



Einstein Telescope (ET)  
Euregion Meuse-Rhine (EMR)

Civil Engineering Feasibility Phase

**WP 6**

**GEOTECHNICAL CORE LOGGING**

**ETB-11 - HOMBOURG BOREHOLE RESULTS**

Code: 7009004377-GEN-WP6 ETB-11 -GEO-REP-A

|                               |          |            |          |            |          |      |
|-------------------------------|----------|------------|----------|------------|----------|------|
|                               |          |            |          |            |          |      |
|                               |          |            |          |            |          |      |
| A<br>1 <sup>st</sup> emission | GAN      | 08.07.2024 | LPA      | 09.07.2024 |          |      |
| Review                        | Produced | Date       | Reviewed | Date       | Approved | Date |



## Distribution list

| Acknowledged:    | Email                          | Date: |
|------------------|--------------------------------|-------|
| Wim WALK         | wim.walk@nikhef.nl             |       |
| Guid BARTHOLOMEE | guid.bartholomee@maastricht.nl |       |
| John KERSTJE     | jkerstje@nikhef.nl             |       |
| Geert Jan VIS    | geert-jan.vis@tno.nl           |       |

## Intentional distribution list

| Acknowledged:    | Email                                | Date: |
|------------------|--------------------------------------|-------|
| Wim WALK         | wim.walk@nikhef.nl                   |       |
| Guid BARTHOLOMEE | guid.bartholomee@maastricht.nl       |       |
| Bjorn VINK       | bjorn2vink@gmail.com                 |       |
| John KERSTJENS   | jkerstje@nikhef.nl                   |       |
| Geert Jan VIS    | geert-jan.vis@tno.nl                 |       |
| Philippe ORBAN   | p.orban@uliege.be                    |       |
| Frédéric NGUYEN  | f.nguyen@uliege.be                   |       |
| Michael KIEHN    | michael.kiehn@magenta.de             |       |
| Marius WALDVOGEL | marius.waldvogel@geol.rwth-aachen.de |       |
| Rudy SWENNEN     | rudy.swennen@kuleuven.be             |       |
| Yves VANBRABANT  | yvanbrabant@naturalsciences.be       |       |
| ..               |                                      |       |
|                  |                                      |       |

## Authors & reviewers

| Name               | Acronim |
|--------------------|---------|
| Antoine GAUFFRIAUX | GAN     |
| Nicolas COUSSAERT  | CON     |
| Patricia LAMAS     | LAP     |



## Comments record

| Rev. | N° | Reviewer | Comment                  | Processing comments | Reaction date |
|------|----|----------|--------------------------|---------------------|---------------|
| 00   |    | LAP      | page, \$chapter, comment | Acknowledged        | 09.07.2024    |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |
|      |    |          |                          |                     |               |



## Table of Contents

|                                                     |     |
|-----------------------------------------------------|-----|
| Distribution list.....                              | i   |
| Comments record.....                                | ii  |
| Table of Contents .....                             | iii |
| Table of Figures .....                              | v   |
| 1 Introduction .....                                | 1   |
| 2 Abbreviation & references .....                   | 2   |
| 2.1 Abbreviations.....                              | 2   |
| 2.2 References .....                                | 2   |
| 3 QA/QC on ETB11 BH .....                           | 4   |
| 3.1 QA/QC on cores - Results.....                   | 4   |
| 3.1.1 Overall core review.....                      | 4   |
| 3.1.2 Depth issues .....                            | 5   |
| 4 Geological log.....                               | 6   |
| 4.1 Methodology and classification.....             | 6   |
| 4.1.1 Lithological logging.....                     | 6   |
| 4.1.2 Structural and defects logging.....           | 6   |
| 4.2 Structural data base.....                       | 7   |
| 4.3 Fault kinematics and tectonic data.....         | 8   |
| 4.4 Results – Synthetic strip log.....              | 8   |
| 4.4.1 Lithology and stratigraphy (attempt) .....    | 8   |
| 4.4.2 Fault zones and structural domains .....      | 10  |
| 4.4.3 Tectonic history recorded in ETB-11.....      | 12  |
| 4.4.4 Tectonic models implications for the EGM..... | 12  |
| 5 Rock mechanics results .....                      | 16  |
| 5.1 Strength and Weathering index.....              | 16  |
| 5.2 Core recovery – RQD- .....                      | 16  |
| 5.3 Joints distribution / m.....                    | 16  |
| 5.4 Q system .....                                  | 16  |
| 5.4.1 Joint set .....                               | 16  |
| 5.4.2 Joint characteristics .....                   | 17  |
| 5.4.3 Joint water reduction factor.....             | 17  |
| 5.4.4 Stress reduction factor .....                 | 17  |
| 5.4.5 Q index .....                                 | 17  |
| 6 Conclusions .....                                 | 19  |
| 7 Appendix .....                                    | 20  |





## Table of Figures

|                                                                                                          |    |
|----------------------------------------------------------------------------------------------------------|----|
| Figure 1 : Depths inconsistency between BHTV and cores .....                                             | 5  |
| Figure 2 : Compilation of all structural data.....                                                       | 7  |
| Figure 3 : Strip log – see large scale in appendix .....                                                 | 9  |
| Figure 4 : Structural domains .....                                                                      | 10 |
| Figure 5 : Structural patterns of each tectonic domains toward depth.....                                | 11 |
| Figure 6 : ETB-11 projected structures on NS orientation - stratigraphy related to Laiterie BH.....      | 13 |
| Figure 7 : Schematic model and cross section – BH data.....                                              | 13 |
| Figure 8 : Model 01 – Simple stratigraphic correlation – do not account for Laiterie reverse fault ..... | 14 |
| Figure 9 : Model 2 – Double thrusts not displacing the erosion surface .....                             | 14 |
| Figure 10 : Model 3 – Double thrusts deeply rooted and affecting the Viséan and deeper units.....        | 15 |



## 1 Introduction

This report is a preliminary analysis of the results of the ETB-11 Hombourg Borehole. It is based on core logs observation mission executed at the Core shed of ET in Aubel in April 2024. The cored part of the borehole (00-251m) has been logged in details (rock mechanics) to support the engineering Geological Model (EGM, [1]).

These log is supported by a set of core pictures [9] the BHTV from Terratec [8] and its structural picking (processed by the ET geo Team [10]).

This report describes :

- 1) QA/QC on core quality (depths, recovery, core damages, etc),
- 2) Geological results and preliminary stratigraphic/tectonic interpretation,
- 4) Rock mechanics results
- 5) Synthesis and recommendations

The main objective of the works here is to provide a geotechnical assessment of the underground conditions of the ETB-11 Hombourg Borehole.

As a reminder, the borehole rationale (strategy of location) for the first (ongoing) borehole campaign has been defined previous to **E= mc2** incorporation to the Project Office Team. Such rationale has not been explicitly discussed among the ET geo team after **E= mc2** incorporation to the Project's Office in January 2024 [1]. The geological, structural, and tectonic context of the Borehole has not been presented to **E= mc2** previous to their geotechnical logging activities / kick off.

In order to optimize the borehole investments this report makes diligent efforts to improve the geological and structural data collection and subsequent tectonic interpretation. New insights of this borehole into the stratigraphical and tectonic context are discussed. It directly impacts the assessment of the rock mass quality geometry and distribution. Recommendations are provided to support the Engineering Geological Model.



## 2 Abbreviation & references

### 2.1 Abbreviations

- ETB Einstein Telescope Borehole
- SPV Sint Pietersvoeren
- BHTV Bore Hole Tele Viewer
- EGM Engineering Geological Model
- QA/QC Quality Assurance / Quality Control
- DCD Deep Core Damages
- DIF Drilling Induced Fractures
- DIR Drilling Induced Rotation
- DOP Drilling Over-Pushed
- PEP Project Execution Plan
- QM/QP Quality Manual / Quality Plan

### 2.2 References

#### E=mc2 Project documents

- [1] WP2- Geotechnics - (2024) Review of geological knowledge Ref. 7009004377-GEN-WP2-GEO-REP-A- Rev A (2024/04/29)
- [2] E=mc2 QMS document - Refers to the QMS of each partner of the Consortium –
- [3] Geotechnical car logging Hombourg QA/QC evaluation (2024) - Ref. 7009004377-GEN-WP6-GEO-REP-00-QAQC Hombourg- E=mc2

#### ET documents

- [4] Technical specifications for Drilling – not available
- [5] Technical specifications for Geophysical logging – not available
- [6] Technical specification for Laboratory works – not available
- [7] **Stump** - ETB-11-SPV Partial drilling reports
- [8] **Terratec geophysical logging** – ETB11 Folder date 2024-04 - Acoustic BHTV logging– No structural picking available – Various geophysical logging - PDFs
- [9] **ET geo team** – BH 11 Core photos - jpegs
- [10] **ET geo team** – BHTV processing – Structural picking –Aachen University -29/04/2024

#### Guidelines and standards

- [11] EN ISO 22475 (2006). Geotechnical investigation and testing – Sampling methods and groundwater measurements - Part 1, 2, and 3.
- [12] ASTM D4220-95 (2000). Standard Practices for Preserving and Transporting Soil Samples.
- [13] ASTM D5079-90 (1996). Standard Practices for Preserving and Transporting Rock Core Samples.
- [14] EN ISO 14688-2 (2016) Geotechnical investigation and testing – Identification and classification of soil – Part 2: Classification Principles
- [15] EN ISO 14689-1 (2003) Geotechnical investigation and testing – Identification and classification of rock – Part 1: Identification and description

- [16] ASTM D6032-96. Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.
- [17] AS 1726-2017 Standards Australia (2017) Geotechnical Site Investigations.
- [18] E. Hoek (2007) Practical Rock Engineering, RocScience 341p
- [19] NGI (2015) Using the Q-system : Rock mass classification and support design, handbook, 55p
- [20] Passchier & Trouw (2015) Microtectonics Springer Edition
- [21] J.M. Graulich (1965) Sondage de la Laiterie de Hombourg – Detailed Log
- [22] J.M. Graulich (1968) Sondage de la Laiterie de Hombourg , Professional Paper n°9 – Pl.Henri Chapelle 123W-N°274

### 3 QA/QC on ETB11 BH

The **E=mc²** geological team has received the following documents:

- Before logging :
  - Core pictures [9] : high quality dry and wet core pictures.
  - Partial drilling reports [7]
- After logging :
  - BHTV and geophysical logging reports [8];
  - BHTV structural data picking [10],
  - Borehole coordinates.

The following documents are not yet available.

- Factual drilling report including drilling architecture, drilling execution problems, etc,
- Quality Manual / Quality Plan related to Drilling works, geo physical logging, and laboratories.
- Technical specification for drilling, geophysical logging and laboratories and contractual agreements.

#### 3.1 QA/QC on cores - Results

##### 3.1.1 Overall core review

Detailed QA/QC is available on a separated QA /QC note for this ETB-11 [3]. In summary, we observed a significant amount of core damages, core inversions in boxes, labelling issues and lack of depths precisions/control which are mostly related to core handling, labelling and preservation of samples works more drilling techniques themselves (see table 3 [3]).

This affects the quality of possible observations and prevent us to provide the project with proper geotechnical logs according to required standards. Efforts deployed during logging to identify man induced fractures, core recovery issue, etc. are both time and manpower consuming efforts which cannot, nevertheless, completely overcome the upstream lack of quality control of the drilling contractor.

This situation also affects the geological data base quality since the structural data is partially lost. For instance fault zones are only partially recorded and their tectonic interpretation suffers from low core quality and from difficulties to compare cores and BHTV. Consequently, data fault kinematics are partly lost.

For this first borehole logging, no depth correction has been applied. Indeed, comparison between cores and BHTV complete database could only took place after the logging works on site. Based on our experience of this ETB-11 , a dedicated QA/QC procedure is now set up in order to improve our data base quality and correct depths for the next borehole logging. This procedure will include in a first stage, before to start logging :

- Recovery control and evaluation of core run depths shifts, correction of depths and labelling them on core boxes,
- Quantitative evaluation of core damages,
- Impacts on geotechnical database.

Core damages, and mostly drilling and handling induced fractures are clearly impacting the RQD evaluation. **In order to improve the geotechnical database, some corrections have been applied after logging by comparing the BHTV structural data and the core boxes photos.** No depths corrections have been made on the core boxes for this drilling.

### 3.1.2 Depth issues

We use some reference levels (crushed zones, structures, lithology, etc.) to compare depths between BHTV and cores (not exhaustive control):

- At 40.45m, 56.0m, 67.2m, 78/81m, 99.6m, no significant shifts are identified (10cm resolution);
- At 111.3m, it seems cores are 30cm lower than BHTV data;
- At 123.6, cores are 30cm higher.
- At 130m, 160.6m, 176m, no significant shift;
- From 184m punctual controls shows that cores are 40cm higher than BHTV data (same value at 209m, 213.2, 229m). This is illustrated on the Figure 1.

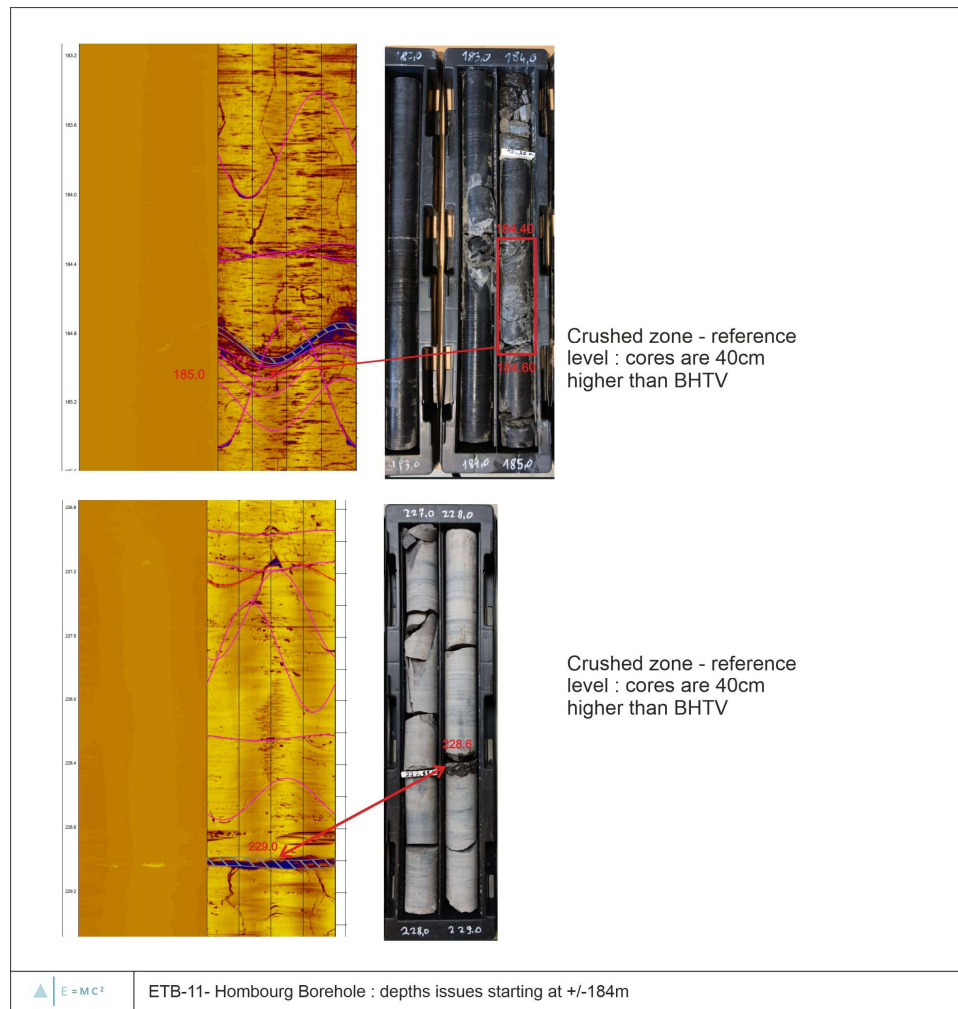


Figure 1 : Depths inconsistency between BHTV and cores

There exists depths shifts at least between 100 and 130m between the data sets. From c.a. 180m, our control suggest a general depth inconsistency of around 40cm between core depths (too shallow) compared to BHTV data. We are not able to robustly demonstrate that the BHTV is more reliable than the core depths. **Therefore no correction have been applied.** This should be solved by the ET-Geoteam (direct drilling depths control, instruction to driller, logging control – propre calibration, detailed execution report, etc).



## 4 Geological log

The geological context of the Borehole is presented on the local 1/25000 geological map in appendix 1. Main lithologies and defects photos are presented in appendix 4.

### 4.1 Methodology and classification

#### 4.1.1 Lithological logging

The lithological description follow the EN ISO 14688-2 (2016) [14] and EN ISO 14689-1 (2003) [15].

Below the Chalk / Cretaceous, the main Namurian lithologies encountered are the following :

- **thinly bedded grey SILTSTONE** : laminated very thinly to thinly bedded grey clayey SILTSTONE, with cm siderite clasts. mm to cm coarser grained beds (Silt?) attribute this lithology to SILTSTONE according to the primary grain size proportion. Fabric of siderite clast is either interbedded or softly elongated with the lamination. Locally well cemented beds, implies a stronger mechanical resistance.
- **laminated dark grey CLAYSTONE** : laminated silty/clayey dark grey CLAYSTONE, with cm siderite clasts. Bedding can be locally (over few meters) affected by gravitational deformation of unconsolidated rock toward depth. Presence of slumps, folds and shears related to rapid post-depositional deformation (convolute lamination) can be observed.
- **MUDSTONE** : Thinly bedded to laminated MUDSTONE; intermediate facies between clay and silt stones.
- **Graphite bed** : Coal seam, mostly deformed.
- **fined grained SANDSTONE** : very fine grained indistinct bedded (massive) SANDSTONE.

Below the Namurian mudstones, the **carbonated serie of the Dinantian** is present. It is composed of massive to crudely bedded wackestones, locally packstones, with sparse bioclastic debris and possible fine-clastic fraction. Abundant stylolitization and calcite-filled veins.

#### 4.1.2 Structural and defects logging

The weak Cretaceous sequence does not register the deformation patterns. Therefore no structural observation have been made possible macroscopically.

Carboniferous sequence is affected by both rapid post-depositional deformation and brittle tectonic event(s). Tectonic deformation affecting the Mudstone sequence evolves from slightly micro fracturing to penetrative brittle structures into fault core zones. The following descriptions are applied in parallel to the lithological description (according to the AS 1726 Standard) and gradually decrease the rock quality (for a same lithology) :

- **(slightly to deeply) micro-fractured** : Penetrative brittle micro-fractured structure affecting the host rock. Overlay the bedding fabric. Sub-mm clay/silt and/or quartz filling. The bedding can become invisible while density of the micro-fracturing fabric increases. Locally, the rock matrix is deeply weathered (mechanical resistance drops). It is related to tectonic origin due to its relation with Sheared Seam and post depositional Tensile Fracture networks. Very deeply micro-fractured host rock do not show isolated clasts visible at the macroscale.
- **Crushed Seam (CSm)** : monogenetic cemented crushed zone, composed of soft to firm silt/clay matrix and mm to cm well to poorly sorted angular clasts. Roughly to almost parallel planar boundaries, composed of disoriented, angular fragments of the host rock material. This defines a cataclastic tectonic brecciated texture : it varies from proto-crushed zones of few cm to large brecciated zone at meter scale. Its mechanical resistance is poor.

•



- **Shear Zone (Sz):** Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closed spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersects to divide the mass into lenticular or wedge shaped blocks.

## 4.2 Structural data base

BHTV structural data base has been classified based on our observations on cores / core pictures. The following classes are selected : primary bedding, continuous and discontinuous fractures, fault, and few unclassified patterns. Data are presented either in stereogram or on the synthetic strip log (dip value – small circles and dip direction – symbol with small bar). On strip logs, bedding are separated from other structures to clearly illustrate the effect of the fault zones on the primary bedding reorientation.

Compilation of all structural data (Figure 2) illustrates the overall joint sets identified in the borehole. This structural data base is key for both structural / tectonic interpretation on cross sections and for geotechnical assessment. This data base is described for each structural domain in the following section.

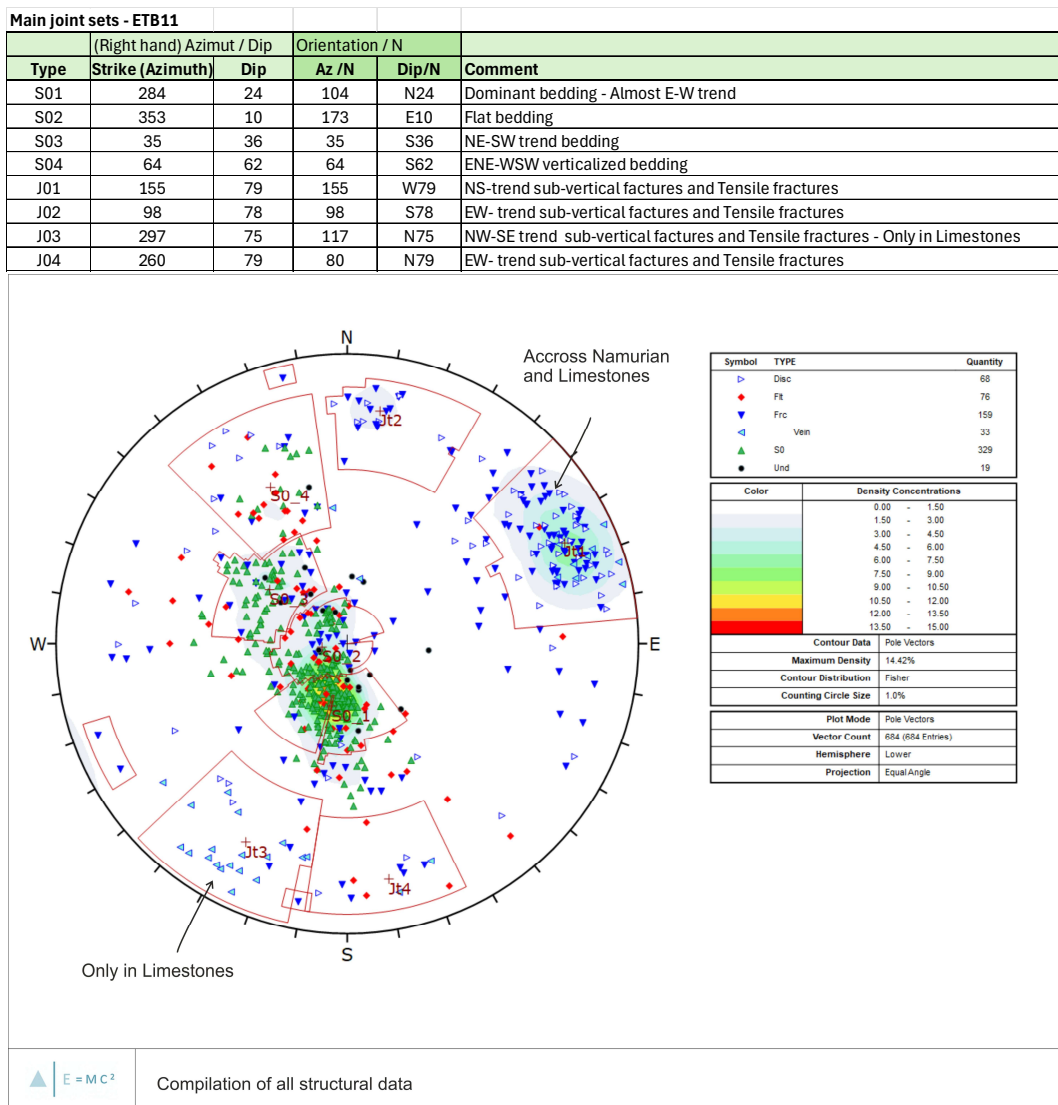


Figure 2 : Compilation of all structural data.

