Gas monitoring while Drilling the Ivrea-Verbano zonE (DIVE) with miniRUEDI

DUTOIT HUGO

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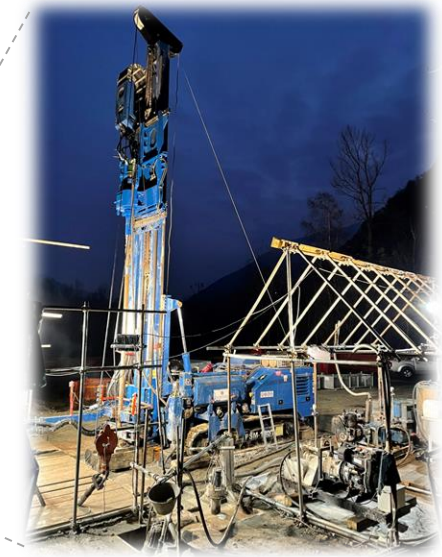
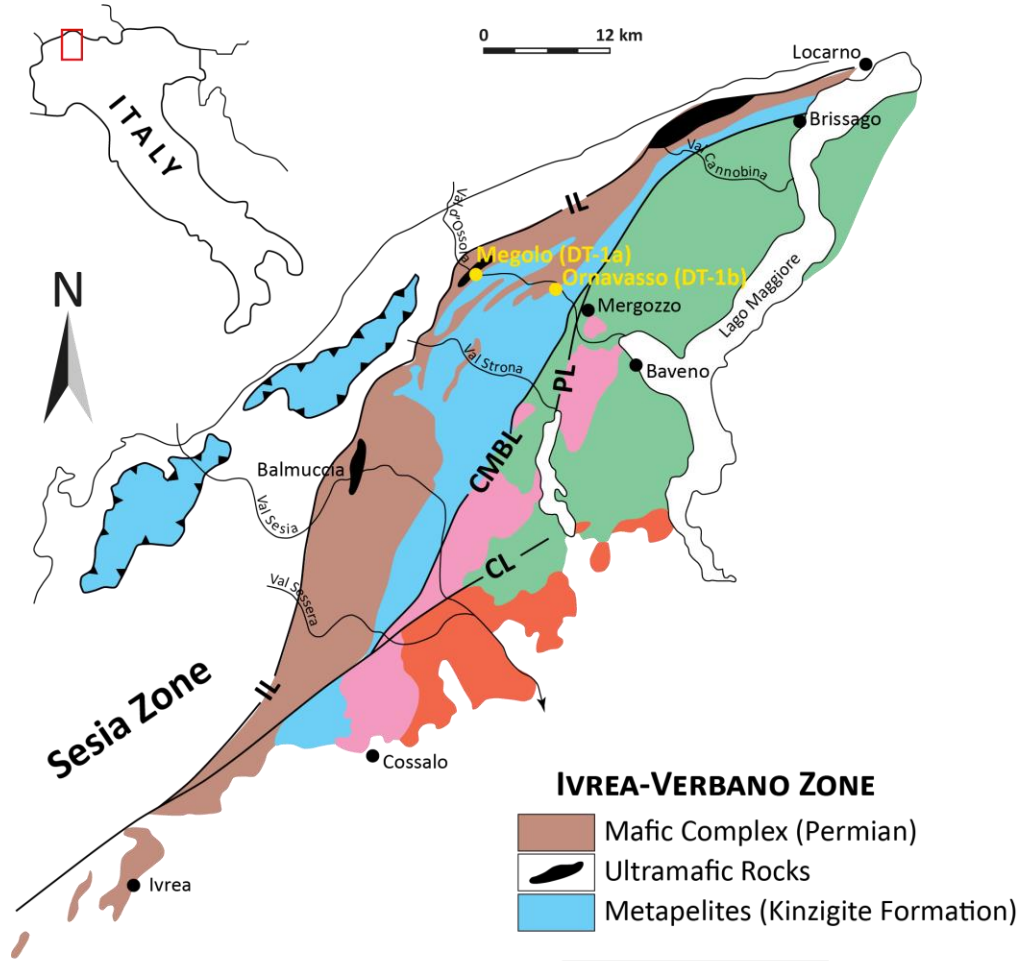
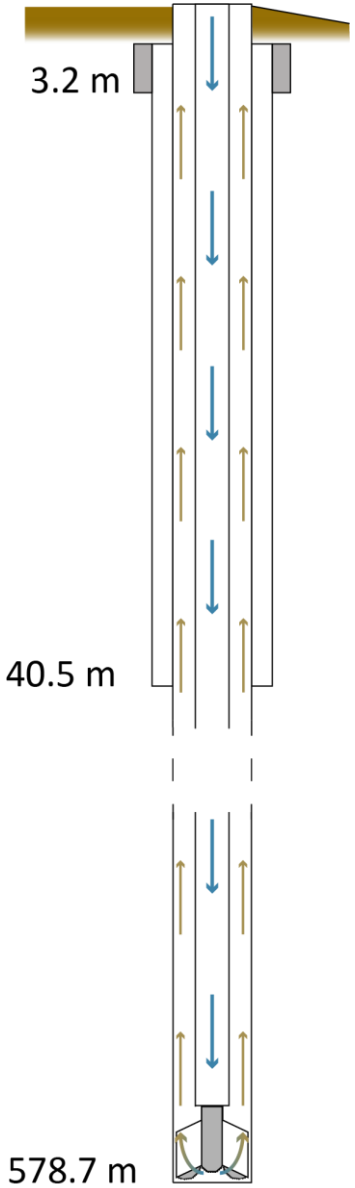
ICDP–Drilling the Ivrea Verbano zonE





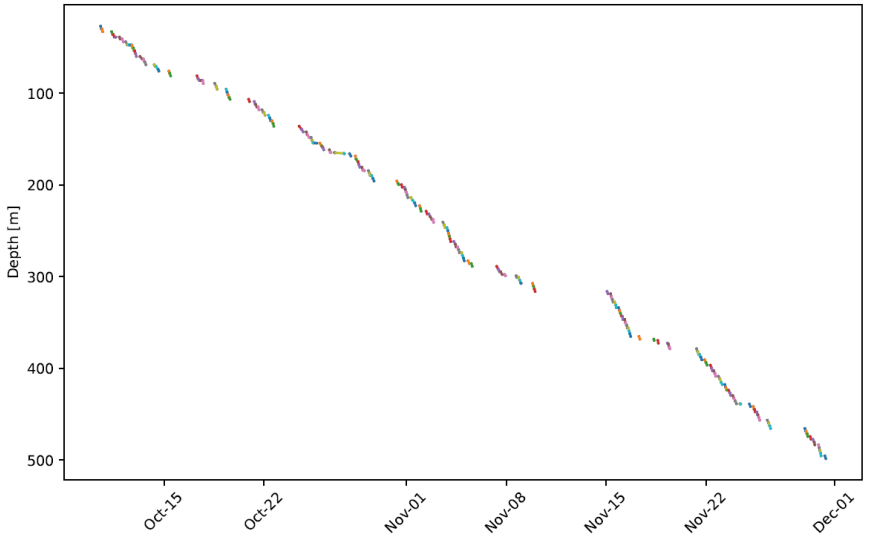
Modified after Snoke et al., 1999

DT-1b and Scientific goals



Details of Hole

- Hole DT-1b
- 2022-10-06 to 2022-12-15
- Location (WGS84) :
  latitude 45.983284
  longitude 8.398739
- 578.7 m drilled (578.5 m cored)
- >99 % of core recovery
- Mostly amphibolites, metapelites and calcsilicates

