Arbeitsbericht NAB 21-22

TBO Bözberg-2-1: Data Report

Dossier II
Core Photography

April 2022

National Cooperative
for the Disposal of
Radioactive Waste

Hardstrasse 73
P.O. Box 280
5430 Wettingen
Switzerland
Telefon 056 437 11 11

www.nagra.ch

nagra.

Arbeitsbericht NAB 21-22

TBO Bözberg-2-1: Data Report

Dossier II Core Photography

April 2022

D. Kaehr[1] & M. Gysi[2]

[1] Maya & Daniele
[2] Nagra

Keywords:
BOZ2-1, Jura Ost, TBO, deep drilling campaign, drill cores, cuttings, photos, composites, CoreScan3

National Cooperative for the Disposal of Radioactive Waste

Hardstrasse 73
P.O. Box 280
5430 Wettingen
Switzerland
Telefon 056 437 11 11

www.nagra.ch

Nagra Arbeitsberichte NAB ("Working Reports") present the results of work in progress that have not necessarily been subject to a comprehensive review. They are intended to provide rapid dissemination of current information.

This NAB aims at reporting drilling results at an early stage. Additional borehole-specific data will be published elsewhere.

In the event of inconsistencies between dossiers of this NAB, the dossier addressing the specific topic takes priority. In the event of discrepancies between Nagra reports, the chronologically later report is generally considered to be correct. Data sets and interpretations laid out in this NAB may be revised in subsequent reports. The reasoning leading to these revisions will be detailed there.

This Dossier was prepared by:
D. Kaehr (photography post-processing and core photograph composite design and compilation)
M. Gysi (project management, conceptualisation, QC and writing)

Editorial work: Geomecon and M. Unger

The Dossier has greatly benefitted from technical discussions with, and reviews by, external and internal experts. Their input and work are very much appreciated!

"Copyright © 2022 by Nagra, Wettingen (Switzerland) / All rights reserved.
All parts of this work are protected by copyright. Any utilisation outwith the remit of the copyright law is unlawful and liable to prosecution. This applies in particular to translations, storage and processing in electronic systems and programs, microfilms, reproductions, etc."

Table of Contents

Table of Contents I

List of Tables II

List of Figures II

List of Appendices II

1 Introduction 1

1.1 Context 1

1.2 Location and specifications of the borehole 2

1.3 Documentation structure for the BOZ2-1 borehole 6

1.4 Scope and objectives of this dossier 7

2 Executed working procedures 9

2.1 On-site core handling 9

2.2 Core photography 13

2.2.1 Specifications 13

2.2.2 Colour drift monitoring 14

2.3 Post processing of core photographs 16

2.4 Signatures 17

3 Bözberg-2-1 core- and cuttings composites 19

4 References 149

List of Tables

Tab. 1-1: General information about the BOZ2-1 borehole 2

Tab. 1-2: Core and log depth for the main lithostratigraphic boundaries in the BOZ2-1 borehole..... 5

Tab. 1-3: List of dossiers included in NAB 21-22..... 6

List of Figures

Fig. 1-1: Tectonic overview map with the three siting regions under investigation..... 1

Fig. 1-2: Overview map of the investigation area in the Jura Ost siting region with the location of the BOZ2-1 borehole in relation to the boreholes Riniken and BOZ1-1..... 3

Fig. 1-3: Lithostratigraphic profile and casing scheme for the BOZ2-1 borehole..... 4

Fig. 2-1: The inner core barrel is placed on the pipe rack..... 9

Fig. 2-2: The 3 m core in the plastic liner is carried to the core processing area..... 10

Fig. 2-3: A core covered in drilling fluid on the core processing table..... 11

Fig. 2-4: A core is washed with water on the core processing table to remove the drilling fluid..... 11

Fig. 2-5: A core is marked with orientation lines 12

Fig. 2-6: Cleaned, measured and marked core..... 12

Fig. 2-7: Modified DMT CoreScan^3 system at the drill site 14

Fig. 2-8: Reference photograph setup of the CoreScan^3 system with a Datacolor SpyderCHECKR 48 colour chart, a metre scale, a BST14 greyscale chart and an X-Rite ColorChecker Classic Mini colour chart 15

Fig. 2-9: CoreScan^3 system setup during core photography with a metre scale, a BST14 grey-scale chart and an X-Rite ColorChecker Classic Mini colour chart..... 16

Fig. 2-10: White hachures signature used for missing core due to FIT pilot hole or drilling related technical issues in the composite displays..... 17

List of Appendices

App. A: Lithostratigraphy profile Bözberg-2-1, 1:2'500, 0.00 m to 829.11 m MD core depth

Note: In the digital version of this report the appendices can be found under the paper clip symbol.

1 Introduction

1.1 Context

To provide input for site selection and the safety case for deep geological repositories for radioactive waste, Nagra has drilled a series of deep boreholes ("Tiefbohrungen", TBO) in Northern Switzerland. The aim of the drilling campaign is to characterise the deep underground of the three remaining siting regions located at the edge of the Northern Alpine Molasse Basin (Fig. 1-1).

In this report, we present the results from the Bözberg-2-1 borehole.

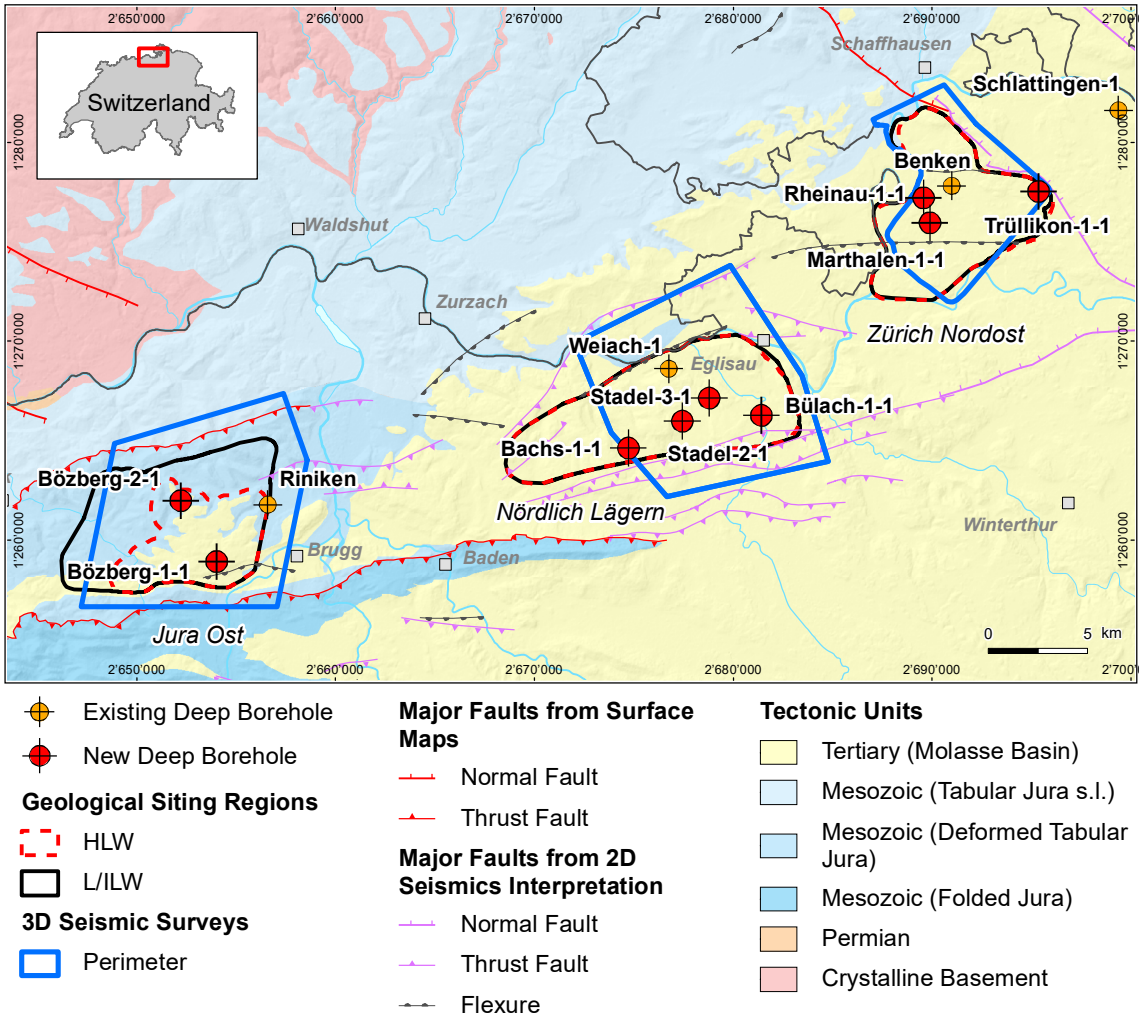


Fig. 1-1: Tectonic overview map with the three siting regions under investigation

1.2 Location and specifications of the borehole

The Bözberg-2-1 (BOZ2-1) exploratory borehole is the fifth borehole drilled within the framework of the TBO project. The drill site is located in the northern part of the Jura Ost siting region (Fig. 1-2). The vertical borehole reached a final depth of 829.11 m (MD)[1]. The borehole specifications are provided in Tab. 1-1.

Tab. 1-1: General information about the BOZ2-1 borehole

Siting region	Jura Ost
Municipality	Bözberg (Canton Aargau / AG), Switzerland
Drill site	Bözberg-2 (BOZ2)
Borehole	Bözberg-2-1 (BOZ2-1)
Coordinates	LV95: 2'652'218.764 / 1'261'985.437
Elevation	Ground level = top of rig cellar: 624.33 m above sea level (asl)
Borehole depth	829.11 m measured depth (MD) below ground level (bgl)
Drilling period	11th August – 14th December 2020 (spud date to end of rig release)
Drilling company	Daldrup & Söhne AG
Drilling rig	Wirth B 152t
Drilling fluid	Water-based mud with various amounts of different components such as:[2] 0 – 370 m: Bentonite & polymers 370 – 615 m: Potassium silicate & polymers 615 – 829.11 m: Pure-Bore®

The lithostratigraphic profile and the casing scheme are shown in Fig. 1-3. The comparison of the core versus log depth[3] of the main lithostratigraphic boundaries in the BOZ2-1 borehole is shown in Tab. 1-2.

[1] Measured depth (MD) refers to the position along the borehole trajectory, starting at ground level, which for this borehole is the top of the rig cellar. For a perfectly vertical borehole, MD below ground level (bgl) and true vertical depth (TVD) are the same. In all Dossiers depth refers to MD unless stated otherwise.

[2] For detailed information see Dossier I.

[3] Core depth refers to the depth marked on the drill cores. Log depth results from the depth observed during geophysical wireline logging. Note that the petrophysical logs have not been shifted to core depth, hence log depth differs from core depth.

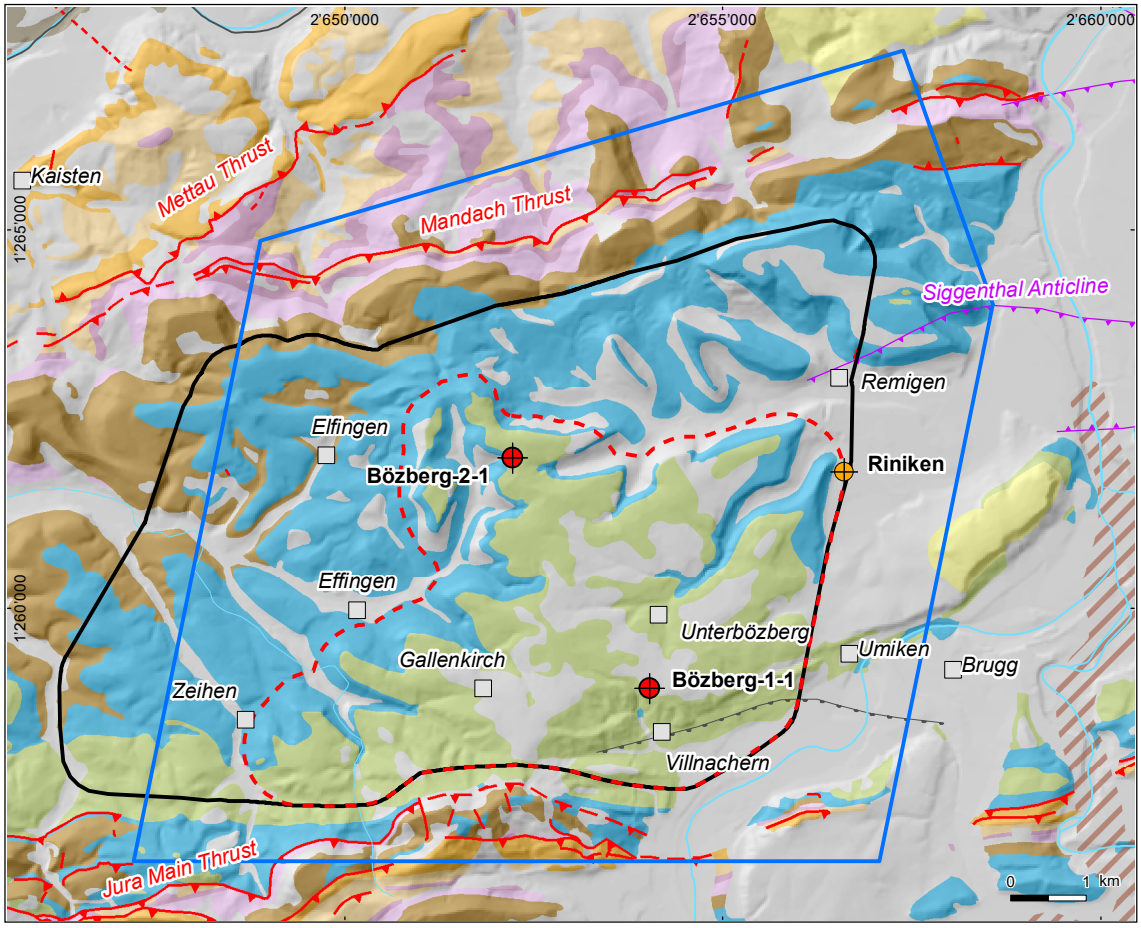


Fig. 1-2: Overview map of the investigation area in the Jura Ost siting region with the location of the BOZ2-1 borehole in relation to the boreholes Riniken and BOZ1-1

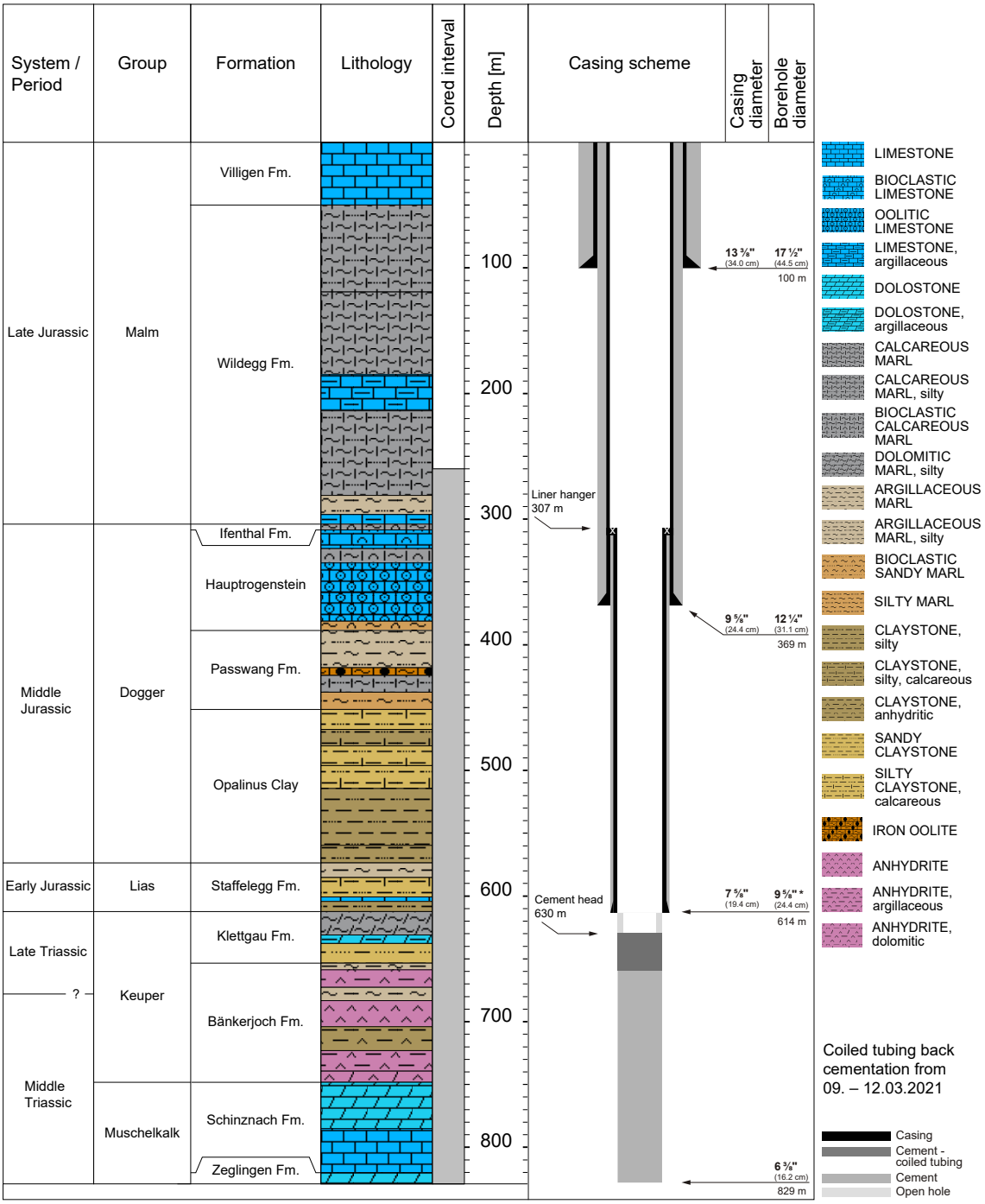


Fig. 1-3: Lithostratigraphic profile and casing scheme for the BOZ2-1 borehole[4]

[4] For detailed information see Dossier I and III.

Tab. 1-2: Core and log depth for the main lithostratigraphic boundaries in the BOZ2-1 borehole[5]

System / Period	Group	Formation	Core depth in m (MD)	Log depth in m (MD)	
Jurassic	Malm	Villigen Formation	50.0		—
		Wildegg Formation	303.95	304.38	—
	Dogger	Ifenthal Formation	308.70	309.07	—
		Hauptrogenstein	388.54	388.97	—
		Passwang Formation	451.54	451.90	—
		Opalinus Clay	573.68	573.89	—
	Lias	Staffelegg Formation	**612.46**	**612.76**	—
Triassic	Keuper	Klettgau Formation	653.45	654.70	—
		Bänkerjoch Formation	748.27	749.52	—
	Muschelkalk	Schinznach Formation	820.32	821.09	—
		Zeglingen Formation	829.11 final depth	829.88	—

[5] For details regarding lithostratigraphic boundaries see Dossier III and IV; for details about depth shifts (core goniometry) see Dossier V.

