Go to the 'Title' slide

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Get more Info about this slide

Find and click on gray boxes to get to other slides

Go to the very last slide

Go to the very first slide

Or use the keyboard to navigate

When was the last time, that ice eroded bedrock?

Drilling into mid-Pleistocene sediments in the overdeepened Aare Valley, CH

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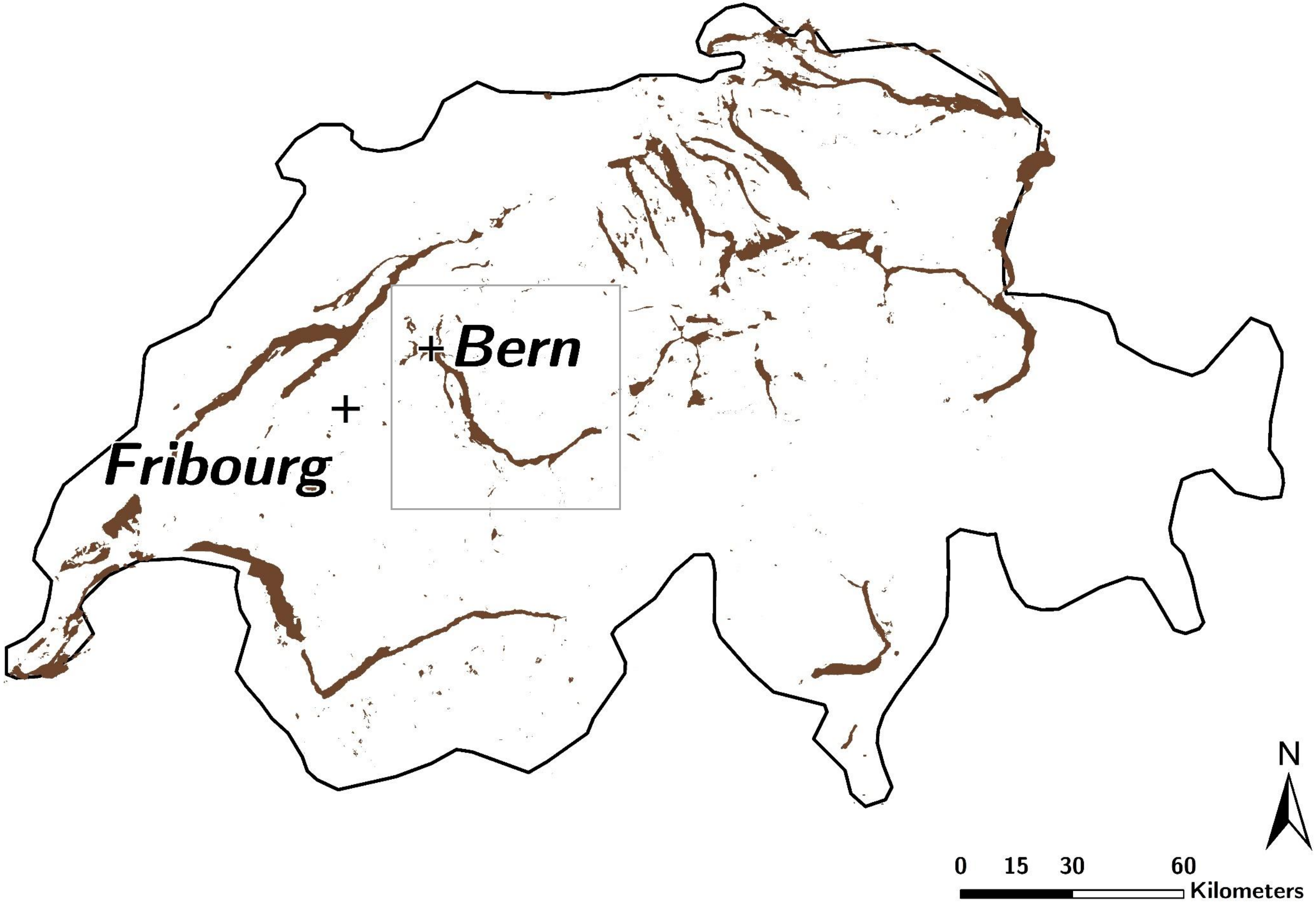
See an overview of the Swiss overdeepenings.



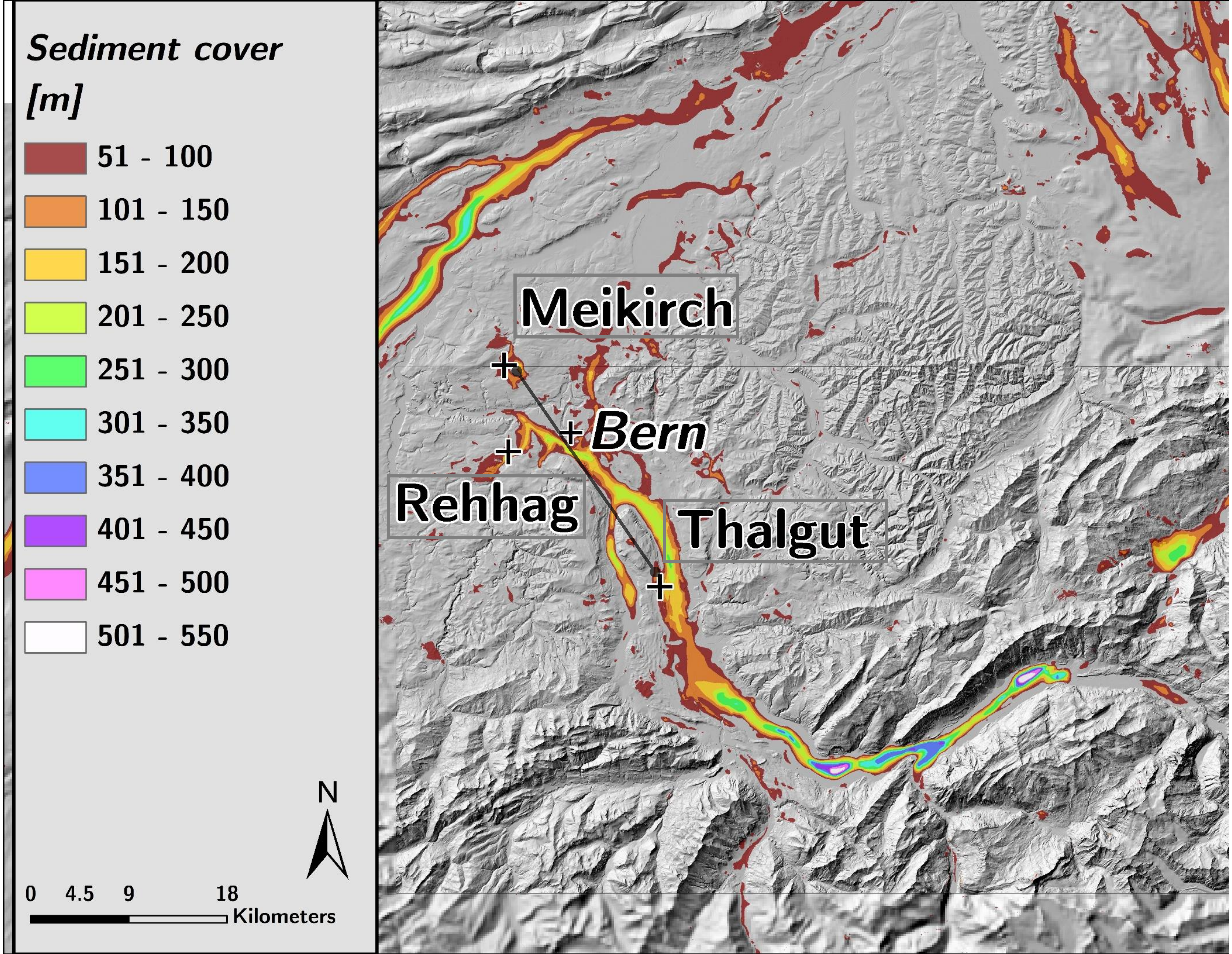
Over...
what?

Overdeepenings in Switzerland

In recent years, a bedrock model of Switzerland was created. This model is based on several individual studies (e.g. Dürst-Stucki et al., 2010; Jordan, 2010; Reber et al., 2016). These studies used drill logs available from all over Switzerland to create a contour map of the bedrock surface.

The model revealed the position of bedrock troughs in Switzerland and allowed evaluation of the bedrock morphology and the thickness of the contained sediment. These troughs follow the direction of all major valleys. As the elevation of the bedrock within these troughs is below the current base level, they are called overdeepenings. Their formation is generally linked to increased subglacial erosion since the Mid-Pleistocene Transition (~0.8 Myr ago).

Take a closer look at the Aare Valley overdeepening and our drill site.


Sediment cover [m]
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151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
451 - 500
501 - 550
0 4.5 9 18
Kilometers
N
Meikirch
Bern
Rehhag
Thalgut

Sediment fill and drill locations

This map shows the Aare Valley overdeepening. In its alpine section, the sediment is up to 500 m thick.
Alongside you can see three drilling locations. The Meikirch and Thalgut sites were first investigated in the 1980s (Welten, 1982a,b, 1988; Schlüchter, 1989). There, sediments were found as old as the fourth last interglacial. Go to the drill logs.