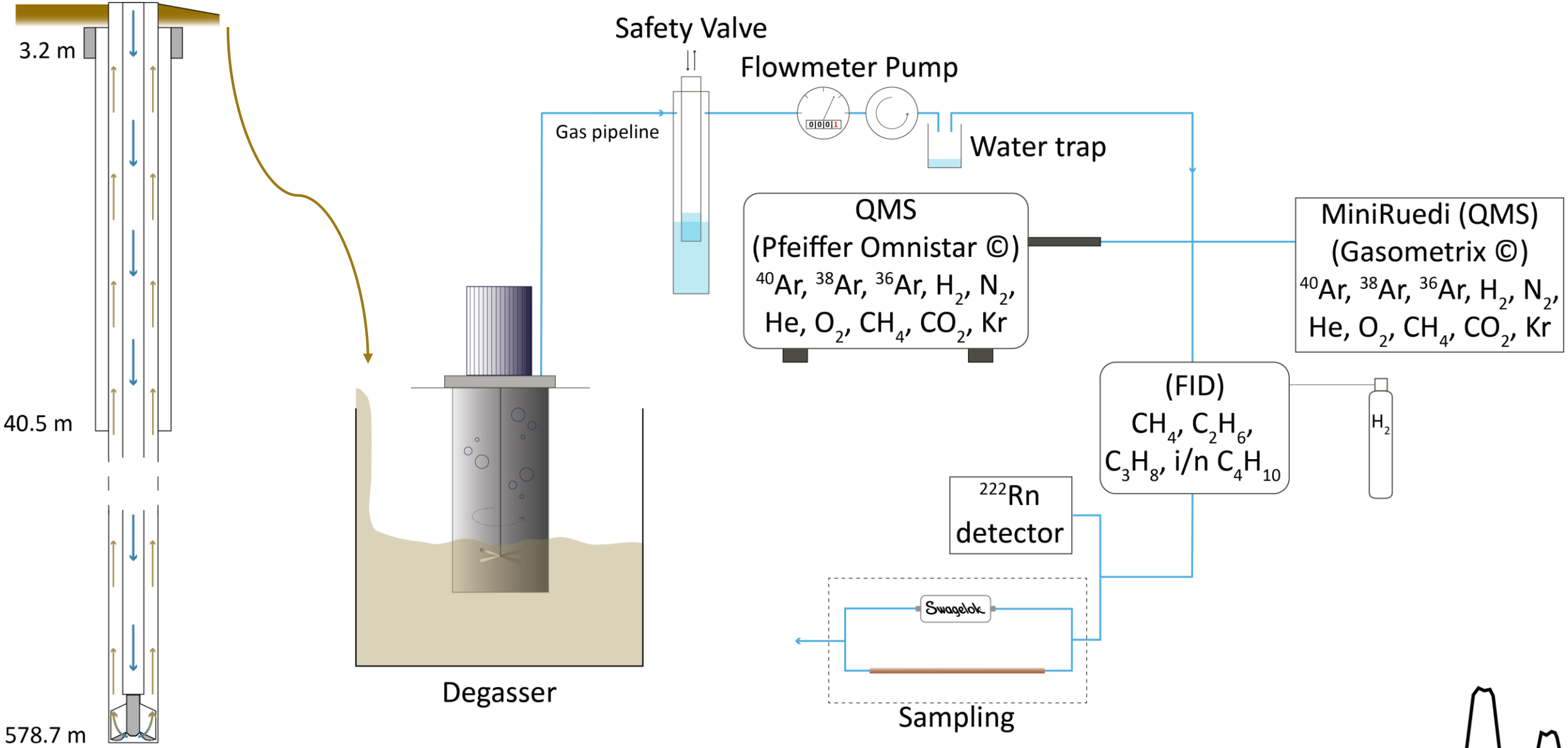


Scientific goals

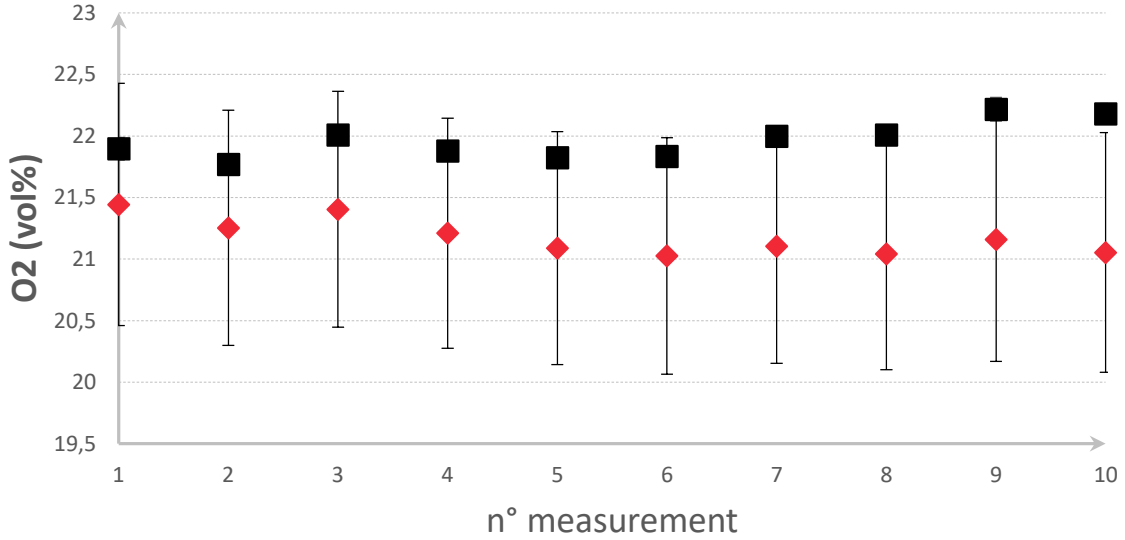
- Composition of the lower continental crust and its transition to the mantle
- Geophysical characterization and modeling from crustal scale to grain scale
- Fluid rock interactions, C, S and N budget in the lower crust
- Deep life activity and diversity

- **Document the presence, location, source and migration of the gases in the lower crust and upper mantle**