1.3 Documentation structure for the BOZ2-1 borehole

NAB 21-22 documents the majority of the investigations carried out in the BOZ2-1 borehole, including laboratory investigations on core material. The NAB comprises a series of stand-alone dossiers addressing individual topics and a final dossier with a summary composite plot (Tab. 1-3).

This documentation aims at early publication of the data collected in the BOZ2-1 borehole. It includes the majority of the data available approximately one year after completion of the borehole. Some analyses are still ongoing (e.g. diffusion experiments, analysis of veins, hydrochemical interpretation of water samples) and will be published in separate reports.

The current borehole report will provide an important basis for the integration of datasets from different boreholes. The integration and interpretation of the results in the wider geological context will be documented later in separate geoscientific reports.

Tab. 1-3: List of dossiers included in NAB 21-22

Black marks the dossier at hand.

Dossier	Title	Authors
I	TBO Bözberg-2-1: Drilling	P. Hinterholzer-Reisegger
II	**TBO Bözberg-2-1: Core Photography**	**D. Kaehr & M. Gysi**
III	TBO Bözberg-2-1: Lithostratigraphy	P. Jordan, P. Schürch, H. Naef, M. Schwarz, R. Felber, T. Ibele & M. Gysi
IV	TBO Bözberg-2-1: Microfacies, Bio- and Chemostratigraphic Analysis	S. Wohlwend, H.R. Bläsi, S. Feist-Burkhardt, B. Hostettler, U. Menkveld-Gfeller, V. Dietze & G. Deplazes
V	TBO Bözberg-2-1: Structural Geology	A. Ebert, L. Gregorczyk , S. Cioldi, E. Hägerstedt & M. Gysi
VI	TBO Bözberg-2-1: Wireline Logging, Micro-hydraulic Fracturing and Pressuremeter Testing	J. Gonus, E. Bailey, J. Desroches & R. Garrard
VII	TBO Bözberg-2-1: Hydraulic Packer Testing	R. Schwarz, M. Willmann, S. Reinhardt, S.M.L. Hardie, M. Voß & A. Pechstein
VIII	TBO Bözberg 2-1: Rock Properties, Porewater Characterisation and Natural Tracer Profiles	T. Gimmi, L. Aschwanden, L. Camesi, E. Gaucher, A. Jenni, M. Kiczka, U. Mäder, M. Mazurek, D. Rufer, H.N. Waber, P. Wersin, C. Zwahlen & D. Traber
IX	TBO Bözberg-2-1: Rock-mechanical and Geomechanical Laboratory Testing	E. Crisci, L. Laloui & S. Giger
X	TBO Bözberg-2-1: Petrophysical Log Analysis	S. Marnat & J.K. Becker
	TBO Bözberg-2-1: Summary Plot	Nagra

1.4 Scope and objectives of this dossier

The dossier at hand (Dossier II) documents core photography. The objectives are the following:

- summary of core handling and core photography of this drilling campaign
- visual documentation of the cuttings samples and cores of BOZ2-1 from 0 m to 829.11 m MD core depth

2 Executed working procedures

2.1 On-site core handling

The cores were drilled with a 6 m long inner core barrel containing an inner plastic tube. To avoid core jamming and to obtain a better core quality the length of a core run was 3 m, only. After cutting the core, the drilling crew pulled the inner core barrel up with a winch (wireline coring) and placed it on the pipe rack (Fig. 2-1). The core catcher was detached and the inner plastic tube was removed and laid down on trestles. The section containing the core was separated from the empty plastic tube by cutting the tube to a length of approximately 3.5 m. The core was then carried to the core processing area (Fig. 2-2) and pushed out of the tube using an appropriate rod. If the core was jammed inside the tube, the plastic liner was cut laterally using an electric cutting machine.



Fig. 2-1: The inner core barrel is placed on the pipe rack

Showcase picture of rig 16 (Marriott); workflow comparable at the Daldrup rig (picture credits: © Maya & Daniele)



Fig. 2-2: The 3 m core in the plastic liner is carried to the core processing area

Showcase picture of rig 16 (Marriott); workflow comparable at the Daldrup rig (picture credits: © Maya & Daniele)

Once laid out, the core was washed with water to remove the drilling fluid (Figs. 2-3 and 2-4). Afterwards, the top of the newly cut core was aligned with the bottom of the previous core section. If the two core pieces did not fit properly, they were marked with a red cross and a new set of orientation lines was started. If a fit was established, the orientation lines were correctly copied onto the newly cored section. These orientation lines consist of two parallel lines drawn along the core axis with additional arrows indicating the downhole direction. The line on the right hand side when looking towards the core top is red (Figs. 2-5 and 2-6). The colour of the line on the left hand side can be white, yellow or black depending on the colour of the cored rock. The core depth was marked on the core with a line perpendicular to the core axis and corresponding depth labels at 0.5 m intervals.

To facilitate proper core handling, transportation and further analyses, the core sections were cut into pieces approximately one metre long using a diamond impregnated rock saw before being stored in one metre core boxes.



Fig. 2-3: A core covered in drilling fluid on the core processing table

Picture credits: © Maya & Daniele



Fig. 2-4: A core is washed with water on the core processing table to remove the drilling fluid

Picture credits: © Maya & Daniele



Fig. 2-5: A core is marked with orientation lines

Picture credits: © Maya & Daniele

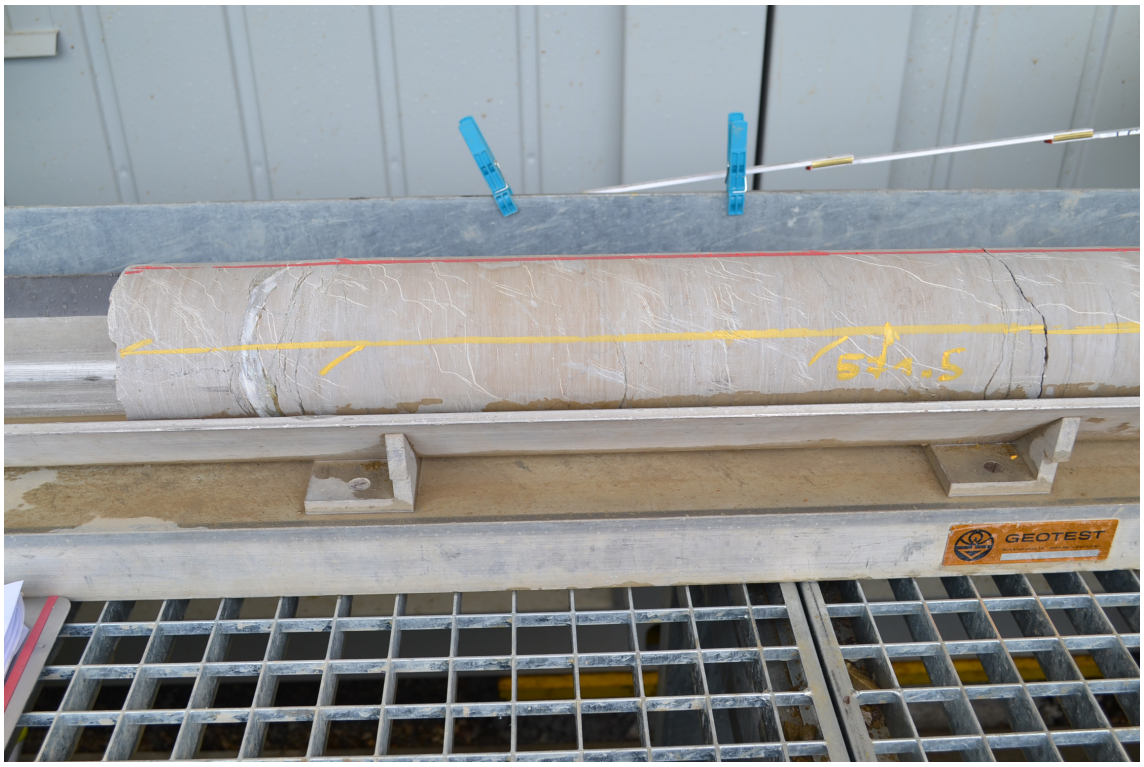


Fig. 2-6: Cleaned, measured and marked core

2.2 Core photography

All core pieces were photographed (planar pictures) using a modified version of the DMT CoreScan^3 system (Fig. 2-7) specifically designed to take high resolution core photographs (10 px/mm). If the core geometry and condition allowed it, 360° photographs of the core surface were also taken (not documented in this dossier). For both planar and 360° photographs, the core was placed on two rubber rollers and a digital line scan camera recorded the picture via an inclined mirror in the top section of the CoreScan^3 system. During 360° photography, the core was rotated around its longitudinal axis and the picture was taken at the upper section of the core. In addition, all 360° photographs were digitally rotated to set the red orientation line to 0°. Both planar and 360° photographs were saved on the CoreScan^3 computer, which automatically synchronised the data with the Nagra network-attached storage (NAS) located at the core storage facility in Würenlingen.

2.2.1 Specifications

Camera:

- manufacturer: avaluar GmbH
- camera model: CCD Colour camera CSc3b1.26
- resolution y: 6'400 (10 px/mm)
- resolution x: 10'680 (10 px/mm)
- spectral response: 400 nm to 700 nm
- sharpening: 0
- gamma: 1.4
- lens maker: Schneider Kreuznach
- lens model: APO COMPONON f4.0/60mm
- aperture: f/8
- focal length: 35 mm
- exposure time: program very dark (custom calibrated for Nagra's LED panels)

LED panels:

- 4x Aladdin BI FLEX 4 (200 W Bi-Colour Panel): two at the back and two at the front of the CoreScan^3 system, protected in aluminium boxes with a diffusor plate as front cover
- 2x Aladdin BI FLEX 2 (70 W Bi-Colour Panel): one on the left hand side and one on the right hand side of the CoreScan^3 system, protected in an aluminium box with a diffusor plate as front cover
- all six panels are calibrated to 5'000 K with a Sekonic C-800 SpectroMaster

Reference cards:

- X-Rite ColorChecker White Balance: used for camera calibration (shading)
- X-Rite ColorChecker Classic Mini colour chart: colour reference on every core photo
- BST14 greyscale chart: greyscale reference on every core photo
- Datacolor SpyderCHECKR 48 colour chart: colour reference chart for reference photographs

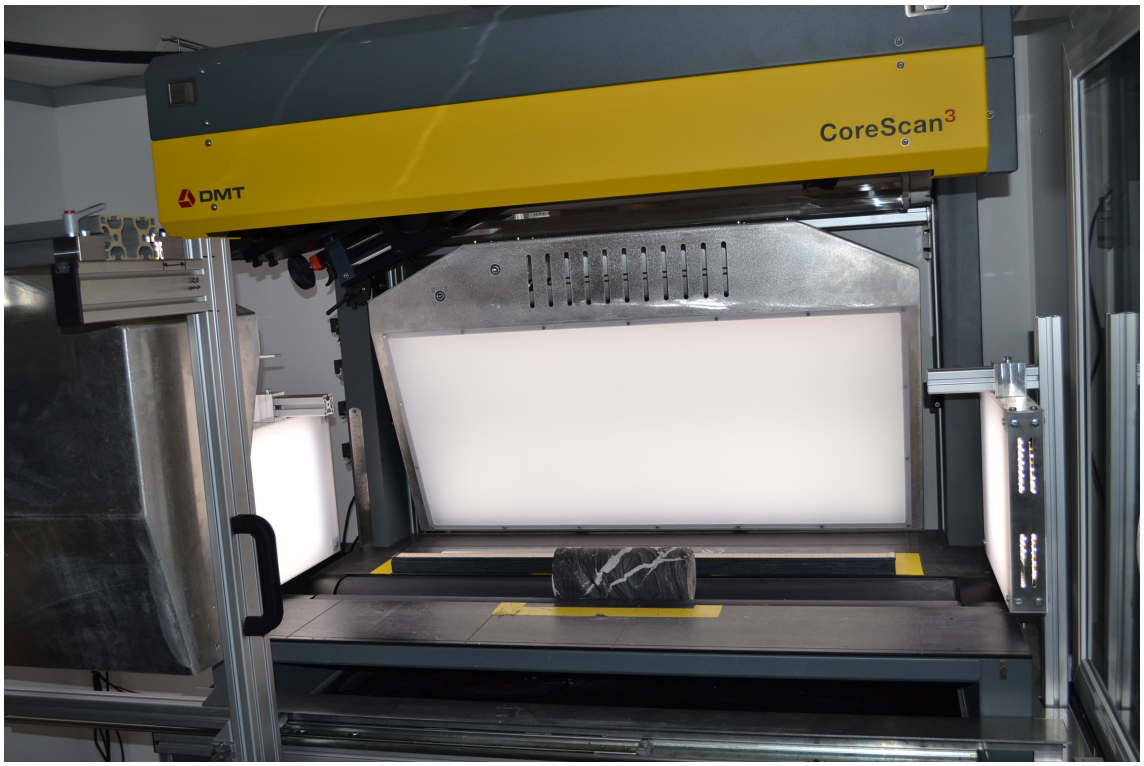


Fig. 2-7: Modified DMT CoreScan^3 system at the drill site

2.2.2 Colour drift monitoring

During coring operations, a reference photograph of the Datacolor SpyderCHECKR 48 colour chart was taken with the CoreScan^3 system at least twice per 24 h (Fig. 2-8). These reference photographs enabled to monitor the proper functioning of the CoreScan^3 system during operations. Issues regarding colour correctness and contrast could be detected early and necessary adjustments to the CoreScan^3 system or environment conditions (especially room temperature) could be made. The reference photographs could further be used to create an ICC profile (International Color Consortium): a data set characterising the colour input / output for the most accurate colour matching.

Each core photograph taken included a metre scale, a BST14 greyscale chart and an X-Rite ColorChecker Classic Mini colour chart (Fig. 2-9). The metre scale is essential to have a depth indicator on the core photograph, whereas the colour and greyscale charts allow manual colour management during post processing of the core photograph if required.



Fig. 2-8: Reference photograph setup of the CoreScan[3] system with a Datacolor Spyder-CHECKR 48 colour chart, a metre scale, a BST14 greyscale chart and an X-Rite ColorChecker Classic Mini colour chart

Picture credits: © Maya & Daniele



Fig. 2-9: CoreScan³ system setup during core photography with a metre scale, a BST14 grey-scale chart and an X-Rite ColorChecker Classic Mini colour chart

Picture credits: © Maya & Daniele

2.3 Post processing of core photographs

All core photographs taken on the drill site were post-processed by a professional photographer. The colour management of the post-processing workflow provided colour-matched, high-resolution core photograph reproductions with enhanced quality and fidelity. The following post-processing steps were applied to a batch of core photographs with comparable camera settings and environmental conditions:

1. noise reduction of the reference photographs of the Datacolor SpyderCHECKR 48 colour chart, shot with the CoreScan³ system
2. ICC profiling of the noise-reduced reference photographs, shot with the CoreScan³ system
3. evaluation of the ICC profiles and selection of the best ICC profile for the post processing of the core photographs
4. ICC profile application to the core photographs in batch mode
5. correction of contrast and brightness of the core photographs in batch mode
6. conversion of the photographs to eciRGB_v2 standard colour space in batch mode
7. noise reduction and pre sharpening of every single core photograph
8. correction of colour, exposure and contrast of the core photographs in batch mode

9. comparison between the best ICC profile of the Datacolor SpyderCHECKR 48 colour chart reference photograph, shot with the CoreScan^3 system and the ICC profile of the Datacolor SpyderCHECKR 48 colour chart reference photograph, shot with a Canon 5DmkIV camera
10. visual adjustment of the best ICC profile of the Datacolor SpyderCHECKR 48 colour chart reference photograph, shot with the CoreScan^3 system to the ICC profile of the Datacolor SpyderCHECKR 48 colour reference photograph, shot with a Canon 5DmkIV camera
11. application of the colour adjustement defined in the previous step to the core photographs in batch mode
12. if required, manual colour neutralisation of every single core photograph based on the BST14 greyscale chart and the X-Rite ColorChecker Classic Mini colour chart
13. cropping of the core photographs to the core outlines
14. export of the core photographs as .jpg and .tiff in pre-defined resolutions and corresponding sharpening parameters

2.4 Signatures

The following signature was used in the composite displays of the complete cores:

- white hachures: missing core due to formation integrity test (FIT) pilot hole or drilling-related technical issues (Fig. 2-10)