The Rehhag is the site at which the drilling for the present study was conducted.
Go to the drill log.

Overdeepening is generally linked to increased subglacial erosion since the Mid-Pleistocene Transition (~0.8 Myr ago).

Glaciations prior to the Mid-Pleistocene Transition (0.8 Ma)

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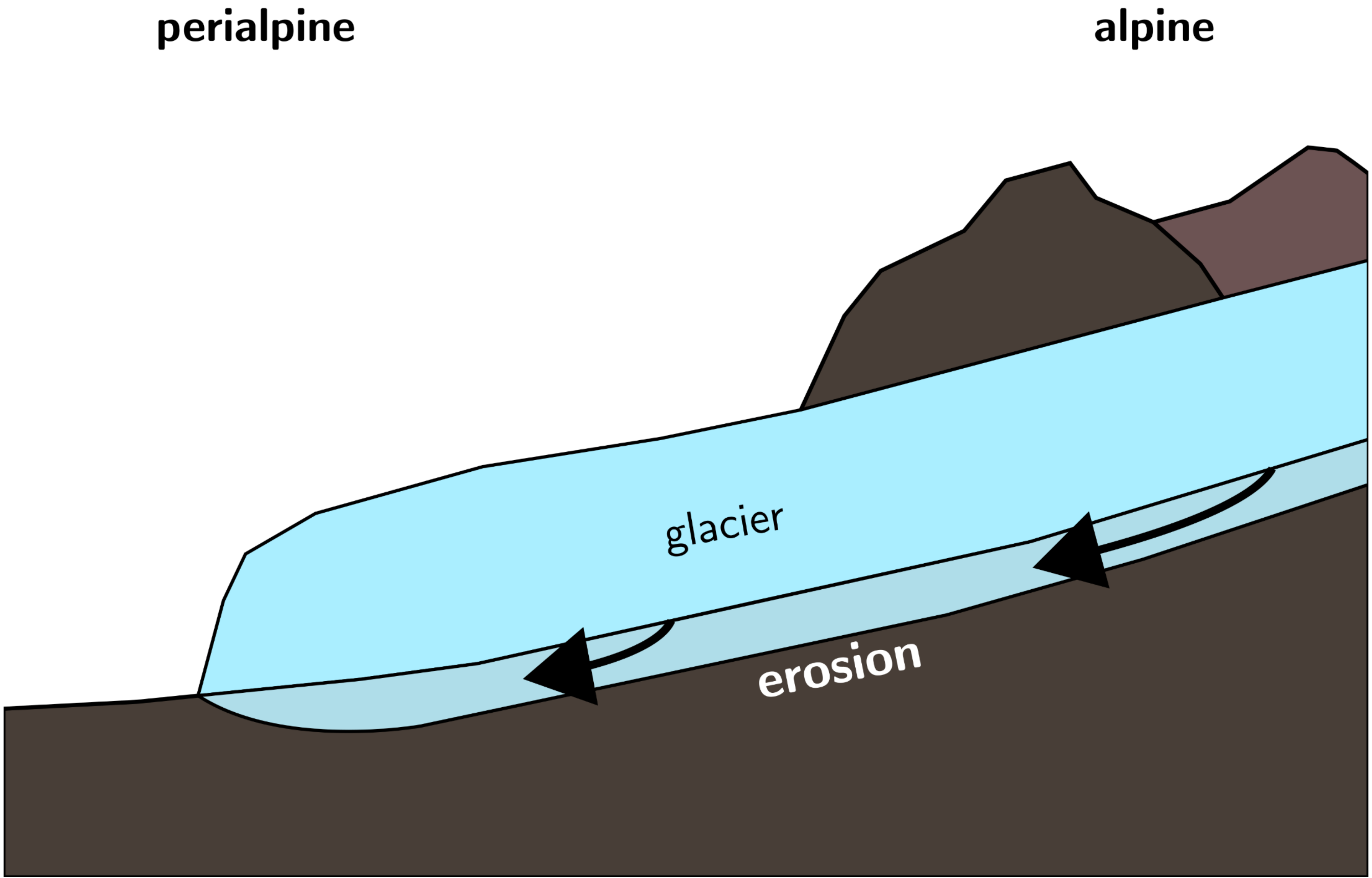

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Glaciations after the Mid-Pleistocene Transition (0.8 Ma)

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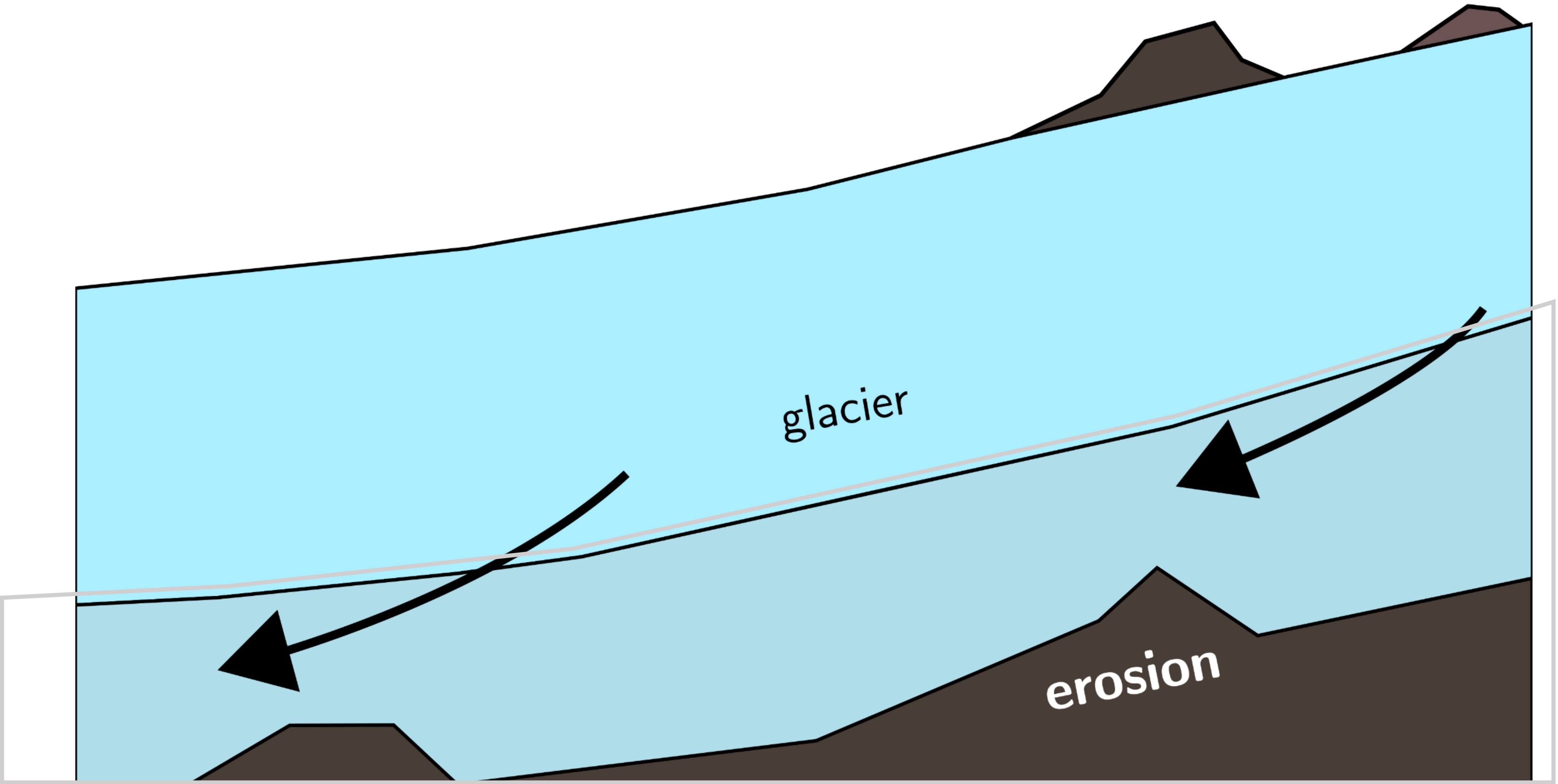


AFTER

The Mid-Pleistocene Transition (MPT)