On-Line Gas Analysis set-up

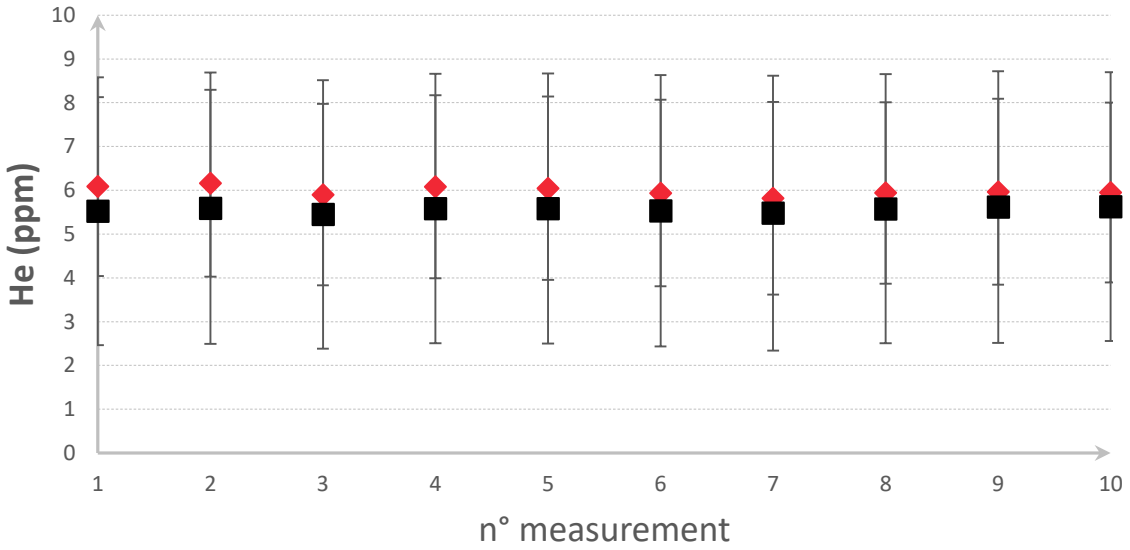


miniRUEDI set-up



miniRUEDI with ambient air as standard

miniRUEDI calibrated

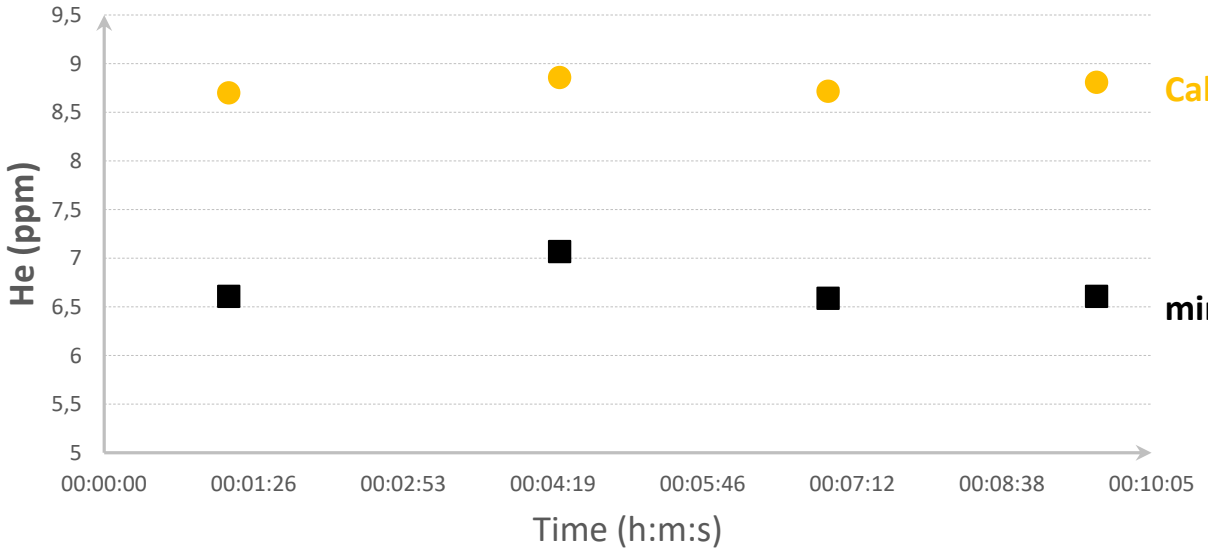


miniRUEDI calibrated

miniRUEDI with ambient air as standard

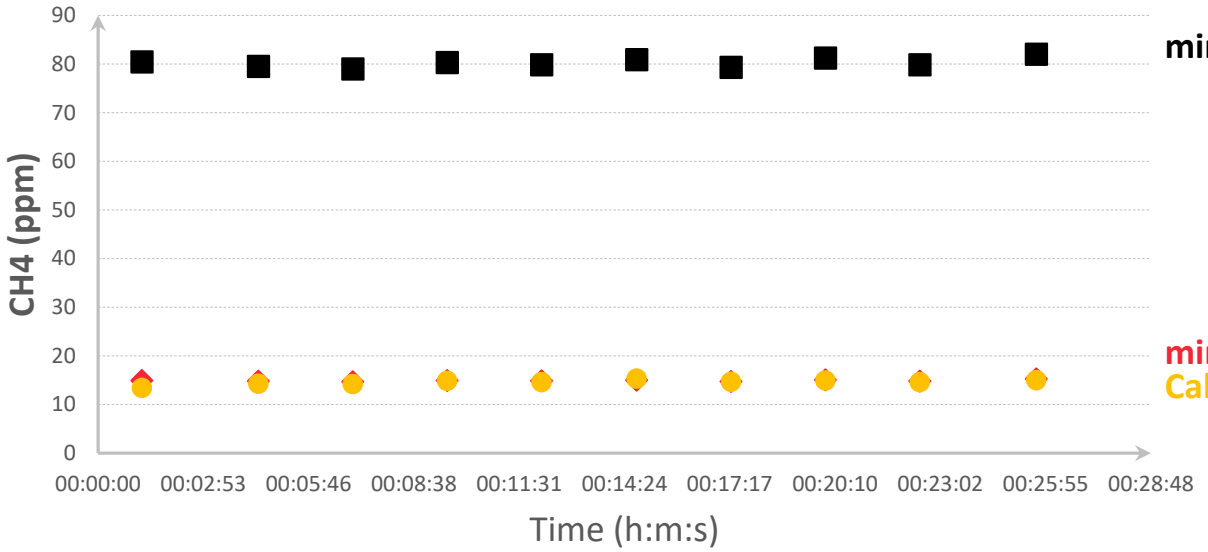
- Measurements overlap well
- Data processing need to be done by hand