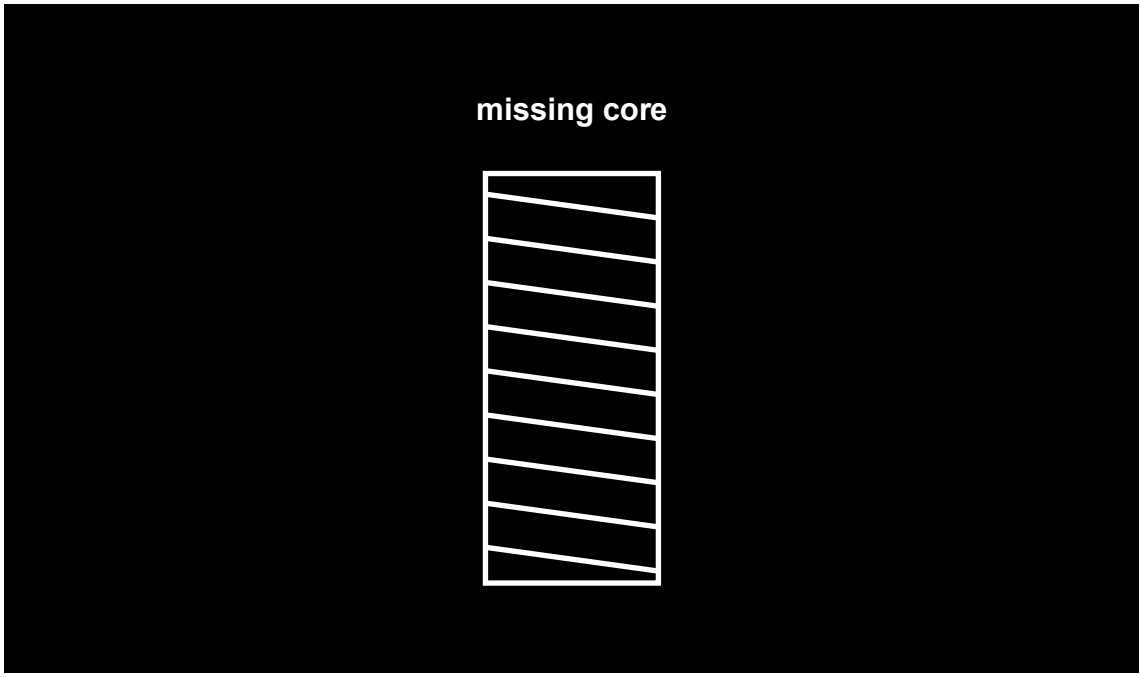
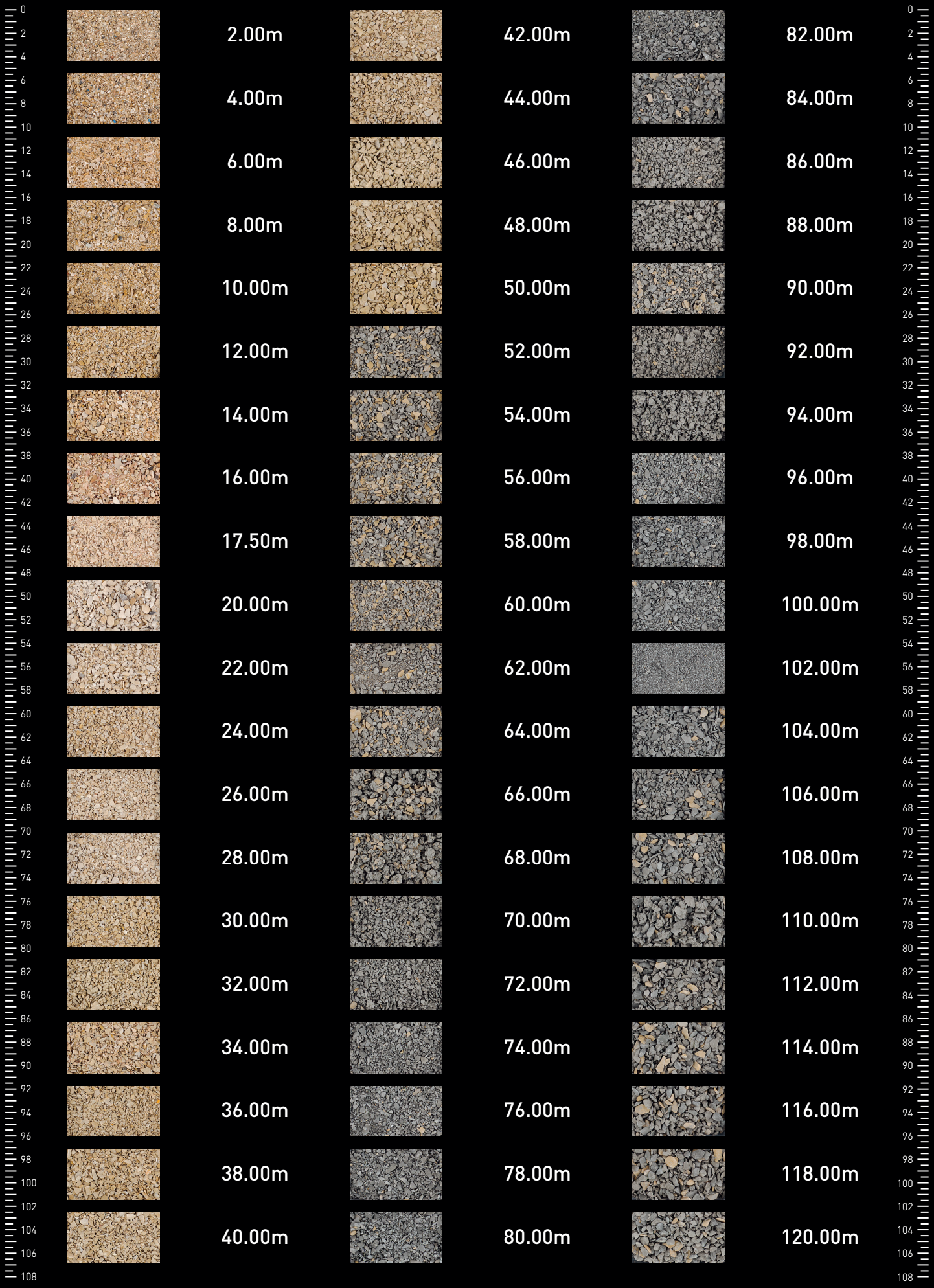


Fig. 2-10: White hachures signature used for missing core due to FIT pilot hole or drilling related technical issues in the composite displays

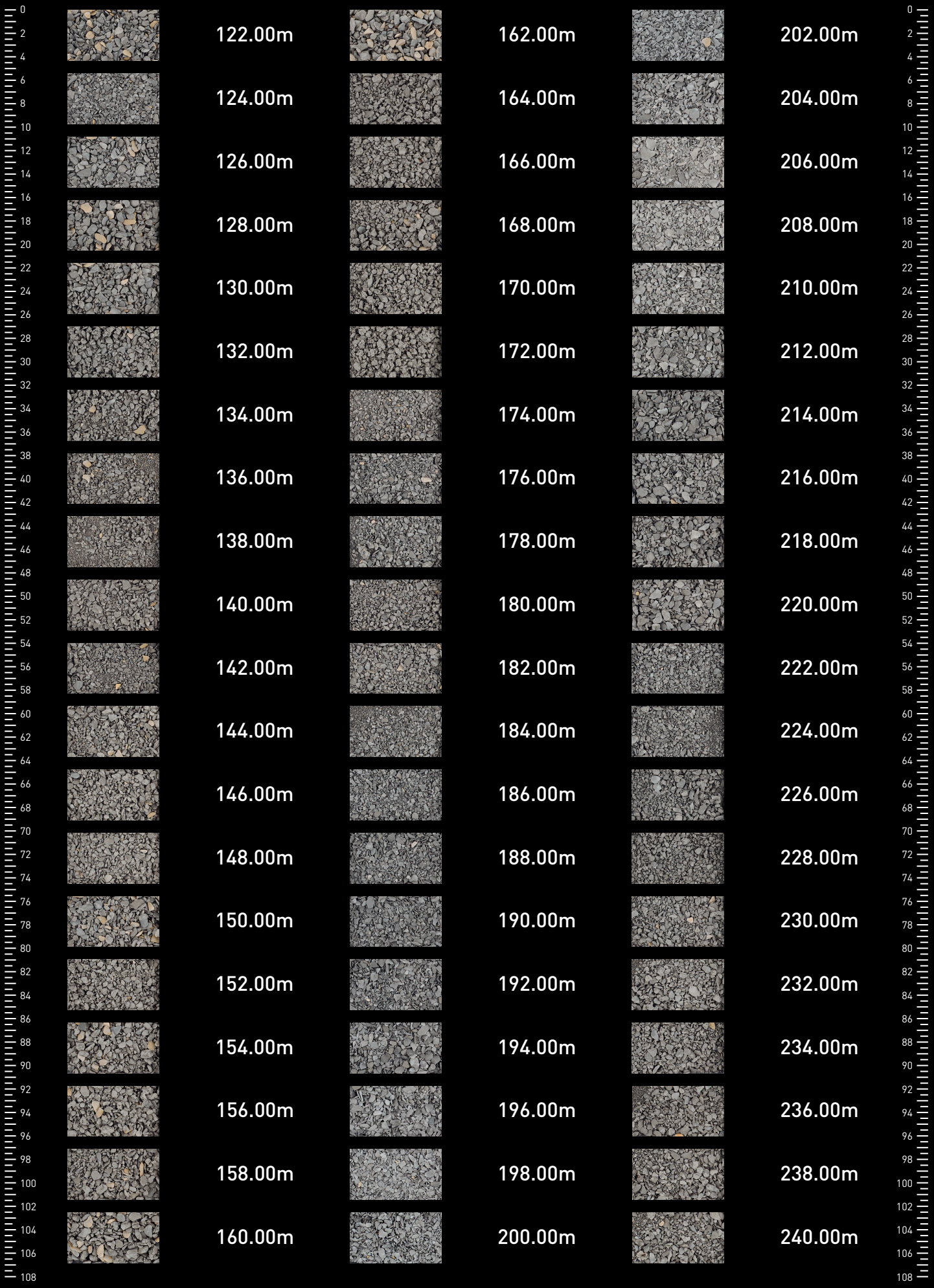
3 Bözberg-2-1 core- and cuttings composites

2.00m 42.00m 82.00m



40.00m 80.00m 120.00m

122.00m 162.00m 202.00m



160.00m 200.00m 240.00m

242.00m



242.00m

244.00m

246.00m

248.00m

250.00m

252.00m

254.00m

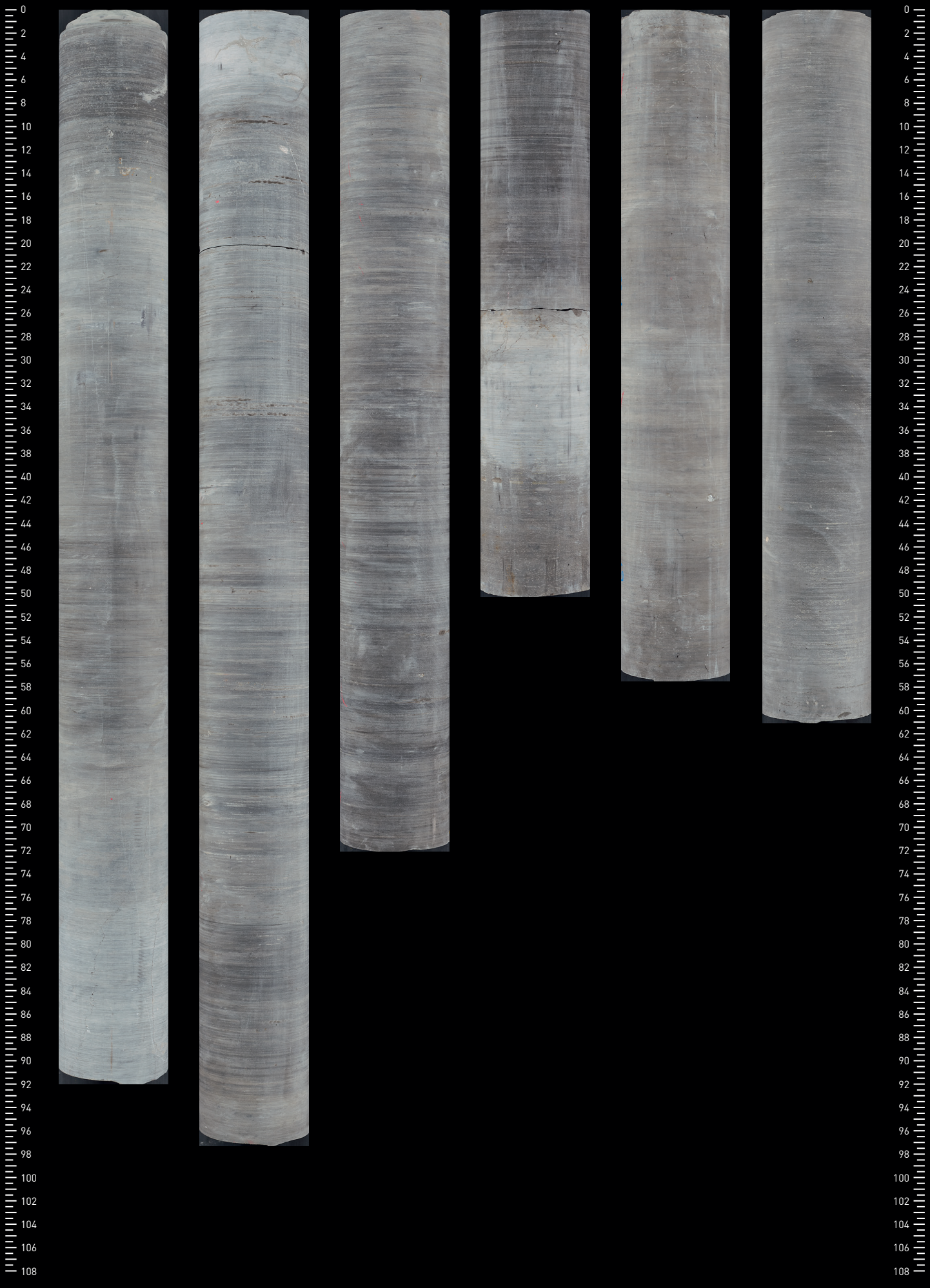
256.00m

258.00m

260.00m

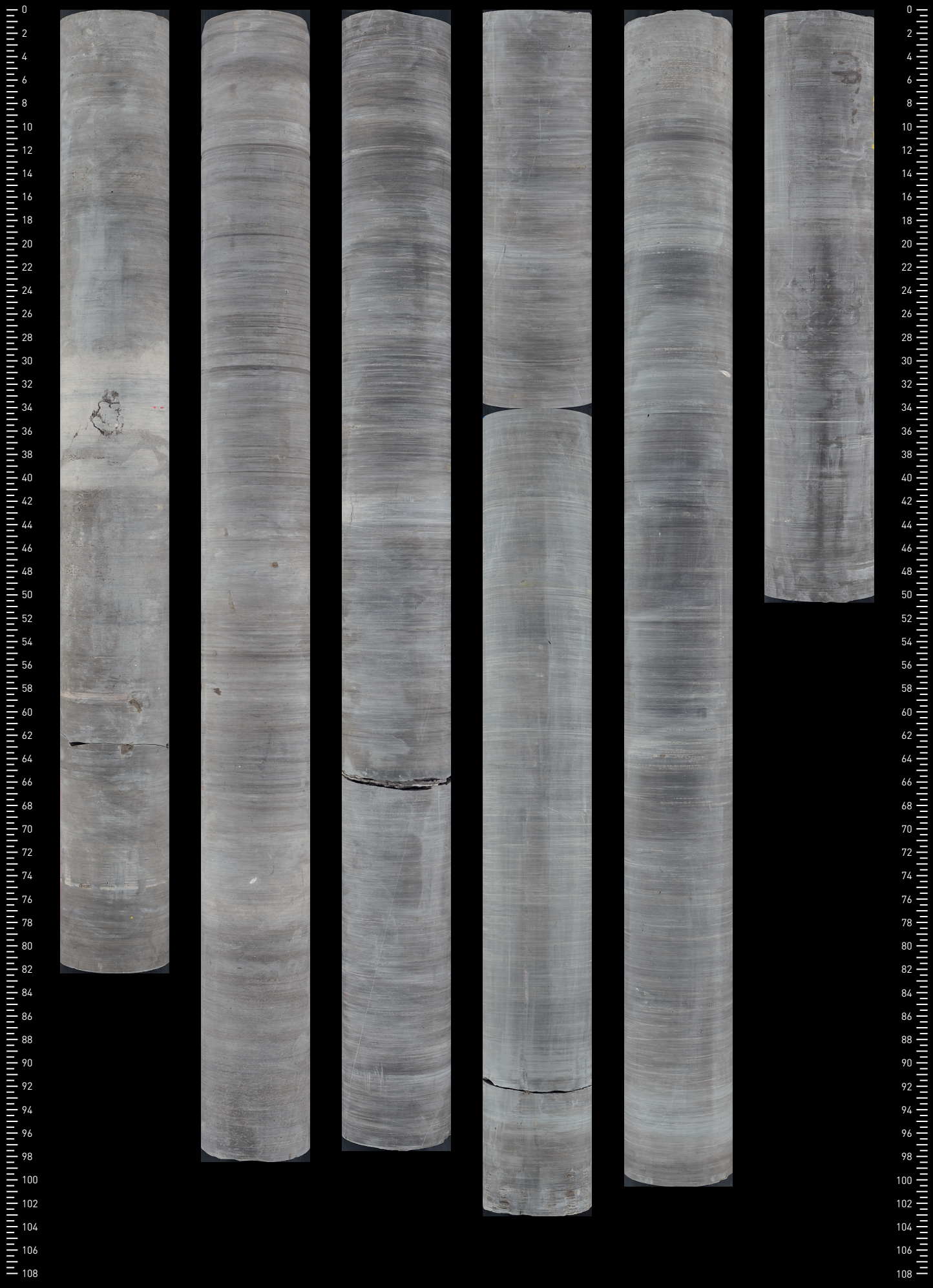
260.00m

260.00m 260.90m 261.85m 262.65m 263.05m 263.60m



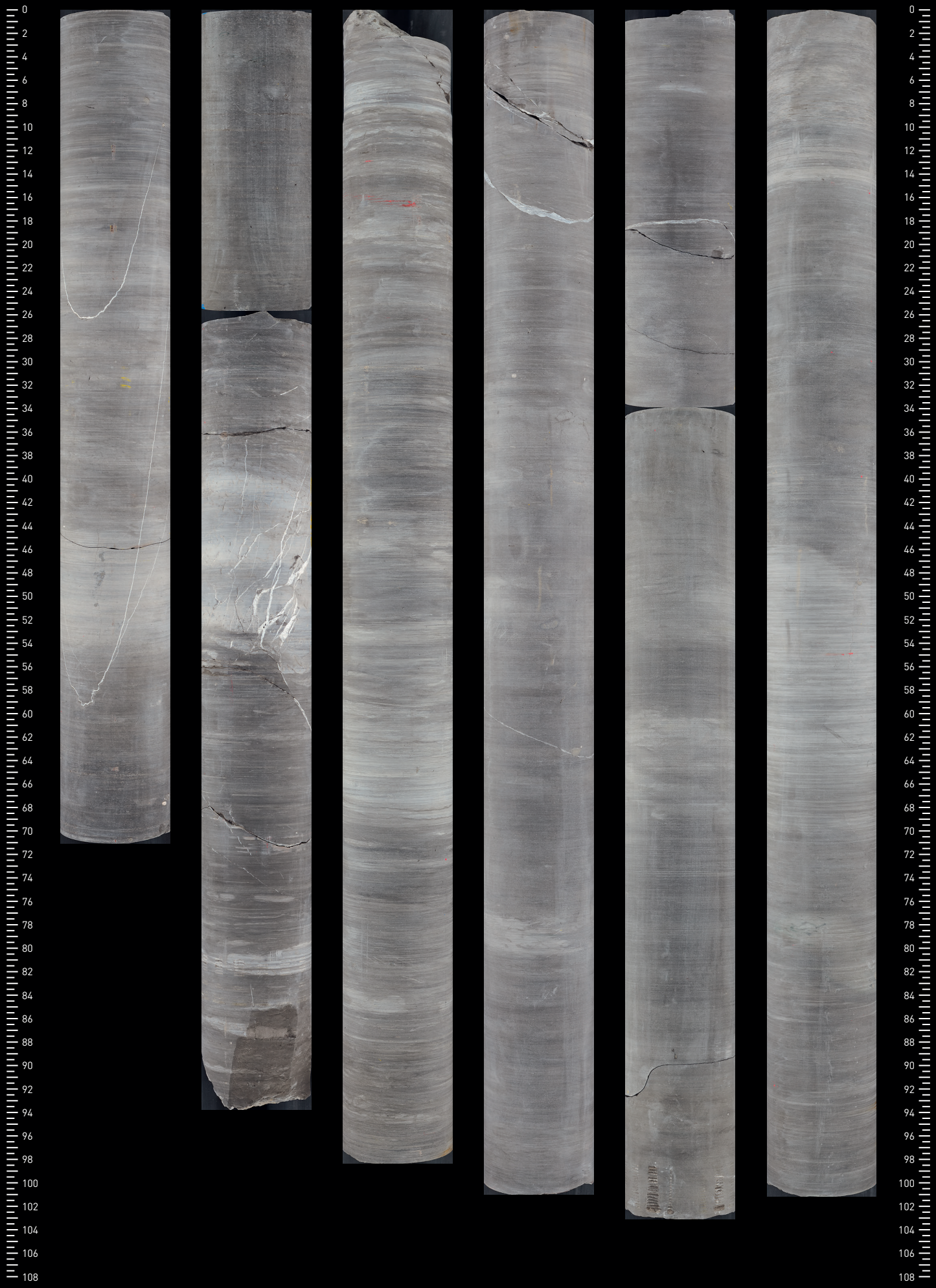
260.90m 261.85m 262.65m 263.05m 263.60m 264.20m