### 4.3 Fault kinematics and tectonic data

Evidences of joint movement (i.e. fault planes bearing slickensides, Striaes, etc.) and their kinematics have been also recorded toward depth. The orientation of each fault plane is assessed based on the BHTV data.

**Note :** *since the cores are not oriented, assigning each slickenside to its oriented observation plane has been produced indirectly by comparing core observations and BHTV data. Despite depths issues, this effort is finally (mostly) successful. **Developing this robust microtectonic data base is a clear added value to further constrain the tectonic evolution affecting the borehole.***

Fault evidences and main kinematics are classified as follows on strip logs (

Figure 3 and appendix 2) :

- Slickenside with inverse movement (close to vertical) – largely dominant
- Slickenside with normal movement (close to vertical) – local effect?

**Quasi all of the movements observed are inverse.** Potential lateral component (Strike-slip) of the deformation regime affecting the cores remain possible. This has not been recorded in details yet. Beside these microtectonics data, macro-scale shear sense indicators could be identified but should be reviewed in details. This macro scales markers have not been studied exhaustively (out of scope) and could be part of a dedicated research work.

### 4.4 Results – Synthetic strip log

The overall results of the borehole log is presented on the synthetic strip log (

Figure 3 and appendix) and described here under from top to bottom. For detailed depths and observations please refer to the tables in appendixes.

#### 4.4.1 Lithology and stratigraphy (attempt)

##### Nearby Laiterie borehole

The attempt to stratigraphic interpretation is based on the correlation with the nearby Laiterie Borehole drilled in 1965 [21][22]. This borehole was drilled only 450m south of ETB-11 (see map and log in appendix 1 and appendix 3). Comments on stratigraphy (issued by M.Dusar) on this log are based on the outcomes of the Workshop organised with external experts.

The Laiterie borehole log description [22] does **only provides dips of structures (bedding, etc) but not their azimuths**. The stratigraphic and tectonic interpretation of this borehole as described precisely on the ‘professional paper’ [21], should be reviewed in details since it is located very close to the ETB-11 Hombourg.

This part of the works is out of scope but was not made available prior to start logging. Also, it seems that geophysical logging were done during the 1980 by TNO (source M. Dusar), but data are not made available to us.

##### Chalk / very fine grained carbonates

The first 9.5m are attributed to soil cover and Cretaceous chalk / carbonates in unconformity on top of the Namurian Mudstone. Attribution to a specific Fm. of Cretaceous requires specific study. The weak chalk does not allow to properly register deformation patterns. Therefore no detailed structural analyse is produced.

### Namurian Series

- **Between 9.5-72m**, the lithology reveals alternance of Claystone and Siltstones **At 62m in the condensed marine beds, with Goniatites are identified**. This can mark the R1a regional substage (base of Kinderscoutian).
- **From 72 to 115m**, we note the presence of strongly tectonized sandstones / claystones which could be attributed to the paralic interval 'zone des murs' (H2, Alportian).
- **Below 115 and until c.a.200m**, shales/claystones are present. No goniatites have been identified (no exhaustive research). We note the presence of gravitational figures and the quasi absence of tectonic defects (high RQD, homogeneous TRC and R value, low joints/m). This could be attributed to the brackish water conditions of the Chokierian H1 regional substage.

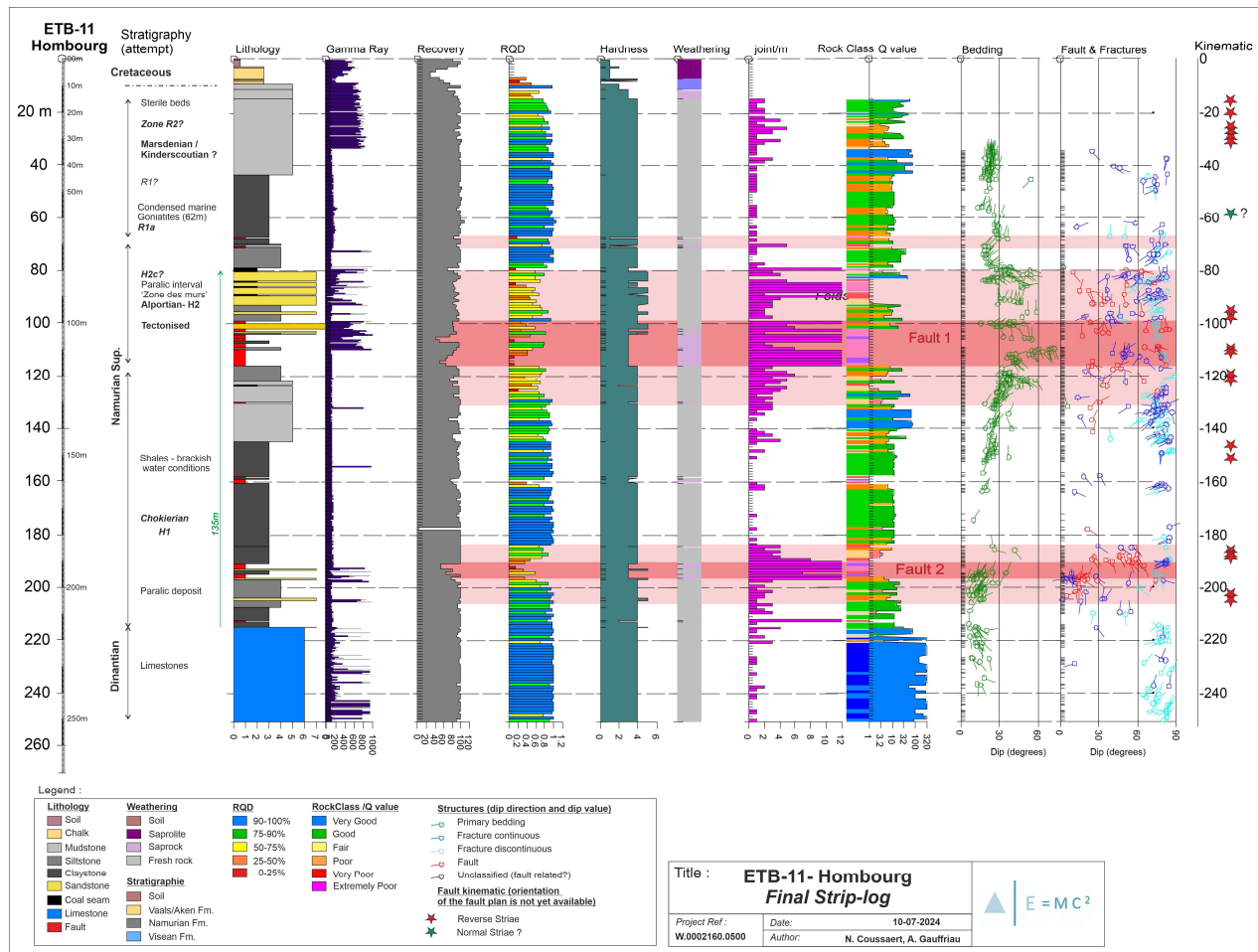


Figure 3 : Strip log – see large scale in appendix

- From 200 to 215.4m, the claystones/siltstones alternance are deeply tectonized. We did not identify specific major marine transgression (no detailed research of marine fauna, to be done). The lithologies could be attributed to paralic deposits. This base of the Namurian sequence could be here attributed to the Arnsbergian substage (Zone E2c)
- At 215.4m the borehole reaches the contact with the Visean formations.

#### 4.4.2 Fault zones and structural domains

**Two main fault zones** are clearly evidenced on the strip log by the defects density, the RQD, TRC and joints/m and structural data. They clearly separate three structural domains where the bedding is homogeneous. From top to bottom, the structural patterns shows (Figure 4 and Figure 5)

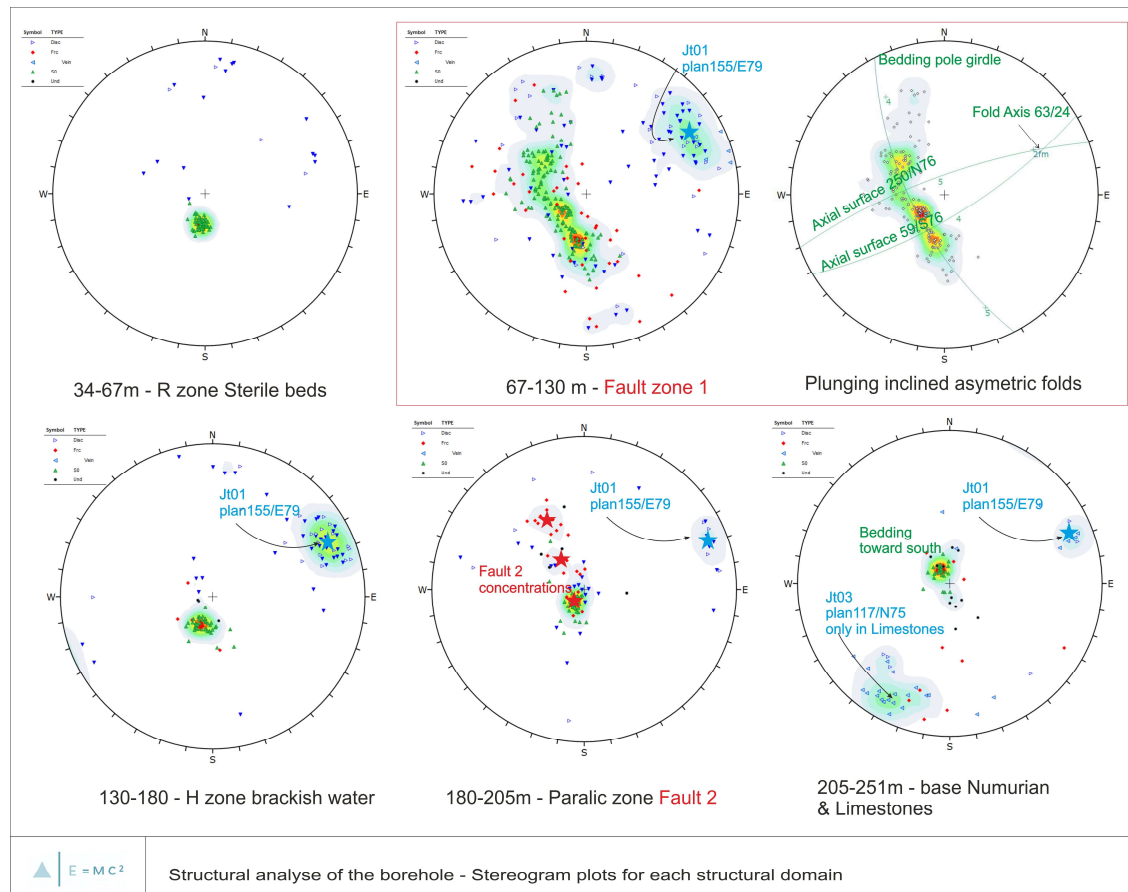


Figure 4 : Structural domains

- **Sterile beds (34-97m) :** Almost no fractures, very dense and homogeneous bedding; oriented 104/N24 (S01). Reverse slickensides are regularly present on the bedding.
- **First fault (80-116m) :** complex deformation, sharp bedding reorientation and verticalisation with a general reverse kinematic. The fault cores deeply affect the rock resistance (large crushed zones, shears, breccias, etc.). **The bedding pole griddle and the pole distribution define an inclined and asymmetric fold axis plunging 24° toward the NE (63/24°).** The bedding concentration defines in fact 3 bedding poles, with potential 2 axial surfaces (250/N76 and 56/S76), which are quite vertical. **Tectonic evidences (crushed zones, shear zones, etc implies that these axial surfaces are reverse fault plans cross cutting the bedding poles.**

The whole zone is then affected by a compressive deformation with a lateral component (inclined faulted fold).

Notably, in this fault zone, the 155/W79 joint01 are present, not above.

**Note:** In order to further analyse the detailed kinematic of the zone, sub structural domains should be defined within the fault zone.

- **Brackish water H zone (130-180m)** : there the 155/W79 joint 01 set is still present, and the bedding is identical to the Sterile bed zone, above the fault 1 - oriented 104/N24 (S01). Reverse slickensides are regularly present on the bedding.
- **Second fault zone (180-205m)** : characterized by microfractures and locally crushed seams. The reverse kinematic is clearly dominant and the fault plans define denser concentration but with similar orientation compared to the fault 1. The bedding is more homogeneous and flatter. There the 155/W79 joint 01 set is still present
- **Base Namurian and Visean limestones (205-251m)** : the bedding in the Visean is flat but dips toward the south. Joint 01 is still present and a new subvertical fracture pattern appears (Joint 03).

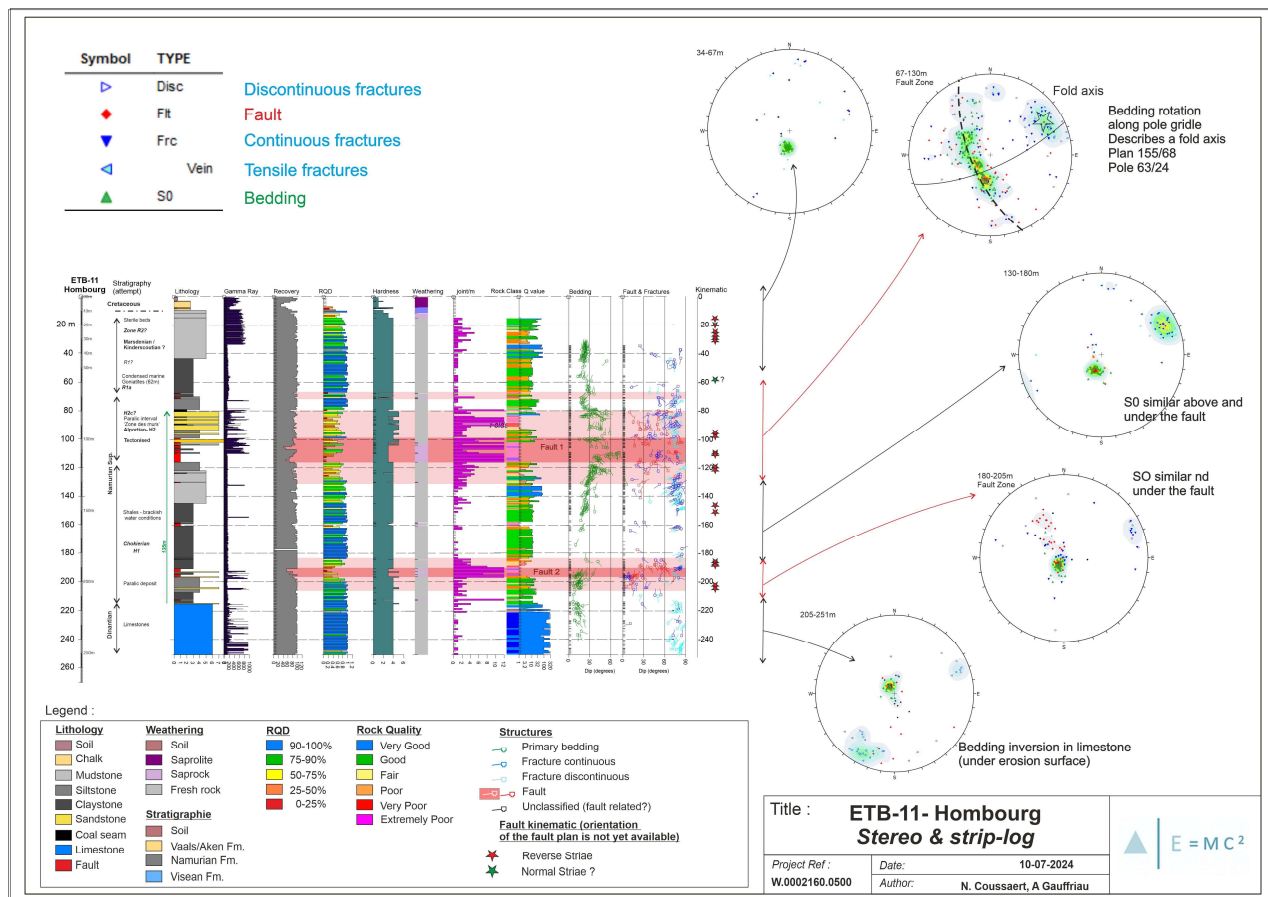


Figure 5 : Structural patterns of each tectonic domains toward depth



#### 4.4.3 Tectonic history recorded in ETB-11

The **oldest tectonic event** affects the Visean unit only, and is related to the development of the Joint 03, subvertical and with NW-SE azimuth. No detailed kinematics are available.

In the Namurian serie, out of the faulted zones, the database shows that the orientation of the bedding has a E-W trending azimuth and dips around 24° **toward the north (104N24)**. The clear reverse kinematic indicators, present also outside the fault zones, imply **that the whole serie is affected by compressive deformation from north to south**. This compressive regime coalesces the deformation in the paralic zones which is probably caused by the rheological heterogeneity of the deposits.

**The very coherent structural pattern and the brittle cores defects imply that this sedimentary facies induced fault zones are of clear tectonic origin.** The vertical throw across the faults could be significant and should not be minimized with regards to its implications and importance for the Engineering Geological Model.

***Note :** At this stage, fault throw cannot be evaluated without having detailed and independent age dating across sequence. We believe that the original stratigraphic sequence could be affected by numerous repetitions / duplexes of the original stratigraphic sequence. This hypothesis cannot be ruined out at this stage. We lack direct evidence for age dating across the sequences.*

**Attributed to a more recent tectonic event, the presence of the 155/W79 Joint 01 set cross cuts the whole serie, except the first 67m.** Indeed, this fracture network has no clear structural relation with the compressive structures. It can be correlated with the N155 fault of the geological map, located c.a. 90m east of the BH location. Its kinematic and the age of last movement remain unclear, and requests further specific studies on cores.

#### 4.4.4 Tectonic models implications for the EGM

We propose cross-section and discuss here the models between the ETB-11 and Laiterie boreholes (450m distance between). This is a very good exemple to illustrate the preparation of the large scale cross sections needed for the EGM.

**Data available** (Figure 6 and Figure 7)

Our ETB-11 structural borehole data are presented on a NS cross section direction (Figure 6). It allows to extrapolate close to the borehole the internal structure of the reverse fault 1 near the ETB-11 which is well constrained by the bedding changes and faults plans available.

The ETB-11 and Laiterie BH are presented on the NS cross-section (Figure 7). For the sake of comparison, Graulich (1968) already proposed a reverse fault to explain their interpretation of a possible repetition of the H zone at the top of the Namurian of the Laiterie Borehole (report [22], should be read and analyzed in details – out of scope).

ETB-11 faulted fold /fault structure and bedding orientations are well constrained. In the Laiterie borehole only the dipping of the structures are available. On the opposite, age determination seems better constrained in the Laiterie borehole compared to ETB-11.

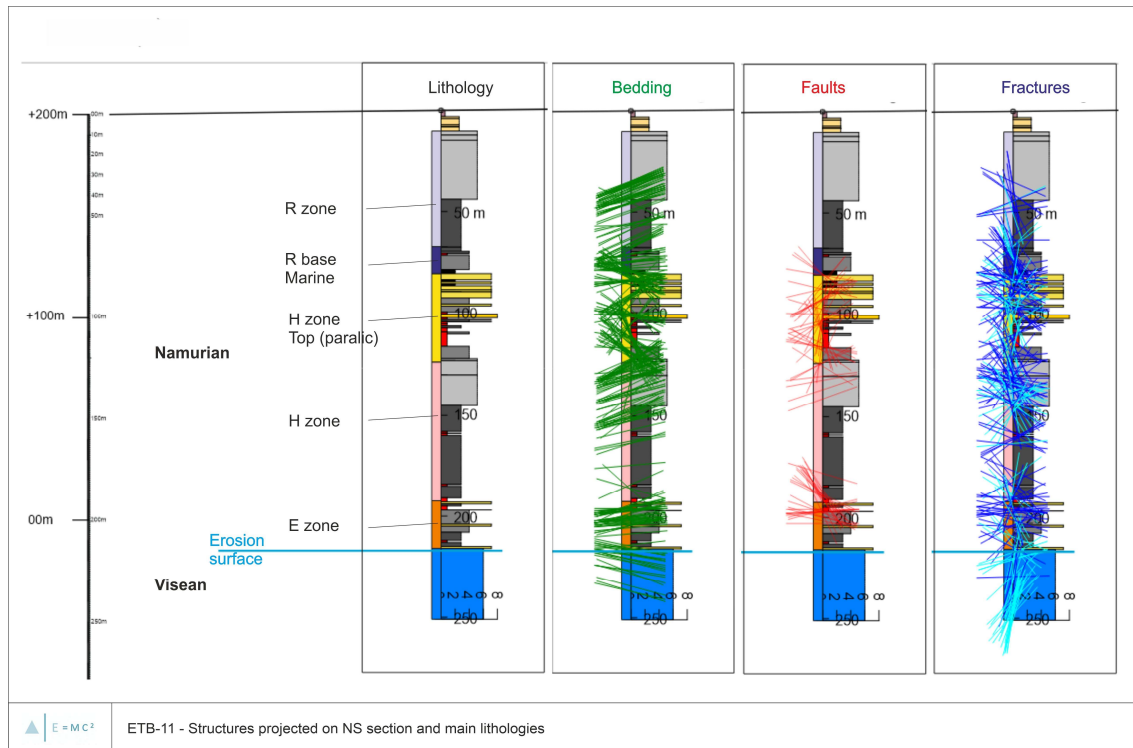


Figure 6 : ETB-11 projected structures on NS orientation - stratigraphy related to Laiterie BH.