miniRUEDI set-up



Calibrated QMS

miniRUEDI with ambient air as standard



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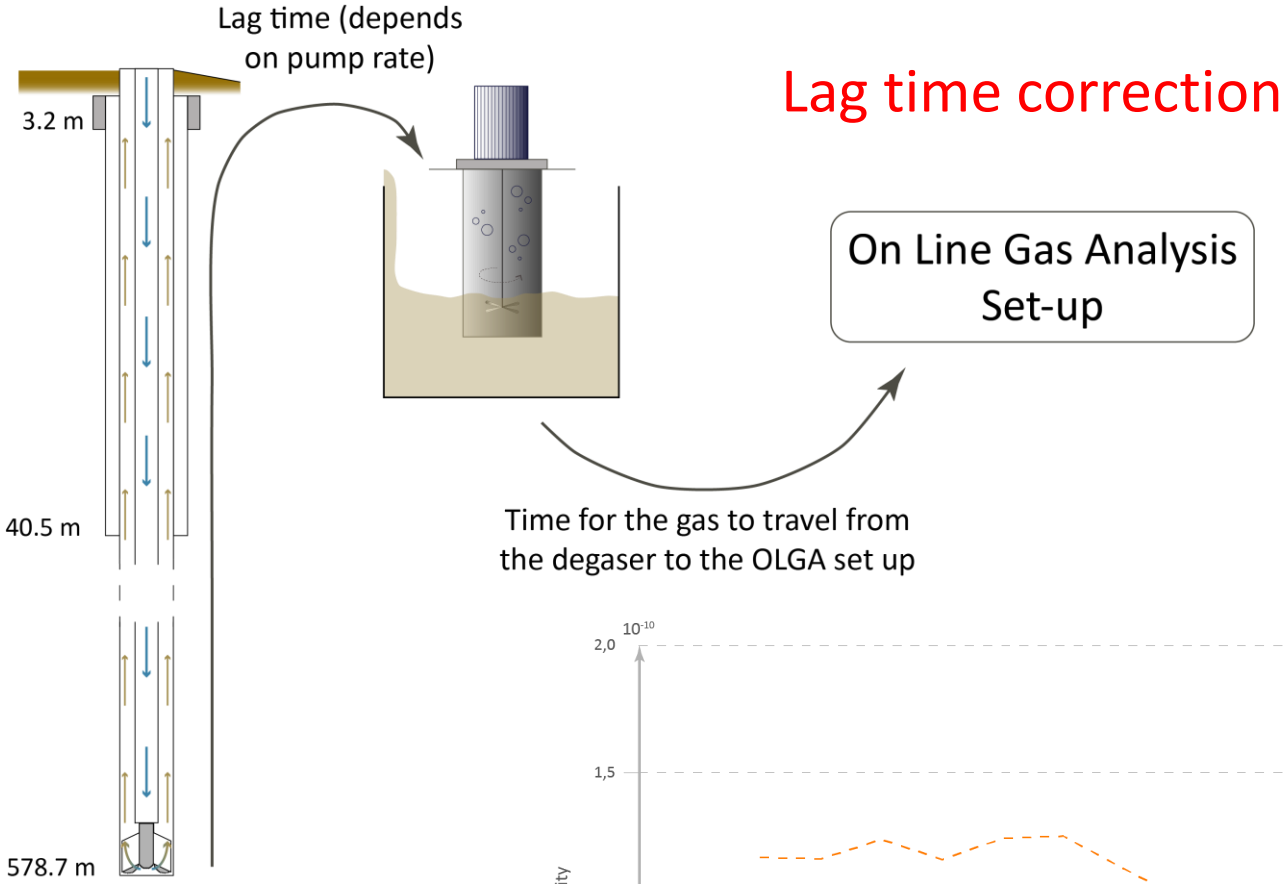
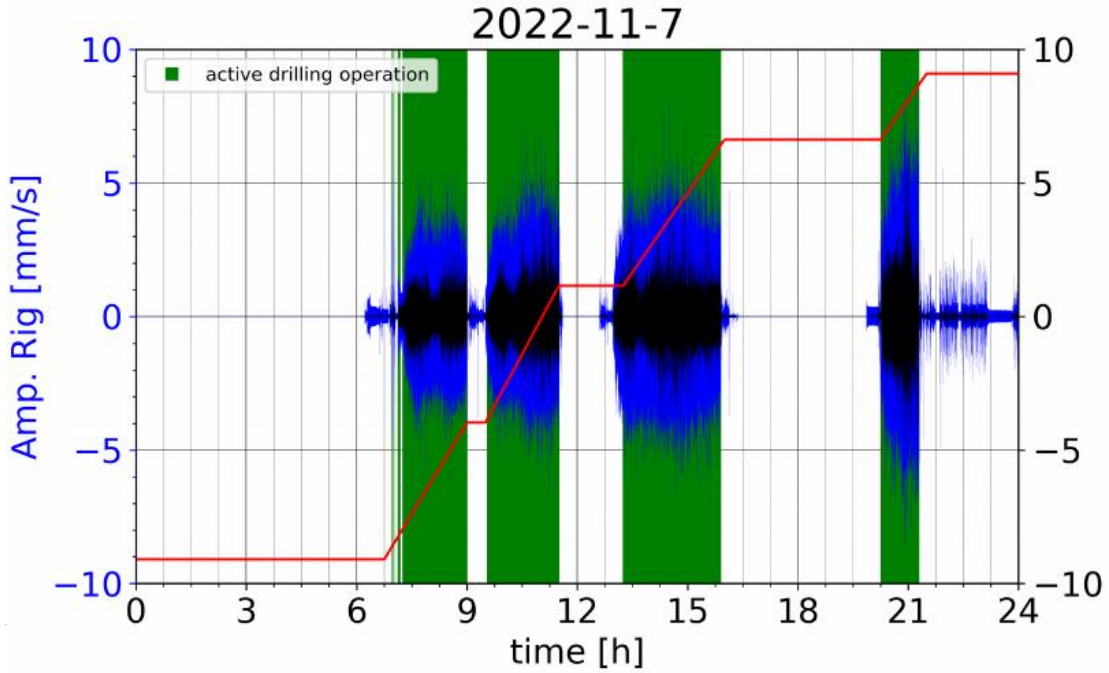
Data processing