264.20m 265.01m 265.97m 266.93m 267.93m 268.91m



265.01m 265.97m 266.93m 267.93m 268.91m 269.40m

269.40m 270.10m 271.00m 271.96m 272.95m 273.94m



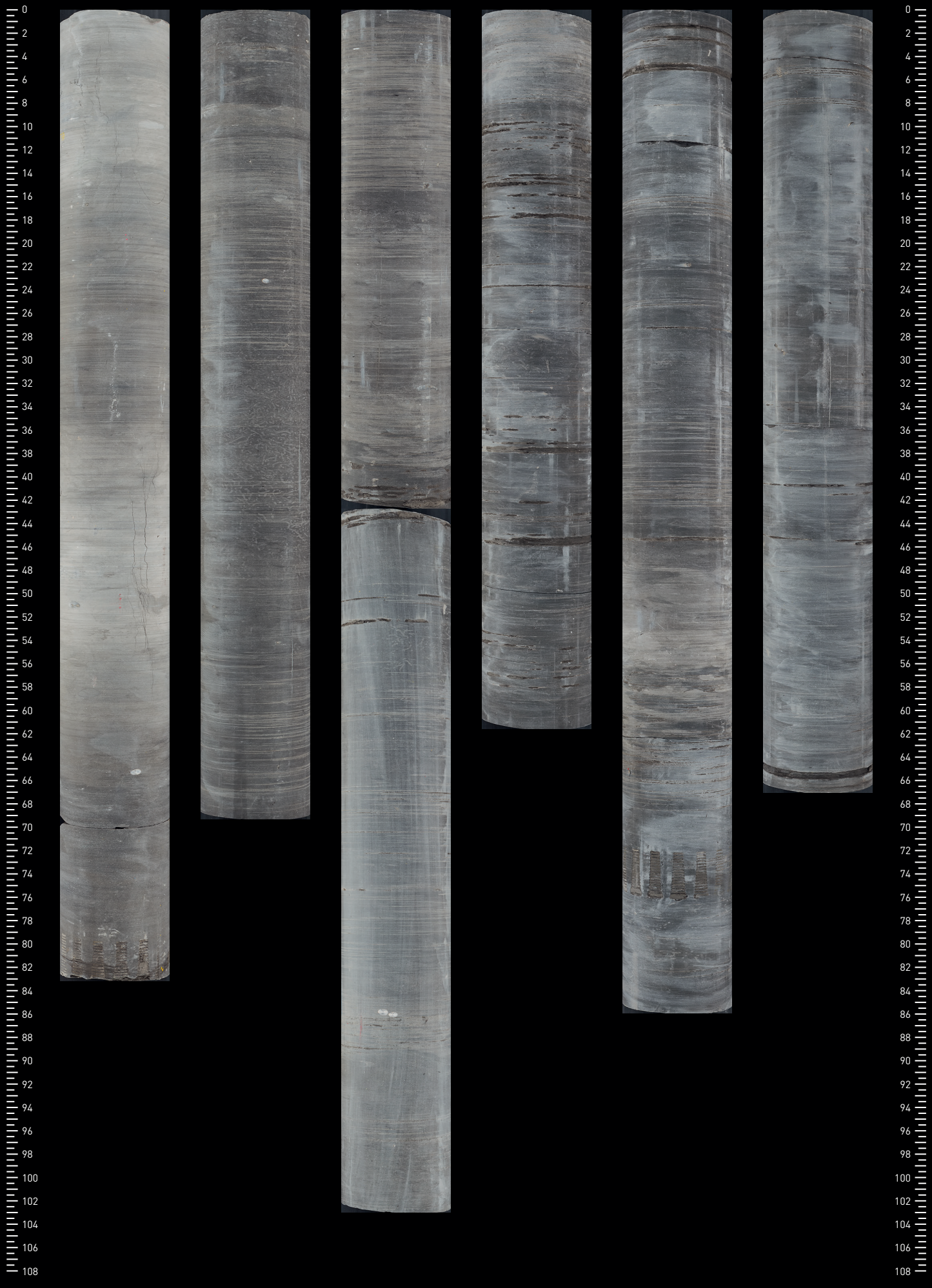
270.10m 271.00m 271.96m 272.95m 273.94m 274.92m

274.92m 275.80m 276.45m 276.94m 277.65m 278.40m



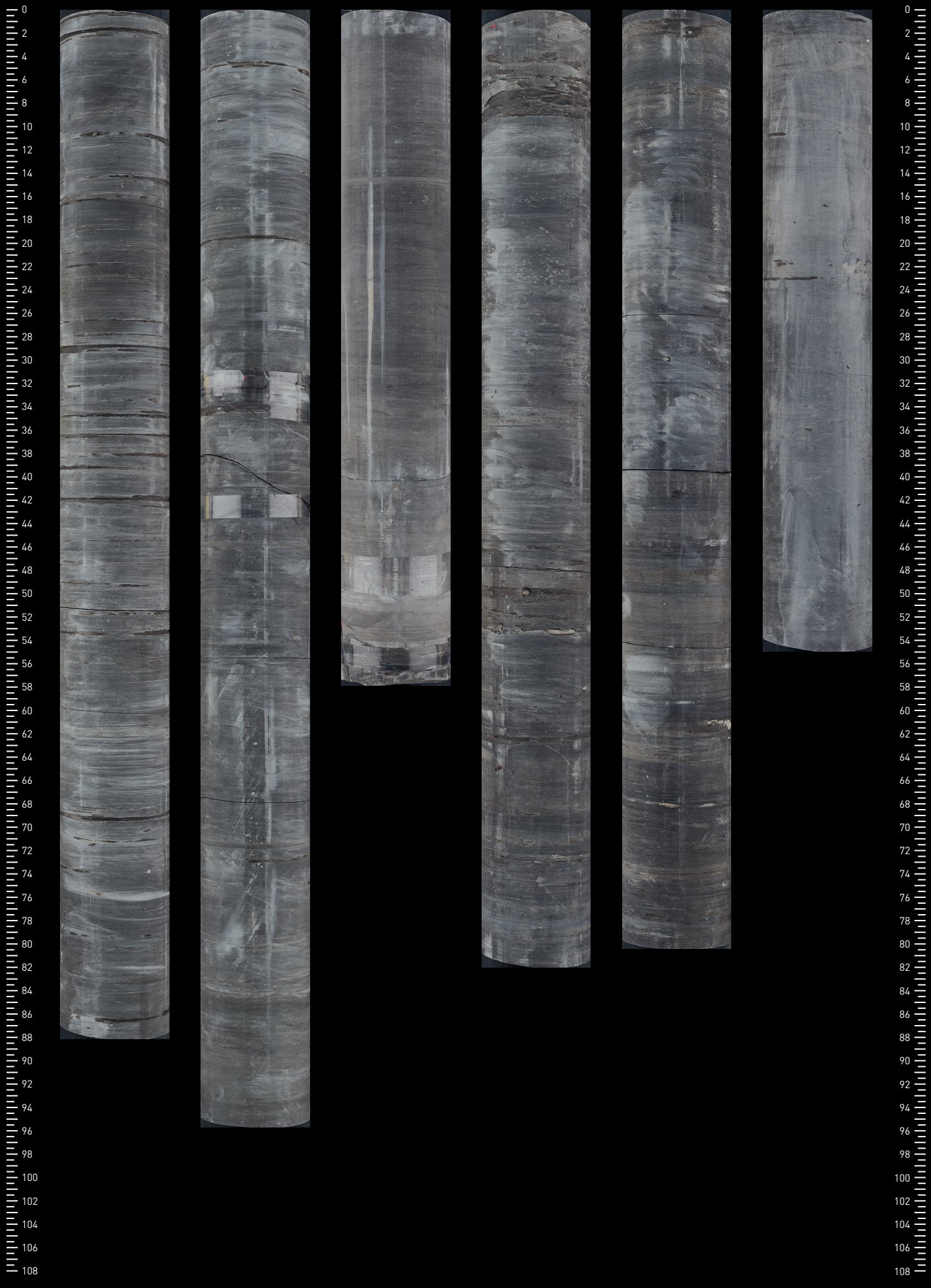
275.80m 276.45m 276.94m 277.65m 278.40m 279.15m

279.15m 279.97m 280.65m 281.65m 282.25m 283.08m



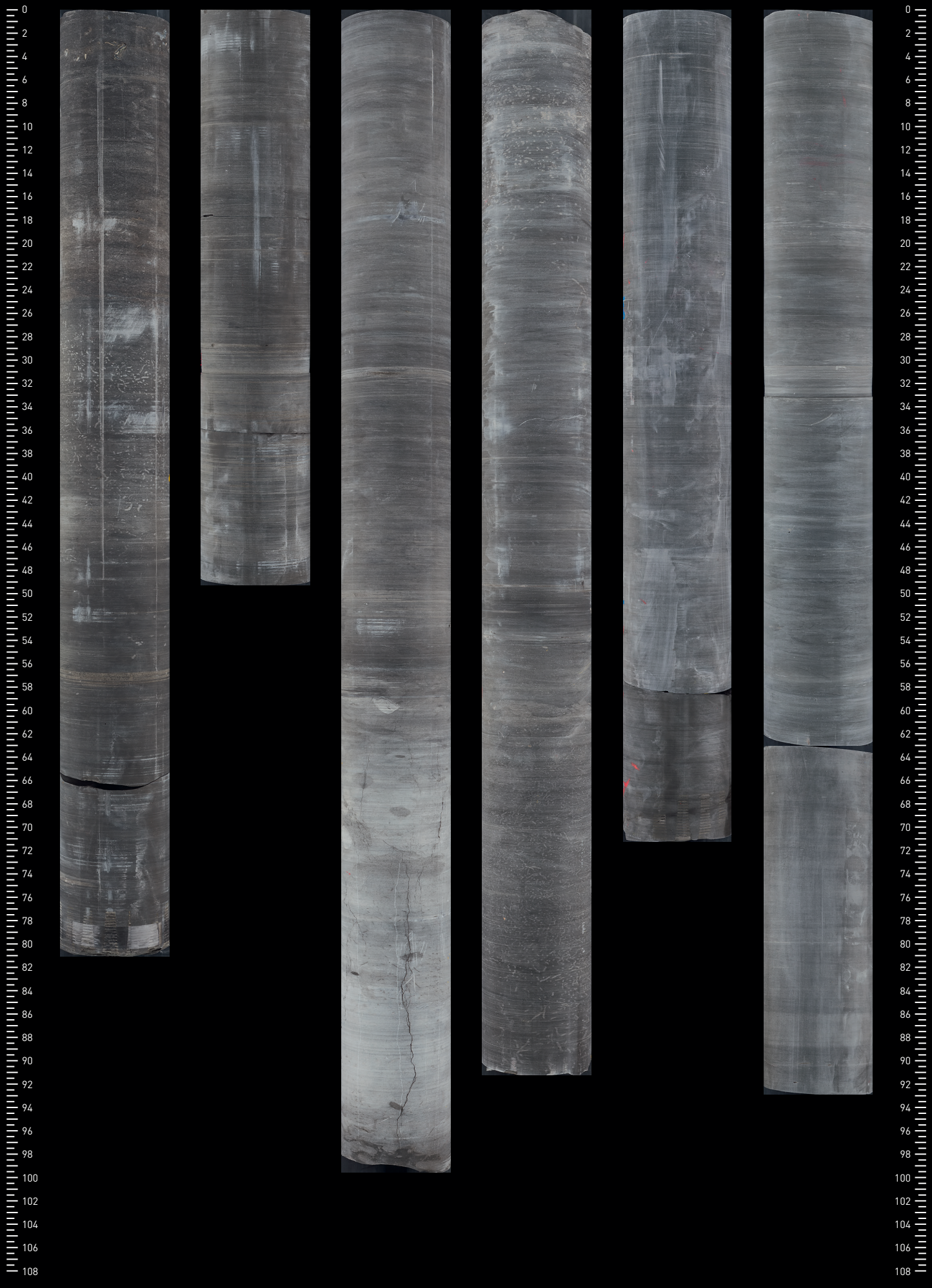
279.97m 280.65m 281.65m 282.25m 283.08m 283.74m

283.74m 284.60m 285.53m 286.08m 286.89m 287.67m



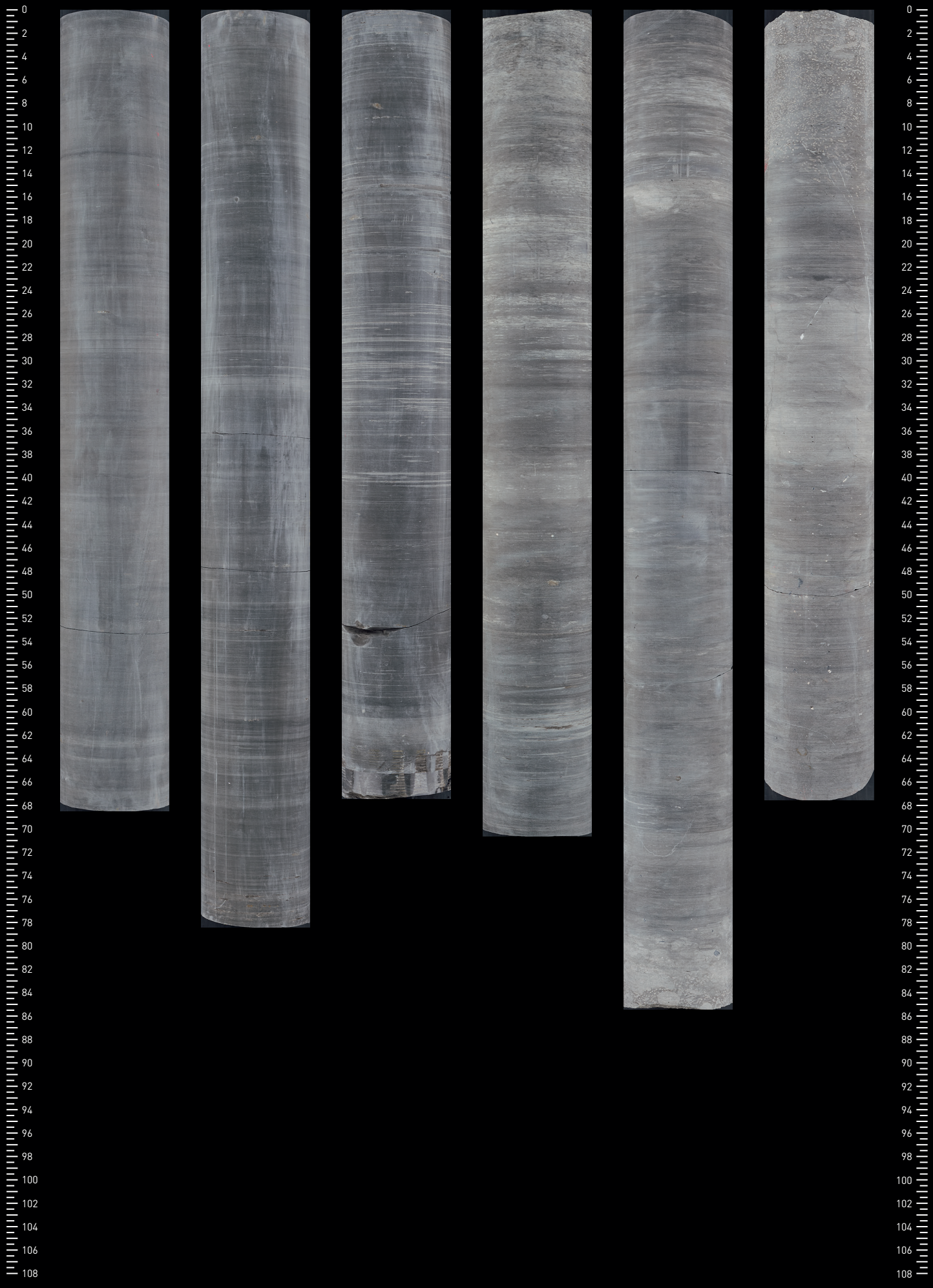
284.60m 285.53m 286.08m 286.89m 287.67m 288.20m