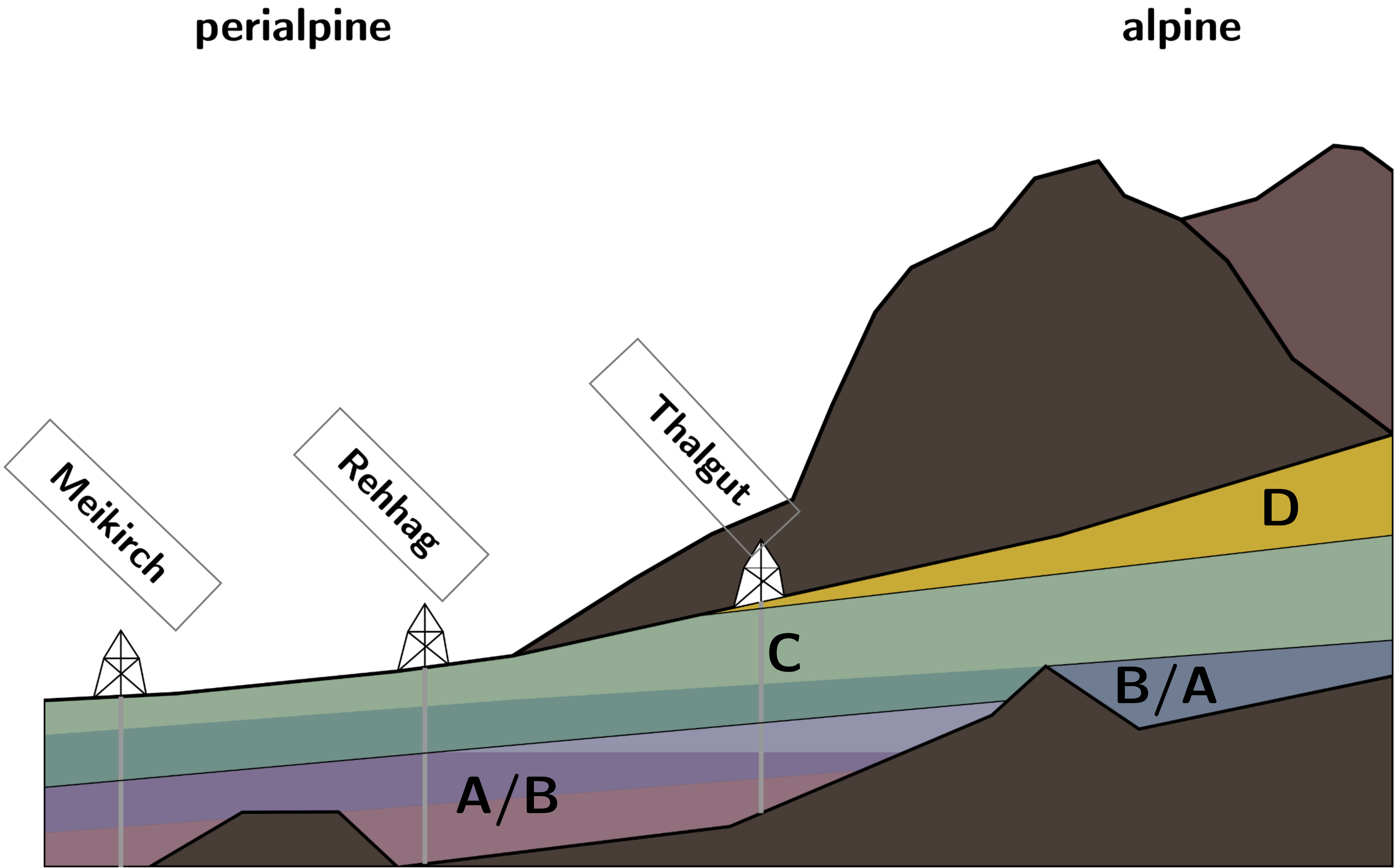
Investigations of valley incision in the Rhône (Valla et al., 2011) and along the Aare Valley (Haeuselmann et al., 2007) showed a distinct increase in glacial valley erosion around the Mid-Pleistocene Transition (0.8-1.0 Ma). Across this transition, glacial cyclicality changed from 41 kyr to 100 kyr due to greater eccentricity forcing (Lisiecki, 2010).

The observed increase in glacial valley erosion after the Matuyama chron is linked to the formation of overdeepenings in the northern Alps and their foreland (Schlüchter, 2004).

Hence, glacial erosion was less effective before the Mid-Pleistocene Transition.

See a schematic of today's overdeepenings.

Stratigraphy in an overdeepening



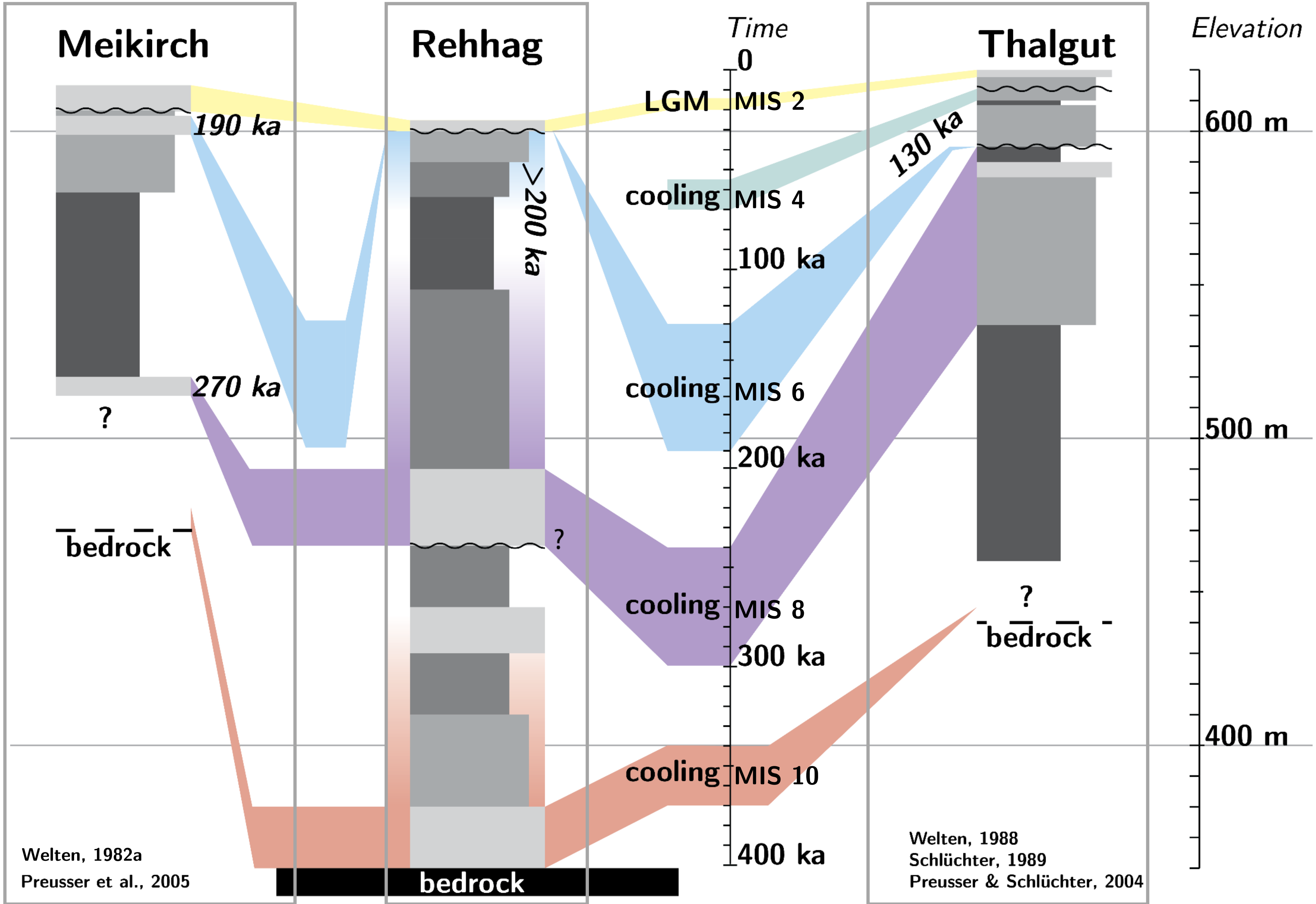
Stratigraphy in an overdeepening

Deposits of the glaciation that excavated an overdeepening last form the lowermost unit in the Quaternary sediment record within such a bedrock trough. However, throughout the Quaternary different glaciations can have excavated different parts of an overdeepening and to varying depth.

Hence, overdeepenings can contain deposits from a variety of glaciations along their course, from side to side and at depth.

See our interpretation of the stratigraphy in the overdeepened Aare Valley.

Local stratigraphy



Stratigraphy in the overdeepened Aare Valley

Here, we provide a correlation of the Meikrich, Thalgut and Rehhag sites based on available datings, palynological analyses, and sedimentary successions (Preusser & Schlüchter, 2004; Preusser et al., 2005; Schlüchter, 1989; Welten, 1982a,b, 1988).

- **We found indications, that glaciers eroded the bedrock the last time during MIS 10.**

- Deposits of the glacial-interglacial-glacial cycle from the third last glaciation on (MIS 8) were encountered in Meikirch, based on luminescence dating; the interglacial lacustrine deposits (MIS 7) contain more than 5 % *Fagus* and abundant (>40 %) *Carpinus* pollen, which is atypical for MIS 5e. **We correlate unit B to the glaciation during MIS 8 based on our minimum luminescence age of 200 ka.** The lacustrine deposits in unit B did not contain pollen.

- MIS 5 deposits where encountered in Thalgut, based on luminescence dating and palynological analyses (*Fagus* absent, *Pterocarya* absent).
  Glacifluvial deposits were encountered overlying lacustrine deposits from the Holsteinian (MIS 9 or MIS 11); the Holsteinian was identified based on the *Pterocarya*.
  We correlate unit A to the glaciation during MIS 10 based on the stratigraphic order and with regard to the local stratigraphic background provided by the Meikirch and Thalgut drillings.