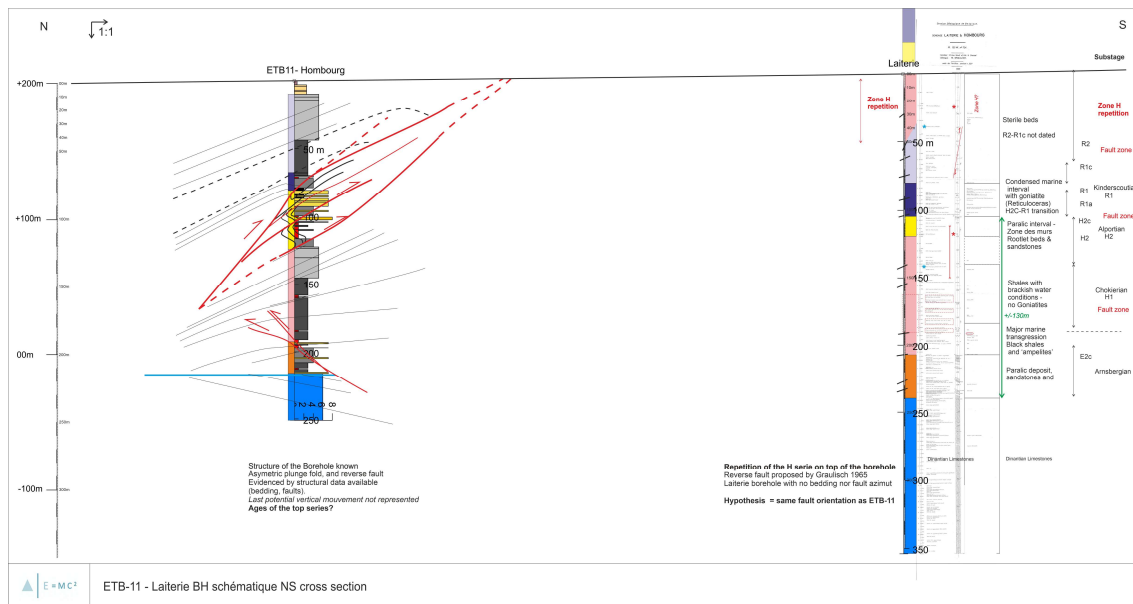


Figure 7 : Schematic model and cross section – BH data

### Model 01 – Simple stratigraphic correlation

If we do not account for the presence of the H Zone repetition on the top of the Laiterie BH and we make the hypothesis that the reverse fault on the top of this borehole is not present, a simple model can be proposed.

In this case, the displacement (fault throw) along the ETB-11 fault 01 could be of small scale.

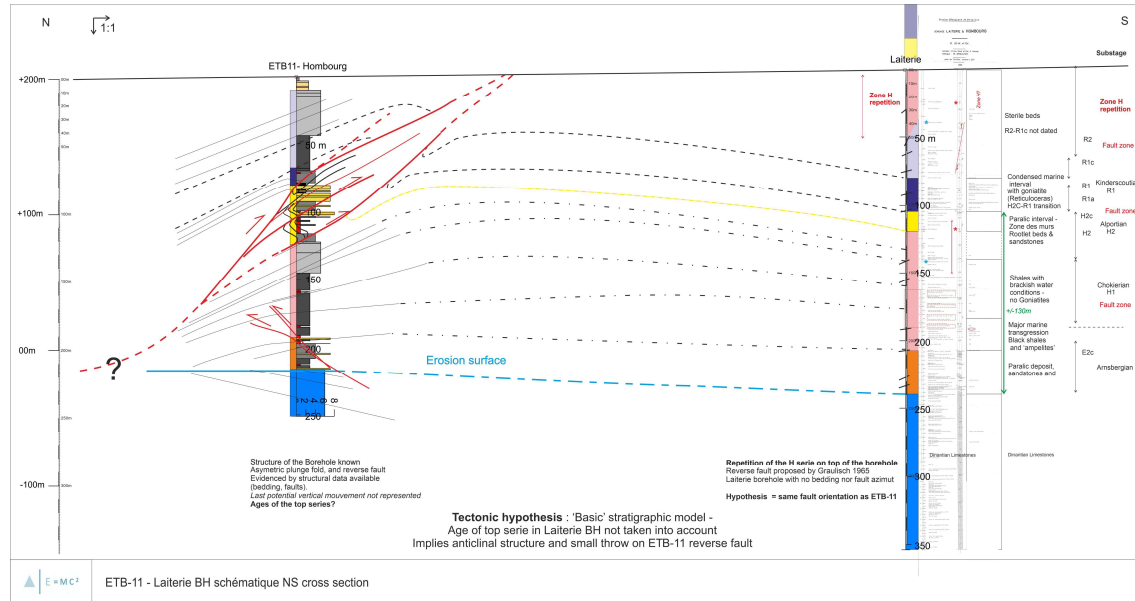


Figure 8 : Model 01 – Simple stratigraphic correlation – do not account for Laiterie reverse fault

### Model 02 – Synthetic south verging thrusts (Figure 9)

By taking into account the presence of the repetition of the H serie at the top of the Laiterie BH, as proposed by Graulich (1968) [22], a model of synthetic south verging thrusts can be proposed. In this model, the thrusts are emerging from the erosion surface and are not affecting / displacing it. This is a standard deformation pattern in the Namurian series. In this case the fault throws could be very large.

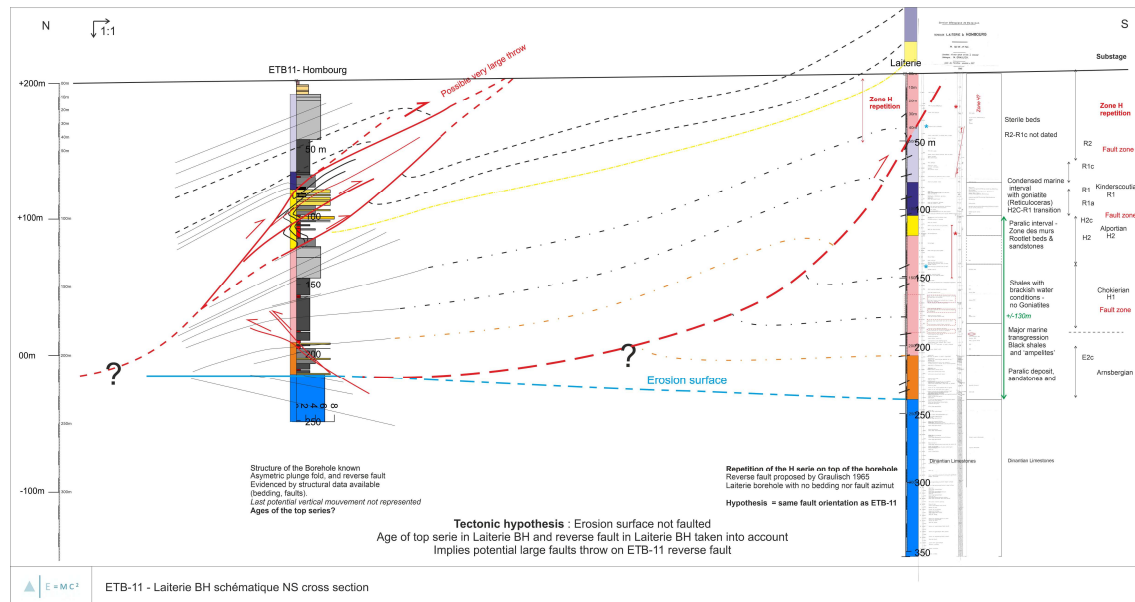


Figure 9 : Model 2 – Double thrusts not displacing the erosion surface





### Model 03 – Deeply rooted thrusts (Figure 10)

The rooting of the inverse faults displacing the Namurian / Dinantian erosion surface remains possible like it is presented in this model. Here the reverse faults affect the Visean 'basement', and will also affect the older Famennian deposits expected underneath which are the target host rocks for the caverns. If such faults exist, they will directly impact the underground design and cavern / tunnel locations.

According to our knowledge, very few data exist in the literature about the rooting of the faults. Structural data of deep boreholes are often not available. This should be screened out and documented in details. This hypothesis can be controlled by inclined drilling as illustrated here.

**This explains the upmost importance of the structural and the need to combine them with detailed age determination for each borehole.** These are key data required to build a correct and reliable EGM.

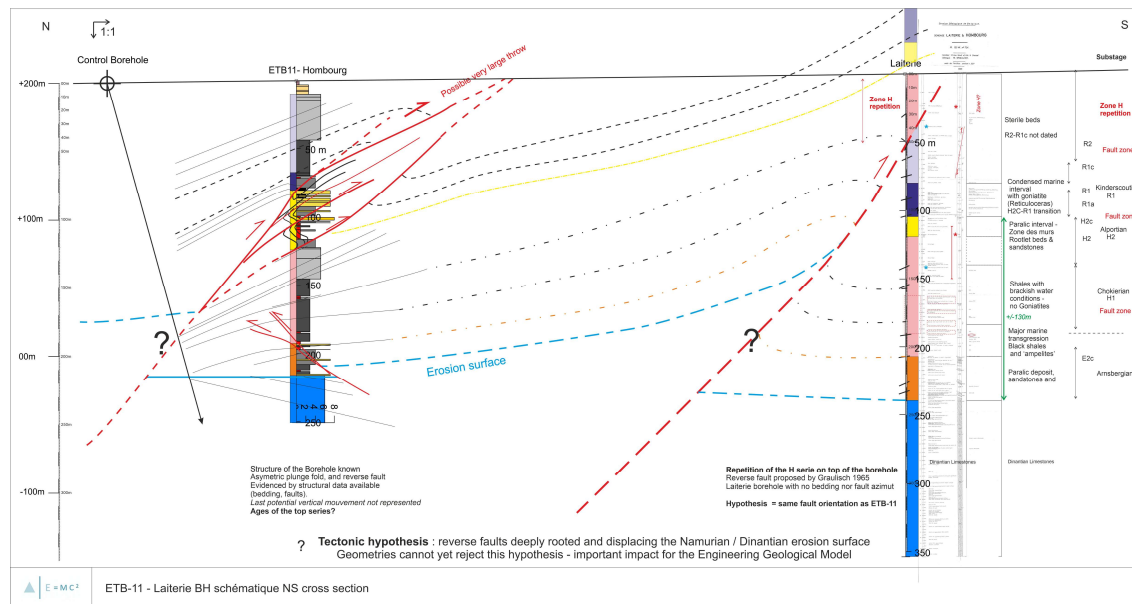


Figure 10 : Model 3 – Double thrusts deeply rooted and affecting the Visean and deeper units

## 5 Rock mechanics results

### 5.1 Strength and Weathering index

In this borehole, the Namurian rocks are strong (R4) to very strong (R5) rocks. The presence of local tectonic defects degrades the rock strength (medium, weak to very weak R3 to R1). This becomes logically dominant in faulted zones. The crushed zones are generally less resistant compared to the microfracture rocks (for the same lithology);

Weathering is moderated in the first fault core over 15m. For the rest of the Namurian, the rock is fresh except locally in fault zones.

### 5.2 Core recovery – RQD-

Core recovery is overall acceptable, close to 95%. Recovery strongly drops in the faults over respectively 35m and 22m length in faults 1 and 2.

The RDQ results are locally affected by the core damages, as explained here above (See QA/QC). This will be further monitored for the next boreholes. Below, the results show that **most of the Borehole is of good quality hard rock (RQD >75%)**. Lower rock quality (<50%) is related to fault zones

### 5.3 Joints distribution / m

The joints/m results are negatively affected by the core damages, as explained here above. By defaults, in the fault zones, with attribute the value of 12j/m according to standard [19].

These distributions are strongly influenced by the fault zones and by the structural joints set corresponding to fractures and stratigraphic accommodation. The relationship between this joints distribution and the RQD values indicates the blocky nature of the rock in these zones implying a reduction in self-support capacity during caverns, shaft and tunnel excavation.

### 5.4 Q system

**Note :** *the Q value calculation and assessment of the rock mass quality and rock support is a first attempt and will be re-evaluated based on the UCS laboratory results. Still the borehole logs and details observations will remain to fine tune the rock masses quality in later stages.*

The Q-value gives a description to the rock mass quality into seven groups varying from “Very good rock” to “Exceptionally poor” [19]. High Q-values indicates good stability and low values means poor stability.

#### 5.4.1 Joint set

The joint set number (Jn) has been defined based on our direct core observations and our link to the structural database issued by the BHTV (Figure 2).

- **Namurian sedimentary rocks :** The main hazard in its lithologies are the beddings which are obviously present everywhere (very thinly bedded deposits). A Jn=2 value is assigned to the whole serie. 4 sets of beddings are identified (S01 and S02-S04 in fault zones), related to the change of the bedding in the fold/faulted zones. Jn evolves according the presence of other joints (fractures, etc.). 4 sets of joints are also identified (see table Figure 2).
- **Visean limestones :** Jn=1 is applied considering the massive and lower number of joints. The bedding joint set is the S02, and the joint set observed is Jt03.
- **Fault zones:** with attribute the value of Jn=15 according to standard [19].

#### 5.4.2 Joint characteristics

The  $J_a$  and  $J_r$  parameters define the roughness and frictional characteristics of joints are listed in the appendix 5 table. They are attributed per RQD interval (per meter). Results are as follows :

- **Namurian sedimentary rocks** -depends on the lithologies
  - Claystones : planar and smooth joints are dominant, locally organic traces.  **$J_r=1$ ,  $J_a=4$** ;
  - Siltstones : slightly rough plans (more silty matrix).  **$J_r=1.5$ ,  $J_a=3$**
  - Mudstones : planar and mostly not weathered, slightly rough, also depending on the local presence of fine material.  **$J_r=1$  to  $1.5$  and  $J_a=4$**
  - Sandstones : massive rocks where joints are mostly related to fracturation, irregular to rough without alteration.  **$J_r=3$ ,  $J_a=1$**
  - In the clay, silt and mudstones, we note the presence of many movement on the beddings (slikenlides). There  **$J_r=0.5$  by default**
- **Specific defects** : for the faults and the crushed zones,  $J_r=1$  and  $8 < J_a < 12$  according to the resistance of the cemented matrix (fully cemented or cohesive)
- **Visean limestones** : irregular and non-weathered beddings.  **$J_r=3$ ,  $J_a=1$** . Joints related to fractures are here planar and mostly rough.  **$J_r=1.5$** .

#### 5.4.3 Joint water reduction factor

Water reduction factor  $J_w$  is a key factor which reduce the friction on the joint planes. Water pressure may reduce the normal stress on the joint walls and cause the blocks to shear more easily.

**The water conditions on joints are not documented to correctly evaluate this parameter. In consequence, a standard value of  $J_w=1$  is considered (optimum situation, dry or minor inflow).**

#### 5.4.4 Stress reduction factor

The stress reduction factor (SRF) describes the relation between stress and rock strength around an underground opening. In core Hombourg cores, the strength rock index indicate that rock are good quality along the borehole, except in the faulted zone. For this reason, **SRF value is mainly 1** along the borehole corresponding to competent rock (UCS value c.a. 30Mpa) with a favorable stress condition considering that infrastructures are localized at a depth to c.a. 200m.

**In the fault zones, SRF varies between 2.5 and 7.5** according to the presence of either punctual crushed zone or larger defects. For **very dense fractured zones SRF=5** is applied (sugar cube, loose open joints, etc.).

#### 5.4.5 Q index

The Q index calculated based on our core descriptions and joint parameters is distributed as follows :

- Two main domains are clear between the Namurian (various Q index) shales and the Visean Limestones (very high Q index, Exceptionally Good to Very good);
- The Namurian Q index values are lithologically driven : Very good in Mudstones and Sandstones, and Good in claystones ( $11 < Q < 13$ ) and siltstones ( $22 < Q < 36$ );
- Q index values are in parallel strongly influenced by the general deformation affecting the whole serie. Regular presence of movement on bedding (slikenlides) impact the Q index which drops to Fair ( $4 < Q < 10$ ) and even to Poor in local crushed zones ( $1 < Q < 4$ ).



These local defects even if they are tectonically driven are very difficult to predict since they can appear outside the main fault zones (bedding slides, tension between beds, small crushed zones, etc.). Their impact on the rock mass quality will require local rock support during excavation.

- In the fault zones the Q index  $< 1$  (very poor to exceptionally poor). It will require special evaluation of the support structures.



## 6 Conclusions

Based on our observations of the ETB-11 and detailed QA/QC on the data, we proposed actions to improve the core quality. Despite core damages, and depths issues, we attempted to valorise the cores at the maximum.

The cross check of core observations and BHTV structural data is providing key information on the lithology, stratigraphy and structure of the underground in the vicinity of the borehole. Detailed structural and geotechnical logging allows to objectively identify two main fault zones affecting the Namurian Formation. Moreover, we identified different structural data sets affecting the cores, which can be related to different tectonic events / regimes. The whole Namurian serie shows a clear bedding dipping to the north, and affected by compressive deformation. The faults zones are interpreted as south verging reverse faults (asymmetric and plunging faulted folds). An older tectonic event affects the Visean Formation only, and an more recent tectonic regime is responsible for the development of N155 sub-vertical fractures cross cutting almost the whole series. This most recent event is coherent with the NS trending faults of the local geological maps.

We used the Laiterie borehole drilled around 1965, and located only 450m to the south, to provide with preliminary stratigraphic interpretation of the ETB-11. We present a local NS cross-section. Several models are possible since on one hand the ETB-11 structural data are available with less constrains on age dating, and on the other hand the Laiterie borehole has no clear structural data but more reliable age determination. Detailed review of the Laiterie borehole report is needed to further discuss which model is potentially more reliable. However, we point out the possible presence of deep rooting reverse faults which could affect and displace the Visean formation (and the Famennian underneath too). This model cannot be ruled out without complementary data, but has direct and significant impacts on the Engineering Geological Model (EGM).

This small scale cross-section exercise illustrate the issues that will face the large scale cross section establishment. It is therefore fundamental to better evaluate the geometry/kinematics of the fault zones in each Borehole prior to propose interpretative cross section and their lateral extensions. Thus we recommend, aside detailed review of existing deep boreholes data (literature), to execute specific research program on the ETB cores using state of the art petrographic, stratigraphic, structural and age dating technics to be able to reduce these above mentioned uncertainties.

Preliminary geotechnical results allowed to evaluate the Q indexes. Out of the fault zones, the Namurian Q index values are lithologically driven : very good in Mudstones and Sandstones, and Good in claystones ( $11 < Q < 13$ ) and siltstones ( $22 < Q < 36$ ). In the Visean Limestones Q index is Exceptionally Good to Very good. In parallel Q index values are strongly influenced by the general deformation affecting the whole serie. Regular presence of movement on bedding (slikensides) impact the Q index which drops to Fair ( $4 < Q < 10$ ) and even to Poor in local crushed zones ( $1 < Q < 4$ ). These local defects even if they are tectonically driven are very difficult to predict since they can be appear outside the main fault zones (bedding slides, tension between beds, small crushed zones, etc.). Their impact on the rock mass quality will require local rock support during excavation.

In the fault zones the Q index  $< 1$  (very poor to exceptionally poor). It will require special evaluation of the support structures.