288.20m 288.98m 289.46m 290.43m 291.32m 292.02m



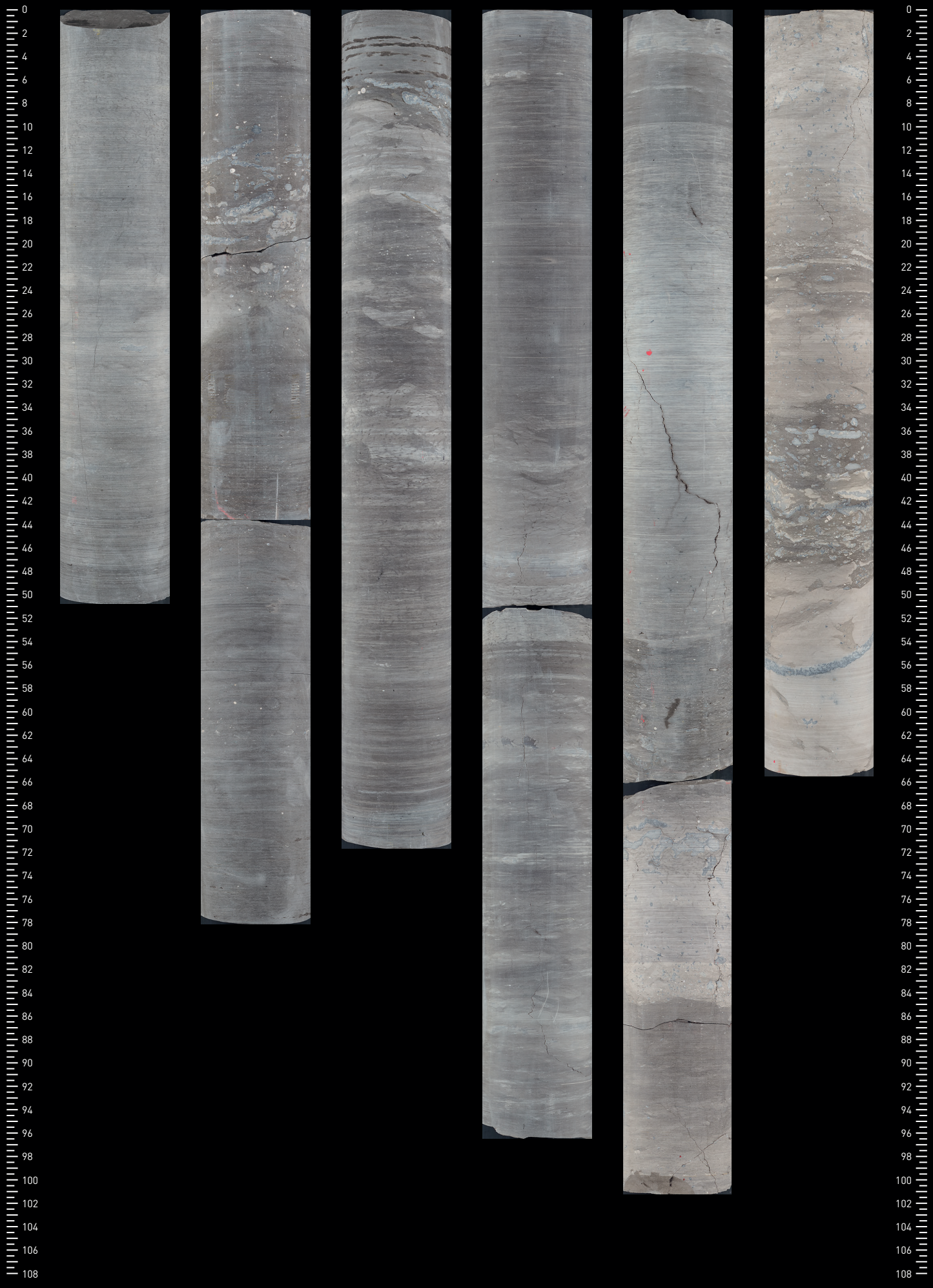
288.98m 289.46m 290.43m 291.32m 292.02m 292.91m

292.91m 293.58m 294.34m 295.00m 295.69m 296.52m



293.58m 294.34m 295.00m 295.69m 296.52m 297.16m

297.16m 297.66m 298.41m 299.11m 300.06m 301.02m



297.66m 298.41m 299.11m 300.06m 301.02m 301.66m

301.66m 302.36m 303.21m 304.04m 304.32m 305.18m



302.36m 303.21m 304.04m 304.32m 305.18m 305.93m

305.93m 306.88m 307.66m 308.62m 309.50m 310.15m



306.88m 307.66m 308.62m 309.50m 310.15m 311.01m

311.01m 311.80m 312.43m 313.03m 313.81m 314.47m



311.80m 312.43m 313.03m 313.81m 314.47m 315.34m

315.34m 316.05m 317.00m 317.80m 318.62m 319.11m

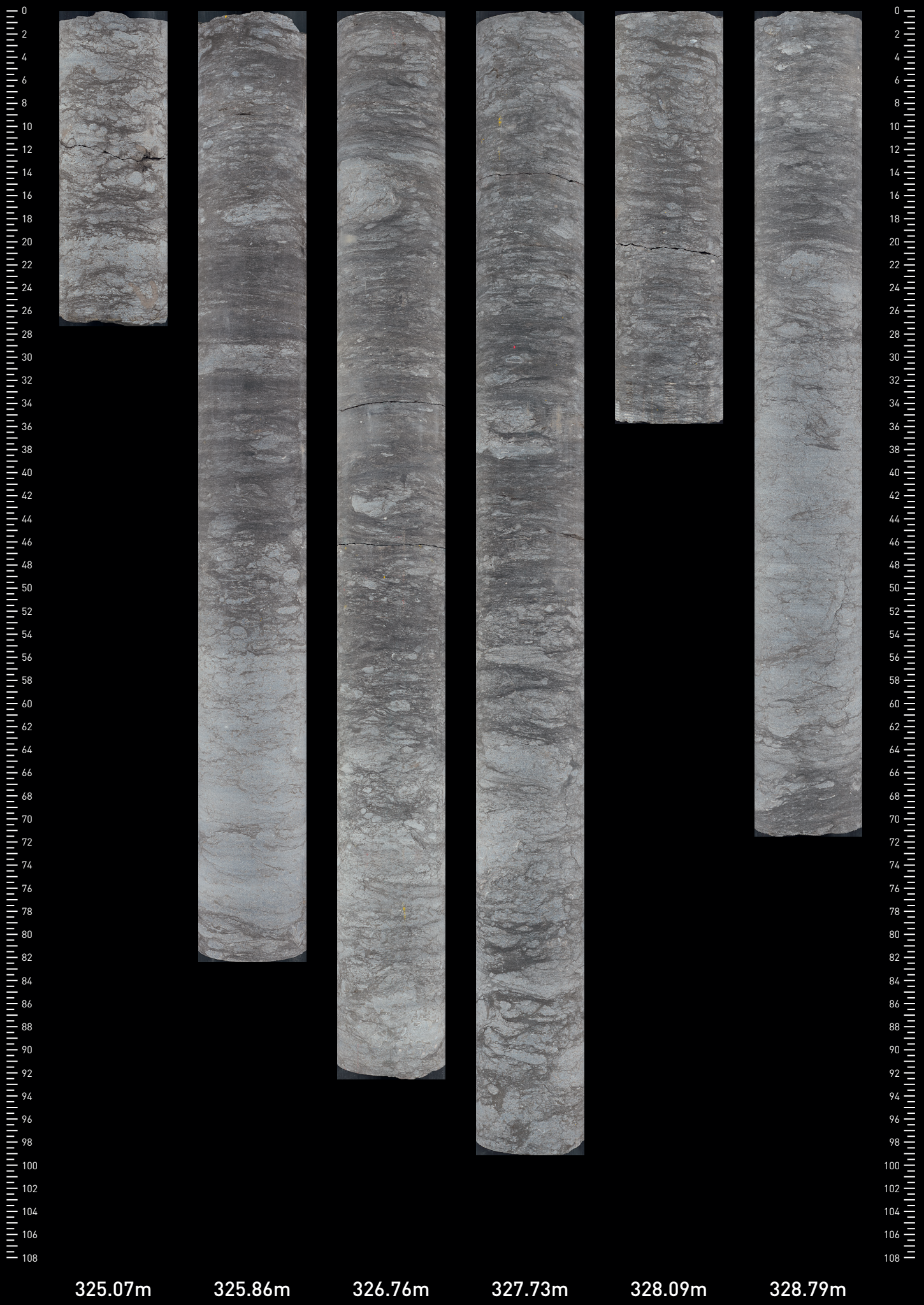


316.05m 317.00m 317.80m 318.62m 319.11m 320.02m

320.02m 320.79m 321.40m 322.14m 323.10m 324.05m



320.79m 321.40m 322.14m 323.10m 324.05m 324.80m

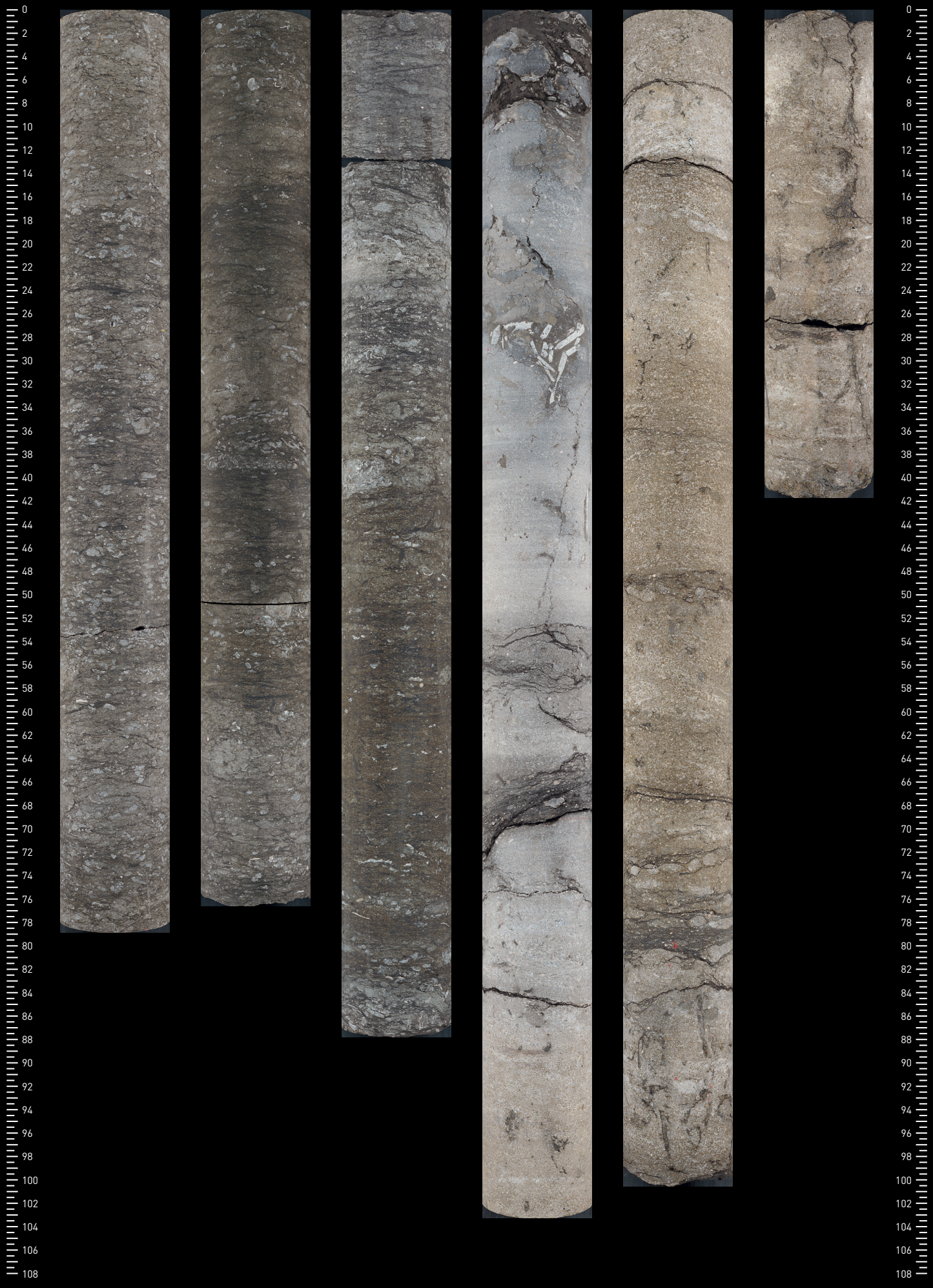

324.80m
325.07m
325.86m
326.76m
327.73m
328.09m
325.07m
325.86m
326.76m
327.73m
328.09m
328.79m

328.79m 329.50m 330.00m 330.58m 331.09m 331.78m



329.50m 330.00m 330.58m 331.09m 331.78m 332.44m

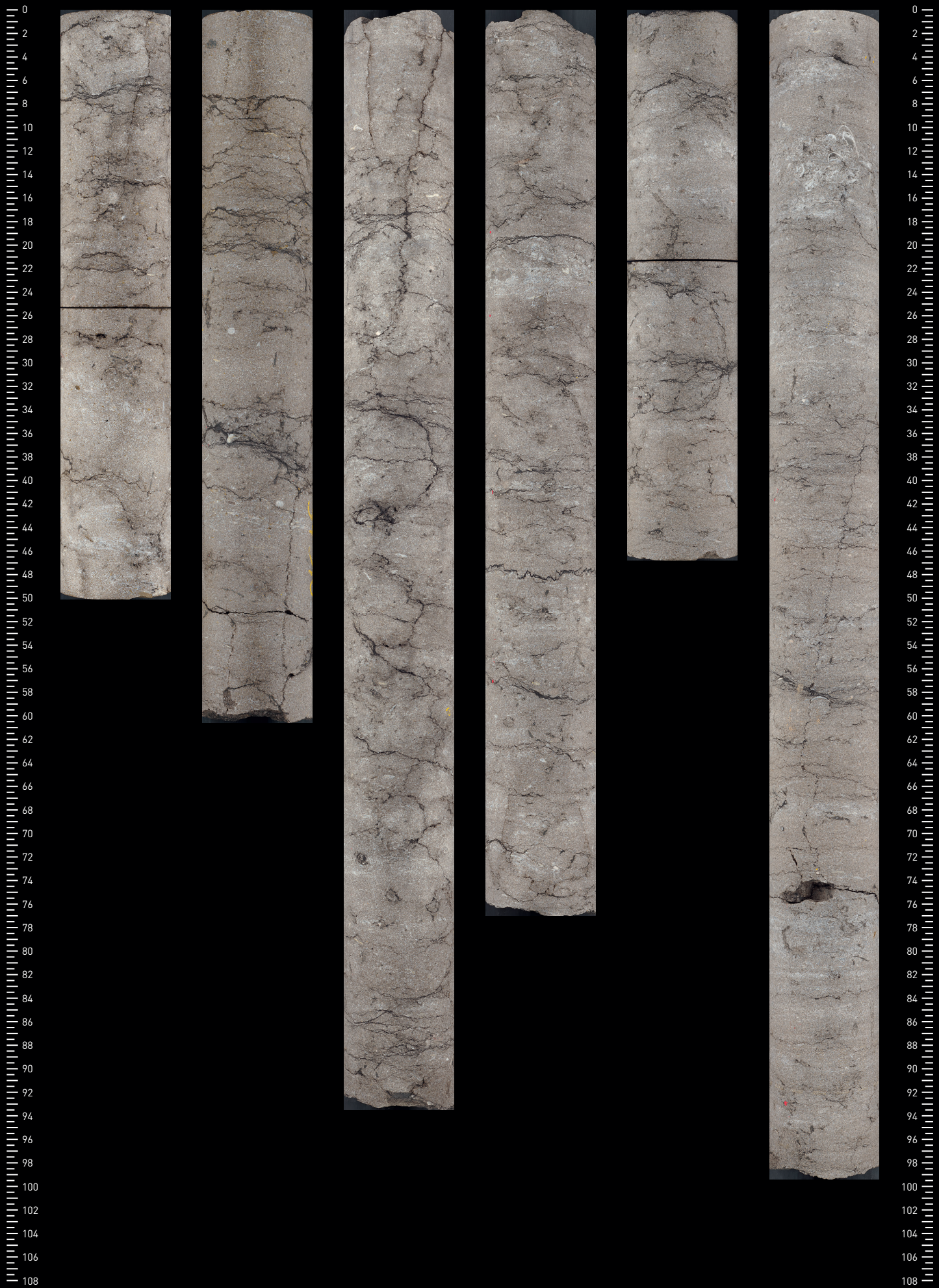
332.44m 333.21m 333.96m 334.81m 335.80m 336.79m



333.21m 333.96m 334.81m 335.80m 336.79m 337.18m

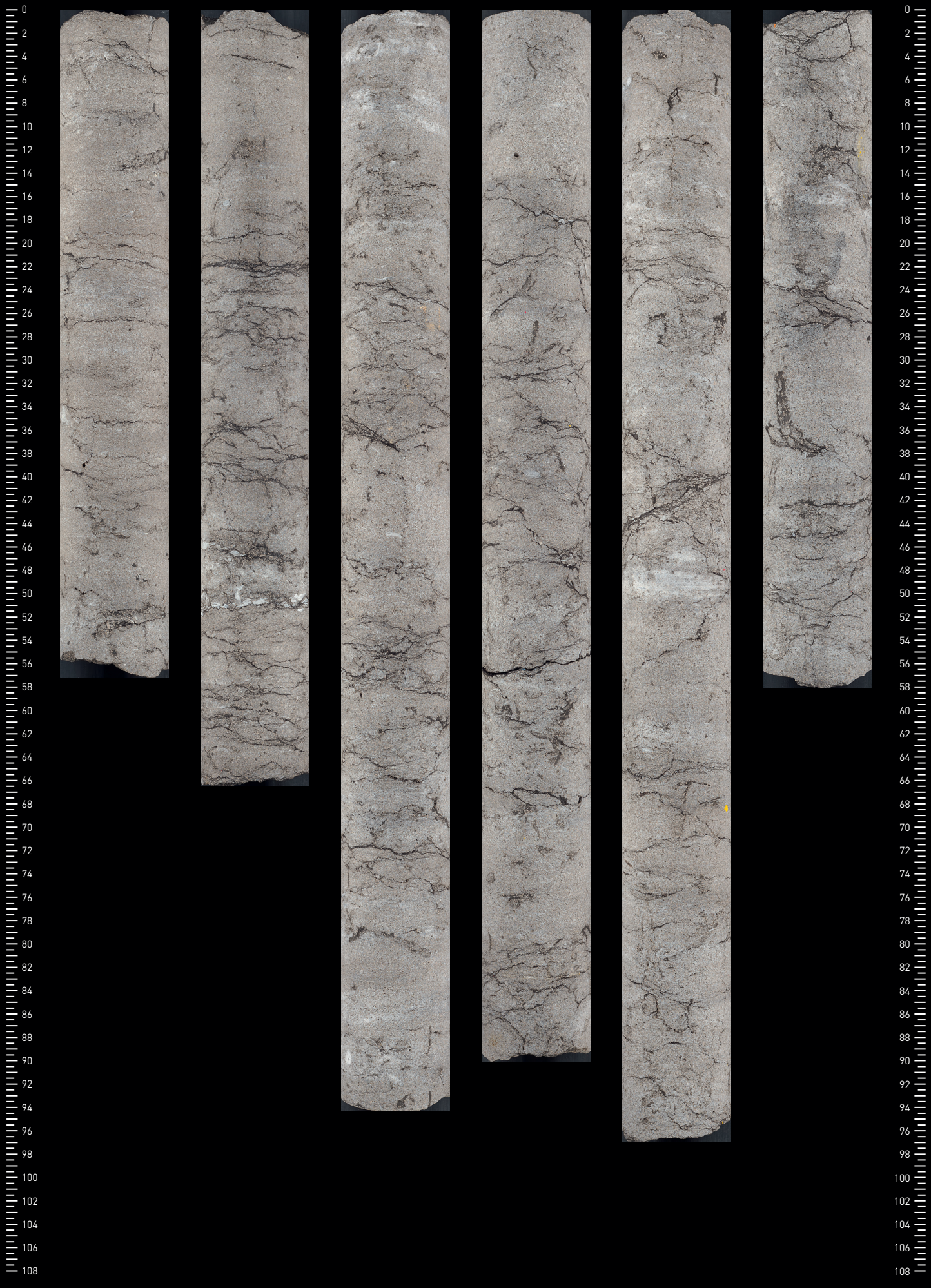

337.18m
338.08m
338.91m
339.37m
340.14m
341.09m
338.08m
338.91m
339.37m
340.14m
341.09m
342.06m

