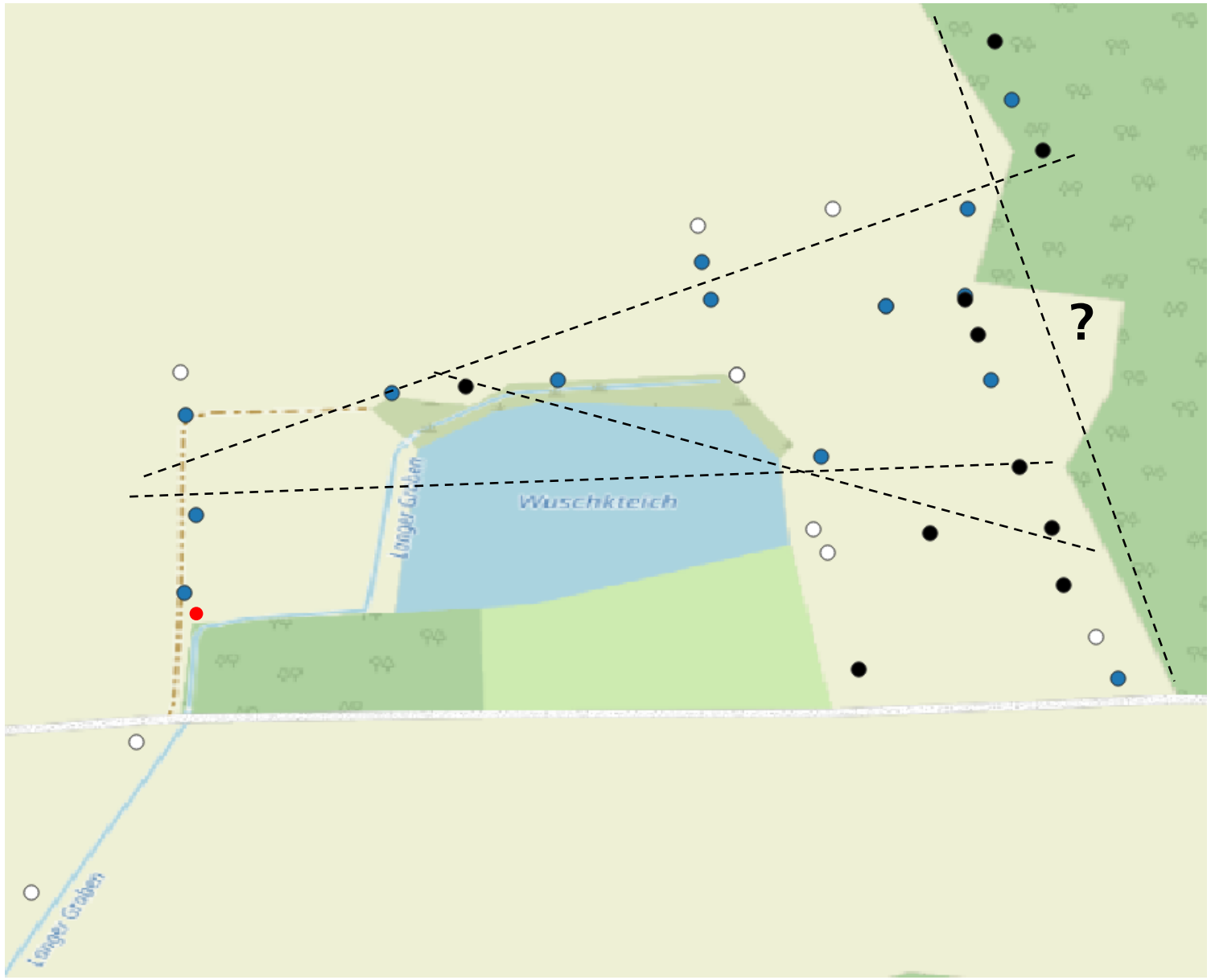
Results: CO_2



○ 0-0.9 %
● >0.9%

●DZA-01/2022

Results: H_2



- 0-400 ppm
- 400-1000 ppm
- >1000 ppm
- DZA-01/2022

Kontakt

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