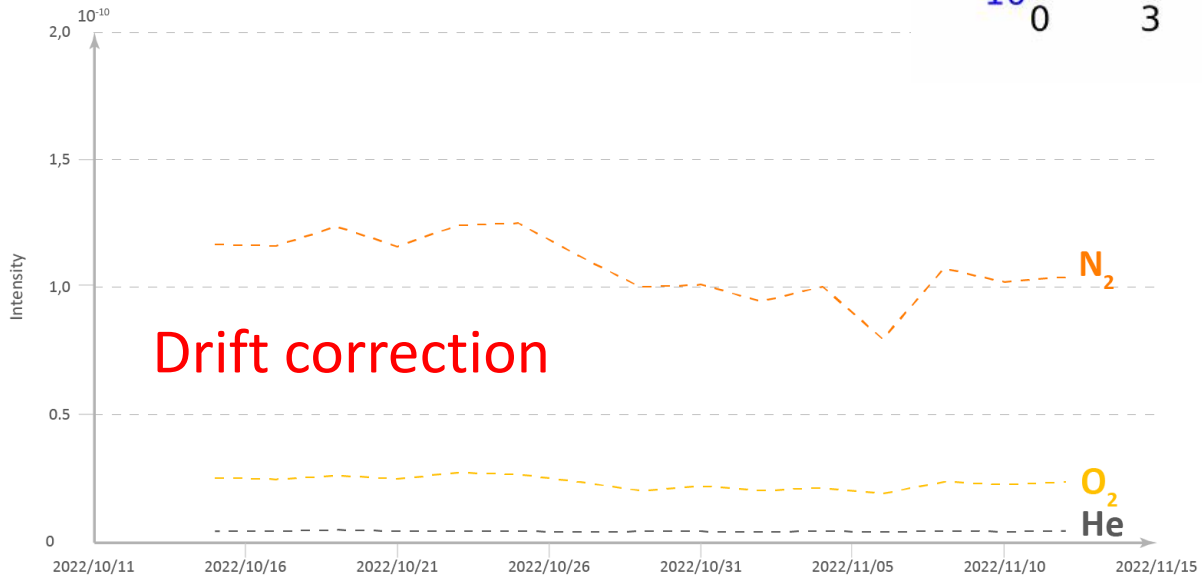


Lag time correction

On Line Gas Analysis Set-up

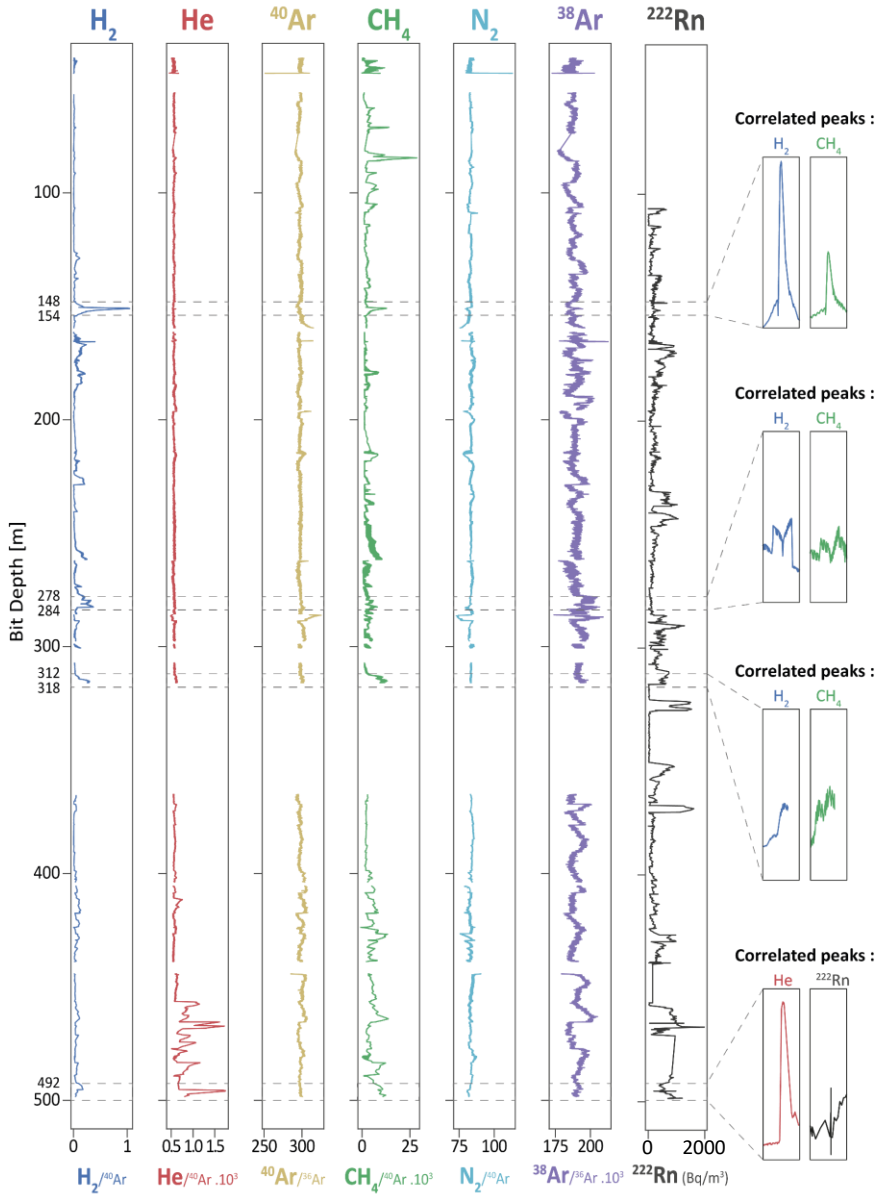


Non drilling data correction



Drift correction

Results



- H_2 is correlated to CH_4
- He and ^{222}Rn are correlated
- H_2 and He are correlated at depth > 400 m

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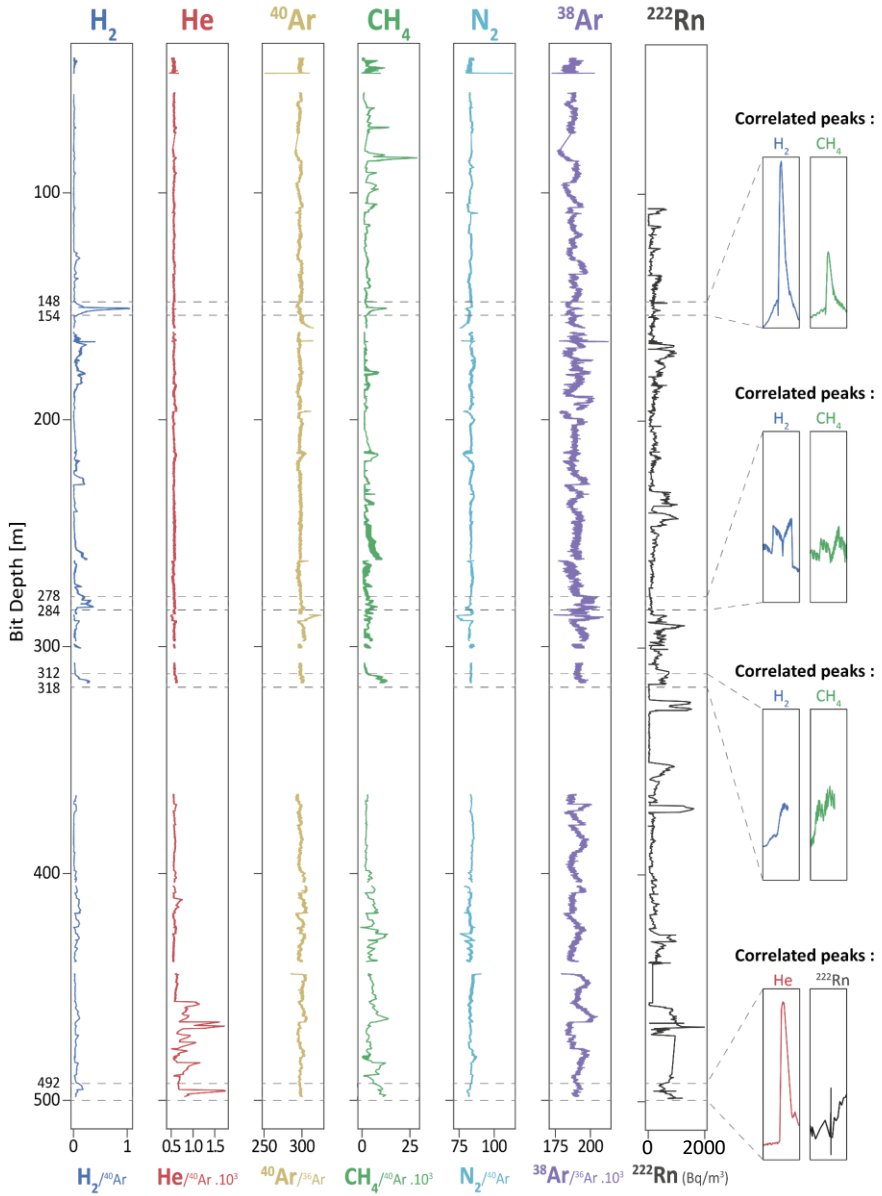