342.06m 342.56m 343.14m 344.04m 344.78m 345.23m



342.56m 343.14m 344.04m 344.78m 345.23m 346.20m

346.20m 346.75m 347.39m 348.30m 349.19m 350.13m



346.75m 347.39m 348.30m 349.19m 350.13m 350.68m

350.68m 351.68m 352.18m 353.05m 353.89m 354.34m



351.68m 352.18m 353.05m 353.89m 354.34m 355.25m

355.25m 356.03m 356.84m 357.24m 358.19m 358.90m



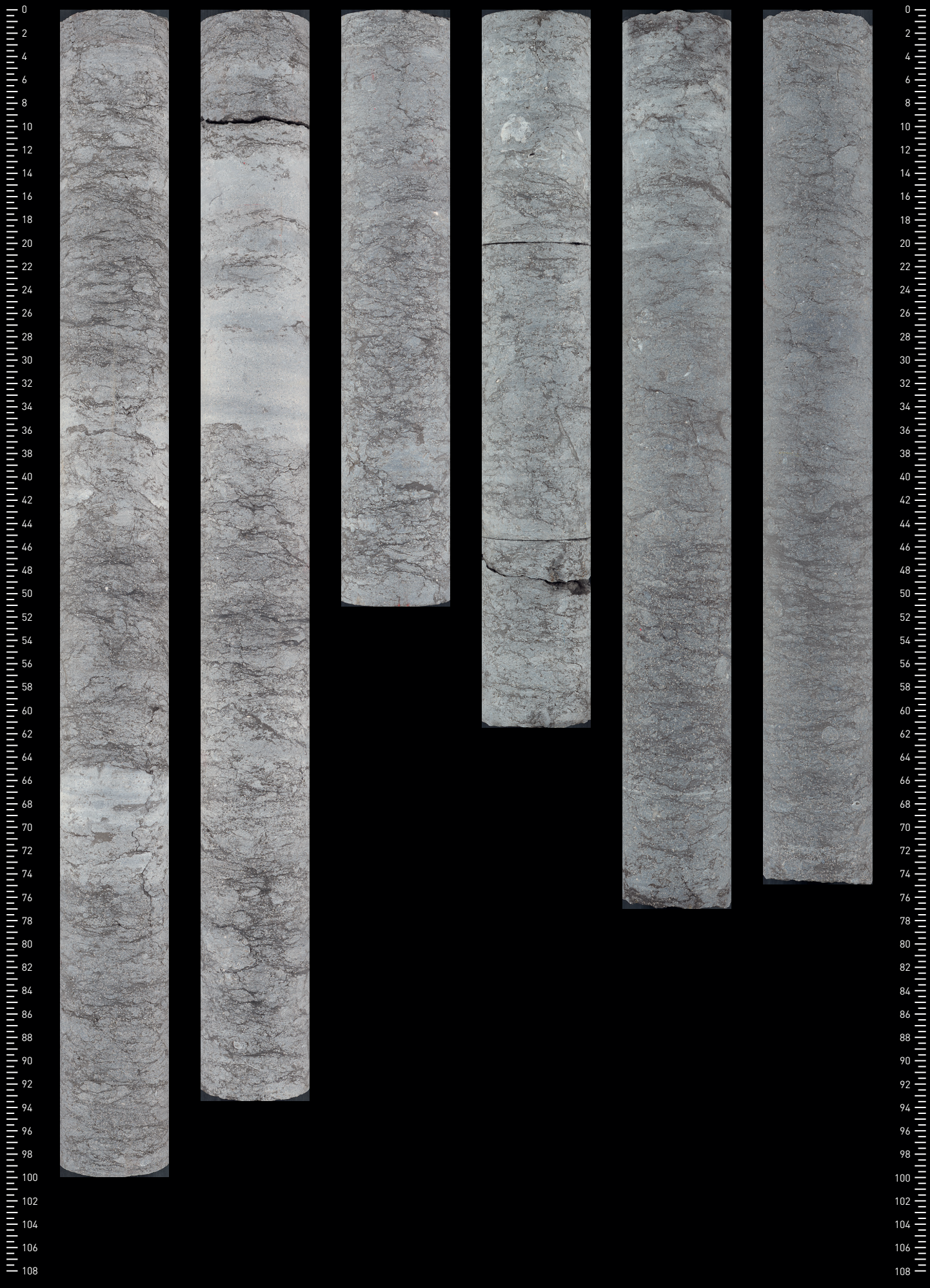
356.03m 356.84m 357.24m 358.19m 358.90m 359.82m

359.82m 360.52m 361.20m 362.10m 363.01m 363.86m



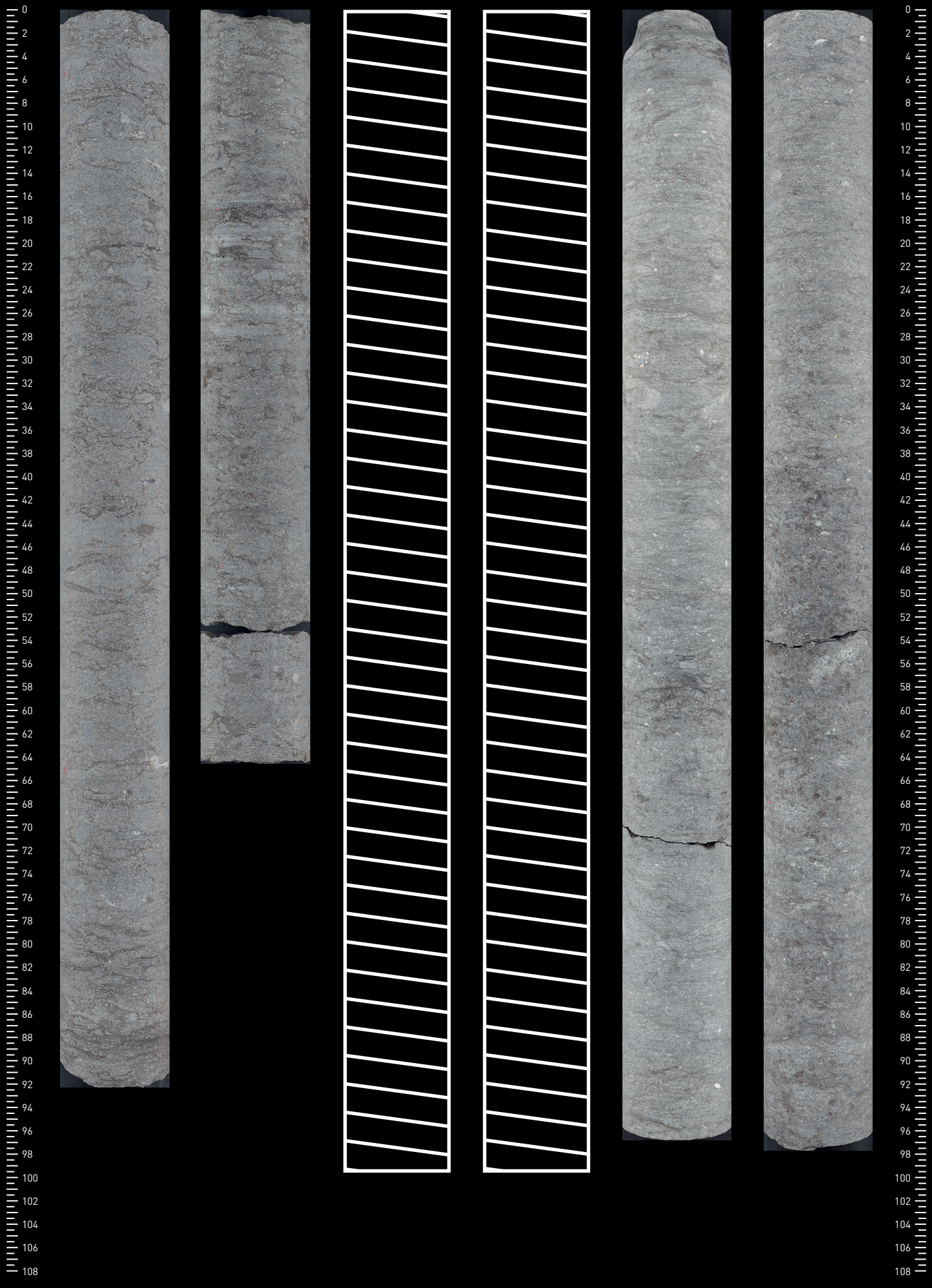
360.52m 361.20m 362.10m 363.01m 363.86m 364.19m

364.19m 365.16m 366.07m 366.58m 367.18m 367.93m



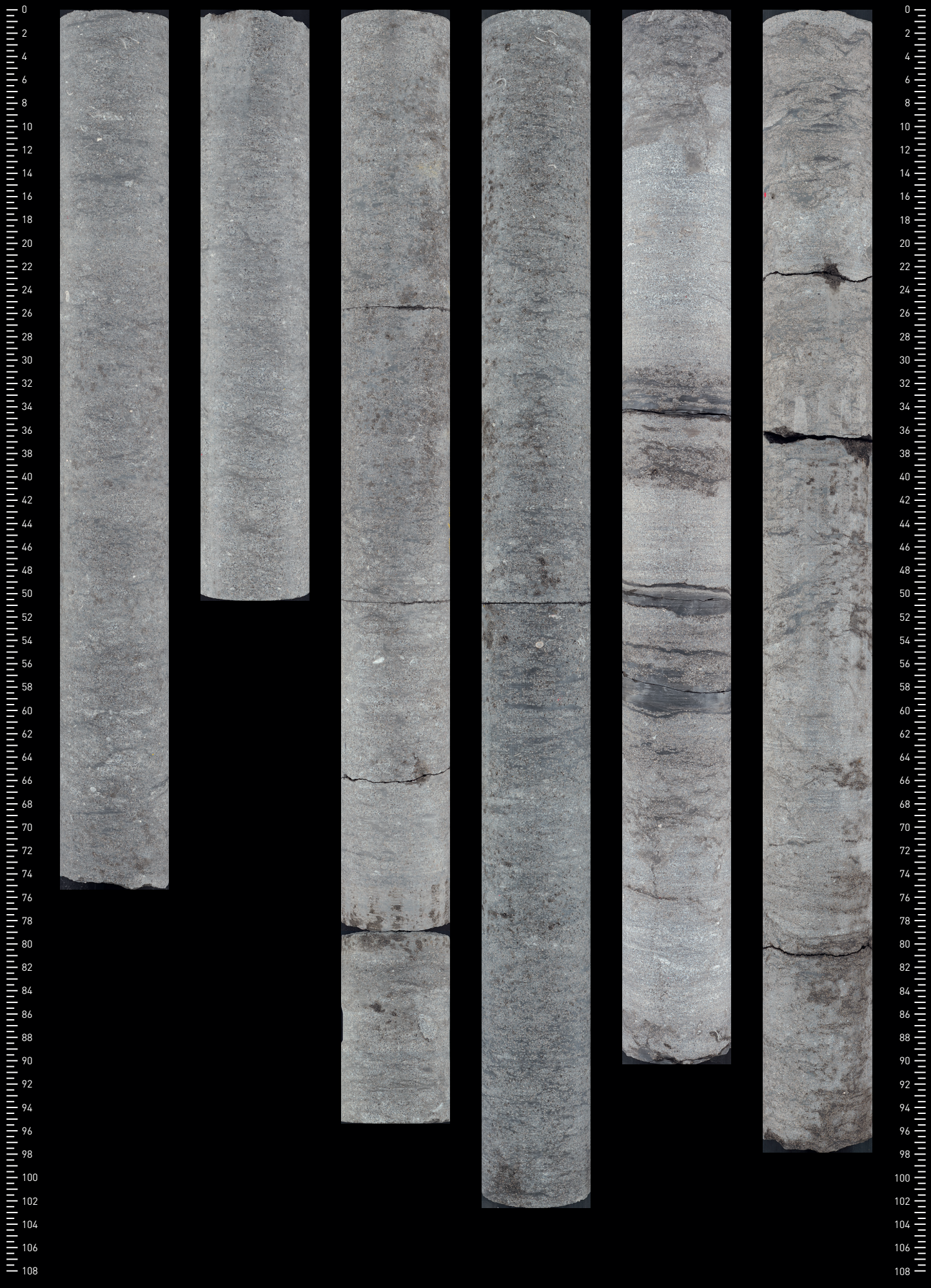
365.16m 366.07m 366.58m 367.18m 367.93m 368.65m

368.65m 369.54m 370.16m 371.00m 372.00m 372.95m

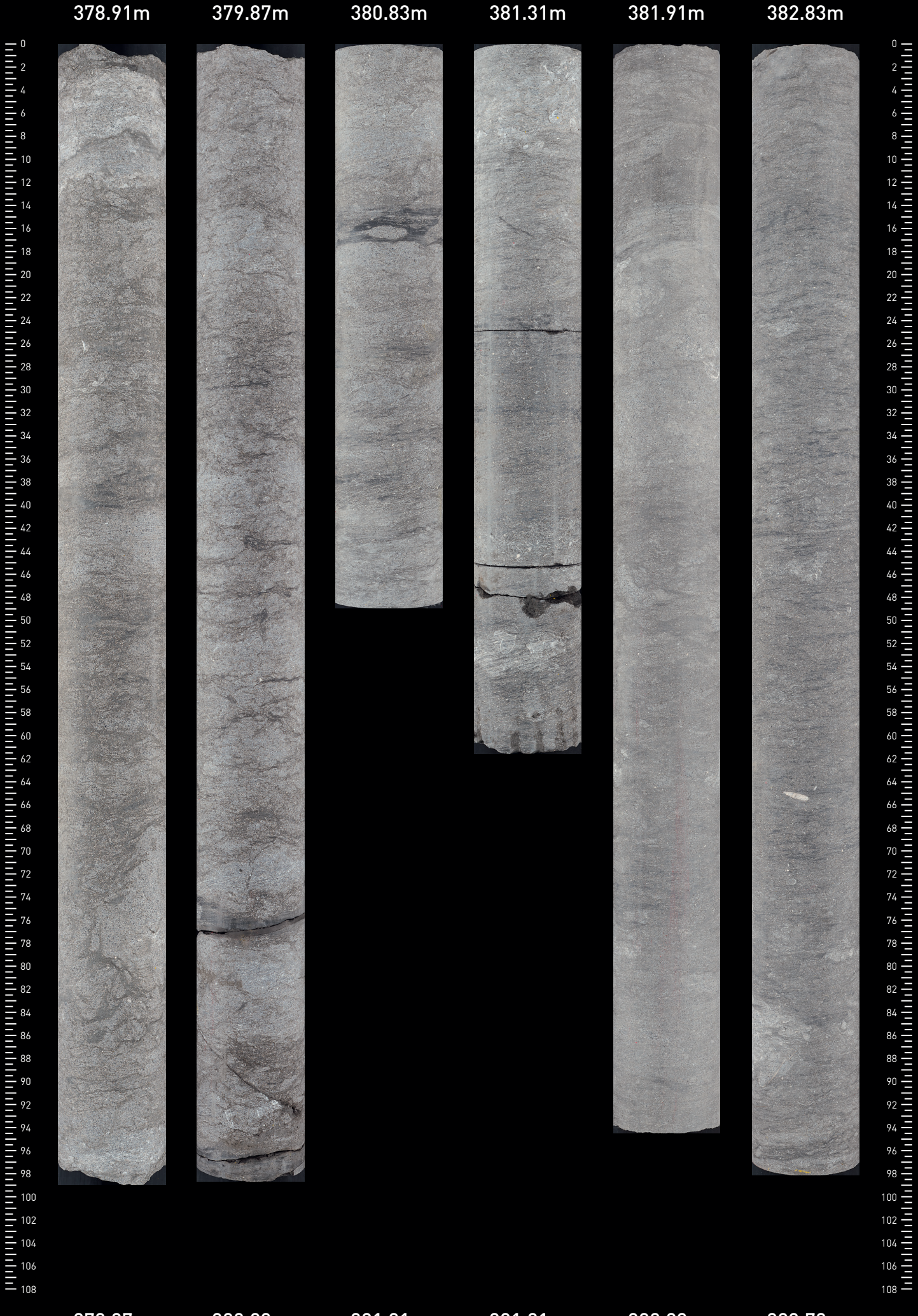


369.54m 370.16m 371.00m 372.00m 372.95m 373.90m

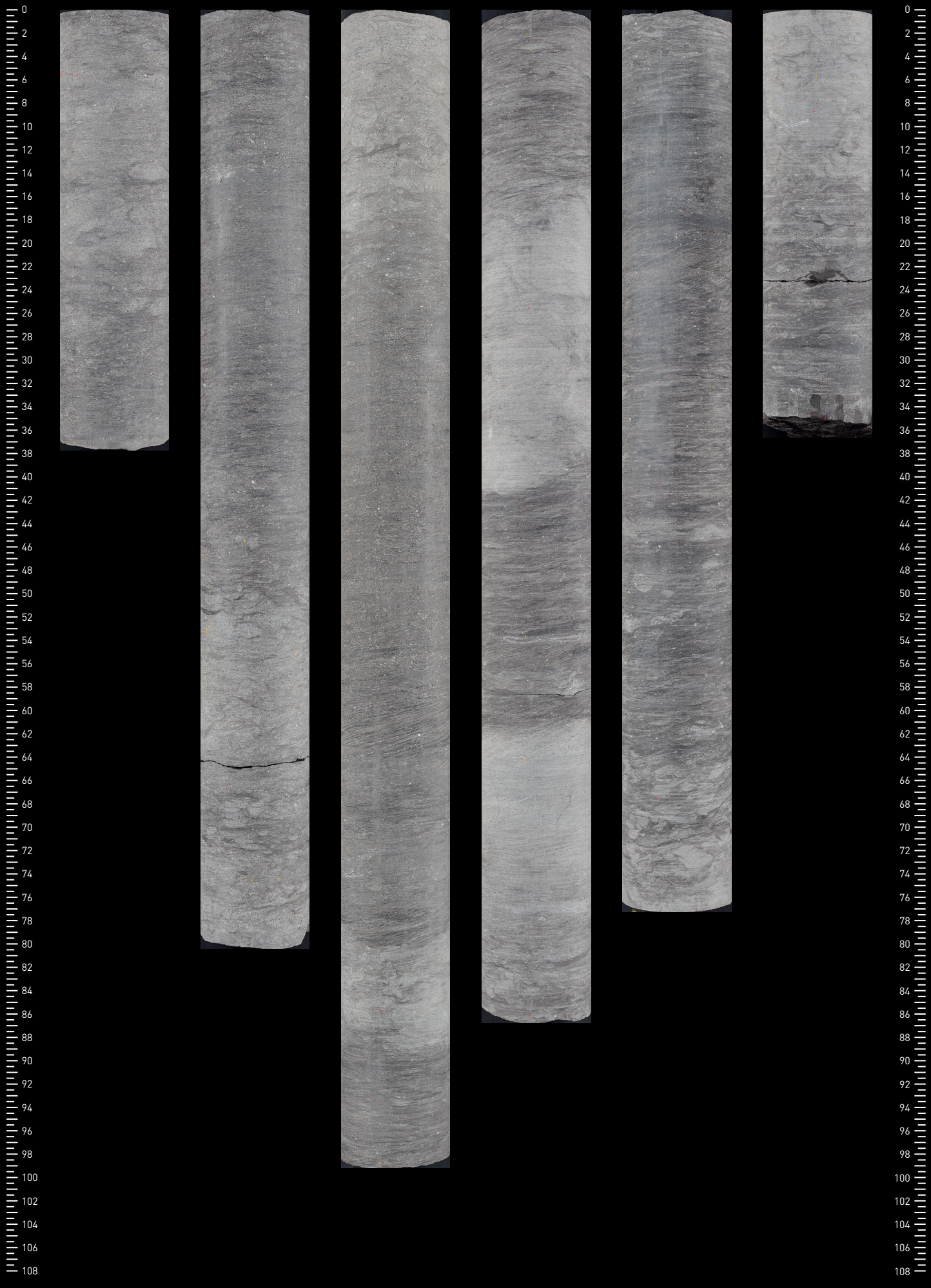
373.90m 374.64m 375.13m 376.07m 377.07m 377.96m