## 7 Appendix

### Appendix 1 : Geological context – Maps





## Deep Boreholes & Seismics

### ET\_BOREHOLES

- Not executed
- Executed

### Seismic reflection lines & geological sections (various publications)

- Balanced Section
- Seismic line
- ETN\_2024-03-24\_Geological\_Section\_published\_pl
- Possible Val Dieu 'Ridge'

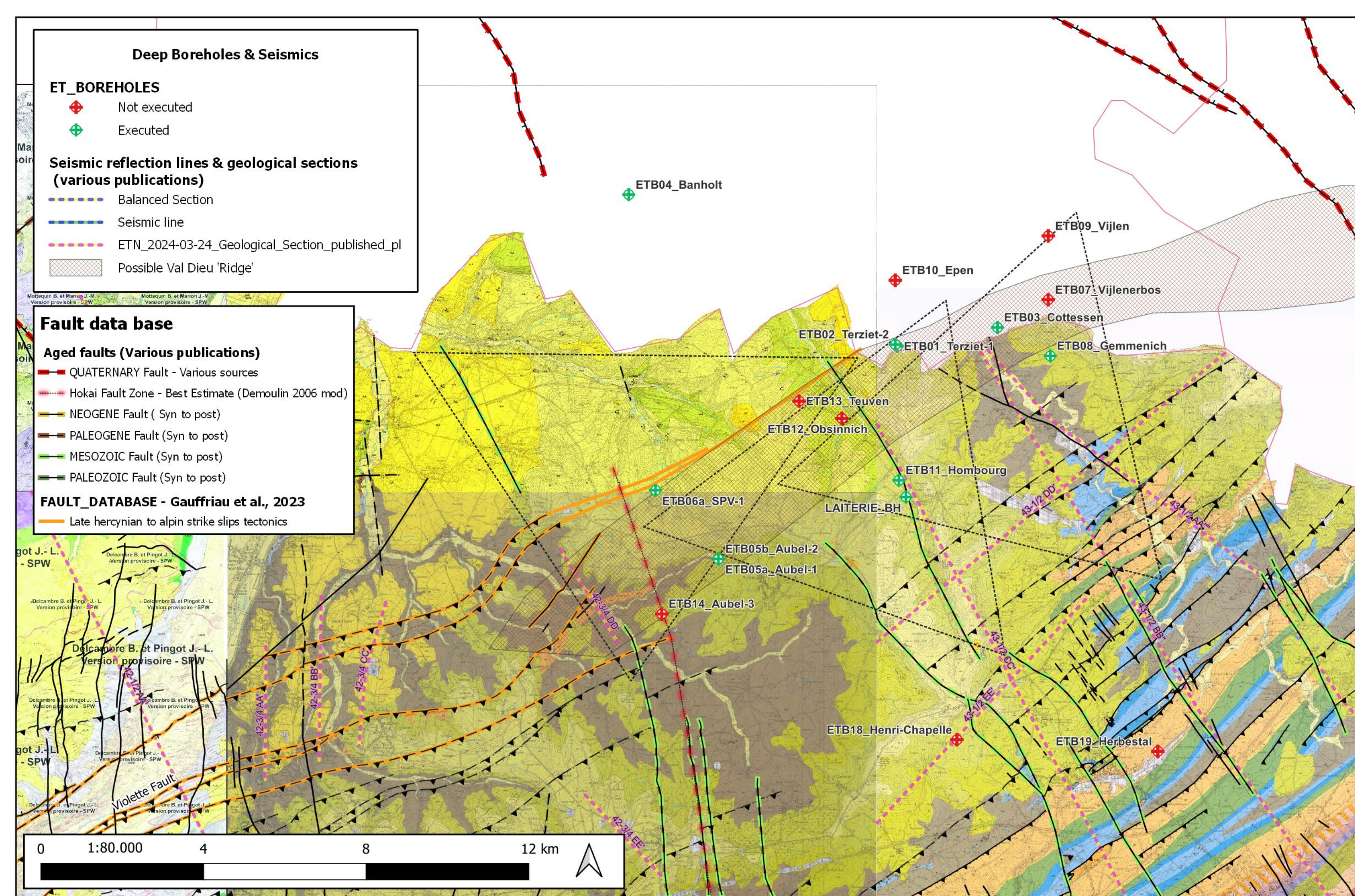
### Fault data base

#### Aged faults (Various publications)

- QUATERNARY Fault - Various sources
- Hokai Fault Zone - Best Estimate (Demoulin 2006 mod)
- NEOGENE Fault ( Syn to post)
- PALEOGENE Fault (Syn to post)
- MESOZOIC Fault (Syn to post)
- PALEOZOIC Fault (Syn to post)

#### FAULT\_DATABASE - Gauffriau et al., 2023

- Late hercynian to alpin strike slips tectonics



E = MC<sup>2</sup>

Project - Task - ET Feasibility Study - WP02  
Date : 2024 / 06

Author-  
Tractebel- A.Gauffriau

TITLE :  
Geological context - Borehole locations



## Deep Boreholes & Seismics

### ET\_BOREHOLES

- Not executed
- Executed

### Seismic reflection lines & geological sections (various publications)

- Balanced Section
- Seismic line
- ETN\_2024-03-24\_Geological\_Section\_published\_pl
- Possible Val Dieu 'Ridge'

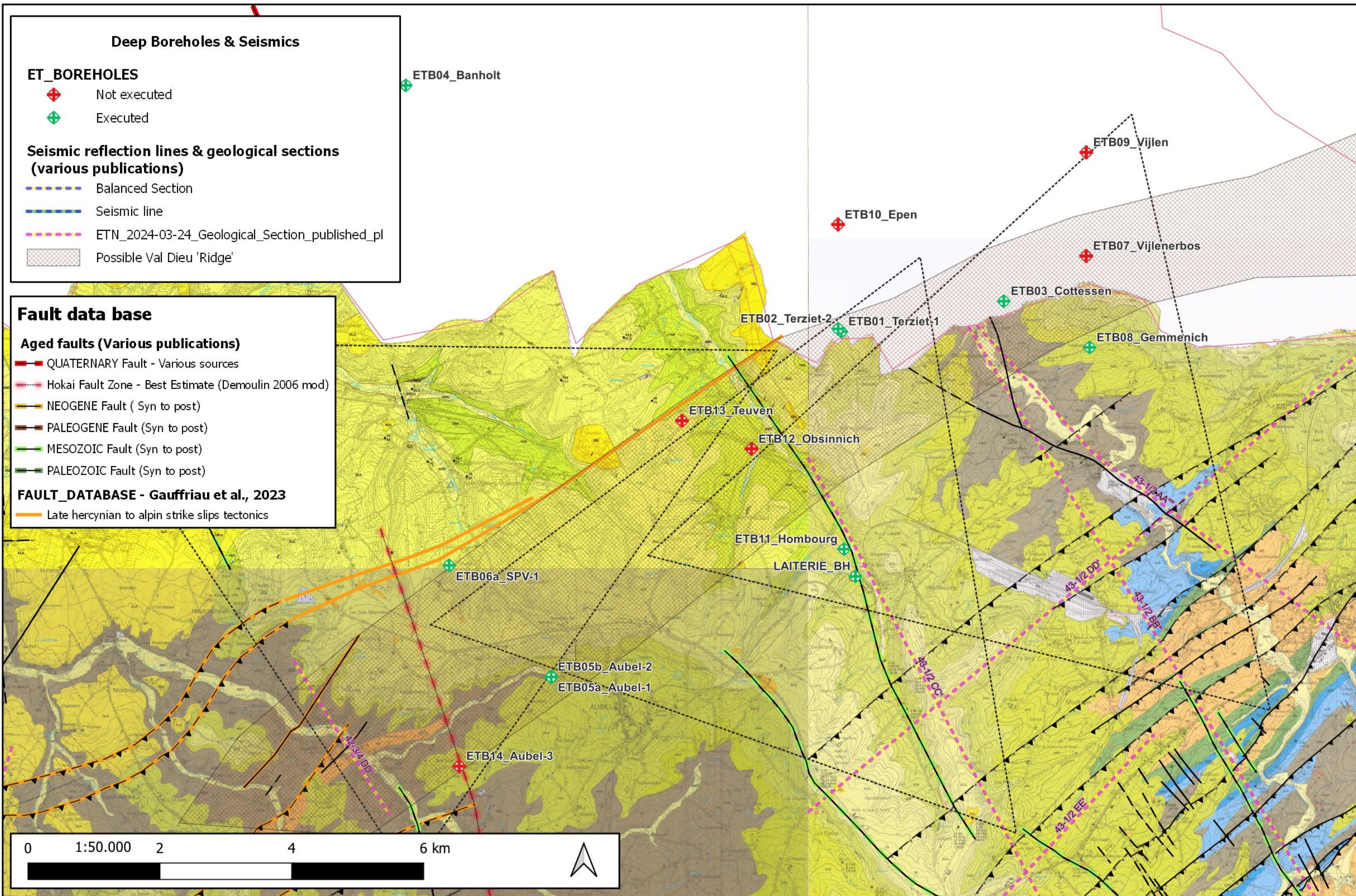
## Fault data base

### Aged faults (Various publications)

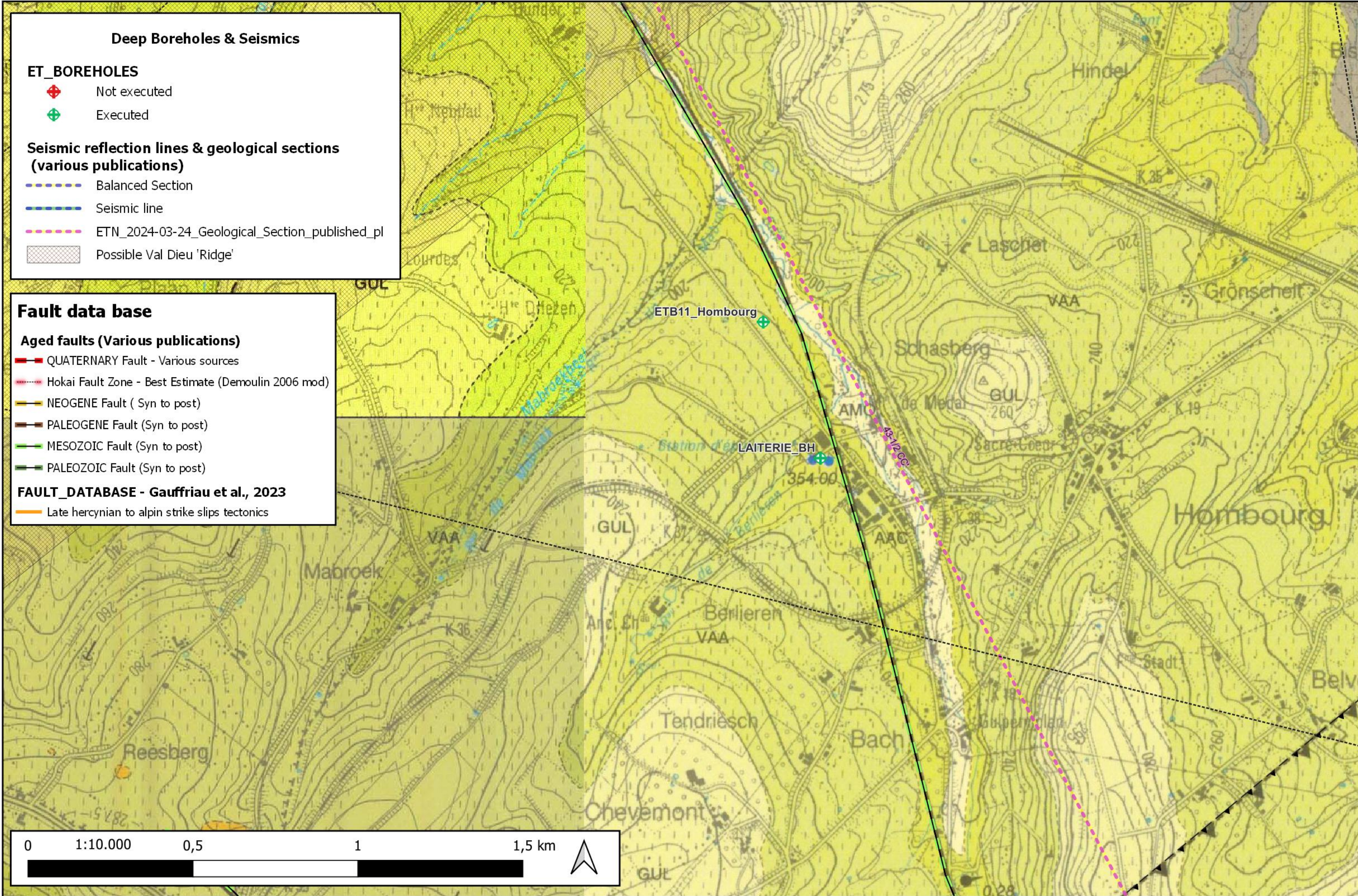
- QUATERNARY Fault - Various sources
- Hokai Fault Zone - Best Estimate (Demoulin 2006 mod)
- NEOGENE Fault ( Syn to post)
- PALEOGENE Fault (Syn to post)
- MESOZOIC Fault (Syn to post)
- PALEOZOIC Fault (Syn to post)

### FAULT\_DATABASE - Gauffriau et al., 2023

- Late hercynian to alpin strike slips tectonics



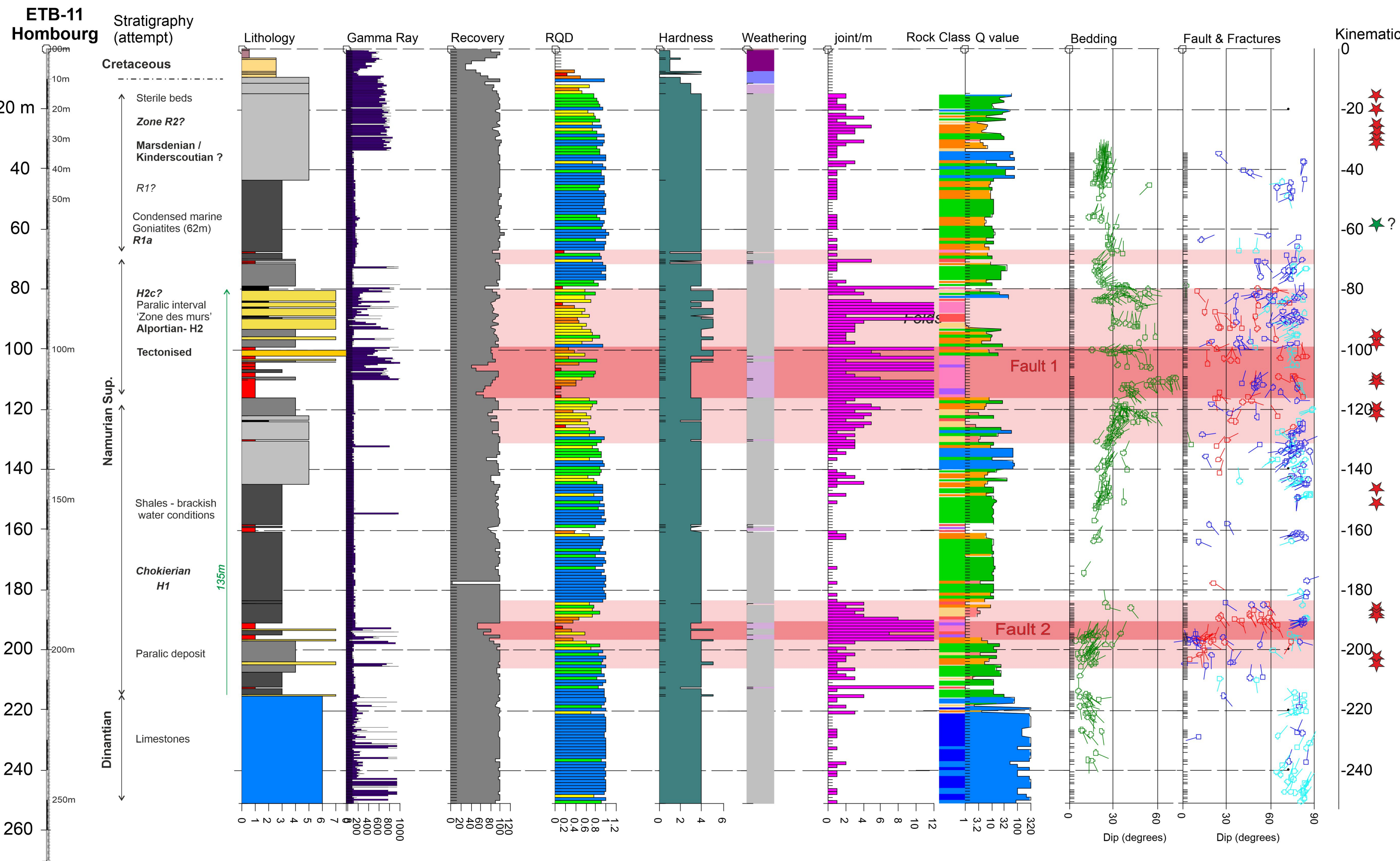




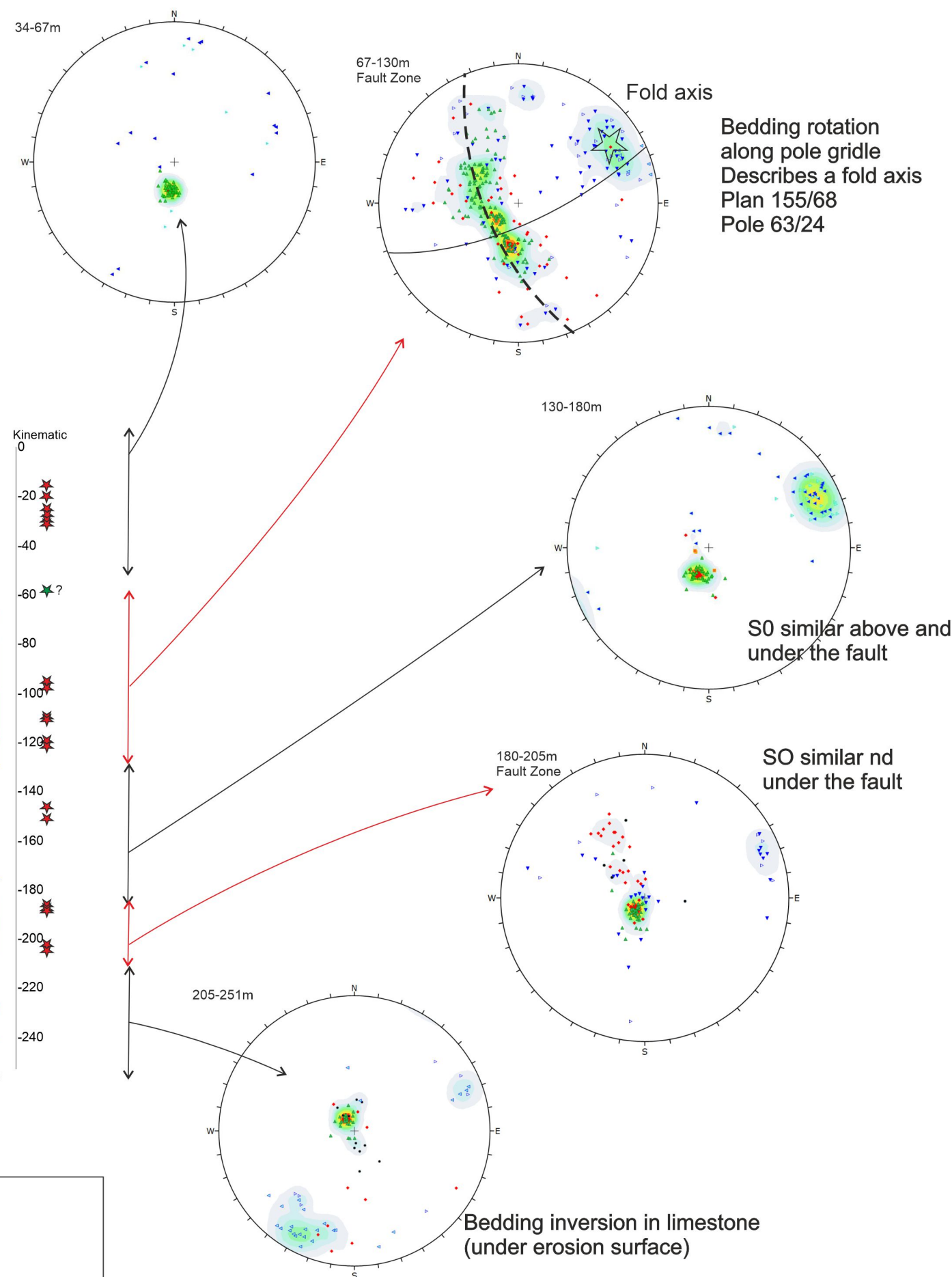
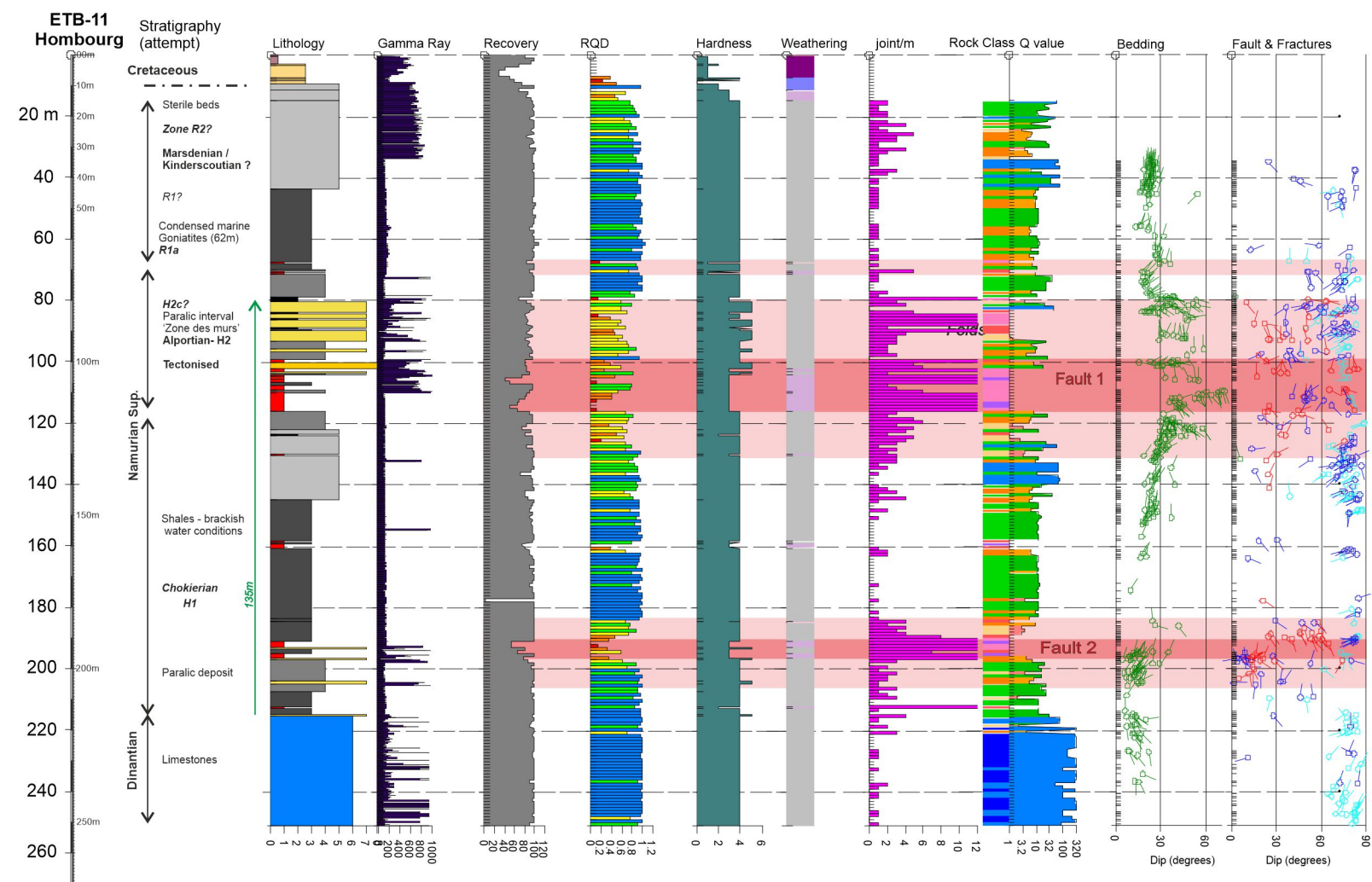
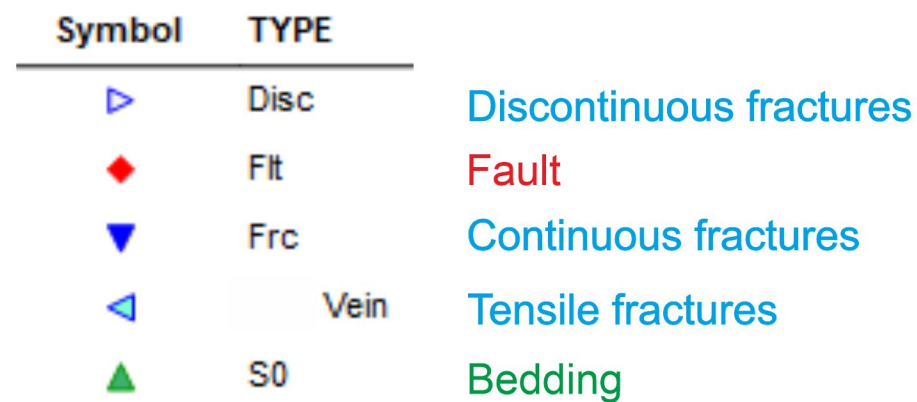