- **Nevertheless, unit A and B could both be much older.**

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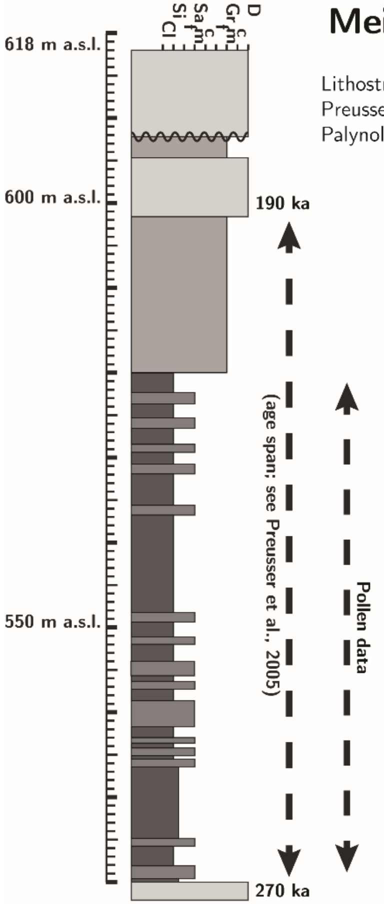
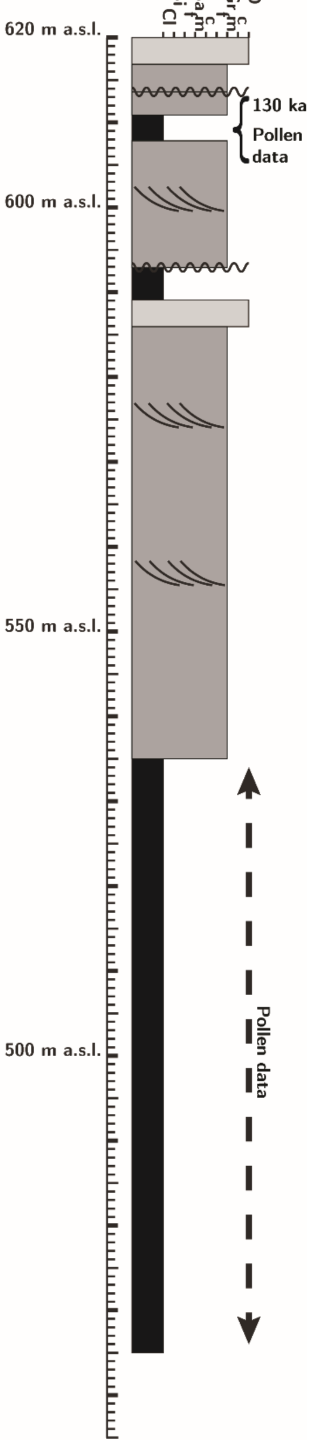


Meikirch

Lithostratigraphy edited from and OSL ages according to Preusser et al. (2005)
Palynological analysis by Welten (1982a, 1988)

Thalgut

Lithostratigraphy edited from Schlüchter (1989)
OSL age according to Preusser & Schlüchter (2004)
Palynological analysis by Welten (1982a,b, 1988)



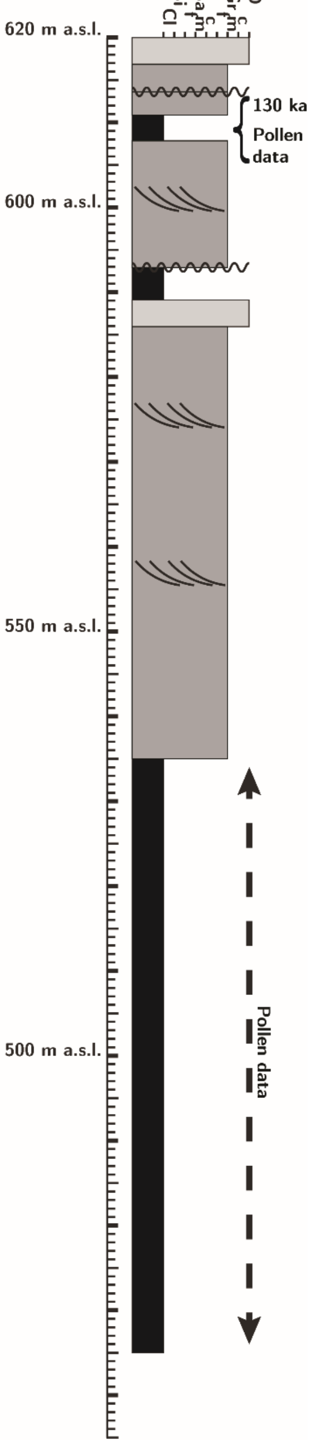
From top to bottom:

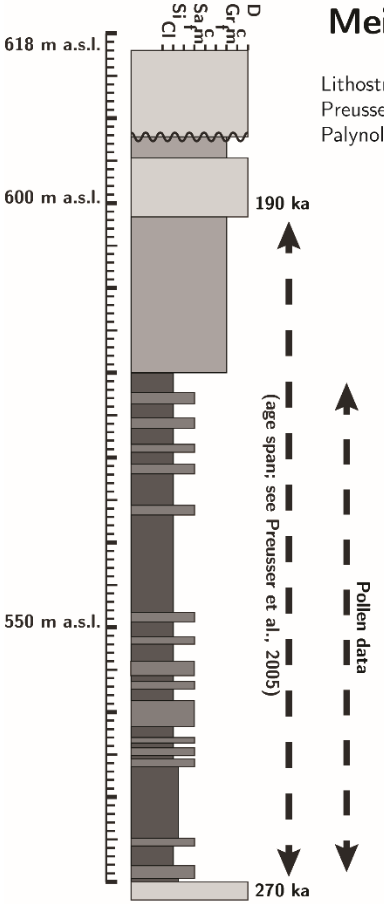
1. Till from the last glacial maximum and an older outwash gravel containing a paleosol and related to a minor glaciation.
2. Lacustrine sediments from the last interglacial (MIS 5e), based on pollen analysis and luminescence dating. Underlain by delta fore-sets.
3. Discordance.
4. Laminated lacustrine deposits and top-sets in form of an aquatic till. Glaciolacustrine and lacustrine fore-sets. Underlain by lacustrine deposits that contain pollen. Palynological analysis showed that these sediments can not be correlated to the Meikirch pollen record. Most likely, they are from the interglacial during MIS 9 or 11.

See the stratigraphic overview.

Thalgut

Lithostratigraphy edited from Schlüchter (1989)
OSL age according to Preusser & Schlüchter (2004)
Palynological analysis by Welten (1982a,b, 1988)





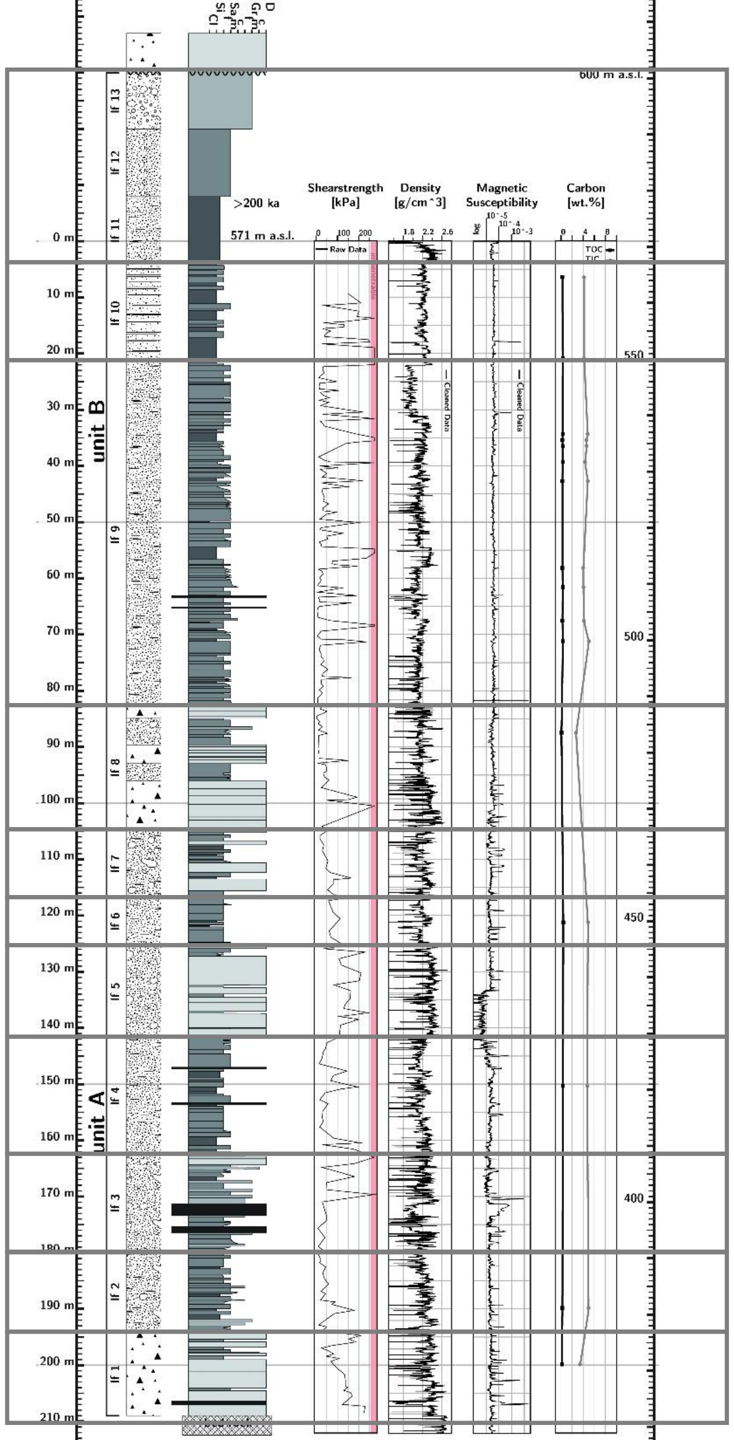
Meikirch

Lithostratigraphy edited from and OSL ages according to Preusser et al. (2005)
Palynological analysis by Welten (1982a, 1988)

From top to bottom:

1. Till from the last glacial.
2. Discordance.
3. Till from the glaciation during MIS 6 with overlying glacifluvial gravel deposits.
4. Glacifluvial gravel deposits.
5. About 70 m-thick lacustrine deposits from the third-last interglacial.
6. Till from the glacial during MIS 8.