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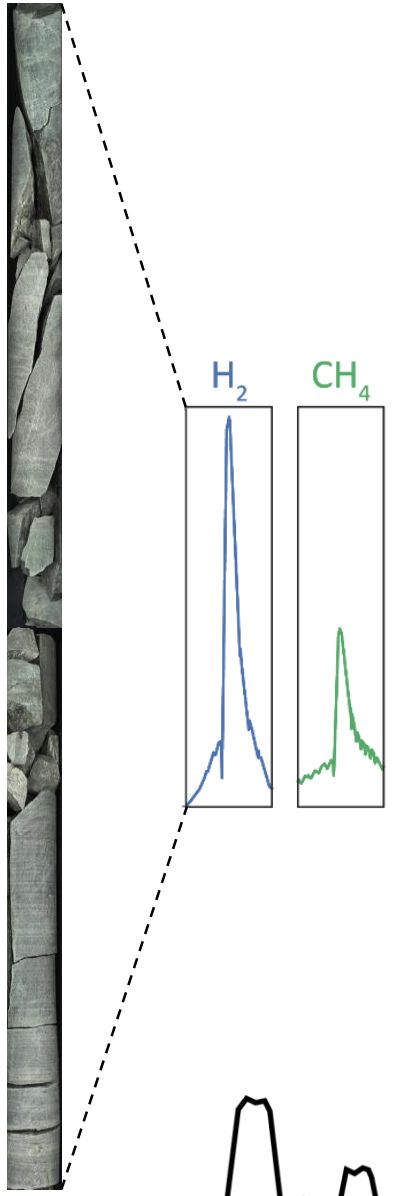

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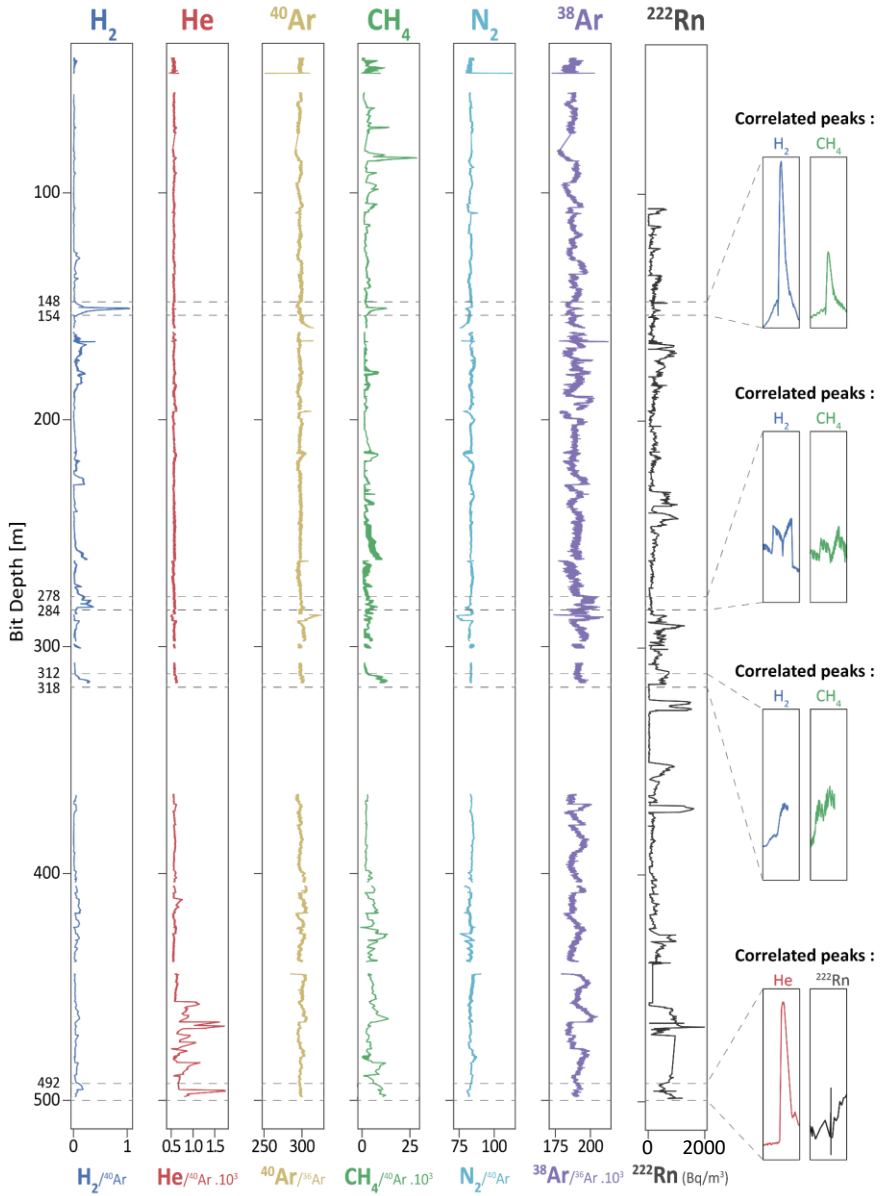

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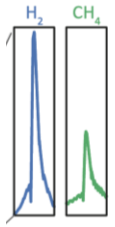
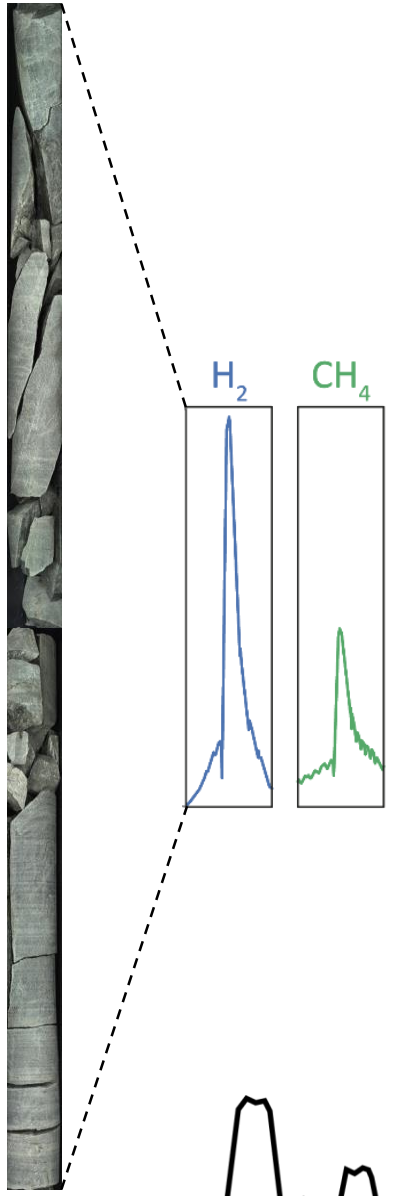


vol%	H_2	CH_4	CO_2	N_2	O_2
On-line measure	1.01	0.01	0.10	78.5	19.2
*Lab sample**	1.45	b.d.l	b.d.l	76.74	21.79