## Appendix 2 : Detailed strip logs and data results

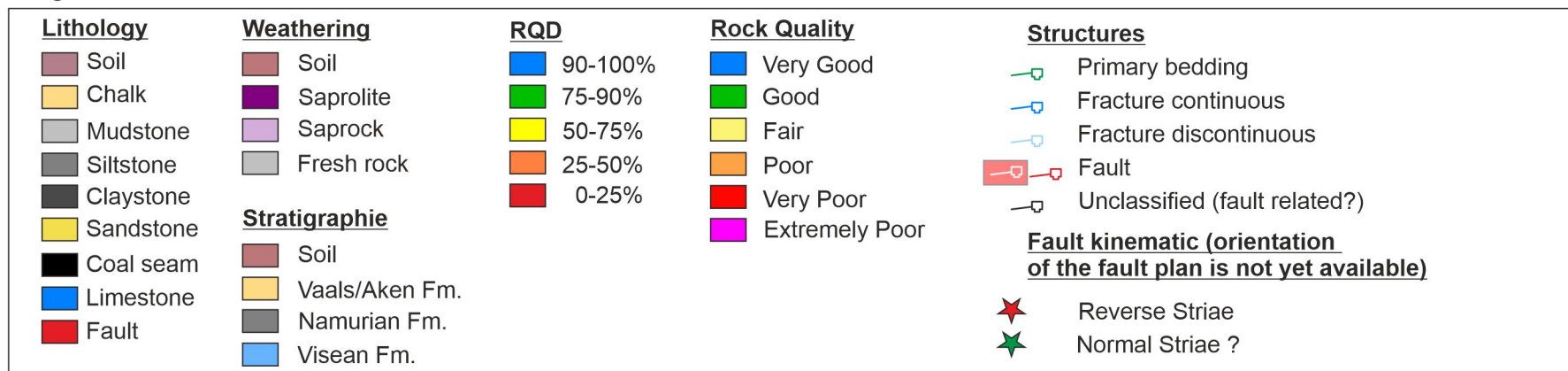








Legend :



Title : **ETB-11- Hombourg**  
**Stereo & strip-log**

Project Ref :  
**W.0002160.0500**

Date: **10-07-2024**  
Author: **N. Coussaert, A Gauffriau**





### Appendix 3 :Laiterie BH Log







Appendix 4 : Lithological and structural description Photos & tables

|                                                                                     |                                              |
|-------------------------------------------------------------------------------------|----------------------------------------------|
|   |                                              |
| laminated black CLAYSTONE                                                           |                                              |
|  |                                              |
| very thinly bedded grey SILTSTONE                                                   |                                              |
|  | ETB-11- Hombourg Borehole : core lithologies |



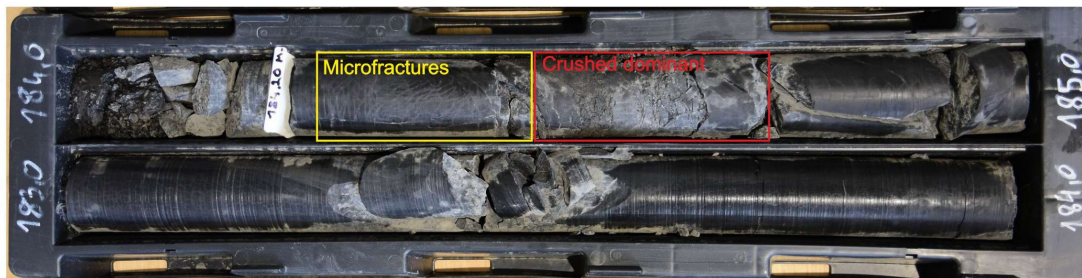


Fined grained SANDSTONE (Namurian)

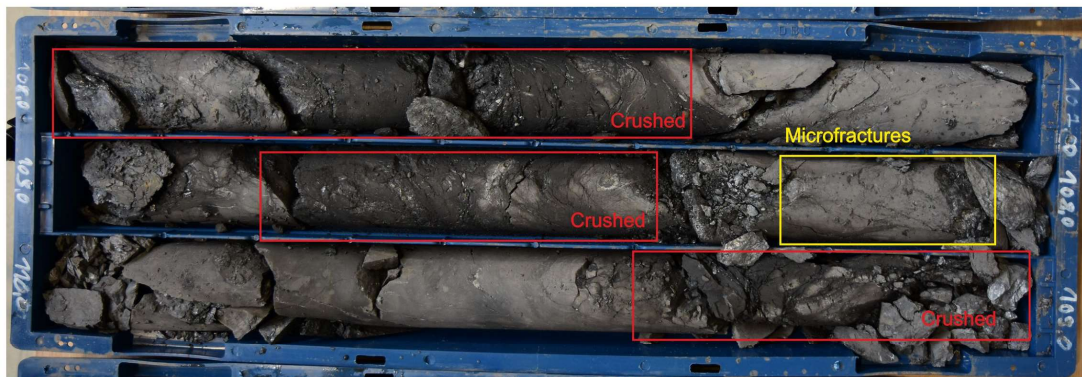


Massive to crudely bedded LIMESTONES (Lives Fm?)





Typical microfractured to Crushed zones defects



Typical microfractured to heavily Crushed zones defects - MUDSTONE



## ETB-11\_Hombourg logging - Lithology, R value and stratigraphy

| From (m) | To (m) | Thickness | R value | Code_Itiho                        | Structural code | Description                                                                                             | Rock weathering                 | Preliminary Stratigraphy |
|----------|--------|-----------|---------|-----------------------------------|-----------------|---------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------|
| 0        | 0.3    | 0.3       | R0      | Soil                              |                 | Gravel soil                                                                                             | Soil                            | Soil                     |
| 0.3      | 2.7    | 2.4       | R1      | Soil                              |                 | Silty to fine grained SANDSTONE clay with shell fragment and centimetric chalks or cherts clasts        | Extremely weathered - saprolite | Soil                     |
| 2.7      | 3.5    | 0.8       | R2      | Clayey to sandy CHALK             |                 | Dark greenish clay with glauconite                                                                      | Extremely weathered - saprolite | Tertiary                 |
| 3.5      | 7.4    | 3.9       | R1      | Clayey to sandy CHALK             |                 | Unconsolidated massive clay, locally silty /fine grained SANDSTONE with spare cm clast of chalks        | Extremely weathered - saprolite | Tertiary                 |
| 7.4      | 7.8    | 0.4       | R4      | Clayey to sandy CHALK             |                 | Highly weathered yellow fine grained SANDSTONEstone with clay                                           | Highly weathered - saprock      | Tertiary                 |
| 7.8      | 8.1    | 0.3       | R0      | Clayey to sandy CHALK             |                 | Yellow fine grained SANDSTONE clay                                                                      | Highly weathered - saprock      | Tertiary                 |
| 8.1      | 8.2    | 0.1       | R4      | Clayey to sandy CHALK             |                 | Highly weathered yellow fine grained SANDSTONE with clay                                                | Highly weathered - saprock      | Tertiary                 |
| 8.2      | 9.5    | 1.3       | R0      | Clayey to sandy CHALK             |                 | Yellow fine grained SANDSTONE clay                                                                      | Highly weathered - saprock      | Tertiary                 |
| 9.5      | 11.5   | 2         | R2      | MUDSTONE                          |                 | highly weathered thinly bedded grey MUDSTONE                                                            | Highly weathered - saprock      | Namurian                 |
| 11.5     | 14.8   | 3.3       | R3      | MUDSTONE                          |                 | moderately weathered thinly bedded grey MUDSTONE                                                        | Moderately weathered            | Namurian                 |
| 14.8     | 43.4   | 28.6      | R4      | MUDSTONE                          |                 | thinly bedded grey MUDSTONE                                                                             | Fresh rock                      | Namurian                 |
| 43.4     | 67.4   | 24        | R4      | dark grey CLAYSTONE               |                 | laminated black CLAYSTONE + bivalve and trace of pyrite and siderite concretions (gonatites level: 62m) | Fresh rock                      | Namurian                 |
| 67.4     | 67.9   | 0.5       | R1      | Fault zone                        | Crushed seam    | Crushed zone inside black shale                                                                         | Slightly weeathered             | Namurian                 |
| 67.9     | 70     | 2.1       | R4      | dark grey CLAYSTONE               |                 | laminated black CLAYSTONE with bivalve and trace of pyrite and siderite concretions                     | Fresh rock                      | Namurian                 |
| 70       | 70.5   | 0.5       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 70.5     | 70.6   | 0.1       | R1      | Fault zone                        | Crushed seam    | crushed zone in SILTSTONE                                                                               | Moderately weathered            | Namurian                 |
| 70.6     | 71     | 0.4       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 71       | 71.2   | 0.2       | R1      | Fault zone                        | Crushed seam    | crushed zone in SILTSTONE                                                                               | Moderately weathered            | Namurian                 |
| 71.2     | 79     | 7.8       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 79       | 79.8   | 0.8       | R3      | Coal - graphitic seam             |                 | Coal - graphitic seam vein                                                                              | Fresh rock                      | Namurian                 |
| 79.8     | 80.2   | 0.4       | R3      | Coal - graphitic seam             |                 | graphitic laminated black CLAYSTONE                                                                     | Fresh rock                      | Namurian                 |
| 80.2     | 83.8   | 3.6       | R5      | fine grained SANDSTONE            | Micro-fractured | massive fine grained SANDSTONESTONE with tension veins                                                  | Fresh rock                      | Namurian                 |
| 83.8     | 84.2   | 0.4       | R3      | Coal - graphitic seam             | Crushed seam    | graphitic laminated black CLAYSTONE                                                                     | Fresh rock                      | Namurian                 |
| 84.2     | 85.7   | 1.5       | R4      | fine grained SANDSTONE            | Micro-fractured | Catalased massive fine grained SANDSTONE with tension veins                                             | Fresh rock                      | Namurian                 |
| 85.7     | 86.4   | 0.7       | R3      | Coal - graphitic seam             | Crushed seam    | graphitic laminated black CLAYSTONE                                                                     | Fresh rock                      | Namurian                 |
| 86.4     | 88.5   | 2.1       | R5      | fine grained SANDSTONE            | Micro-fractured | laminated grey fine grained SANDSTONE                                                                   | Fresh rock                      | Namurian                 |
| 88.5     | 89     | 0.5       | R3      | Coal - graphitic seam             | Crushed seam    | graphitic laminated black CLAYSTONE                                                                     | Fresh rock                      | Namurian                 |
| 89       | 89.4   | 0.4       | R5      | fine grained SANDSTONE            |                 | fine grained SANDSTONEstone with laminations                                                            | Fresh rock                      | Namurian                 |
| 89.4     | 89.7   | 0.3       | R4      | dark grey CLAYSTONE               | Crushed seam    | graphitic laminated black CLAYSTONE                                                                     | Fresh rock                      | Namurian                 |
| 89.7     | 93     | 3.3       | R5      | fine grained SANDSTONE            | Micro-fractured | laminated grey fine grained SANDSTONE                                                                   | Fresh rock                      | Namurian                 |
| 93       | 95.9   | 2.9       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 95.9     | 96.6   | 0.7       | R5      | fine grained SANDSTONE            |                 | Massive fine grained fine grained SANDSTONE                                                             | Fresh rock                      | Namurian                 |
| 96.6     | 99     | 2.4       | R4      | very thinly bedded grey SILTSTONE |                 | Fold head in very thinly bedded dark grey SILTSTONE                                                     | Fresh rock                      | Namurian                 |
| 99       | 100    | 1         | R4      | Fault zone                        |                 | Cimented breccia fault in the fine grained SANDSTONEstone                                               | Fresh rock                      | Namurian                 |
| 100      | 102    | 2         | R5      | fine grained SANDSTONE            | Micro-fractured | fractured fine grained SANDSTONE massive fine grained SANDSTONE with Tensile veins                      | Fresh rock                      | Namurian                 |
| 102      | 103    | 1         | R3      | Fault zone                        |                 | Cimented breccia fault in the siltstone                                                                 | Moderately weathered            | Namurian                 |
| 103      | 103.5  | 0.5       | R5      | fine grained SANDSTONE            | Micro-fractured | fractured fine grained SANDSTONE massive fine grained SANDSTONE with Tensile veins                      | Fresh rock                      | Namurian                 |
| 103.5    | 104    | 0.5       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 104      | 104.2  | 0.2       | R5      | fine grained SANDSTONE            | Micro-fractured | fractured fine grained SANDSTONE massive fine grained SANDSTONE                                         | Fresh rock                      | Namurian                 |
| 104.2    | 104.7  | 0.5       | R3      | Fault zone                        |                 | Brecciated fine grained SANDSTONEstone in fine grained matrice                                          | Moderately weathered            | Namurian                 |
| 104.7    | 105.7  | 1         | R3      | Fault zone                        | Micro-fractured | Recovered as gravel sized rock fragment of fine grained SANDSTONE/siltstone                             | Moderately weathered            | Namurian                 |
| 105.7    | 106.8  | 1.1       | R3      | Fault zone                        | Micro-fractured | Recovered as gravel sized rock fragment of fine grained SANDSTONE/siltstone with organic content        | Moderately weathered            | Namurian                 |
| 106.8    | 107.5  | 0.7       | R3      | dark grey CLAYSTONE               | Micro-fractured | fractured laminated black CLAYSTONE                                                                     | Moderately weathered            | Namurian                 |
| 107.5    | 109    | 1.5       | R3      | Fault zone                        | Crushed seam    | Sheared very thinly bedded dark grey SILTSTONE                                                          | Moderately weathered            | Namurian                 |
| 109      | 110    | 1         | R3      | very thinly bedded grey SILTSTONE | Micro-fractured | fractured very thinly bedded dark grey SILTSTONE                                                        | Moderately weathered            | Namurian                 |
| 109.5    | 116    | 6.5       | R3      | Fault zone                        |                 | Recovered as gravel sized rock fragment of siltstone/claystone with organic content                     | Moderately weathered            | Namurian                 |
| 116      | 122    | 6         | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 122      | 123.6  | 1.6       | R4      | MUDSTONE                          |                 | thinly bedded grey MUDSTONE                                                                             | Fresh rock                      | Namurian                 |
| 123.6    | 123.8  | 0.2       | R2      | MUDSTONE                          | Crushed seam    | thinly bedded grey MUDSTONE                                                                             | Fresh rock                      | Namurian                 |
| 123.8    | 130    | 6.2       | R4      | MUDSTONE                          |                 | thinly bedded grey MUDSTONE                                                                             | Fresh rock                      | Namurian                 |
| 130      | 130.5  | 0.5       | R3      | Fault zone                        |                 | crushed zone in thinly bedded grey MUDSTONE                                                             | Moderately weathered            | Namurian                 |
| 130.5    | 145    | 14.5      | R4      | MUDSTONE                          | Crushed seam    | thinly bedded grey MUDSTONE                                                                             | Fresh rock                      | Namurian                 |
| 145      | 158.4  | 13.4      | R4      | dark grey CLAYSTONE               |                 | laminated black CLAYSTONE with trace of pyrite                                                          | Fresh rock                      | Namurian                 |
| 158.4    | 158.8  | 0.4       | R3      | Fault zone                        | Crushed seam    | cimented breccia fault in the laminated black CLAYSTONE                                                 | SW                              | Namurian                 |
| 158.8    | 159    | 0.2       | R4      | dark grey CLAYSTONE               |                 | laminated black CLAYSTONE with trace of pyrite                                                          | Fresh rock                      | Namurian                 |
| 159      | 160.5  | 1.5       | R3      | Fault zone                        | Micro-fractured | Crushed zone inside laminated black CLAYSTONE                                                           | Moderately weathered            | Namurian                 |
| 160.5    | 183.6  | 23.1      | R4      | dark grey CLAYSTONE               | Crushed seam    | laminated black CLAYSTONE with trace of pyrite                                                          | Fresh rock                      | Namurian                 |
| 183.6    | 184.5  | 0.9       | R4      | dark grey CLAYSTONE               | Micro-fractured | laminated black CLAYSTONE locally catadased                                                             | Fresh rock                      | Namurian                 |
| 184.5    | 184.7  | 0.2       | R3      | Fault zone                        |                 | Crushed zone inside laminated black CLAYSTONE                                                           | Moderately weathered            | Namurian                 |
| 184.7    | 191    | 6.3       | R4      | dark grey CLAYSTONE               | Micro-fractured | laminated black CLAYSTONE                                                                               | Fresh rock                      | Namurian                 |
| 191      | 193    | 2         | R3      | Fault zone                        |                 | Recovered as gravel sized rock fragment of siltstone /shale                                             | Moderately weathered            | Namurian                 |
| 193      | 193.6  | 0.6       | R5      | fine grained SANDSTONE            |                 | Fractured massive fine grained massive fine grained SANDSTONESTONE                                      | Fresh rock                      | Namurian                 |
| 193.6    | 195    | 1.4       | R3      | dark grey CLAYSTONE               | Micro-fractured | laminated black CLAYSTONE                                                                               | Fresh rock                      | Namurian                 |
| 195      | 196.5  | 1.5       | R3      | Fault zone                        |                 | Recovered as gravel sized rock fragment of siltstone/ shale with organic content                        | Moderately weathered            | Namurian                 |
| 196.5    | 196.8  | 0.3       | R5      | fine grained SANDSTONE            | Micro-fractured | Highly fractured massive fine grained SANDSTONE whlt tension vein                                       | Fresh rock                      | Namurian                 |
| 196.8    | 204    | 7.2       | R4      | very thinly bedded grey SILTSTONE |                 | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 204      | 205    | 1         | R5      | fine grained SANDSTONE            |                 | fractured medium grained massive fine grained SANDSTONE                                                 | Fresh rock                      | Namurian                 |
| 205      | 207.5  | 2.5       | R4      | very thinly bedded grey SILTSTONE | Crushed seam    | Very thinly bedded dark grey SILTSTONE                                                                  | Fresh rock                      | Namurian                 |
| 207.5    | 212.3  | 4.8       | R4      | dark grey CLAYSTONE               |                 | laminated black CLAYSTONE with pyrtite traces                                                           | Fresh rock                      | Namurian                 |
| 212.3    | 212.8  | 0.5       | R2      | Fault zone                        |                 | sheared laminated black CLAYSTONE                                                                       | Moderately weathered            | Namurian                 |
| 212.8    | 214.8  | 2         | R4      | dark grey CLAYSTONE               |                 | Black shale with pyrtite traces                                                                         | Fresh rock                      | Namurian                 |
| 214.8    | 215.4  | 0.6       | R5      | fine grained SANDSTONE            |                 | Massive medium grained fine grained SANDSTONE                                                           | Fresh rock                      | Namurian                 |
| 215.4    | 251    | 35.6      | R4      | LIMESTONE                         |                 | Sequence of metric bioclastic limestone with fine grained material to the top                           | Fresh rock                      | Visean                   |