See the stratigraphic overview.



Rehhag drill log and core analyses

Two distinct units were encountered in the Rehhag drilling.

Click on the boxes to see the distinguished lithofacies in more detail.

Results overview

Rehhag sedimentary succession

Oligo-Miocene Molasse bedrock was encountered beneath 208.5 m of sediments. We identified two units in the sedimentary succession. Both units comprise diamictic glacial deposits at their bottom, followed by aquatic deposits.

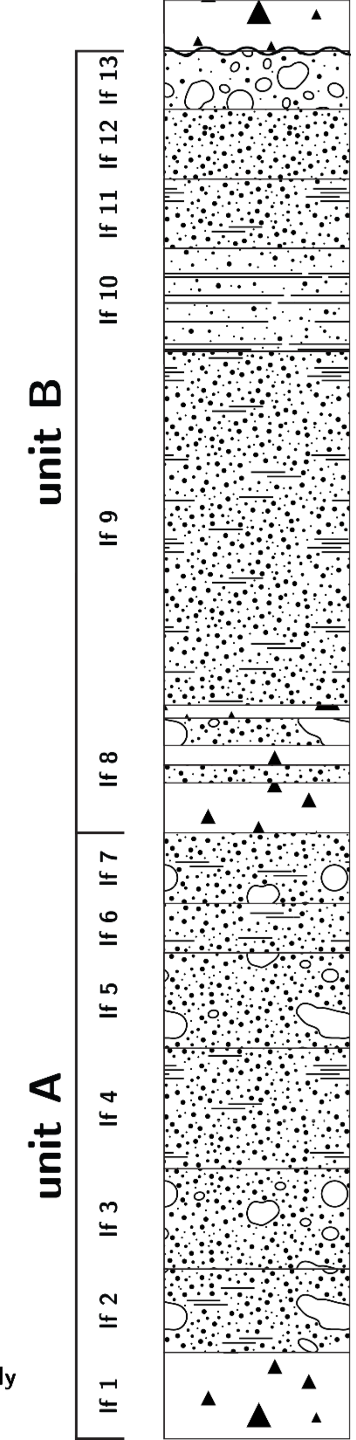
Unit B:

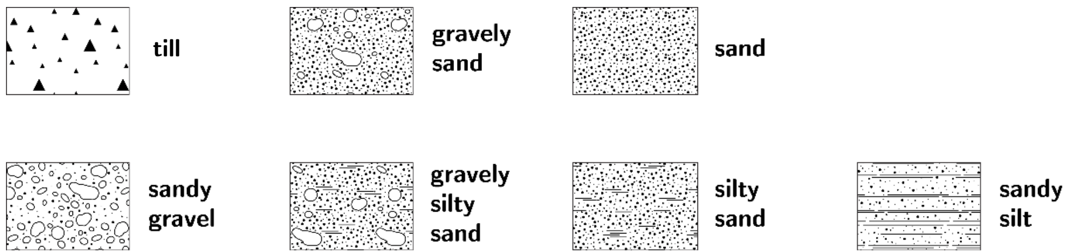
- Development of a fluvial system with excessive sediment supply.
- Aquatic deposits from a quiet environment; massive sand and mud beds; few beds with sedimentary structures.
- Till with no Molasse influence; solely alpine lithologies; by glacial drag oversteepened underlying beds.

Unit A:

- Aquatic deposits of an energetic environment; e.g. ice marginal deltas and subaqueous fans during glacier retreat.
- Till comprises large portion of bedrock fragments; shows glaciotectonic shear planes.

See our interpretation of the local stratigraphy.





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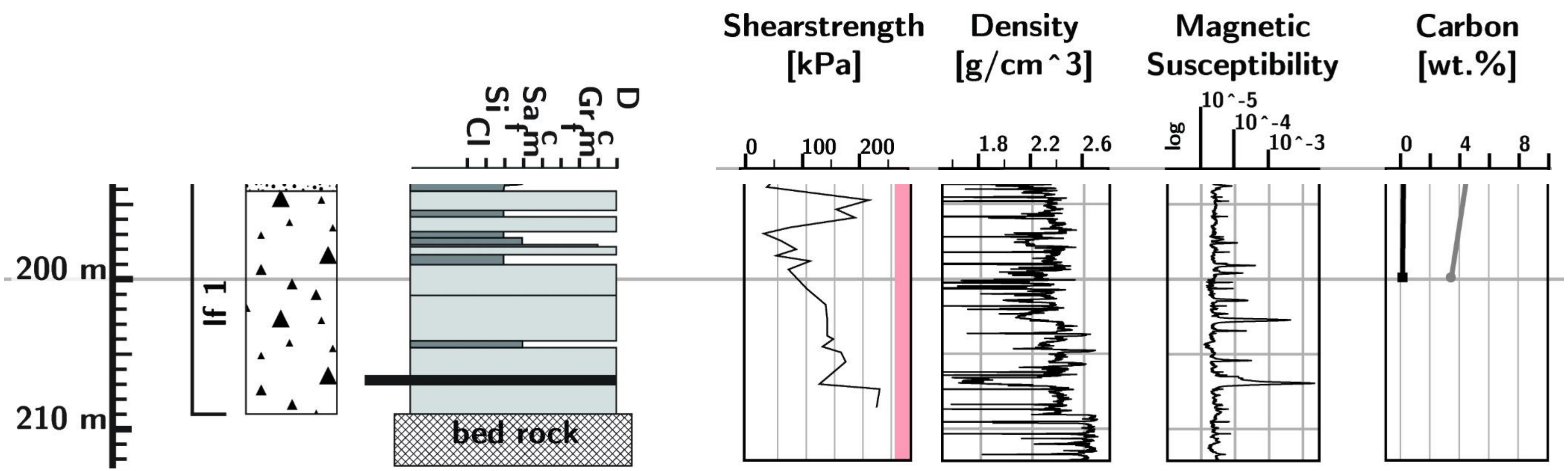

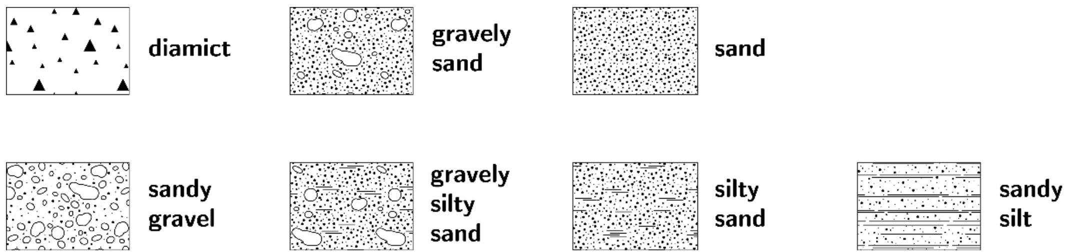

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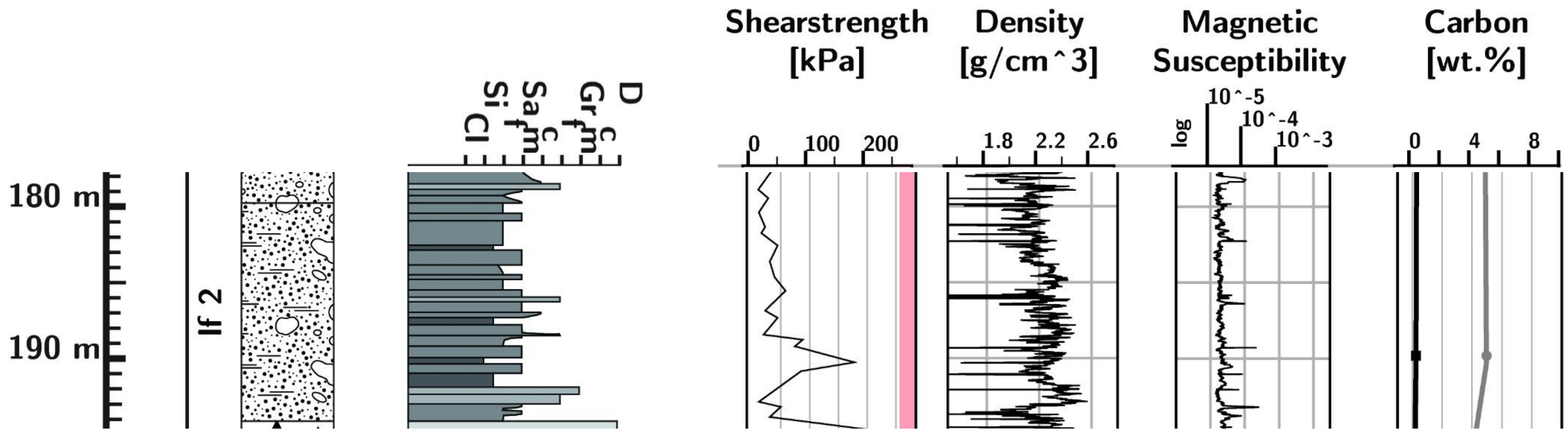