374.64m 375.13m 376.07m 377.07m 377.96m 378.91m

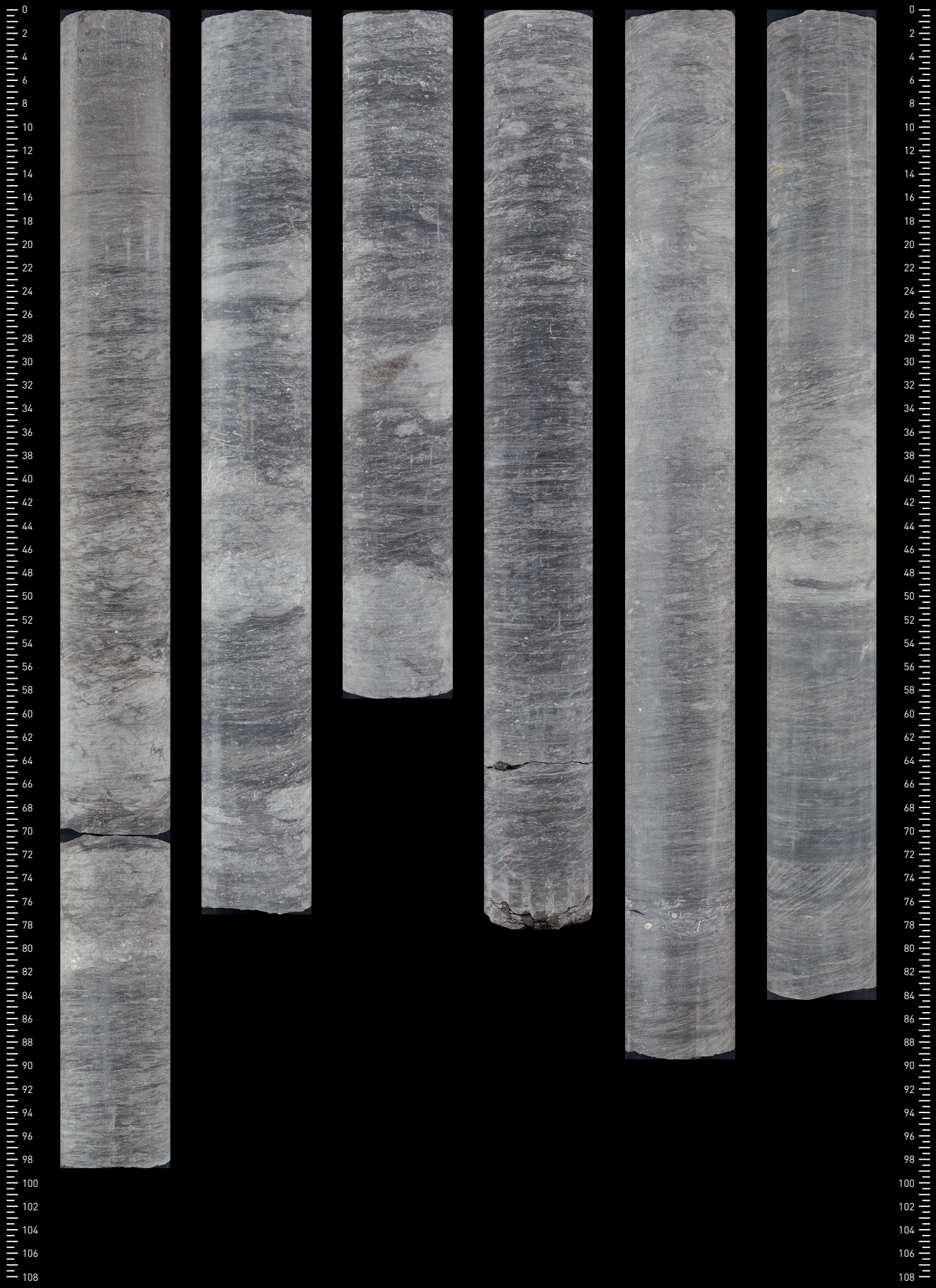

378.91m
379.87m
380.83m
381.31m
381.91m
382.83m
379.87m
380.83m
381.31m
381.91m
382.83m
383.79m

383.79m 384.16m 384.94m 385.91m 386.75m 387.50m



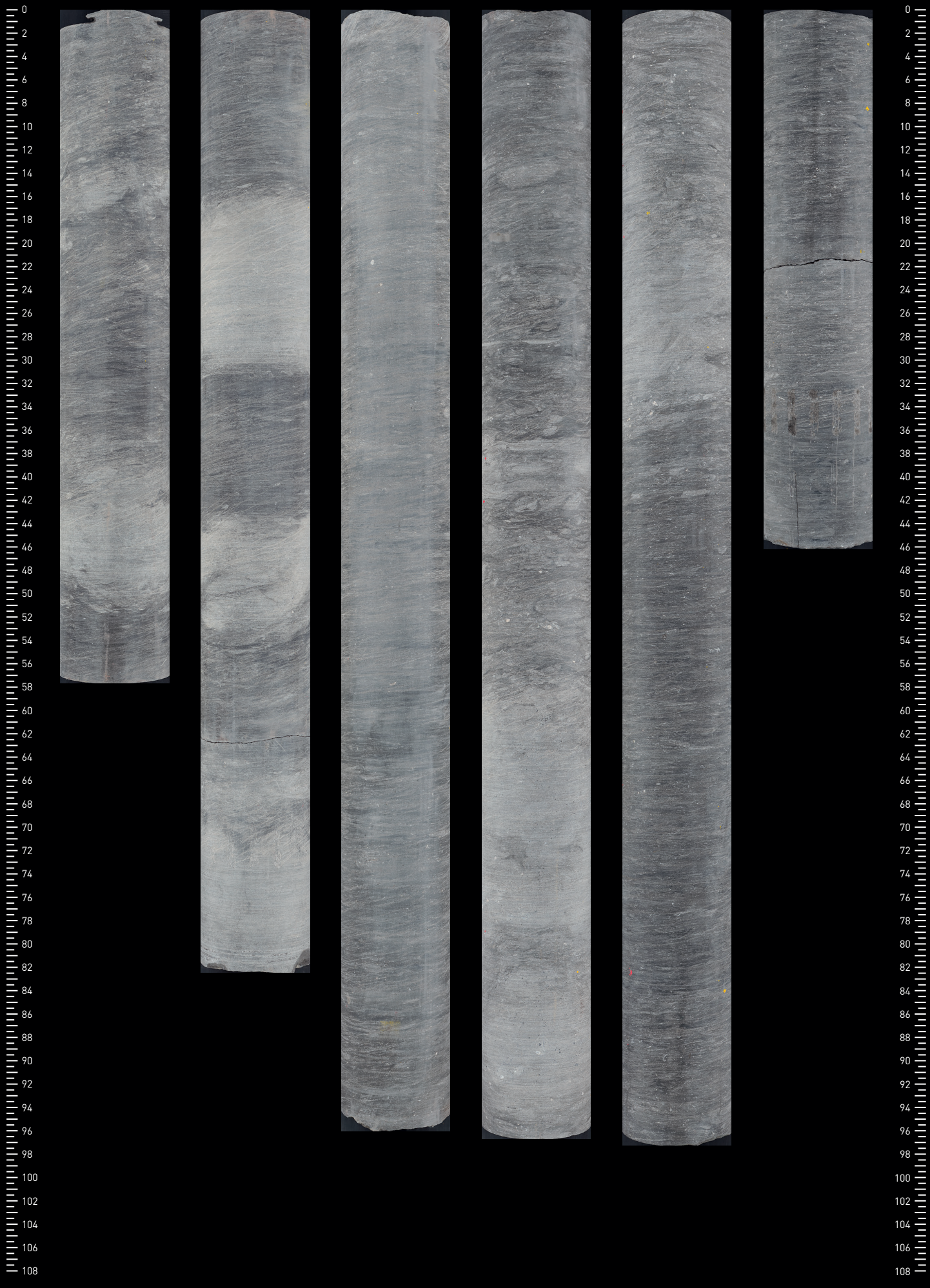
384.16m 384.94m 385.91m 386.75m 387.50m 387.87m

387.87m 388.83m 389.59m 390.16m 390.92m 391.80m



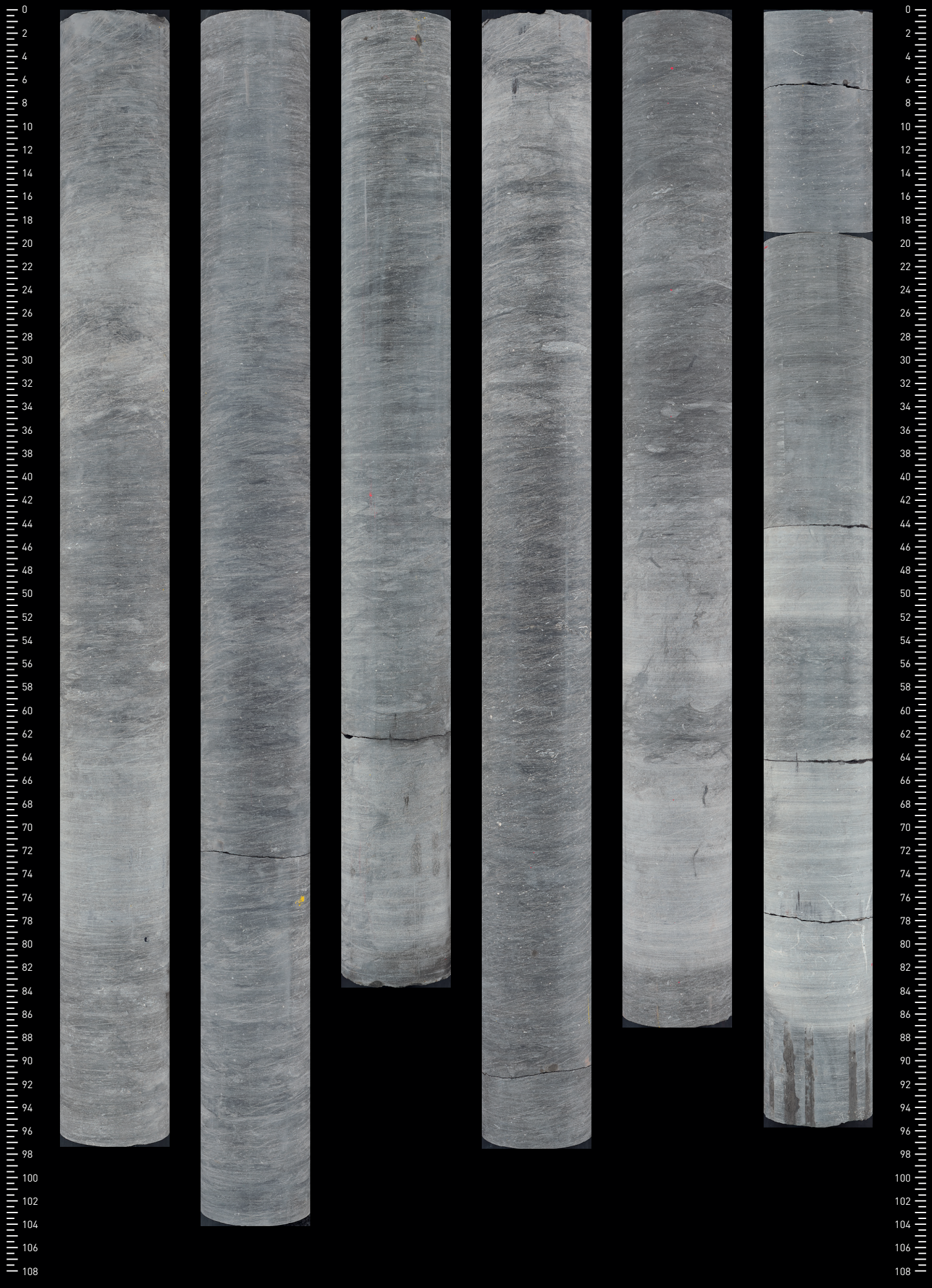
388.83m 389.59m 390.16m 390.92m 391.80m 392.61m

392.61m 393.17m 393.98m 394.90m 395.85m 396.80m

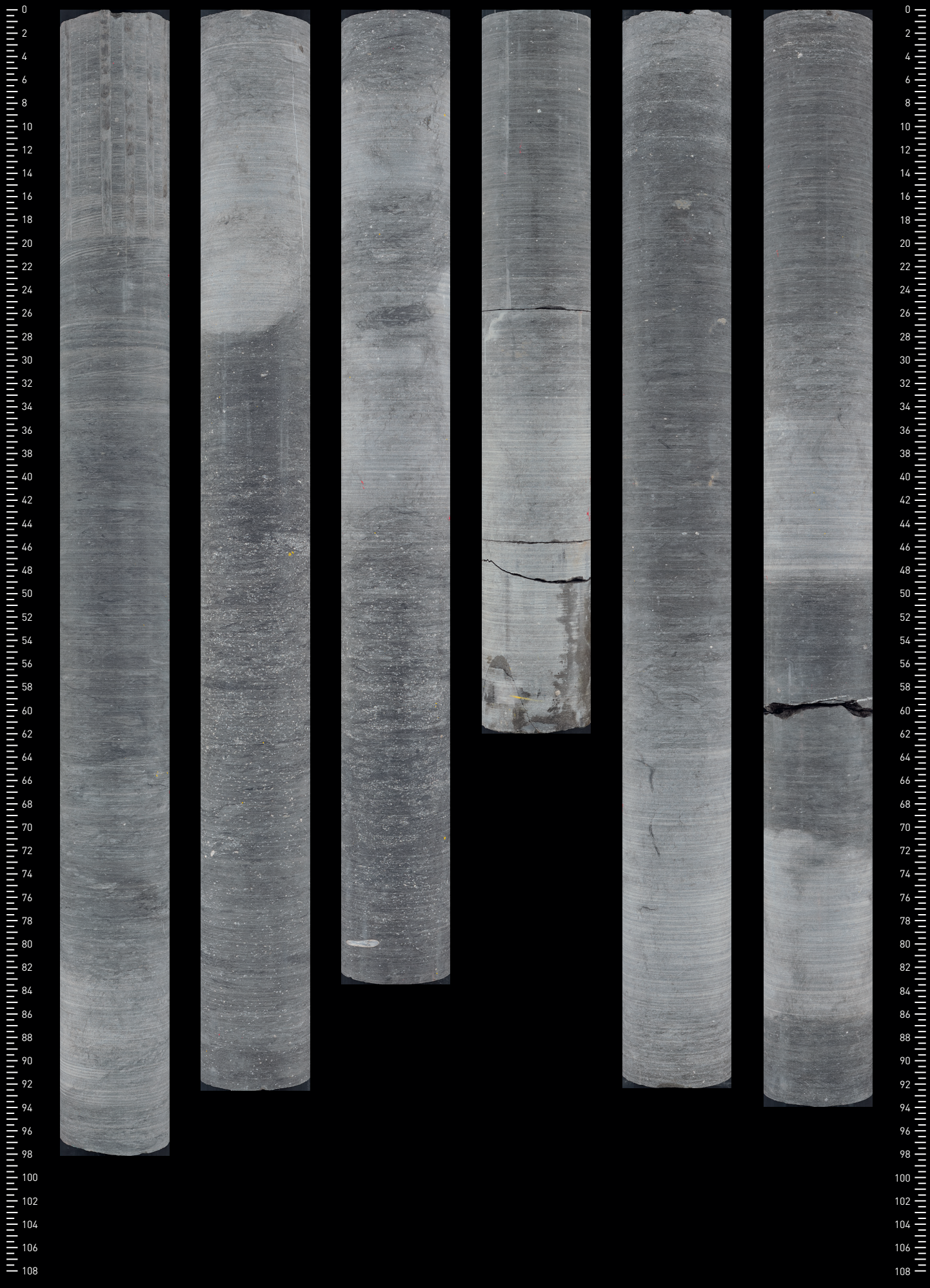


393.17m 393.98m 394.90m 395.85m 396.80m 397.25m

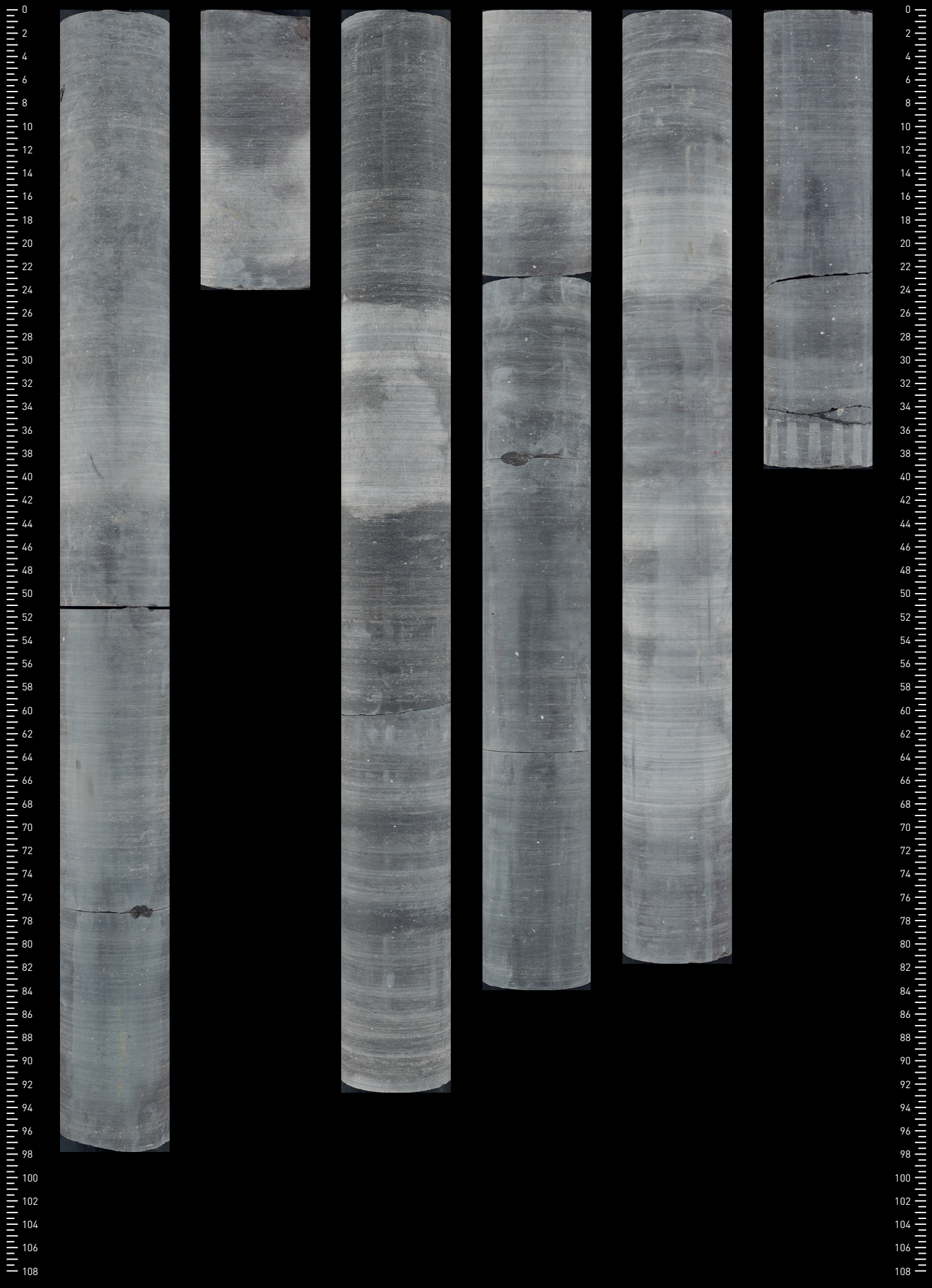
397.25m 398.20m 399.22m 400.03m 400.98m 401.83m