## Appendix 5 : Geotechnical description tables



## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | depth (m) | In (open) | # open joints | Joint sets(In) | Type code | Type structure | set | Surface geom | Jr - Surface   | Ja Alteration | Angle /vert | Filling         | Remarks | azimut | dip | slickenside | sens     | Strie pitch |
|------|-----|-----------|-----------|---------------|----------------|-----------|----------------|-----|--------------|----------------|---------------|-------------|-----------------|---------|--------|-----|-------------|----------|-------------|
| 0    | 1   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 1    | 2   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 2    | 3   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 3    | 4   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 4    | 5   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 5    | 6   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 6    | 7   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 7    | 8   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 8    | 9   |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 9    | 10  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 10   | 11  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 11   | 12  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 12   | 13  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 13   | 14  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 14   | 15  |           |           |               |                |           |                |     |              |                |               |             |                 |         |        |     |             |          |             |
| 15   | 16  |           | 1         | 2             | 1              | pt        | S0             |     | plan         | Rough          | no            | 15          | no              |         |        |     | no          |          |             |
| 16   | 17  |           | 1         | 1             | 1              | pt        | S0             |     | plan         | slickenside    | no            | 25          | no              |         |        |     | yes         | inverse? | 0           |
| 17   | 18  |           | 1         | 1             | 2              | pt        | fr             |     | Step         |                | no            | 25          | no              |         |        |     | no          |          |             |
| 18   | 19  |           | 2         | 2             | 2              | pt        | S0             |     | plan         | smooth         | no            | 25          | graphitic trace | closed  |        |     | no          |          |             |
| 19   | 20  |           | 2         | 2             | 2              | pt        | fr             |     | plan         | smooth         | no            | 25          | no              |         |        |     | no          |          |             |
| 20   | 21  |           | 0         | 0             | 1              | pt        | S0             |     | plan         | Striae         | no            | 30          | no              |         |        |     | yes         | inverse  | 0           |
| 21   | 22  |           | 1         | 2             | 2              | pt        | S0             |     | plan         | rough          | no            | 30          | no              |         |        |     | no          |          |             |
| 22   | 23  |           | 2         | 4             | 2              | pt        | fr             |     | plan         | rough          | no            | 25          | no              |         |        |     | no          |          |             |
| 23   | 24  |           | 1         | 1             | 2              | pt        | S0             |     | plan         | smooth         | no            | 40          | no              |         |        |     | no          |          |             |
| 24   | 25  |           | 2         | 2             | 2              | pt        | fr             |     | plan         | slightly rough | no            | 25          | no              |         |        |     | no          |          |             |
| 25   | 26  |           | 2         | 5             | 2              | pt        | S0             |     | plan         | smooth         | no            | 45          | no              |         |        |     | no          |          |             |
| 26   | 27  |           | 2         | 3             | 2              | pt        | fr             |     | plan         | slightly rough | no            | 20          | no              |         |        |     | no          |          |             |
| 27   | 28  |           | 2         | 3             | 2              | pt        | S0             |     | plan         | smooth         | no            | 40          | no              |         |        |     | no          |          |             |
| 28   | 29  |           | 1         | 1             | 1              | pt        | fr             |     | plan         | slightly rough | no            | 20          | no              |         |        |     | no          |          |             |
| 29   | 30  |           | 1         | 1             | 2              | pt        | S0             |     | plan         | rough          | no            | 45          | mineral         |         |        |     | yes         | inverse  | 0           |
| 30   | 31  |           | 2         | 4             | 2              | pt        | fr             |     | plan         | Step           | no            | 20          | no              |         |        |     | no          |          |             |
| 31   | 32  |           | 2         | 2             | 2              | pt        | S0             |     | plan         | slickenside    | no            | 40          | mineral         |         |        |     | yes         | inverse  | 0           |
| 32   | 33  |           | 1         | 1             | 1              | pt        | S0             |     | plan         | rough          | no            | 45          | mineral         |         |        |     | yes         | inverse  | 0           |
| 33   | 34  |           | 1         | 1             | 1              | pt        | S0             |     | plan         | slickenside    | no            | 55          | mineral         |         |        |     | yes         | inverse  | 0           |
| 34   | 35  |           | 1         | 1             | 2              | pt        | S0             |     | plan         | slickenside    | no            | 55          | mineral         |         |        |     | yes         | inverse  | 0           |
| 35   | 36  | 34.78     | 1         | 1             | 1              | pt        | fr             |     | plan         | rough          | no            | 40          | no              |         |        |     | no          |          |             |
| 36   | 37  | 35.3      | 0         | 0             | 1              | pt        | S0             |     | plan         | smooth         | no            |             | no              |         |        |     | no          |          |             |
| 37   | 38  | 37.31     | 2         | 3             | 2              | pt        | S0             |     | plan         | smooth         | no            | 70          | no              |         |        |     | no          |          |             |
| 38   | 39  | 37.46     |           |               |                | pt        | fr             |     | plan         | smooth         | no            | 20          | mineral 2mm     |         |        |     | 0.96        | 18.75    | no          |
| 39   | 40  | 37.78     | 1         | 2             | 1              | pt        | S0             |     | plan         | slightly rough | no            | 70          | no              |         |        |     | 191.76      | 81.98    | no          |
| 40   | 41  | 38.2      | 0         | 0             | 1              | pt        | S0             |     | plan         | smooth         | no            | 70          | no              |         |        |     | 354.9       | 24.41    | no          |
| 41   | 42  | 40.41     | 1         | 1             | 2              | pt        | S0             |     | plan         | smooth         | no            |             | no              |         |        |     | 3.65        | 23.08    | no          |
| 42   | 43  | 41.1      | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 43   | 44  | 43.22     | 1         | 1             | 2              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     | 123.62      | 41.26    | no          |
| 44   | 45  | 44.5      | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 45   | 46  | 45.95     | 1         | 1             | 2              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 46   | 47  | 46.14     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 47   | 48  | 47.3      | 1         | 1             | 2              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 48   | 49  | 48.78     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 49   | 50  | 49.38     | 1         | 1             | 2              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 50   | 51  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 51   | 52  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 52   | 53  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 53   | 54  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 54   | 55  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 55   | 56  | 55.55     | 1         | 1             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 56   | 57  | 56.08     | 1         | 1             | 1              | Csm       | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 57   | 58  | 56.88     | 1         | 1             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 58   | 59  | 58.92     | 1         | 1             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 59   | 60  | 59.04     | 1         | 1             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 60   | 61  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 61   | 62  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 62   | 63  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 63   | 64  | 62.76     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 64   | 65  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 65   | 66  | 65.61     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 66   | 67  | 66.33     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 67   | 68  | 0         | 0         | 0             | 1              | Csm       | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 68   | 69  | 68.51     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 69   | 70  | 0         | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 70   | 71  | 70.16     | 2         | 5             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 71   | 72  | 70.18     |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 72   | 73  | 70.54     |           |               |                | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 73   | 74  | 70.73     |           |               |                | Csm       | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 74   | 75  | 70.96     |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 75   | 76  | 71        | 1         | 1             | 1              | Csm       | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 76   | 77  | 72.25     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 77   | 78  | 73.81     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 78   | 79  | 74        | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 79   | 80  | 75        | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 80   | 81  | 76        | 0         | 0             | 1              | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 81   | 82  | 77.2      | 1         | 2             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 82   | 83  | 77.4      |           |               |                | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 83   | 84  | 78.59     | 1         | 1             | 2              | pt        | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 84   | 85  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 85   | 86  |           |           |               |                | Csm       | fr             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 86   | 87  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 87   | 88  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 88   | 89  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 89   | 90  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 90   | 91  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 91   | 92  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 92   | 93  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 93   | 94  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 94   | 95  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 95   | 96  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 96   | 97  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 97   | 98  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 98   | 99  |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |
| 99   | 100 |           |           |               |                | pt        | S0             |     | plan         | rough          | no            |             | no              |         |        |     |             |          |             |



## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | depth (m) | 3n (open) | # open joints | joint sets(3n) | Type code | Type structure | set       | Surface geom   | Jr - Surface       | Ja Alteration | Angle /vert | Filling                   | Remarks                        | azimut | dip   | slickenside | sens         | Strie pitch |
|------|-----|-----------|-----------|---------------|----------------|-----------|----------------|-----------|----------------|--------------------|---------------|-------------|---------------------------|--------------------------------|--------|-------|-------------|--------------|-------------|
| 84   | 85  | 83.9      |           |               |                | Pt        | S0             | S0_2      | irregular      | Rough              | no            | 70          | no                        | coal seam                      | 57.65  | 21.93 | no          |              |             |
| 85   | 86  |           |           |               |                | Csm       | Flt            |           |                |                    |               |             |                           | breccia/ cataclased fault zone |        |       |             |              |             |
| 86   | 87  |           |           |               |                | Csm       | Flt            |           |                |                    |               |             |                           | crushed fault zone             |        |       |             |              |             |
| 87   | 88  |           |           |               |                | Csm       | Flt            |           |                |                    |               |             |                           | crushed fault zone             |        |       |             |              |             |
| 88   | 89  | 88.5      | 2         | 2             | 2              | Csm       | Flt            |           | irregular      | smooth             | no            | 70          | no                        | microfracturing zone           |        |       |             |              |             |
|      |     | 88.3      |           |               |                | Jt        | fr             | S0_3      | plan           | rough              | no            | 20          | no                        | continued                      | 115.45 | 77.55 | no          |              |             |
| 89   | 90  |           |           |               |                | Flt       |                |           | irregular      | rough              | no            | 10          | argileux                  | microfracturing zone / crushed |        |       |             |              |             |
| 90   | 91  | 90.64     | 2         | 4             | 2              | Pt        | S0             | S0_1      | plan           | rough, slickenside | no            | 60          | graphit, fault gouge      | continued                      | 340.53 | 31.61 | no          |              |             |
|      |     | 90.1      |           |               |                | Jt        | fr             | Jt1       | irregular      | rough              | no            | 20          | no                        | continued                      | 248.65 | 68.58 | no          |              |             |
|      |     | 90.88     |           |               |                | Jt        | fr             | Jt1       | step           | rough              | no            | 20          | no                        | discontinued                   | 229.51 | 79.6  | no          |              |             |
|      |     | 90.92     |           |               |                | Pt        | S0             | S0_1      | plan           | smooth             | no            | 60          | graphitic                 | continued                      | 355.55 | 36.66 | no          |              |             |
| 91   | 92  | 91.26     | 2         | 3             | 2              | pt        | S0             | S0_1      | plan           | smooth             | no            | 50          | graphitic                 |                                | 19.38  | 33.69 | no          |              |             |
|      |     | 91.6      |           |               |                | pt        | S0             | S0_1      | plan           | smooth             | no            | 50          | graphitic                 |                                | 15.32  | 46.42 | no          |              |             |
|      |     | 91.88     |           |               |                | Jt        | fr             | Jt1       | plan           | slightly rough     | no            | 30          | no                        | discontinued                   | 246.96 | 76.67 | no          |              |             |
| 92   | 93  | 92.21     | 1         | 3             | 1              | Pt        | S0             | S0_1      | plan           | smooth             | no            | 30          | graphite, <1mm - gouge    |                                | 351.94 | 46.59 | no          |              |             |
|      |     | 92.44     |           |               |                | Pt        | S0             | S0_1      | plan           | smooth             | no            | 30          | graphitic                 |                                | 355.51 | 45.91 | no          |              |             |
|      |     | 92.68     |           |               |                | Pt        | S0             | S0_1      | plan           | smooth             | no            | 30          | graphitic                 |                                | 342.55 | 24.92 | no          |              |             |
| 93   | 94  | 93.08     | 1         | 3             | 1              | Pt        | S0             | S0_1      | ondulant       | Smooth             | no            | 20          | graphiteux                |                                | 341.5  | 50.97 | no          |              |             |
| 94   | 95  | ??        | 1         | 2             | 1              | pt        | S0             | S0_1      | plan           | sllickenside       | no            | 40          | Trace mineral             | ??                             | ??     | yes   | inverse     | 10           |             |
| 95   | 96  | 95.69     | 2         | 2             | 2              | pt        | S0             | S0_1      | irregular      | sllickenside       | no            | 30          | Trace mineral             |                                | 357.79 | 58.62 | yes         |              |             |
|      |     | 95.22     |           |               |                | Jt        | fr             | Jt1       | plan           | rough              | no            | 20          | no                        | continued                      | 244.65 | 77.58 | no          |              |             |
| 96   | 97  | 96.04     | 2         | 2             | 2              | pt        | S0             | S0_1      | irregular      | smooth             | no            | 30          | graphit, fault gouge      |                                | 357.79 | 58.62 |             |              |             |
|      |     | 96.62     |           |               |                | Jt        | fr             | Jt4       | plan           | rough              | no            | 30          | Quartz                    | continued                      | 353.88 | 63.63 |             |              |             |
| 97   | 98  | 97.72     | 3         | 3             | 3              | Pt        | S0             | S0_3      | irregular      | plan               | no            | 40          | no                        |                                | 149.94 | 47.61 | no          |              |             |
|      |     | 97.84     |           |               |                | Pt        | Flt            | S0_2      | plan           | stries             | no            | 45          | Quartz                    | continued                      | 129.59 | 18.35 | yes         | inverse      |             |
|      |     | 97.78     |           |               |                | Jt        | fr             | Jt_1      | plan           | rough              | no            | 20          | no                        | continued                      | 246.78 | 78.05 | no          |              |             |
| 98   | 99  |           | 0         | 0             | 1              |           |                |           |                |                    |               |             |                           |                                |        |       |             |              |             |
| 99   | 100 |           |           |               |                | Pt        | Flt            | S0_2      | plan           | smooth             | no            | 30          | graphite, crushed 20-30cm | Microfracturing zone           | 70.53  | 23.16 |             |              |             |
| 100  | 101 | 100.06    | 2+n       | 5             | 2              | Pt        | S0             | S0_2      | irregular      | rough              | no            |             | no                        | microfracturing zone           | 106.15 | 15.7  |             |              |             |
|      |     | 100.18    |           |               |                | Pt        | S0             | S0_3      | irregular      | rough              | no            | 60          | no                        |                                | 96.17  | 36.99 | no          |              |             |
|      |     | 100.51    |           |               |                | Jt        | fr             | ind       | plan           | slightly rough     | no            | 15          | no                        | discontinued                   | 216.05 | 76.51 | no          |              |             |
|      |     | 100.42    |           |               |                | Pt        | S0             | S0_2      | irregular      | rough              | no            |             | no                        |                                | 64.59  | 25.8  |             |              |             |
|      |     | 100.65    |           |               |                | Pt        | S0             | S0_2      | irregular      | rough              | no            |             | no                        |                                | 85.48  | 37.83 |             |              |             |
| 101  | 102 | 101.04    | 1         | 6             | 1              | Pt        | S0             | S0_2      | irregular      | rough              | no            | 60          | no                        | microfracturing zone           | 83.12  | 30.96 | no          |              |             |
| 102  | 103 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 103  | 104 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 104  | 105 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 105  | 106 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 106  | 107 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 107  | 108 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 108  | 109 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 109  | 110 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
|      |     | 109.41    |           |               |                |           | Flt            | S0_4      |                | stries             |               | 20          |                           |                                | 162.38 | 70.58 | yes         | inverse      | 60          |
| 110  | 111 |           | 1         | 1             | 1              |           | Flt            | S0_4      | plan           | stries             | no            | 30          | Breccia                   | crushed fault zone             | 162.44 | 57.33 | yes         | inverse      | 30          |
|      |     | 110.64    |           |               |                |           |                |           |                |                    | no            |             | Trace mineral             |                                |        |       |             |              |             |
| 111  | 112 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 112  | 113 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 113  | 114 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 114  | 115 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 115  | 116 |           |           |               |                |           |                |           |                |                    | no            |             | Breccia                   | crushed fault zone             |        |       |             |              |             |
| 116  | 117 | 116.08    | 2         | 3             | 2              |           | S0             |           | irregular      | rough              | no            | 75          | no                        |                                |        |       | no          |              |             |
|      |     | 116.96    |           |               |                | Jt        | fr             |           |                |                    |               |             |                           |                                | 86.62  | 77.96 |             |              |             |
| 117  | 118 | 117.45    | 1         | 2             | 2              | Pt        | Flt            | S0_3      | ondulant       | stries             | no            | 60          | no                        |                                | 92.23  | 41.03 | yes         | indetermined |             |
| 118  | 119 | 118.76    | 1         | 5             | 1              | Pt        | S0             | S0_3      | plan           | sllickenside       | no            | 60          | Trace                     |                                | 130.97 | 34.13 | yes         | inverse      | 5           |
| 119  | 120 | 119.45    | 1         | 6             | 2              | Pt        | Flt            | S0_3      | plan           | stries             | no            | 50          | Trace                     |                                | 92.76  | 29.59 | yes         | inverse      |             |
| 120  | 121 | 120.22    | 2         | 3             | 2              | Jt        | fr             | Jt1       | plan           | slightly rough     | no            | 20          | no                        |                                | 244.95 | 88.35 | no          |              |             |
|      |     | 120.33    |           |               |                | Pt        | S0             | S0_3      | plan           | sllickenside       | no            | 45          | no                        |                                | 144.76 | 32.97 | yes         | normal       |             |
|      |     | 120.29    |           |               |                | Jt        | fr             | Jt_1      | plan           | smooth             | no            | 10          | no                        |                                | 257.75 | 88.06 | no          |              |             |
| 121  | 122 | 121.31    | 2         | 5             | 2              | Pt        | S0             | S0_3      | plan           | sllickenside       | no            | 30          | no                        |                                | 127.12 | 48.01 | yes         |              | 15          |
|      |     | 121.49    |           |               |                | Pt        | S0             | S0_3      |                |                    |               |             |                           |                                | 118.98 | 32.66 |             |              |             |
|      |     | 121.56    |           |               |                | Pt        | S0             | S0_3      |                |                    |               |             |                           |                                | 119.59 | 46.14 |             |              |             |
|      |     | 121.61    |           |               |                | Pt        | S0             | S0_3      |                |                    |               |             |                           |                                | 146.4  | 58.23 |             |              |             |
|      |     | 121.22    |           |               |                | Jt        | fr             | ind       | plan           | smooth             | no            | 10          | no                        |                                | 60.13  | 32.13 | no          |              |             |
| 122  | 123 | 122.02    | 3         | 4             | 3              | Pt        | S0             | S0_3      | plan           | sllickenside       | no            | 50          | no                        |                                | 121.38 | 51.65 | yes         |              |             |
|      |     | 122.3     |           |               |                | Pt        | S0             | ind       |                |                    |               |             |                           |                                | 327.29 | 65.01 |             |              |             |
|      |     | 122.58    |           |               |                | Pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 21.03  | 29.66 |             |              |             |
|      |     | 122.86    |           |               |                | Pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 10.28  | 38.45 |             |              |             |
| 123  | 124 | 123.62    | 2         | 2             | 1              |           | Flt            | S0_1      | plan           | stries             | no            | 60          | no                        | crushed fault zone - 123.6     | 9.75   | 33.04 | yes         |              |             |
|      |     | 123.82    |           |               |                | fr        | Jt2            |           |                |                    |               |             |                           |                                | 176.93 | 79.27 |             |              |             |
| 124  | 125 | 125.11    | 2+n       | 5             | 3              | pt        | S0             | S0_1      | plan           | sllickenside       | no            | 60          | no                        | discontinued                   | 4.96   | 33.19 | yes         |              |             |
|      |     | 125.26    |           |               |                | pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 11.15  | 32.94 |             |              |             |
|      |     | 125.81    |           |               |                | pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 26.02  | 28.92 |             |              |             |
|      |     | 125.77    |           |               |                | Pt        | Flt            | Jt1       | plan           | smooth             | no            | 10          | no                        |                                | 238.6  | 75.38 | no          |              |             |
|      |     | 124.58    |           |               |                | Pt        | S0             | Jt2       | plan           | slightly rough     | no            | 5           | Trace                     | discontinued                   | 182.76 | 79.89 | no          |              |             |
| 125  | 126 | 125.11    | 2         | 4             | 2              | Pt        | S0             | S0_1      | plan           | sllickenside       |               | 60          |                           |                                | 4.96   | 33.19 |             |              |             |
|      |     | 125.26    |           |               |                | fr        | S0_1           |           |                |                    |               |             |                           |                                | 11.15  | 32.94 | no          |              |             |
|      |     | 125.77    |           |               |                | Flt       | Jt1            | plan      | slightly rough | no                 | 10            |             | breccia, 1cm              |                                | 238.6  | 75.38 |             |              |             |
|      |     | 125.81    |           |               |                | Pt        | S0             | S0_1      | plan           | smooth             |               | 10          |                           |                                | 26.02  | 28.92 |             |              |             |
| 126  | 127 | 126.49    | 2         | 3             | 2              | Pt        | S0             | S0_1      | plan           | rough, slickenside | no            | 60          | no                        |                                | 38.71  | 27.66 | yes         |              |             |
|      |     | 126.7     |           |               |                | Pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 19.97  | 26.2  |             |              |             |
|      |     | 126.37    |           |               |                | fr        | Jt1            | plan      | smooth         | no                 | 5             | no          |                           |                                | 238.3  | 82.18 | no          |              |             |
| 127  | 128 | 127.1     | 1         | 1             | 2              |           | fr             | Jt1       | plan           | rough              | no            | 20          | no                        |                                | 250.35 | 79.28 | no          |              |             |
| 128  | 129 | 128.75    | 2+n       | 3             | 2              | Pt        | S0             | S0_1      | plan           | rough              | no            | 50          | no                        |                                | 21.26  | 31.55 | no          |              |             |
|      |     | 128.37    |           |               |                | Pt        | S0             | ind       |                |                    |               |             |                           |                                | 60.67  | 33.51 |             |              |             |
|      |     | 128.83    |           |               |                | Fr        | Jt2            |           |                |                    |               |             |                           |                                | 187.87 | 74.04 |             |              |             |
| 129  | 130 | 129.14    | 1         | 2             | 1              | Pt        | S0             | S0_1      | plan           | rough              | no            | 20          | no                        |                                | 39.89  | 26.84 | no          |              |             |
|      |     | 129.95    |           |               |                | Flt       | S0_1           |           | plan           | slightly rough     | no            | 60          | no                        |                                | 56.86  | 30.7  | no          |              |             |
| 130  | 131 | 130.27    | 2         | 3             | 2              | Fr        | Jt1            | irregular | stepped        |                    | no            | 60          | breccia, <1mm             | crushed zone 5cm               | 227.39 | 75.88 | no          |              |             |
|      |     | 130.72    |           |               |                | Pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 20.86  | 25.74 |             |              |             |
|      |     | 130.95    |           |               |                | Pt        | S0             | S0_1      |                |                    |               |             |                           |                                | 42.91  | 26.84 |             |              |             |
| 131  | 132 | 131.17    | 1         | 3             | 1              |           | Jt1            | irregular | rough          |                    | no            | 30          | no                        |                                | 245.59 | 80.51 | no          |              |             |
|      |     | 131.33    |           |               |                |           | Jt1            |           |                |                    |               |             |                           |                                | 247.22 | 78.07 |             |              |             |
|      |     | 131.65    |           |               |                |           | Jt1            |           |                |                    |               |             |                           |                                | 235.55 | 52.79 |             |              |             |
| 132  | 133 | 132.15    | 2         | 3             | 2              | Pt        | S0             | S0_1      | plan           | sllickenside       | no            | 60          | mineralization            |                                | 32.14  | 23.75 | yes         | indetermined |             |
|      |     | 132.59    |           |               |                | fr        | Jt1            | plan      | rough          | no                 | 20            | no          |                           |                                | 230.85 | 75.9  | no          |              |             |
|      |     | 132.72    |           |               |                | fr        | Jt1            | plan      | rough          | no                 | 20            | no          |                           |                                | 242.44 | 79.93 | no          |              |             |
| 133  | 134 | 133.22    | 1         | 1             | 2              | fr        | Jt1            | plan      | rough          | no                 | 20            | no          |                           |                                | 233.31 | 81.8  | no          |              |             |
| 134  | 135 | 134.23    | 1         | 2             | 2              | fr        | Jt1            |           |                |                    |               |             |                           |                                |        |       |             |              |             |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | depth (m) | ln (open) | # open joints | Joint sets(ln) | Type code | Type structure | set            | Surface geom           | Jr - Surface       | Ja Alteration | Angle /vert   | Filling       | Remarks                  | azimut | dip   | slickenside  | sens    | Strie pitch |
|------|-----|-----------|-----------|---------------|----------------|-----------|----------------|----------------|------------------------|--------------------|---------------|---------------|---------------|--------------------------|--------|-------|--------------|---------|-------------|
|      |     | 148,15    |           |               |                |           | fr             | J11            | plan                   | smooth             | no            | 10            | no            | discontinued             | 255,05 | 84,33 | no           |         |             |
| 149  | 150 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 150  | 151 | 150,74    | 1         | 1             | 1              | Pt        | S0             | S0_1           | irregular              | slickenside        | no            | 70            | no            |                          | 355,07 | 37,26 | yes          | inverse |             |
| 151  | 152 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 152  | 153 |           | 0         | 0             | 0              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 153  | 154 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 154  | 155 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 155  | 156 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 156  | 157 |           | 0         | 0             | 2              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 157  | 158 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 158  | 159 |           |           |               |                |           |                |                | irregular              | rough              |               | 35            | breccia, 7 cm | 158.4-158.8-Crushed zone |        |       |              |         |             |
| 159  | 160 |           |           |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 160  | 161 | 160,99    | 1         | 1             | 1              | fr        | J11            | plan           | slightly rough         | no                 | 10            | pyrite        |               | 252,5                    | 79,65  | no    |              |         |             |
| 161  | 162 | 161,69    | 1         | 2             | 1              | fr        | J11            | plan           | slightly rough         | no                 | 10            | pyrite        |               | 252,5                    | 81,25  | no    |              |         |             |
|      |     | 161,44    |           |               |                | fr        | J11            |                |                        |                    |               |               |               |                          | 254,7  | 75,43 |              |         |             |
| 162  | 163 | 162,73    | 2         | 2             | 2              | fr        | J11            | plan           | slightly rough         | no                 | 10            | no            |               | 252,46                   | 83,63  | no    |              |         |             |
|      |     | 162,48    |           |               |                | Pt        | S0             | S0_1           | plan                   | smooth             | no            | 70            | no            |                          | 31,54  | 18,4  | no           |         |             |
| 163  | 164 |           | 0         | 0             | 2              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 164  | 165 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 165  | 166 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 166  | 167 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 167  | 168 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 168  | 169 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 169  | 170 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 170  | 171 |           | 0         | 0             | 2              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 171  | 172 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 172  | 173 | 172,13    | 1         | 1             | 1              | Pt        | S0             | S0_1           | irregular              | slickenside        | no            | 70            | no            |                          | 346,23 | 18,82 | yes          |         |             |
| 173  | 174 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 174  | 175 |           | 0         | 0             | 0              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 175  | 176 |           | 0         | 0             | 0              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 176  | 177 |           | 0         | 0             | 0              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 177  | 178 | 177,04    | 1+n       | 1             | 2              | fr        | ind            |                | plan                   | slightly rough     | no            | 5             | quartz, <1mm  |                          | 69,77  | 84,73 | no           |         |             |
|      |     | 177,85    |           |               |                | Flt       | S0_2           |                | plan                   | stries             | no            | 70            | Trace         |                          | 118,76 | 20,97 | no           |         |             |
| 178  | 179 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 179  | 180 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 180  | 181 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 181  | 182 | 181,03    | 1         | 1             | 2              | fr        | J11            | plan           | rough                  |                    |               | 10            |               |                          | 240,8  | 84,74 |              |         |             |
| 182  | 183 |           | 0         | 0             | 1              |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 183  | 184 | 183,19    | 1         | 1             | 1              | fr        | J11            | irregular      | rough                  | no                 | 5             | no            |               | 250,16                   | 84,22  | no    |              |         |             |
| 184  | 185 | 184,34    | 2+n       | 4             | 3              | Pt        | S0             | S0_1           | ondulant               | no                 | 70            | no            |               | 356,21                   | 24,58  | no    |              |         |             |
|      |     | 184,85    |           |               |                | Flt       | S0_3           | plan           | breccia, 20 cm         | no                 | 30            | no            |               | 144,4                    | 57,95  | yes   | inverse      |         |             |
|      |     | 185,07    |           |               |                | fr        | J14            | plan           | slightly rough         | no                 | 10            | no            |               | 6,48                     | 81,73  | no    |              |         |             |
| 185  | 186 | 185,07    | 1+n       | 2             | 2              | fr        | J14            | ondulant       | rough                  | no                 | 50            | Trace         |               | 6,48                     | 81,73  | no    |              |         |             |
|      |     | 185,77    |           |               |                | Pt        | S0             | S0_3           | ondulant               | no                 | 40            | no            |               | 102,97                   | 26,33  | no    |              |         |             |
| 186  | 187 | 186,79    | 2+n       | 4             | 3              | Flt       | S0_4           | plan           | rough, stries          | no                 | 40            | trace         |               | 160,12                   | 48,54  | yes   | inverse      |         |             |
|      |     | 186,57    |           |               |                | Pt        | S0             | S0_3           | plan                   | smooth, slickensid | no            | 70            | no            |                          | 150,96 | 33,34 | yes          | inverse |             |
|      |     | 186,8     |           |               |                | fr        |                | plan           | rough                  | no                 | 5             | pyrite        |               | ?                        | ?      | no    |              |         |             |
|      |     | 186,6     |           |               |                | Pt        | S0             | S0_3           | plan                   | smooth, slickensid | no            | 70            | no            |                          | 150,96 | 33,34 | yes          | inverse |             |
| 187  | 188 | 187,58    | 1+n       | 3             | 1              | Flt       | S0_4           | plan           | slightly rough, stries | no                 | 30            | Trace         |               | 154,72                   | 59,76  | yes   | inverse      |         |             |
|      |     | 187,8     |           |               |                | Flt       | S0_4           | plan           | slightly rough, stries | no                 | 30            | Trace         |               | 154,72                   | 59,76  | yes   | inverse      |         |             |
|      |     | 187,5     |           |               |                | fr        | ?              | plan           | rough                  | no                 | 10            | no            |               | ?                        | ?      | no    |              |         |             |
| 188  | 189 | 188,06    | 1         | 4             | 1              | Flt       | S0_3           | ondulant       | stries, smooth         | no                 | 40            | no            |               | 148,75                   | 45,61  | no    | indetermined |         |             |
|      |     | 188,18    |           |               |                | S0_3      | ondulant       | stries, smooth | no                     | 40                 | no            | no            |               | 154,91                   | 53,55  | no    | indetermined |         |             |
|      |     | 188,5     |           |               |                | S0_3      | ondulant       | stries, smooth | no                     | 40                 | no            | no            |               | 139,57                   | 26,24  | no    | indetermined |         |             |
|      |     | 188,69    |           |               |                | S0_3      | ondulant       | stries, smooth | no                     | 40                 | no            | no            |               | 154,79                   | 46,07  | no    | indetermined |         |             |
| 189  | 190 | 189,17    | 3         | 8             | 2              | Flt       | S0_4           | ondulant       | stries, smooth         | no                 | 40            | no            |               | 149,07                   | 58,29  | no    |              |         |             |
|      |     | 189,37    |           |               |                | Flt       | S0_3           | ondulant       | stries, smooth         | no                 | 40            | no            |               | 148,57                   | 24,7   | no    |              |         |             |
|      |     | 189,45    |           |               |                | Flt       | S0_4           | ondulant       | stries, smooth         | no                 | 40            | no            |               | 166,34                   | 58,12  | no    |              |         |             |
|      |     | 189,65    |           |               |                | Flt       | S0_3           | ondulant       | stries, smooth         | no                 | 40            | no            |               | 128,83                   | 39,8   | no    |              |         |             |
|      |     | 189,69    |           |               |                | Fr        | J11            | plan           | smooth                 | no                 | 10            | no            |               | 262,28                   | 83,97  | no    |              |         |             |
|      |     | 189,96    |           |               |                | Fr        | J11            | plan           | smooth                 | no                 | 10            | no            |               | 261,79                   | 82,68  | no    |              |         |             |
|      |     | 189,4     |           |               |                | Fr        | J11            | plan           | smooth                 | no                 | 10            | no            |               | 240,8                    | 84     | no    |              |         |             |
|      |     | 189,42    |           |               |                | Fr        | J11            | plan           | smooth                 | no                 | 10            | no            |               | 244,22                   | 84,66  | no    |              |         |             |
| 190  | 191 |           |           |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 191  | 192 |           |           |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 192  | 193 |           |           |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 193  | 194 |           |           |               |                | fr        |                | plan           | smooth                 | no                 | 45            | no            |               |                          |        |       |              |         |             |
| 194  | 195 | 194,34    | 1+n       | 7             | 2              | Pt        | S0             | S0_1           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 15,87  | 24,55 | yes          |         |             |
|      |     | 194,54    |           |               |                | Pt        | S0             | S0_1           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 25,02  | 35,03 | yes          |         |             |
|      |     | 194,76    |           |               |                | Pt        | S0             | S0_2           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 169,87 | 9,17  | yes          |         |             |
|      |     | 194,81    |           |               |                | Pt        | S0             | S0_2           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 15,05  | 11,76 | yes          |         |             |
|      |     | 194,96    |           |               |                | Pt        | S0             | S0_1           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 22,89  | 16,08 | yes          |         |             |
|      |     | 194,75    |           |               |                | fr        | ind            | plan           | smooth                 | no                 | 10            | no            |               | 100,94                   | 72,97  | no    |              |         |             |
|      |     | 194,99    |           |               |                | Pt        | S0             | S0_1           | plan                   | smooth, slickensid | no            | 75            | no            |                          | 14,22  | 17,81 | yes          |         |             |
| 195  | 196 |           |           |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 196  | 197 | 196,01    |           | 12            | 2              | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 73,28  | 9,45  | yes          |         |             |
|      |     | 196,06    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 57,5   | 9,3   | yes          |         |             |
|      |     | 196,09    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 67,35  | 14,18 | yes          |         |             |
|      |     | 196,25    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 106,31 | 7,66  | yes          |         |             |
|      |     | 196,59    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 128,32 | 5,34  | yes          |         |             |
|      |     | 196,66    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 43,97  | 8,07  | yes          |         |             |
|      |     | 196,69    |           |               |                | Flt       | S0_1           | plan           | smooth, stries         | no                 | 65            | no            |               | 22,33                    | 21,39  | yes   |              |         |             |
|      |     | 196,74    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 33,97  | 12,29 | yes          |         |             |
|      |     | 196,79    |           |               |                | Flt       | S0_1           | plan           | smooth, stries         | no                 | 65            | no            |               | 32,56                    | 16,1   | yes   |              |         |             |
|      |     | 196,84    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 19,62  | 4,54  | yes          |         |             |
|      |     | 196,87    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 49     | 9,46  | yes          |         |             |
|      |     | 196,92    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 28,25  | 84    | yes          |         |             |
| 197  | 198 | 197,22    | 2         | 3             | 2              | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 57,1   | 13,08 | no           |         |             |
|      |     | 197,36    |           |               |                | Flt       | S0_3           | irregular      | rough, stries          | no                 | 65            | no            |               | 137,67                   | 28,86  | no    |              |         |             |
|      |     | 197,48    |           |               |                | Pt        | S0             | S0_2           | irregular              | smooth, slickensid | no            | 75            | no            |                          | 355,65 | 9,59  | no           |         |             |
| 198  | 199 |           | 0         | 0             | 1              | fr        |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |
| 199  | 200 | 199,32    | 1         | 2             | 1              | Pt        | S0             | S0_1           | plan                   | smooth             | no            | 75            | no            |                          | 32,15  | 15,67 | no           |         |             |
|      |     | 199,86    |           |               |                | Pt        | S0             | S0_2           |                        |                    |               |               |               |                          | 41,67  | 12,92 |              |         |             |
| 200  | 201 | 200,6     | 1         | 1             | 1              | Pt        | S0             | S0_2           | plan                   | smooth             | no            | 75            | no            |                          | 27,82  | 12,86 | no           |         |             |
| 201  | 202 | 201,58    | 1+n       | 3             | 3              | Flt       | S0_2           | plan           | smooth                 | no                 | 75            | breccia, 2 cm |               | 164,54                   | 11,63  | no    |              |         |             |
|      |     | 201,07    |           |               |                | Pt        | S0             | S0_2           | plan                   | smooth             | no            | 75            | no            |                          | 40,59  | 12,82 | no           |         |             |
|      |     | 201,8     |           |               |                | fr        | ?              | plan           | slightly rough         |                    | 5             | no            |               | ?                        | ?      |       |              |         |             |
| 202  | 203 | 202,84    | 1         | 2             | 1              | Pt        | S0             | S0_2           | plan                   | smooth             | no            | 75            | no            |                          | 36,21  | 9,13  | no           |         |             |
| 203  | 204 | 203,17    | 1         | 2             | 1              | Flt       | S0_2           | plan           | rough, stries          | no                 | 75            | Trace         |               | 68,21                    | 4,86   | yes   | inverse      |         |             |
|      |     | 203,96    | </        |               |                |           |                |                |                        |                    |               |               |               |                          |        |       |              |         |             |