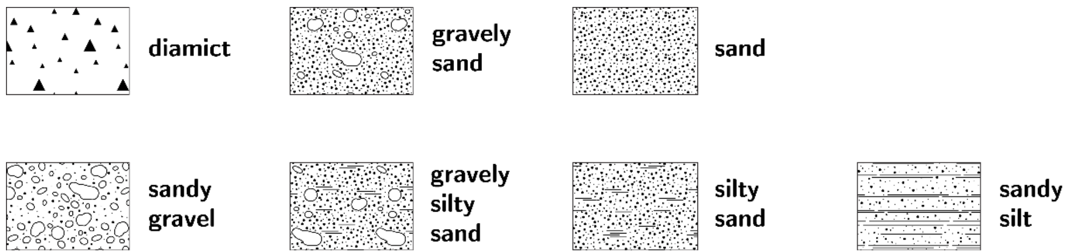

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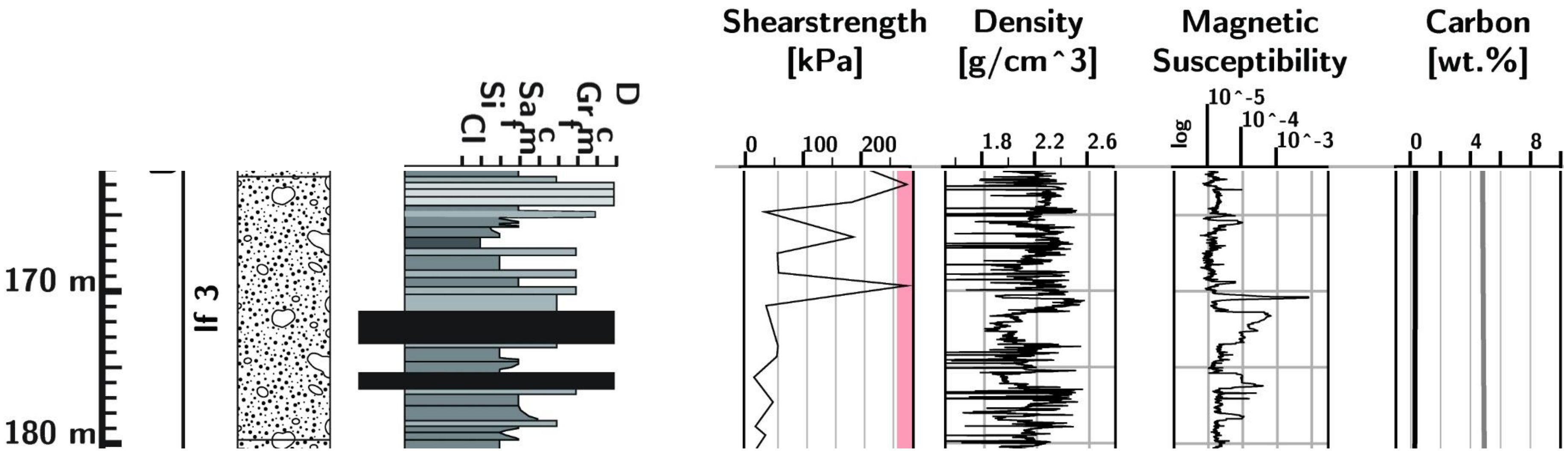

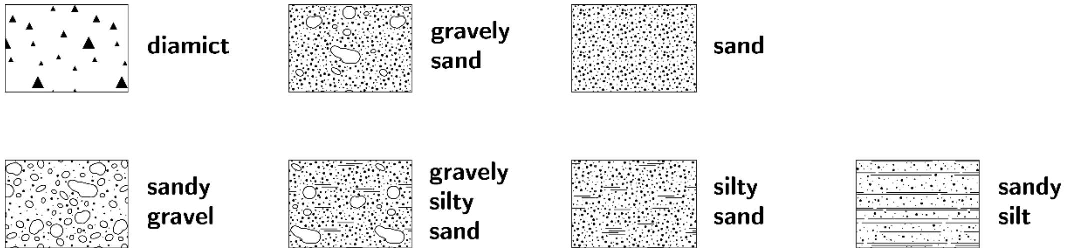

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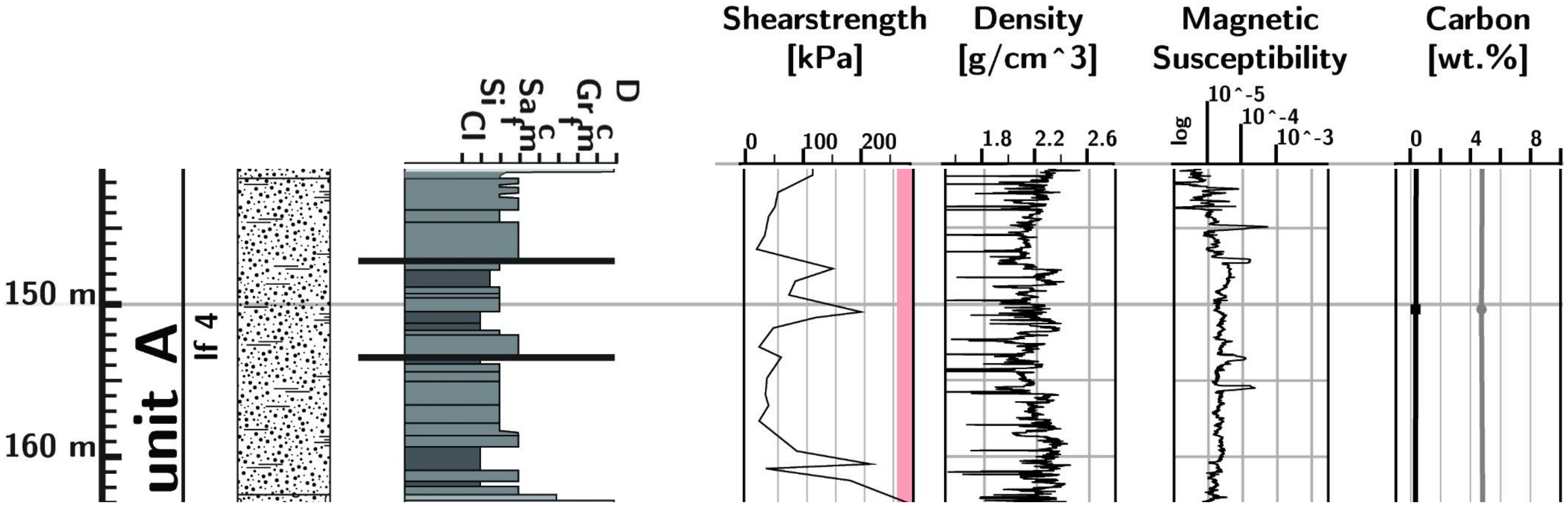