*b.d.l : i.e detection limit 100 ppmv



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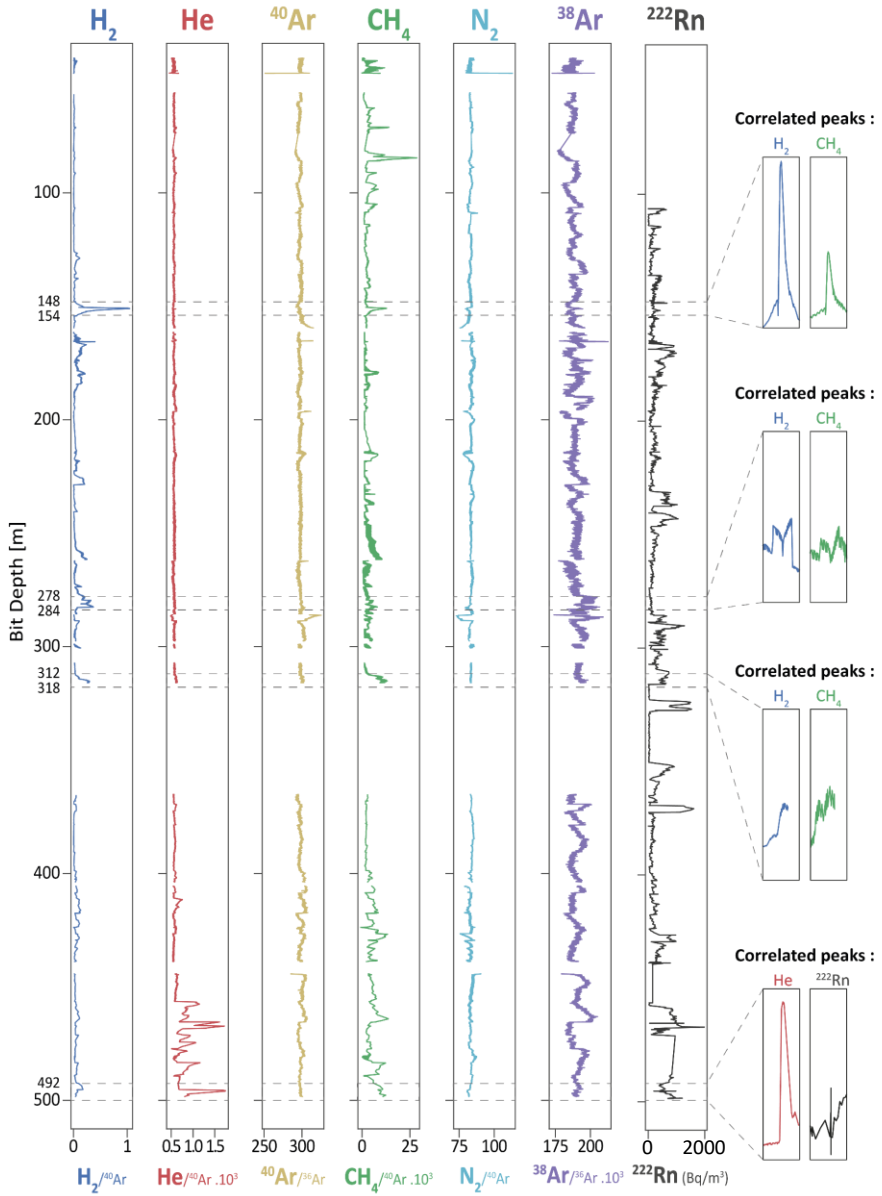

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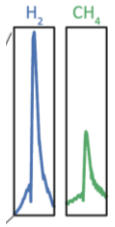

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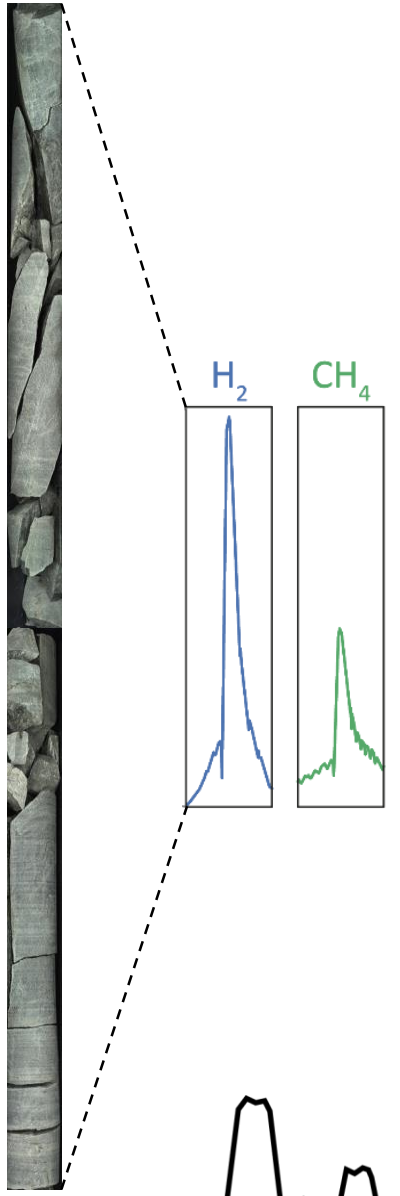
- Artesian upwelling provides bulk gas composition of the borehole

vol%	H_2	CH_4	CO_2	N_2	O_2	He
*Free Gas sample**	0.03	0.01	0.28	81.18	17.31	1.17

*Free gas sample at 578 m



First interpretations

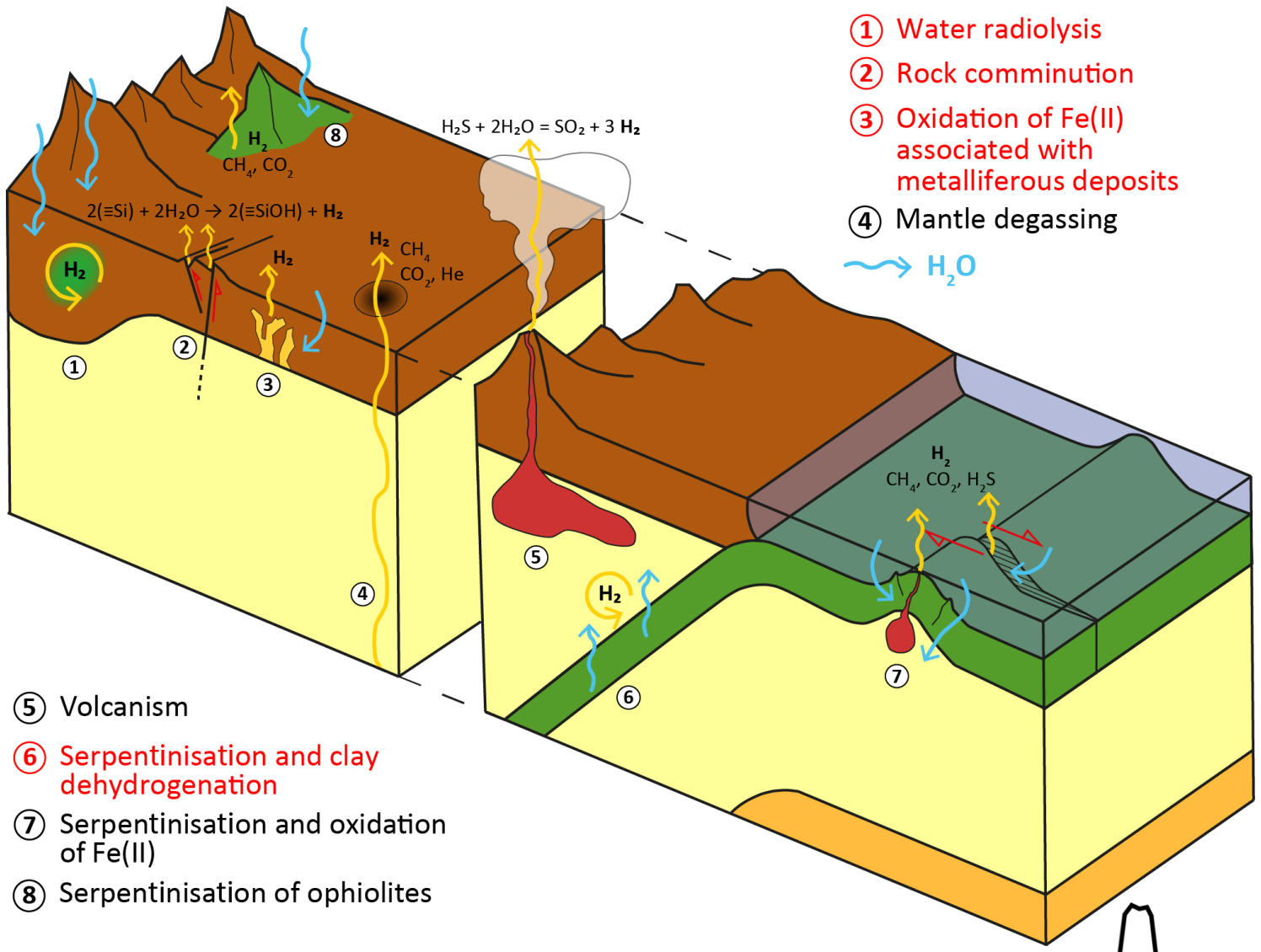
- **Artificial H_2 (rock comminution while drilling)**
→ **Limited (coring)**
→ **Constant 100 to 300 ppm background**