| ETB-11_Hombourg logging - TCR & RDQ |     |           |           |               |                |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
|-------------------------------------|-----|-----------|-----------|---------------|----------------|-----------|----------------|------|--------------|--------------|---------------|-------------|----------------------|--------------|--------|-------|-------------|------|-------------|
| From                                | To  | depth (m) | Jn (open) | # open joints | Joint sets(Jn) | Type code | Type structure | set  | Surface geom | Jr - Surface | Ja Alteration | Angle /vert | Filling              | Remarks      | azimut | dip   | slickenside | sens | Strie pitch |
|                                     |     | 215.97    |           |               |                |           | fr             | ind  | irregular    | rough        | no            | 20          | no                   | discontinued | 318.15 | 77.13 | no          |      |             |
| 216                                 | 217 | 216.99    | 1         | 1             | 1              |           | fr             | J11  | plan         | rough        | no            | 10          | no                   |              | 249.96 | 82.53 | no          |      |             |
| 217                                 | 218 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 218                                 | 219 | 218.71    | 2         | 2             | 2              | Pt        | S0             | S0_2 | plan         | smooth       |               | 80          | joint argileux, 3 cm |              | 171.5  | 7.51  |             |      |             |
|                                     |     | 218.26    |           |               |                |           | fr             | J11  | plan         | rough        |               | 20          | calcite              |              | 252.16 | 82.77 |             |      |             |
| 219                                 | 220 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 220                                 | 221 | 220.98    | 2         | 3             | 2              | Pt        | S0             | S0_2 | plan         | smooth       |               | 80          | joint argileux, 1 cm |              | 138.92 | 12.59 |             |      |             |
|                                     |     | 220.53    |           |               |                |           | fr             | J11  | irregular    | rough        | no            | 5           | no                   |              | 250.65 | 78.92 | no          |      |             |
|                                     |     | 220.61    |           |               |                |           | fr             | J11  |              |              |               |             |                      |              | 252.39 | 74.25 |             |      |             |
| 221                                 | 222 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 222                                 | 223 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 223                                 | 224 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 224                                 | 225 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 225                                 | 226 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 226                                 | 227 | 226.61    | 1         | 1             | 2              | Pt        | S0             | S0_2 | irregular    | rough        | no            | 80          | dissolution ?        |              | 135.42 | 8.6   | no          |      |             |
| 227                                 | 228 | 227.46    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 20          | no                   |              | 19.23  | 78.26 | no          |      |             |
| 228                                 | 229 | 228.23    | 1         | 1             | 1              | Pt        | S0             | S0_2 | irregular    | rough        | no            | 80          | argile, 3 cm         |              | 144.83 | 14.7  | no          |      |             |
| 229                                 | 230 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 230                                 | 231 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 231                                 | 232 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 232                                 | 233 | 232.62    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 5           | no                   |              | 39.27  | 84.32 | no          |      |             |
| 233                                 | 234 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 234                                 | 235 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 235                                 | 236 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 236                                 | 237 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 237                                 | 238 | 236.84    | 1         | 2             | 2              |           | fr             | J13  | plan         | rough        | no            | 10          | no                   |              | 15.63  | 72.22 | no          |      |             |
|                                     |     | 236.92    |           |               |                |           |                | J13  | plan         | rough        | no            | 10          | no                   |              | 10.71  | 84.32 | no          |      |             |
| 238                                 | 239 | 238.23    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 40          | no                   |              | 35.6   | 67.87 | no          |      |             |
| 239                                 | 240 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 240                                 | 241 | 240.73    | 1         | 1             | 2              |           | fr             | J13  | irregular    | rough        | no            | 30          | no                   |              | 40.15  | 64.36 | no          |      |             |
| 241                                 | 242 | 241.44    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 10          | no                   |              | 11.86  | 73.91 | no          |      |             |
| 242                                 | 243 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 243                                 | 244 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 244                                 | 245 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 245                                 | 246 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 246                                 | 247 | 246.87    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 20          | no                   |              | 32.94  | 82.62 | no          |      |             |
| 247                                 | 248 | 247.23    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 20          | no                   |              | 10.76  | 73.54 | no          |      |             |
| 248                                 | 249 |           | 0         | 0             | 0              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 249                                 | 250 |           | 0         | 0             | 1              |           |                |      |              |              |               |             |                      |              |        |       |             |      |             |
| 250                                 | 251 | 250.39    | 1         | 1             | 1              |           | fr             | J13  | irregular    | rough        | no            | 30          | no                   |              | 33.32  | 80.58 | no          |      |             |



## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
|------|----|----------------------|---------------|---------|--------------|------|
| 0    | 1  | 100                  | 80            | 0,8     |              |      |
| 1    | 2  | 100                  | 100           | 1       |              |      |
| 2    | 3  | 100                  | 93            | 0,93    |              |      |
| 3    | 4  | 100                  | 68            | 0,68    |              |      |
| 4    | 5  | 100                  | 40            | 0,4     |              |      |
| 5    | 6  | 100                  | 30            | 0,3     |              |      |
| 6    | 7  | 100                  | 30            | 0,3     |              |      |
| 7    | 8  | 100                  | 50            | 0,5     | 38           | 0,38 |
| 8    | 9  | 100                  | 60            | 0,6     | 24           | 0,24 |
| 9    | 10 | 100                  | 76            | 0,76    | 50           | 0,5  |
| 10   | 11 | 100                  | 100           | 1       | 95           | 0,95 |
| 11   | 12 | 100                  | 70            | 0,7     | 0            | 0    |
| 12   | 13 | 100                  | 86            | 0,86    | 68           | 0,68 |
| 13   | 14 | 100                  | 85            | 0,85    | 46           | 0,46 |
| 14   | 15 | 100                  | 93            | 0,93    | 53           | 0,53 |
| 15   | 16 | 100                  | 95            | 0,95    | 77           | 0,77 |
| 16   | 17 | 100                  | 100           | 1       | 81           | 0,81 |
| 17   | 18 | 100                  | 95            | 0,95    | 84           | 0,84 |
|      |    |                      |               |         |              |      |
| 18   | 19 | 100                  | 98            | 0,98    | 86           | 0,86 |
|      |    |                      |               |         |              |      |
| 19   | 20 | 100                  | 100           | 1       | 92           | 0,92 |
|      |    |                      |               |         |              |      |
| 20   | 21 | 100                  | 90            | 0,9     | 64           | 0,64 |
| 21   | 22 | 100                  | 99            | 0,99    | 75           | 0,75 |
|      |    |                      |               |         |              |      |
| 22   | 23 | 100                  | 100           | 1       | 80           | 0,8  |
|      |    |                      |               |         |              |      |
| 23   | 24 | 100                  | 99            | 0,99    | 88           | 0,88 |
|      |    |                      |               |         |              |      |
| 24   | 25 | 100                  | 94            | 0,94    | 73           | 0,73 |
|      |    |                      |               |         |              |      |
| 25   | 26 | 100                  | 99            | 0,99    | 91           | 0,91 |
|      |    |                      |               |         |              |      |
| 26   | 27 | 100                  | 83            | 0,83    | 72           | 0,72 |
|      |    |                      |               |         |              |      |
| 27   | 28 | 100                  | 95            | 0,95    | 81           | 0,81 |
|      |    |                      |               |         |              |      |
| 28   | 29 | 100                  | 98            | 0,98    | 97           | 0,97 |
| 29   | 30 | 100                  | 90            | 0,9     | 83           | 0,83 |
|      |    | 0                    |               |         |              |      |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD   |
|------|----|----------------------|---------------|---------|--------------|-------|
| 30   | 31 | 100                  | 101           | 1,01    | 96           | 0,96  |
|      |    | 0                    |               |         |              |       |
| 31   | 32 | 100                  | 98            | 0,98    | 92           | 0,92  |
|      |    | 0                    |               |         |              |       |
| 32   | 33 | 100                  | 96            | 0,96    | 83           | 0,83  |
| 33   | 34 | 100                  | 95            | 0,95    | 87           | 0,87  |
| 34   | 35 | 100                  | 96            | 0,96    | 88           | 0,88  |
|      |    |                      |               |         |              |       |
| 35   | 36 | 100                  | 100           | 1       | 100          | 1     |
| 36   | 37 | 100                  | 100           | 1       | 100          | 1     |
| 37   | 38 | 100                  | 96            | 0,96    | 73           | 0,73  |
|      |    | 0                    |               |         |              |       |
|      |    |                      |               |         |              |       |
| 38   | 39 | 100                  | 98            | 0,98    | 94           | 0,94  |
| 39   | 40 | 100                  | 100           | 1       | 99           | 0,99  |
| 40   | 41 | 100                  | 100           | 1       | 90           | 0,9   |
|      |    |                      |               |         |              |       |
| 41   | 42 | 100                  | 98            | 0,98    | 91           | 0,91  |
|      |    |                      |               |         |              |       |
| 42   | 43 | 100                  | 98            | 0,98    | 96           | 0,96  |
| 43   | 44 | 100                  | 98            | 0,98    | 97           | 0,97  |
| 44   | 45 | 100                  | 99            | 0,99    | 97           | 0,97  |
|      |    |                      |               |         |              |       |
| 45   | 46 | 100                  | 99            | 0,99    | 87           | 0,87  |
| 46   | 47 | 100                  | 96            | 0,96    | 85           | 0,85  |
| 47   | 48 | 100                  | 95            | 0,95    | 95           | 0,95  |
| 48   | 49 | 100                  | 101           | 1,01    | 100          | 1     |
| 49   | 50 | 100                  | 100           | 1       | 97           | 0,97  |
| 50   | 51 | 100                  | 96            | 0,96    | 96           | 0,96  |
| 51   | 52 | 100                  | 97            | 0,97    | 96,5         | 0,965 |
| 52   | 53 | 100                  | 101           | 1,01    | 94           | 0,94  |
| 53   | 54 | 100                  | 100           | 1       | 100          | 1     |
| 54   | 55 | 100                  | 100           | 1       | 99           | 0,99  |
| 55   | 56 | 100                  | 95            | 0,95    | 81           | 0,81  |
| 56   | 57 | 100                  | 90            | 0,9     | 87           | 0,87  |
| 57   | 58 | 100                  | 98            | 0,98    | 97           | 0,97  |
| 58   | 59 | 100                  | 97            | 0,97    | 94           | 0,94  |
| 59   | 60 | 100                  | 98            | 0,98    | 90           | 0,9   |
| 60   | 61 | 100                  | 100           | 1       | 100          | 1     |
| 61   | 62 | 100                  | 107           | 1,07    | 104          | 1,04  |
| 62   | 63 | 100                  | 100           | 1       | 100          | 1     |
| 63   | 64 | 100                  | 96            | 0,96    | 79           | 0,79  |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
|------|----|----------------------|---------------|---------|--------------|------|
| 64   | 65 | 100                  | 100           | 1       | 100          | 1    |
| 65   | 66 | 100                  | 98            | 0,98    | 95           | 0,95 |
| 66   | 67 | 100                  | 97            | 0,97    | 97           | 0,97 |
| 67   | 68 | 100                  | 85            | 0,85    | 16           | 0,16 |
| 68   | 69 | 100                  | 99            | 0,99    | 88           | 0,88 |
| 69   | 70 | 100                  | 100           | 1       | 91           | 0,91 |
| 70   | 71 | 100                  | 90            | 0,9     | 72           | 0,72 |
|      |    | 0                    |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
| 71   | 72 | 100                  | 95            | 0,95    | 93           | 0,93 |
| 72   | 73 | 100                  | 99            | 0,99    | 98           | 0,98 |
| 73   | 74 | 100                  | 99            | 0,99    | 99           | 0,99 |
| 74   | 75 | 100                  | 99            | 0,99    | 91           | 0,91 |
| 75   | 76 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 76   | 77 | 100                  | 99            | 0,99    | 98           | 0,98 |
| 77   | 78 | 100                  | 92            | 0,92    | 76           | 0,76 |
|      |    |                      |               |         |              |      |
| 78   | 79 | 100                  | 95            | 0,95    | 84           | 0,84 |
|      |    | 0                    |               |         |              |      |
| 79   | 80 | 100                  | 70            | 0,7     | 15           | 0,15 |
| 80   | 81 | 100                  | 85            | 0,85    | 58           | 0,58 |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
| 81   | 82 | 100                  | 94            | 0,94    | 79           | 0,79 |
|      |    | 0                    |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
| 82   | 83 | 100                  | 98            | 0,98    | 59           | 0,59 |
| 83   | 84 | 100                  | 90            | 0,9     | 69           | 0,69 |
|      |    | 0                    |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
|      |    |                      |               |         |              |      |
| 84   | 85 | 100                  | 80            | 0,8     | 13           | 0,13 |
| 85   | 86 | 100                  | 85            | 0,85    | 39           | 0,39 |
| 86   | 87 | 100                  | 88            | 0,88    | 58           | 0,58 |
| 87   | 88 | 100                  | 85            | 0,85    | 52           | 0,52 |
| 88   | 89 | 100                  | 95            | 0,95    | 67           | 0,67 |
|      |    | 0                    |               |         |              |      |