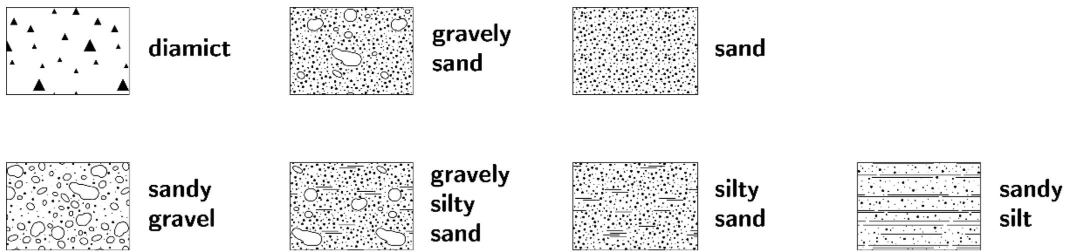

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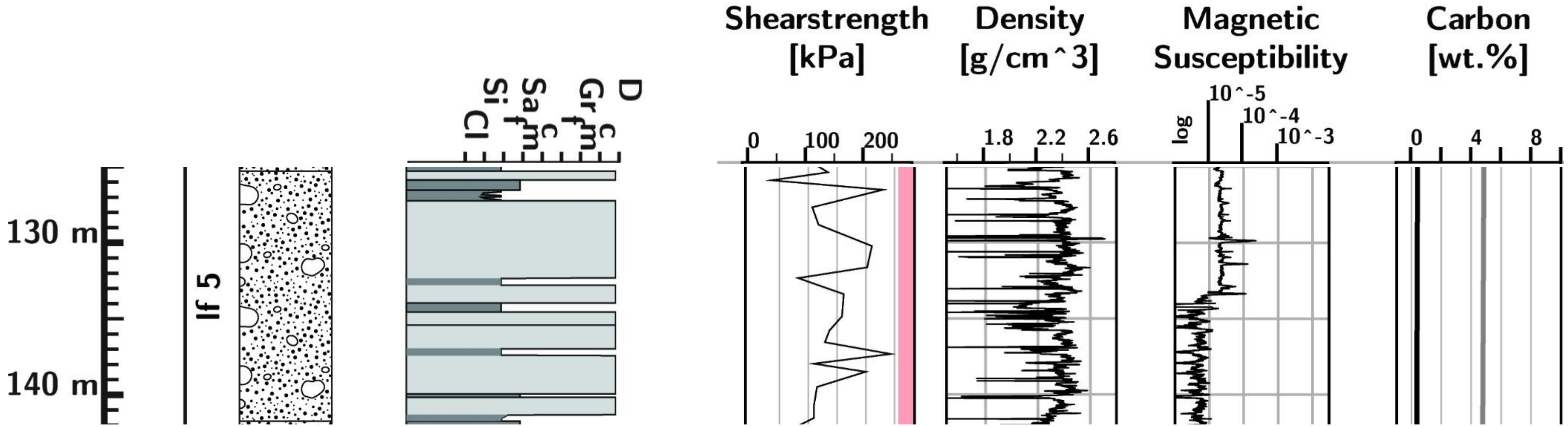

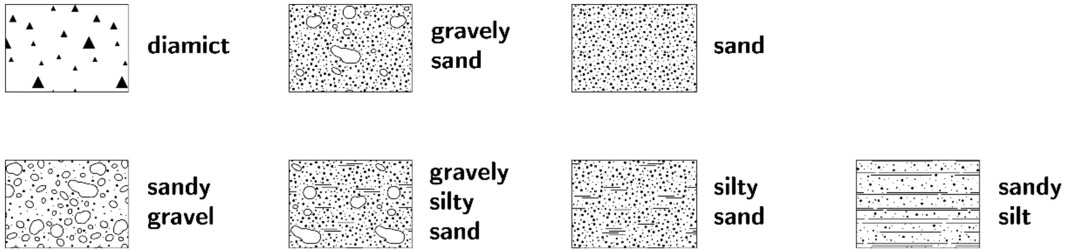

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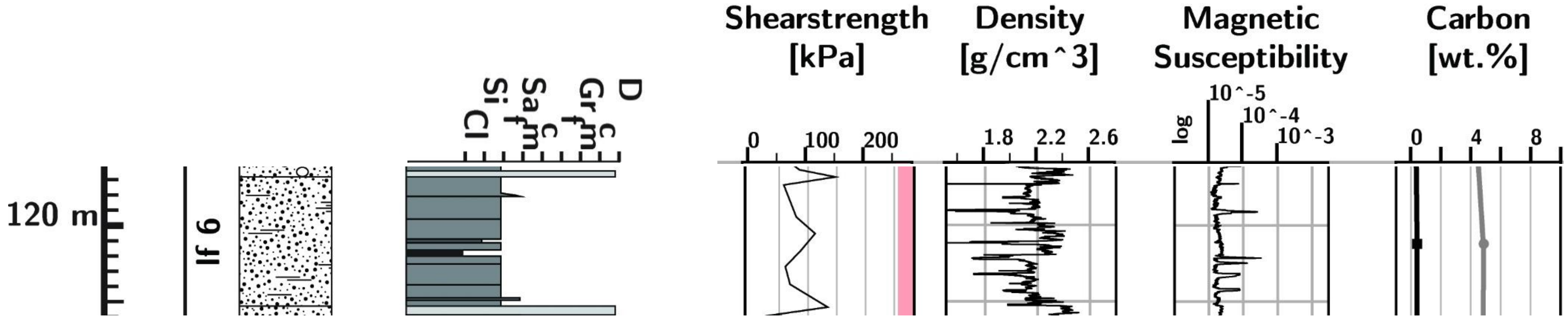

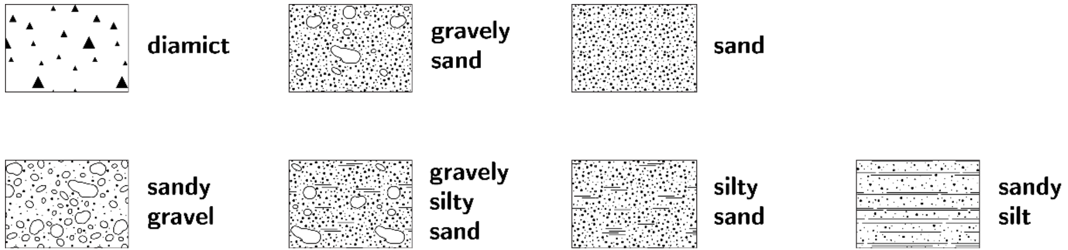

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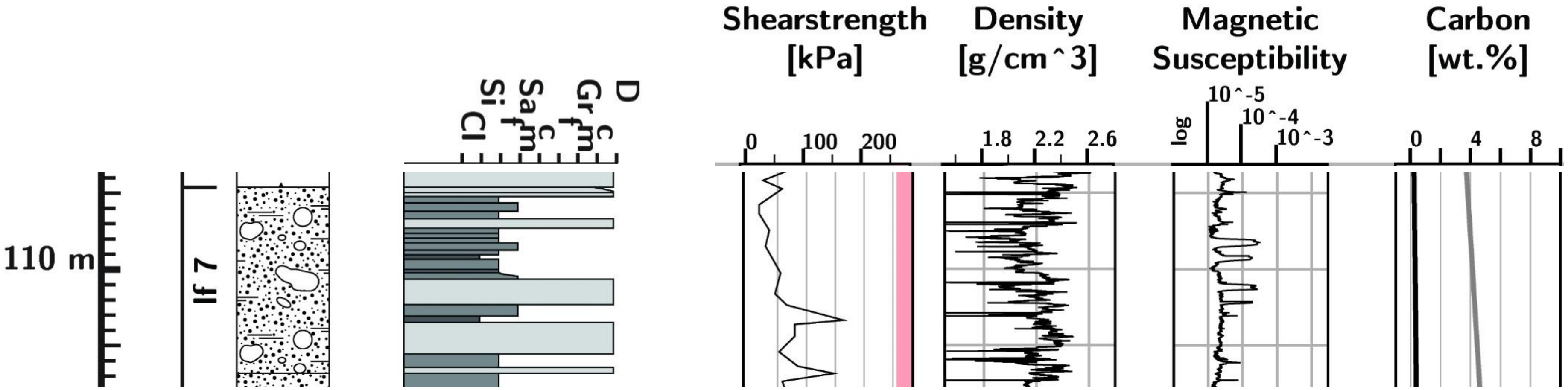

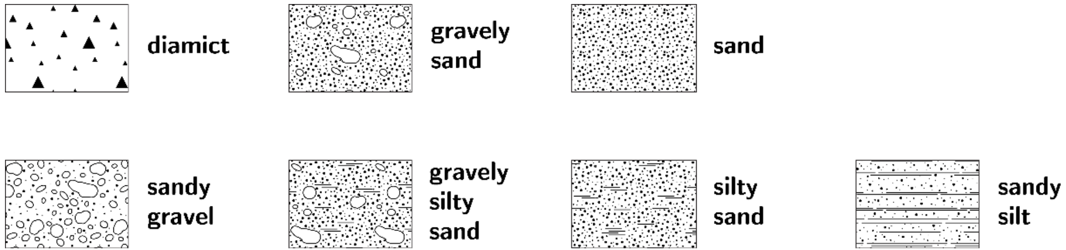

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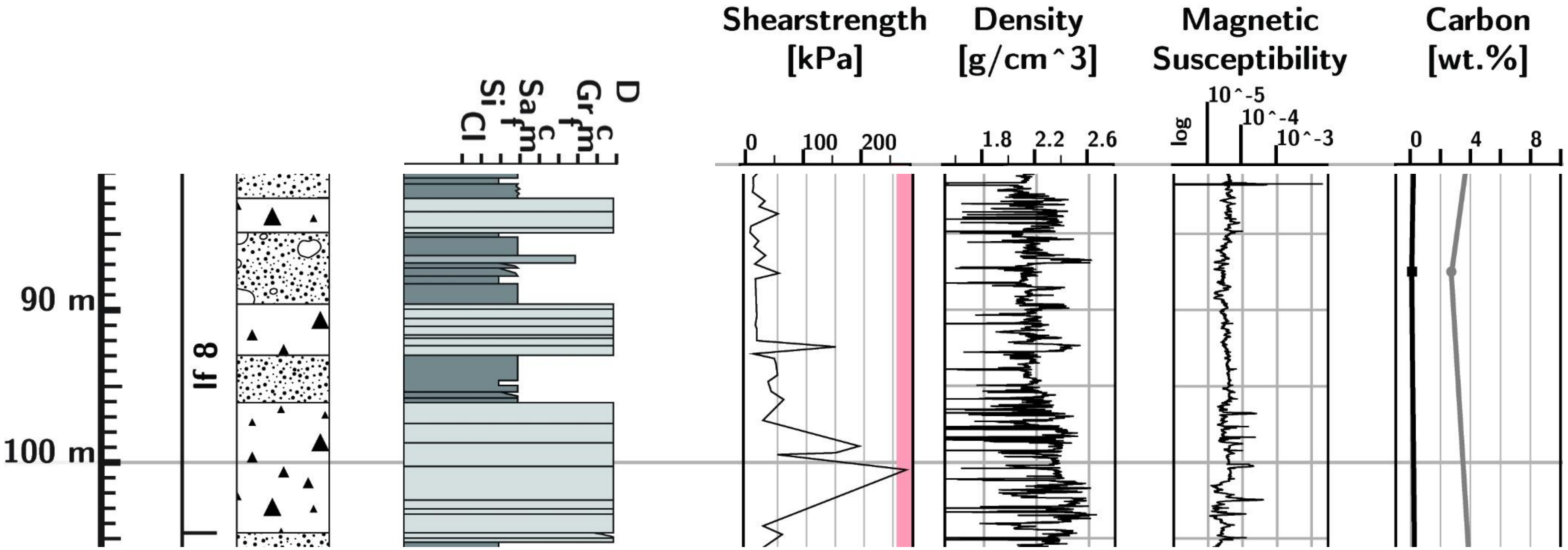