- **Serpentinisation of mafic rocks and oxidation of Fe(II)-rich rocks**

- **Water radiolysis**
→ **Small contribution**

- **CH_4 production by bacterial methanogenesis**
- **CH_4 formation from FTT reactions**

$$CO_2 + H_2 \rightarrow CO + H_2O$$
$$CO + 3\,H_2 \rightarrow CH_4 + H_2O$$



Next step

- Comparison with logging datas :

→ Specific gases correlated with specific fractures orientation ?
→ Correlation of some gases with physical parameters ?
(ex : He, ^{222}Rn and gamma ray ?)
→ Fluids properties

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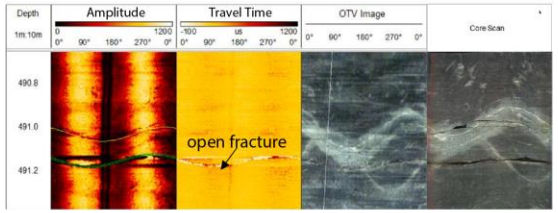

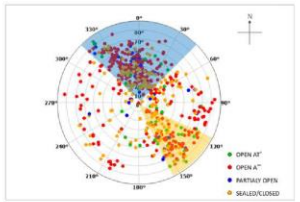

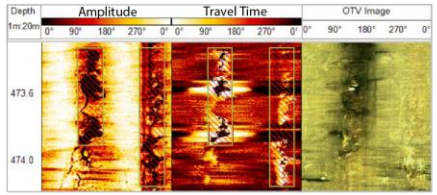

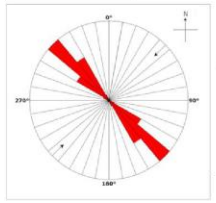

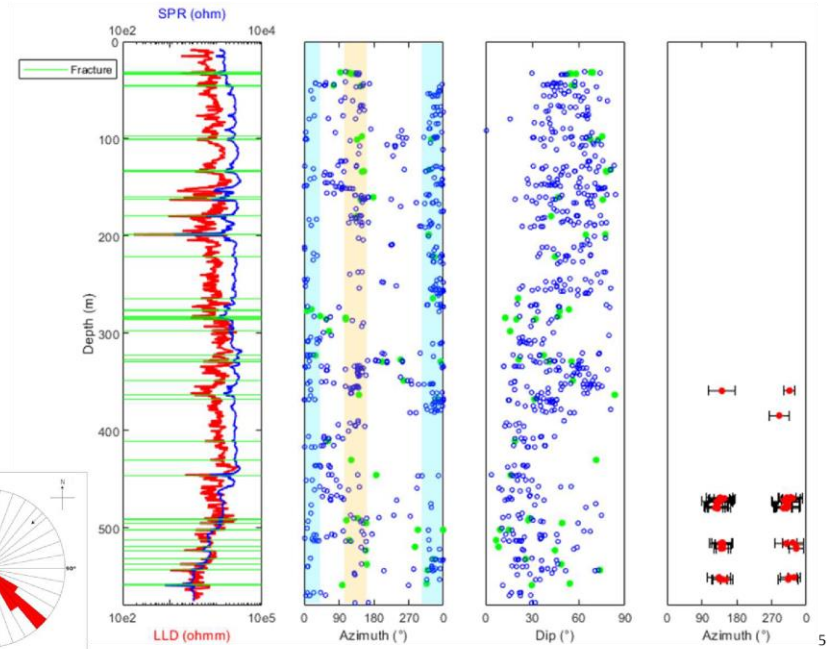

New drilling DT-1a ongoing with the miniRUEDI

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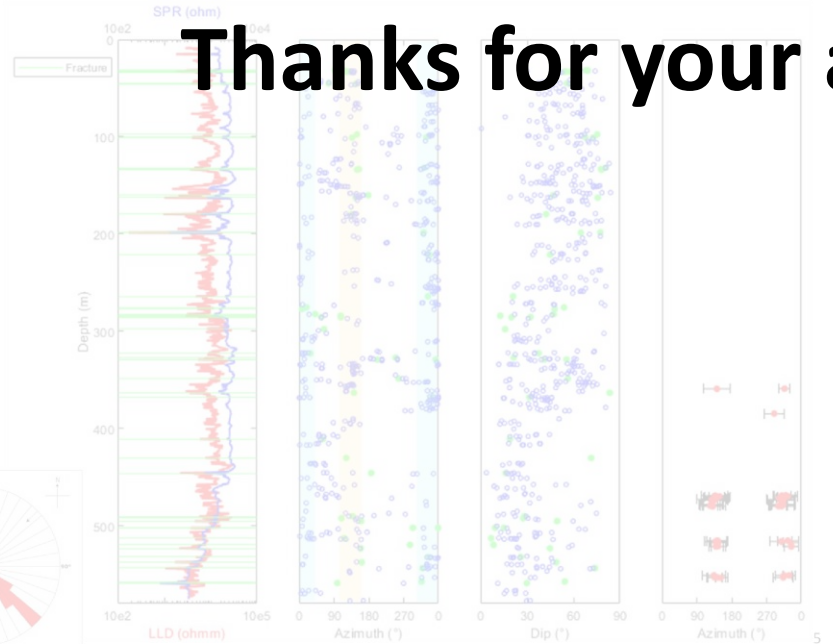

Thanks for your attention

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