| ETB-11_Hombourg logging - TCR & RDQ |     |                      |               |         |              |      |
|-------------------------------------|-----|----------------------|---------------|---------|--------------|------|
| From                                | To  | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
| 89                                  | 90  | 100                  | 90            | 0,9     | 44           | 0,44 |
| 90                                  | 91  | 100                  | 85            | 0,85    | 46           | 0,46 |
|                                     |     |                      |               |         |              |      |
|                                     |     |                      |               |         |              |      |
|                                     |     |                      |               |         |              |      |
| 91                                  | 92  | 100                  | 97            | 0,97    | 60           | 0,6  |
|                                     |     | 0                    |               |         |              |      |
|                                     |     |                      |               |         |              |      |
| 92                                  | 93  | 100                  | 80            | 0,8     | 51           | 0,51 |
|                                     |     |                      |               |         |              |      |
|                                     |     |                      |               |         |              |      |
| 93                                  | 94  | 100                  | 90            | 0,9     | 69           | 0,69 |
| 94                                  | 95  | 100                  | 86            | 0,86    | 72           | 0,72 |
| 95                                  | 96  | 100                  | 92            | 0,92    | 87           | 0,87 |
|                                     |     | 0                    |               |         |              |      |
| 96                                  | 97  | 100                  | 95            | 0,95    | 72           | 0,72 |
|                                     |     | 0                    |               |         |              |      |
| 97                                  | 98  | 100                  | 90            | 0,9     | 53           | 0,53 |
|                                     |     | 0                    |               |         |              |      |
|                                     |     | 0                    |               |         |              |      |
| 98                                  | 99  | 100                  | 97            | 0,97    | 94           | 0,94 |
| 99                                  | 100 | 100                  | 80            | 0,8     | 27           | 0,27 |
| 100                                 | 101 | 100                  | 80            | 0,8     | 39           | 0,39 |
|                                     |     | 0                    |               |         |              |      |
|                                     |     |                      |               |         |              |      |
|                                     |     |                      |               |         |              |      |
|                                     |     |                      |               |         |              |      |
| 101                                 | 102 | 100                  | 85            | 0,85    | 59           | 0,59 |
| 102                                 | 103 | 100                  | 83            | 0,83    | 26           | 0,26 |
| 103                                 | 104 | 100                  | 90            | 0,9     | 81           | 0,81 |
| 104                                 | 105 | 100                  | 75            | 0,75    | 47           | 0,47 |
| 105                                 | 106 | 100                  | 40            | 0,4     | 0            | 0    |
| 106                                 | 107 | 100                  | 50            | 0,5     | 10           | 0,1  |
| 107                                 | 108 | 100                  | 95            | 0,95    | 80           | 0,8  |
| 108                                 | 109 | 100                  | 95            | 0,95    | 76           | 0,76 |
| 109                                 | 110 | 100                  | 90            | 0,9     | 53           | 0,53 |
|                                     |     | 0                    |               |         |              |      |
| 110                                 | 111 | 100                  | 85            | 0,85    | 42           | 0,42 |
|                                     |     | 0                    |               |         |              |      |
| 111                                 | 112 | 100                  | 80            | 0,8     | 40           | 0,4  |
| 112                                 | 113 | 100                  | 70            | 0,7     | 10           | 0,1  |
| 113                                 | 114 | 100                  | 65            | 0,65    | 0            | 0    |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
|------|-----|----------------------|---------------|---------|--------------|------|
| 114  | 115 | 100                  | 50            | 0,5     | 0            | 0    |
| 115  | 116 | 100                  | 65            | 0,65    | 10           | 0,1  |
| 116  | 117 | 100                  | 90            | 0,9     | 68           | 0,68 |
|      |     |                      |               |         |              |      |
| 117  | 118 | 100                  | 95            | 0,95    | 81           | 0,81 |
| 118  | 119 | 100                  | 95            | 0,95    | 74           | 0,74 |
| 119  | 120 | 100                  | 96            | 0,96    | 69           | 0,69 |
| 120  | 121 | 100                  | 85            | 0,85    | 34           | 0,34 |
|      |     | 0                    |               |         |              |      |
|      |     | 0                    |               |         |              |      |
| 121  | 122 | 100                  | 75            | 0,75    | 62           | 0,62 |
|      |     | 0                    |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 122  | 123 | 100                  | 94            | 0,94    | 71           | 0,71 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 123  | 124 | 100                  | 80            | 0,8     | 48           | 0,48 |
|      |     |                      |               |         |              |      |
| 124  | 125 | 100                  | 95            | 0,95    | 65           | 0,65 |
|      |     | 0                    |               |         |              |      |
|      |     | 0                    |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 125  | 126 | 100                  | 97            | 0,97    | 20           | 0,2  |
|      |     | 0                    |               |         |              |      |
|      |     | 0                    |               |         |              |      |
|      |     |                      |               |         |              |      |
| 126  | 127 | 100                  | 95            | 0,95    | 66           | 0,66 |
|      |     | 0                    |               |         |              |      |
|      |     |                      |               |         |              |      |
| 127  | 128 | 100                  | 85            | 0,85    | 80           | 0,8  |
| 128  | 129 | 100                  | 95            | 0,95    | 68           | 0,68 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 129  | 130 | 100                  | 99            | 0,99    | 95           | 0,95 |
|      |     | 0                    |               |         |              |      |
| 130  | 131 | 100                  | 98            | 0,98    | 90           | 0,9  |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
|------|-----|----------------------|---------------|---------|--------------|------|
| 131  | 132 | 100                  | 97            | 0,97    | 82           | 0,82 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 132  | 133 | 100                  | 95            | 0,95    | 72           | 0,72 |
|      |     | 0                    |               |         |              |      |
|      |     |                      |               |         |              |      |
| 133  | 134 | 100                  | 95            | 0,95    | 84           | 0,84 |
| 134  | 135 | 100                  | 98            | 0,98    | 90           | 0,9  |
|      |     |                      |               |         |              |      |
| 135  | 136 | 100                  | 93            | 0,93    | 90           | 0,9  |
| 136  | 137 | 100                  | 73            | 0,73    | 68           | 0,68 |
| 137  | 138 | 100                  | 94            | 0,94    | 92           | 0,92 |
| 138  | 139 | 100                  | 95            | 0,95    | 96           | 0,96 |
| 139  | 140 | 100                  | 97            | 0,97    | 86           | 0,86 |
| 140  | 141 | 100                  | 97            | 0,97    | 90           | 0,9  |
| 141  | 142 | 100                  | 98            | 0,98    | 88           | 0,88 |
|      |     |                      |               |         |              |      |
| 142  | 143 | 100                  | 80            | 0,8     | 65           | 0,65 |
|      |     |                      |               |         |              |      |
| 143  | 144 | 100                  | 80            | 0,8     | 75           | 0,75 |
| 144  | 145 | 100                  | 86            | 0,86    | 82           | 0,82 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 145  | 146 | 100                  | 98            | 0,98    | 92           | 0,92 |
| 146  | 147 | 100                  | 96            | 0,96    | 94           | 0,94 |
| 147  | 148 | 100                  | 94            | 0,94    | 94           | 0,94 |
| 148  | 149 | 100                  | 90            | 0,9     | 75           | 0,75 |
|      |     |                      |               |         |              |      |
| 149  | 150 | 100                  | 97            | 0,97    | 93           | 0,93 |
| 150  | 151 | 100                  | 90            | 0,9     | 88           | 0,88 |
| 151  | 152 | 100                  | 95            | 0,95    | 95           | 0,95 |
| 152  | 153 | 100                  | 93            | 0,93    | 85           | 0,85 |
| 153  | 154 | 100                  | 97            | 0,97    | 97           | 0,97 |
| 154  | 155 | 100                  | 97            | 0,97    | 96           | 0,96 |
| 155  | 156 | 100                  | 97            | 0,97    | 91           | 0,91 |
| 156  | 157 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 157  | 158 | 100                  | 98            | 0,98    | 96           | 0,96 |
| 158  | 159 | 100                  | 96            | 0,96    | 80           | 0,8  |
| 159  | 160 | 100                  | 75            | 0,75    | 0            | 0    |
| 160  | 161 | 100                  | 80            | 0,8     | 39           | 0,39 |
| 161  | 162 | 100                  | 90            | 0,9     | 68           | 0,68 |



## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled interval (m) | Recovery (cm) | TRC (%)     | length >10cm | RQD  |
|------|-----|----------------------|---------------|-------------|--------------|------|
| 162  | 163 | 100                  | 90            | 0,9         | 96           | 0,96 |
| 163  | 164 | 100                  | 95            | 0,95        | 93           | 0,93 |
| 164  | 165 | 100                  | 98            | 0,98        | 93           | 0,93 |
| 165  | 166 | 100                  | 98            | 0,98        | 91           | 0,91 |
| 166  | 167 | 100                  | 90            | 0,9         | 86           | 0,86 |
| 167  | 168 | 100                  | 99            | 0,99        | 99           | 0,99 |
| 168  | 169 | 100                  | 97            | 0,97        | 80           | 0,8  |
| 169  | 170 | 100                  | 99            | 0,99        | 96           | 0,96 |
| 170  | 171 | 100                  | 99            | 0,99        | 99           | 0,99 |
| 171  | 172 | 100                  | 97            | 0,97        | 94           | 0,94 |
| 172  | 173 | 100                  | 90            | 0,9         | 78           | 0,78 |
| 173  | 174 | 100                  | 96            | 0,96        | 96           | 0,96 |
| 174  | 175 | 100                  | 95            | 0,95        | 91           | 0,91 |
| 175  | 176 | 100                  | 100           | 1           | 99           | 0,99 |
| 176  | 177 | 100                  | 100           | 1           | 99           | 0,99 |
| 177  | 178 | 100                  | 0,97          | 0,971428571 | 95           | 0,95 |
|      |     |                      |               |             |              | 0    |
| 178  | 179 | 100                  | 100           | 1           | 98           | 0,98 |
| 179  | 180 | 100                  | 100           | 1           | 94           | 0,94 |
| 180  | 181 | 100                  | 100           | 1           | 96           | 0,96 |
| 181  | 182 | 100                  | 100           | 1           | 100          | 1    |
| 182  | 183 | 100                  | 100           | 1           | 99           | 0,99 |
| 183  | 184 | 100                  | 100           | 1           | 94           | 0,94 |
| 184  | 185 | 100                  | 100           | 1           | 66           | 0,66 |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
| 185  | 186 | 100                  | 100           | 1           | 77           | 0,77 |
|      |     |                      |               |             |              |      |
| 186  | 187 | 100                  | 100           | 1           | 73           | 0,73 |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
| 187  | 188 | 100                  | 100           | 1           | 88           | 0,88 |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
| 188  | 189 | 100                  | 100           | 1           | 73           | 0,73 |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
|      |     |                      |               |             |              |      |
| 189  | 190 | 100                  | 100           | 1           | 47           | 0,47 |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled<br>interval (m) | Recovery (cm) | TRC (%) | length<br>>10cm | RQD  |
|------|-----|-------------------------|---------------|---------|-----------------|------|
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
| 190  | 191 | 100                     | 100           | 1       | 34              | 0,34 |
| 191  | 192 | 100                     | 55            | 0,55    | 0               | 0    |
| 192  | 193 | 100                     | 54,6          | 0,546   | 15              | 0,15 |
| 193  | 194 | 100                     | 81,9          | 0,819   | 31              | 0,31 |
| 194  | 195 | 100                     | 66,4          | 0,664   | 59              | 0,59 |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
| 195  | 196 | 100                     | 100           | 1       | 0               | 0    |
| 196  | 197 | 100                     | 78            | 0,78    | 36              | 0,36 |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
| 197  | 198 | 100                     | 88            | 0,88    | 60              | 0,6  |
|      |     |                         |               |         |                 |      |
|      |     |                         |               |         |                 |      |
| 198  | 199 | 100                     | 100           | 1       | 87              | 0,87 |
| 199  | 200 | 100                     | 94            | 0,94    | 70              | 0,7  |
|      |     |                         |               |         |                 |      |
| 200  | 201 | 100                     | 100           | 1       | 92              | 0,92 |
| 201  | 202 | 100                     | 100           | 1       | 0               | 0    |
|      |     |                         |               |         | 85              | 0,85 |
|      |     |                         |               |         |                 |      |
| 202  | 203 | 100                     | 100           | 1       | 98              | 0,98 |

## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled interval (m) | Recovery (cm) | TRC (%) | length >10cm | RQD  |
|------|-----|----------------------|---------------|---------|--------------|------|
| 203  | 204 | 100                  | 100           | 1       | 93           | 0,93 |
|      |     |                      |               |         |              |      |
| 204  | 205 | 100                  | 96            | 0,96    | 89           | 0,89 |
| 205  | 206 | 100                  | 100           | 1       | 99           | 0,99 |
| 206  | 207 | 100                  | 93            | 0,93    | 89           | 0,89 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 207  | 208 | 100                  | 94            | 0,94    | 89           | 0,89 |
| 208  | 209 | 100                  | 99            | 0,99    | 96           | 0,96 |
|      |     |                      |               |         |              |      |
| 209  | 210 | 100                  | 97            | 0,97    | 82           | 0,82 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 210  | 211 | 100                  | 99            | 0,99    | 99           | 0,99 |
| 211  | 212 | 100                  | 99            | 0,99    | 94           | 0,94 |
| 212  | 213 | 100                  | 100           | 1       | 84           | 0,84 |
| 213  | 214 | 100                  | 100           | 1       | 96           | 0,96 |
| 214  | 215 | 100                  | 100           | 1       | 97           | 0,97 |
| 215  | 216 | 100                  | 95            | 0,95    | 95           | 0,95 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 216  | 217 | 100                  | 100           | 0,95    | 100          | 1    |
| 217  | 218 | 100                  | 93            | 0,93    | 95           | 0,95 |
| 218  | 219 | 100                  | 90            | 1       | 90           | 0,9  |
|      |     |                      |               |         |              |      |
| 219  | 220 | 100                  | 100           | 1       | 99           | 0,99 |
| 220  | 221 | 100                  | 100           | 1       | 71           | 0,71 |
|      |     |                      |               |         |              |      |
|      |     |                      |               |         |              |      |
| 221  | 222 | 100                  | 96            | 0,96    | 96           | 0,96 |
| 222  | 223 | 100                  | 99            | 0,99    | 99           | 0,99 |
| 223  | 224 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 224  | 225 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 225  | 226 | 100                  | 99            | 0,99    | 99           | 0,99 |
| 226  | 227 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 227  | 228 | 100                  | 97            | 0,97    | 97           | 0,97 |
| 228  | 229 | 100                  | 96            | 0,96    | 96           | 0,96 |
| 229  | 230 | 100                  | 98            | 98      | 98           | 0,98 |
| 230  | 231 | 100                  | 98            | 0,98    | 98           | 0,98 |
| 231  | 232 | 100                  | 100           | 1       | 100          | 1    |
| 232  | 233 | 100                  | 99            | 0,99    | 99           | 0,99 |



## ETB-11\_Hombourg logging - TCR &amp; RDQ

| From | To  | Drilled<br>interval (m) | Recovery (cm) | TRC (%) | length<br>>10cm | RQD  |
|------|-----|-------------------------|---------------|---------|-----------------|------|
| 233  | 234 | 100                     | 99            | 0,99    | 99              | 0,99 |
| 234  | 235 | 100                     | 100           | 1       | 100             | 1    |
| 235  | 236 | 100                     | 99            | 0,99    | 99              | 0,99 |
| 236  | 237 | 100                     | 90            | 0,9     | 90              | 0,9  |
| 237  | 238 | 100                     | 98            | 0,98    | 98              | 0,98 |
|      |     |                         |               |         |                 |      |
| 238  | 239 | 100                     | 99            | 0,99    | 99              | 0,99 |
| 239  | 240 | 100                     | 97            | 0,97    | 97              | 0,97 |
| 240  | 241 | 100                     | 98            | 0,98    | 98              | 0,98 |
| 241  | 242 | 100                     | 98            | 0,98    | 98              | 0,98 |
| 242  | 243 | 100                     | 96            | 0,96    | 96              | 0,96 |
| 243  | 244 | 100                     | 98            | 0,98    | 98              | 0,98 |
| 244  | 245 | 100                     | 100           | 1       | 100             | 1    |
| 245  | 246 | 100                     | 100           | 1       | 100             | 1    |
| 246  | 247 | 100                     | 99            | 0,99    | 99              | 0,99 |
| 247  | 248 | 100                     | 96            | 0,96    | 96              | 0,96 |
| 248  | 249 | 100                     | 99            | 0,9     | 75              | 0,75 |
| 249  | 250 | 100                     | 99            | 0,99    | 99              | 0,99 |
| 250  | 251 | 100                     | 90            | 0,9     | 90              | 0,9  |
|      |     |                         |               |         |                 |      |

## Appendix 6 : Geotechnical norms and tables



### Core recovery – RQD – Joints distribution per meter

These parameters are calculated according to or [16] ASTM D6032-96. *Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core* and following the practical Hoek (2007)[18]

### Strength index:

Strength index has been determined following the ISRM rock mass classification system Error! Reference source not found.. This system gives an insight on the mechanical properties based on an intact core of the rock. (Table 1)

| ISRM R Strength | Description           | Field Identification                                                                                                      |
|-----------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------|
| R0              | Extremely Weak Rock   | Indented by thumbnail                                                                                                     |
| R1              | Very Weak Rock        | Crumbles under firm blows with a geological hammer                                                                        |
| R2              | Weak Rock             | Can be peeled with a pocket knife, shallow indentations made by firm blow of a geological hammer                          |
| R3              | Medium Strong Rock    | Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of a geological hammer |
| R4              | Strong Rock           | Specimen requires more than one blow of a geological hammer to fracture                                                   |
| R5              | Very Strong Rock      | Specimen requires several blows of a geological hammer to fracture                                                        |
| R6              | Extremely Strong Rock | Specimen can only be chipped with geological hammer                                                                       |

Table 1: ISRM strength index

### Weathering index

Weathering index is based the Error! Reference source not found. classifying rock material into six weathering grades, ranging from fresh rock to residual soil based on visual impression . In our logs, Saprolite is the equivalent of Highly to Completely weathered (HW, CW), while saprock is attributed to Highly to Moderated weathered (HW, SW).

| Term                 | Symbol | Description                                                                                                                                                                            |
|----------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fresh                | F      | No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces.                                                                            |
| Slightly weathered   | SW     | Discolouration indicates weathering of rock material and discontinuity may be somewhat weaker externally than in its fresh condition.                                                  |
| Moderately weathered | MW     | Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as a corestones.            |
| Highly weathered     | HW     | More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as a corestones.         |
| Completely weathered | CW     | All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.                                                                   |
| Residual soil        | RS     | All rock material is converted to a soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported |

Table 2: Weathering index



## Q system

The joints parameters and Q-value are defined and calculated according to NGI (2015) Using the Q-system : *Rock mass classification and support design, handbook, 55p* [19], as follows :

$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

The six parameters are:

RQD = Degree of jointing (Rock Quality Designation)

$J_n$  = Joint set number

$J_r$  = Joint roughness number

$J_a$  = Joint alteration number

$J_w$  = Joint water reduction factor

SRF = Stress Reduction Factor

The Q-system is used as a classification tool for rock mass conditions and as preliminary design approach to assess support requirements in jointed rock masses. The Q-value gives a description to the rock mass quality into seven groups varying from “Very good rock” to “Exceptionally poor”. High Q-values indicates good stability and low values means poor stability.