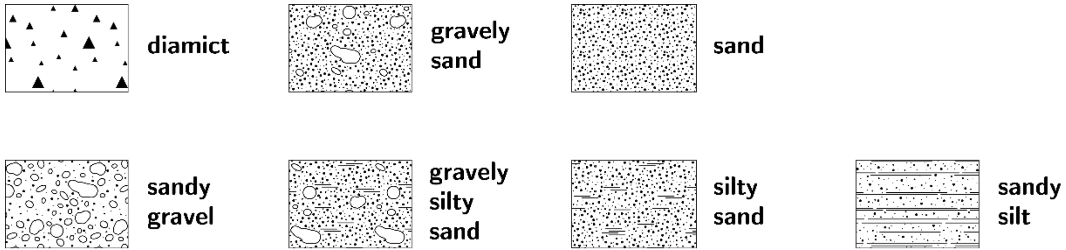

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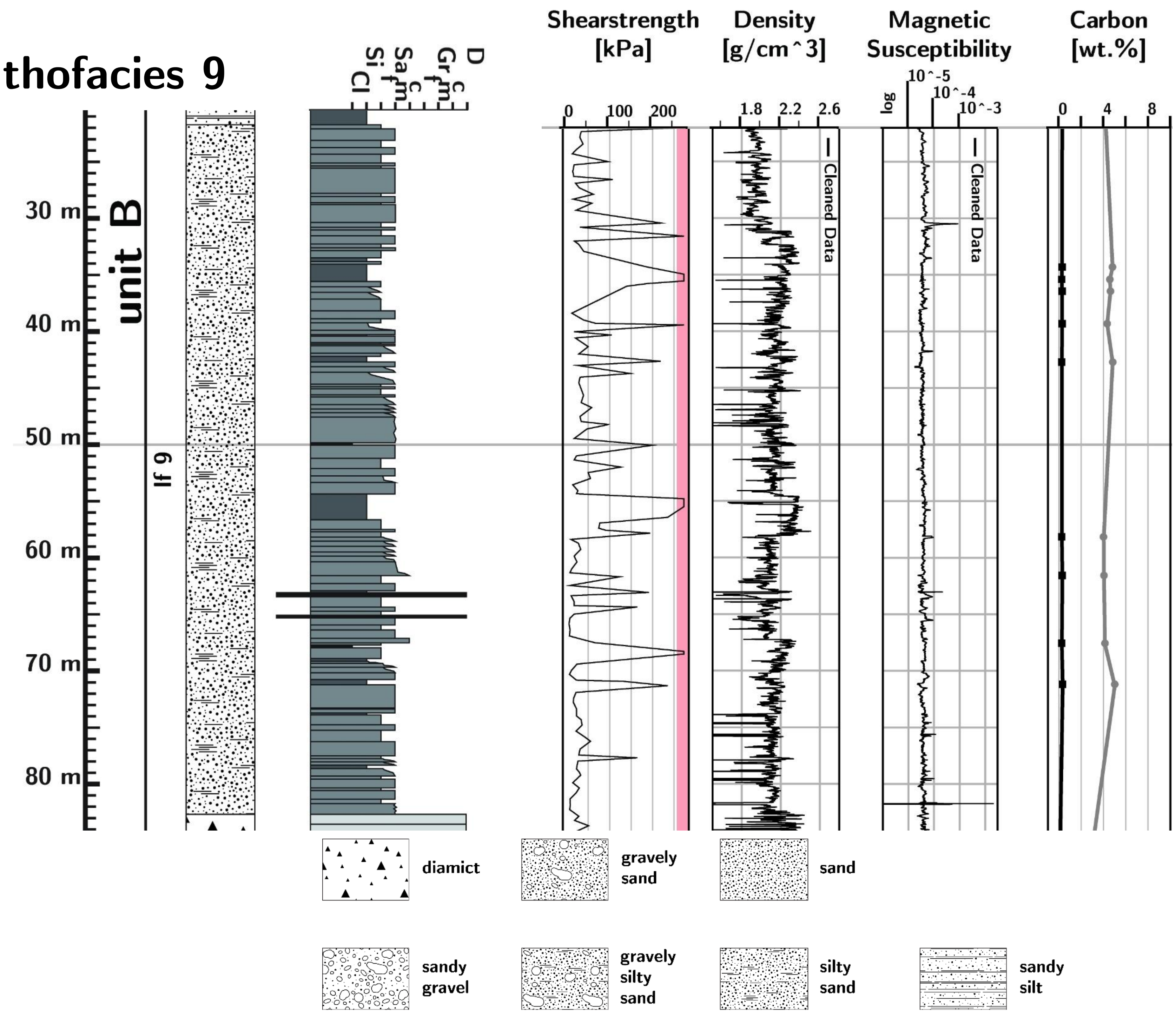

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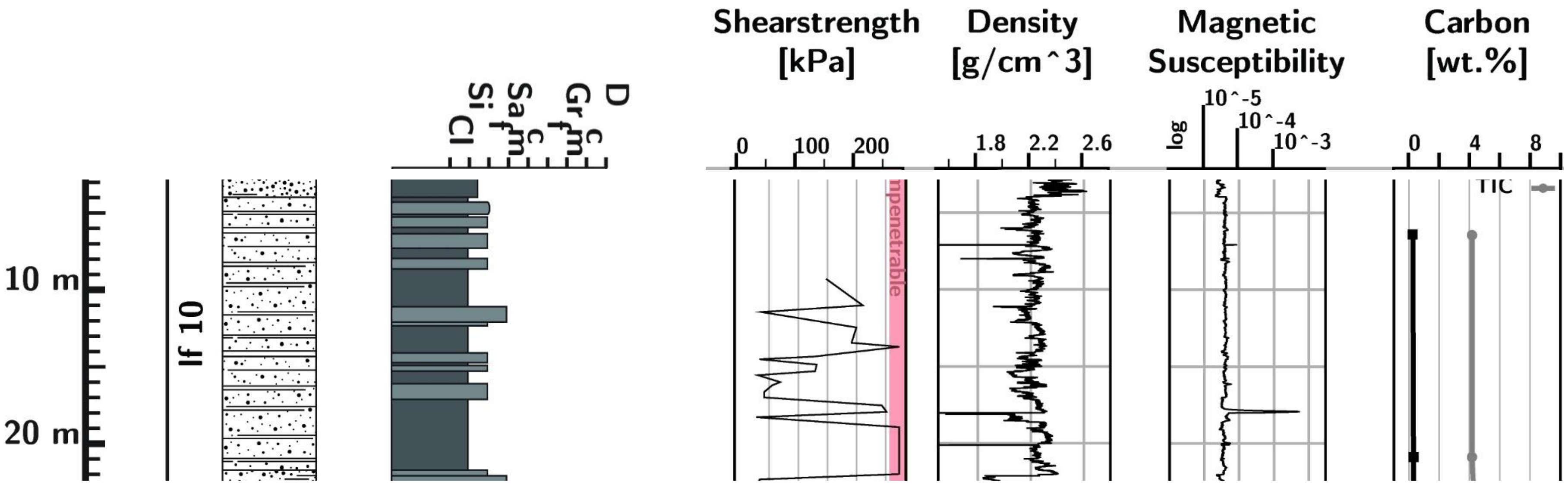

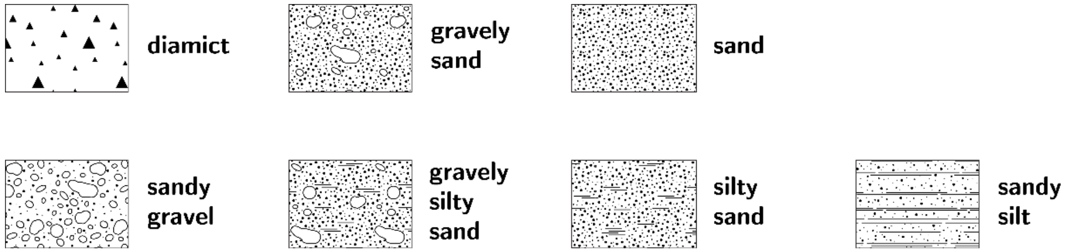

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