398.20m 399.22m 400.03m 400.98m 401.83m 402.77m

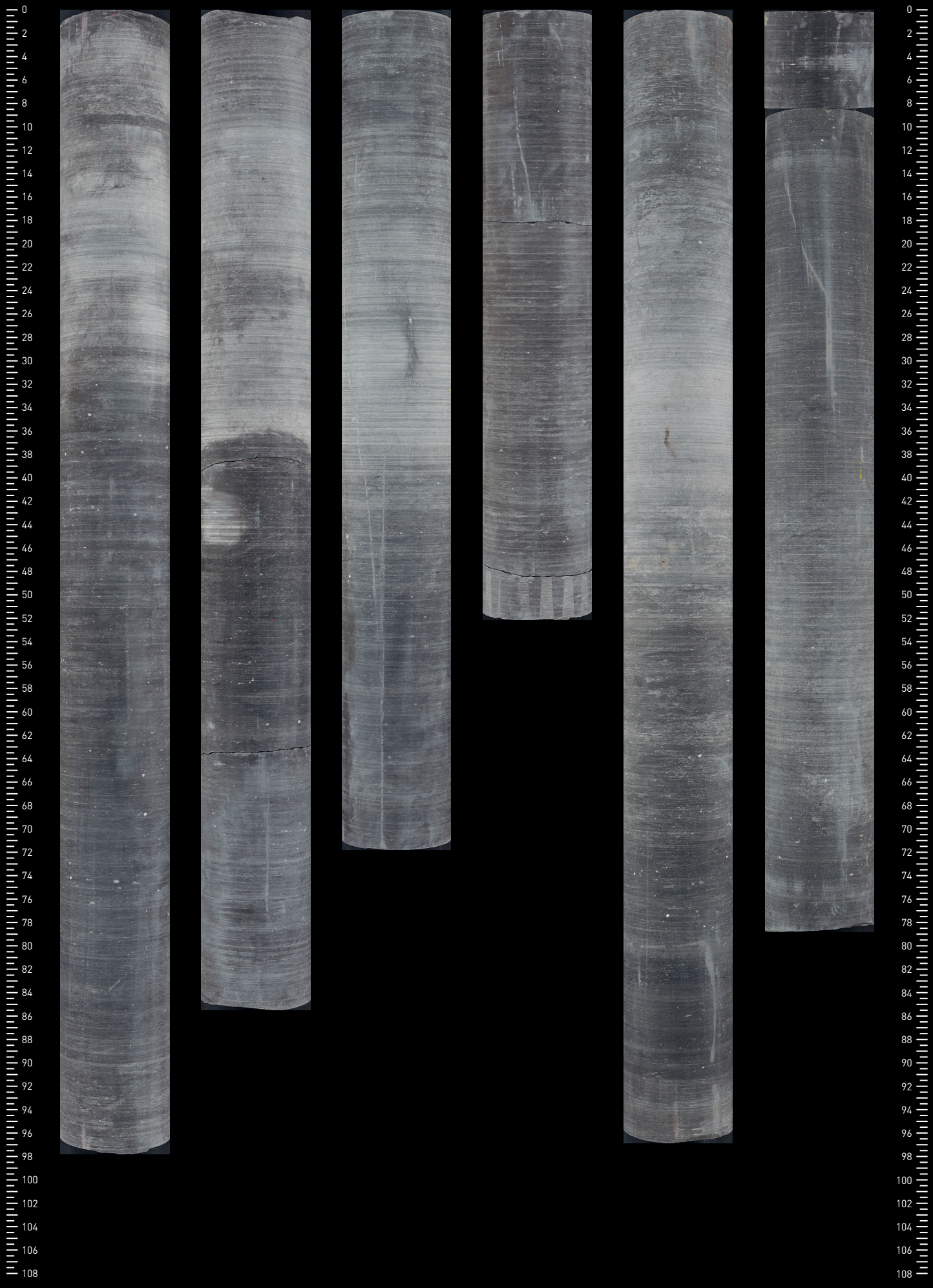

402.77m
403.72m
404.62m
405.43m
406.04m
406.94m
403.72m
404.62m
405.43m
406.04m
406.94m
407.87m

407.87m 408.82m 409.05m 409.95m 410.78m 411.58m



408.82m 409.05m 409.95m 410.78m 411.58m 411.97m

411.97m 412.92m 413.75m 414.45m 414.96m 415.90m



412.92m 413.75m 414.45m 414.96m 415.90m 416.68m

416.68m 417.45m 418.17m 418.67m 419.60m 420.44m



417.45m 418.17m 418.67m 419.60m 420.44m 421.02m

421.02m 421.82m 422.40m 423.20m 424.07m 424.97m



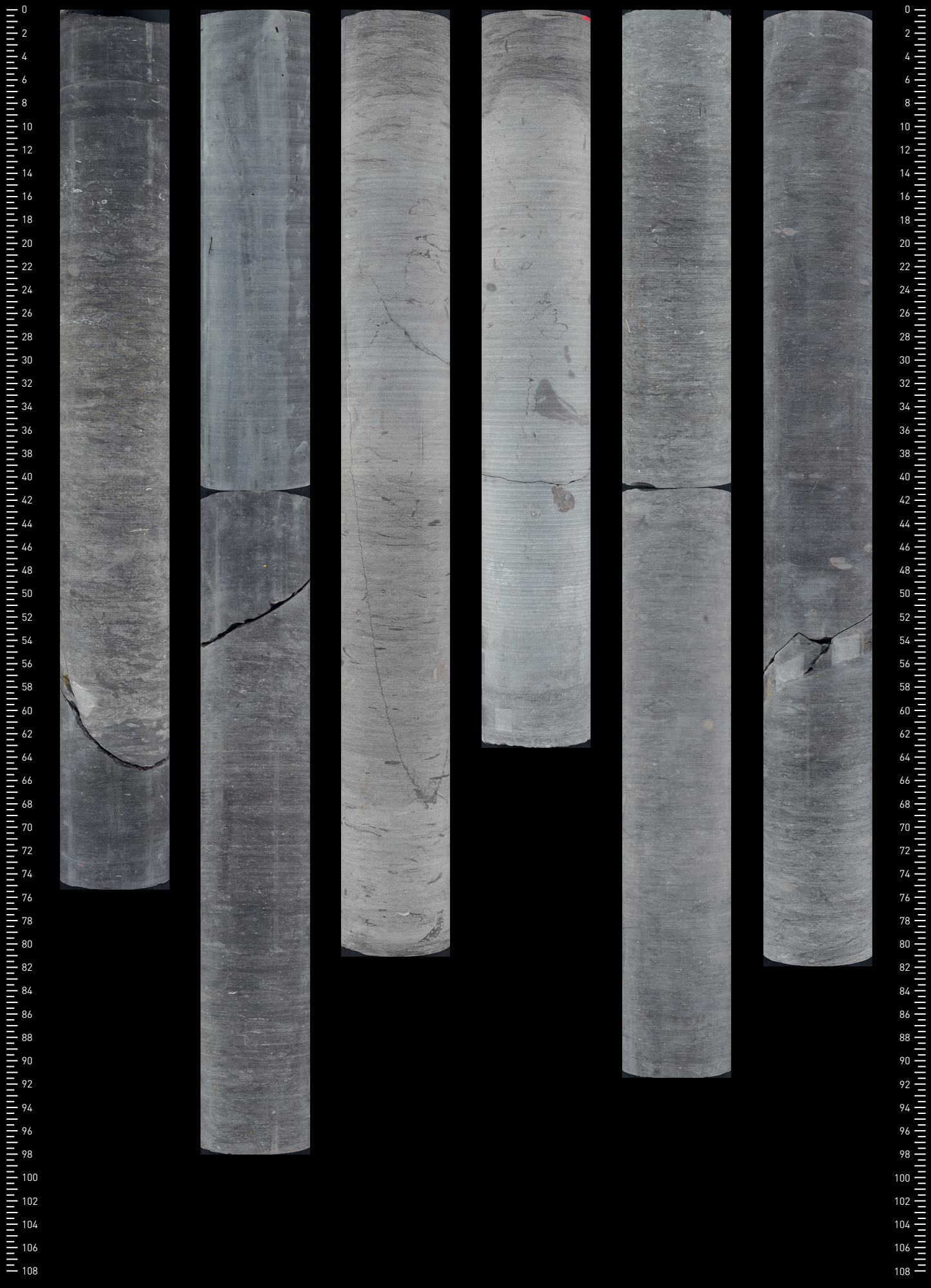
421.82m 422.40m 423.20m 424.07m 424.97m 425.34m

425.34m 426.24m 426.67m 427.37m 428.42m 429.32m



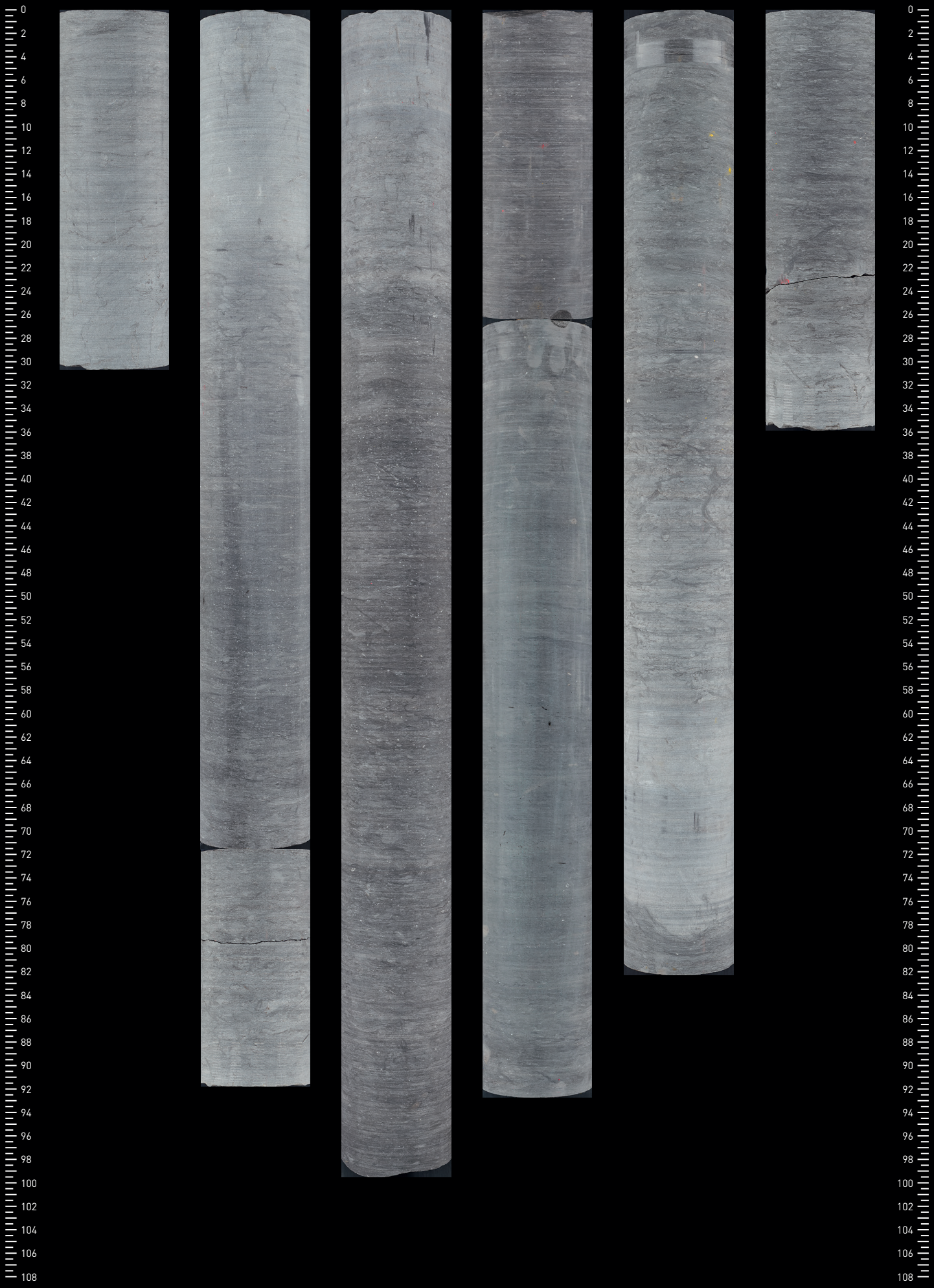
426.24m 426.67m 427.37m 428.42m 429.32m 429.99m

429.99m 430.73m 431.69m 432.48m 433.10m 434.00m



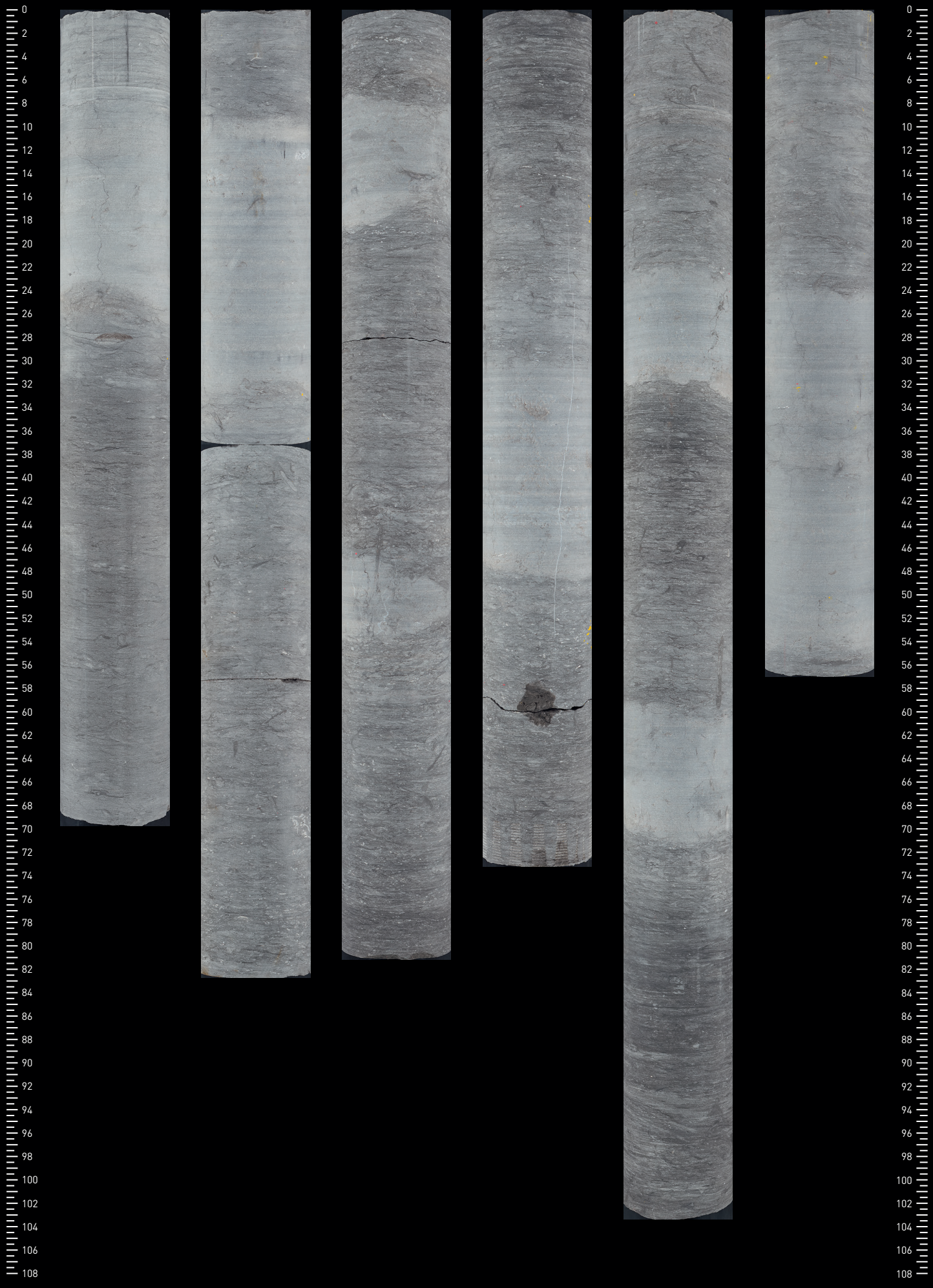
430.73m 431.69m 432.48m 433.10m 434.00m 434.80m

434.80m 435.10m 435.99m 436.96m 437.87m 438.66m



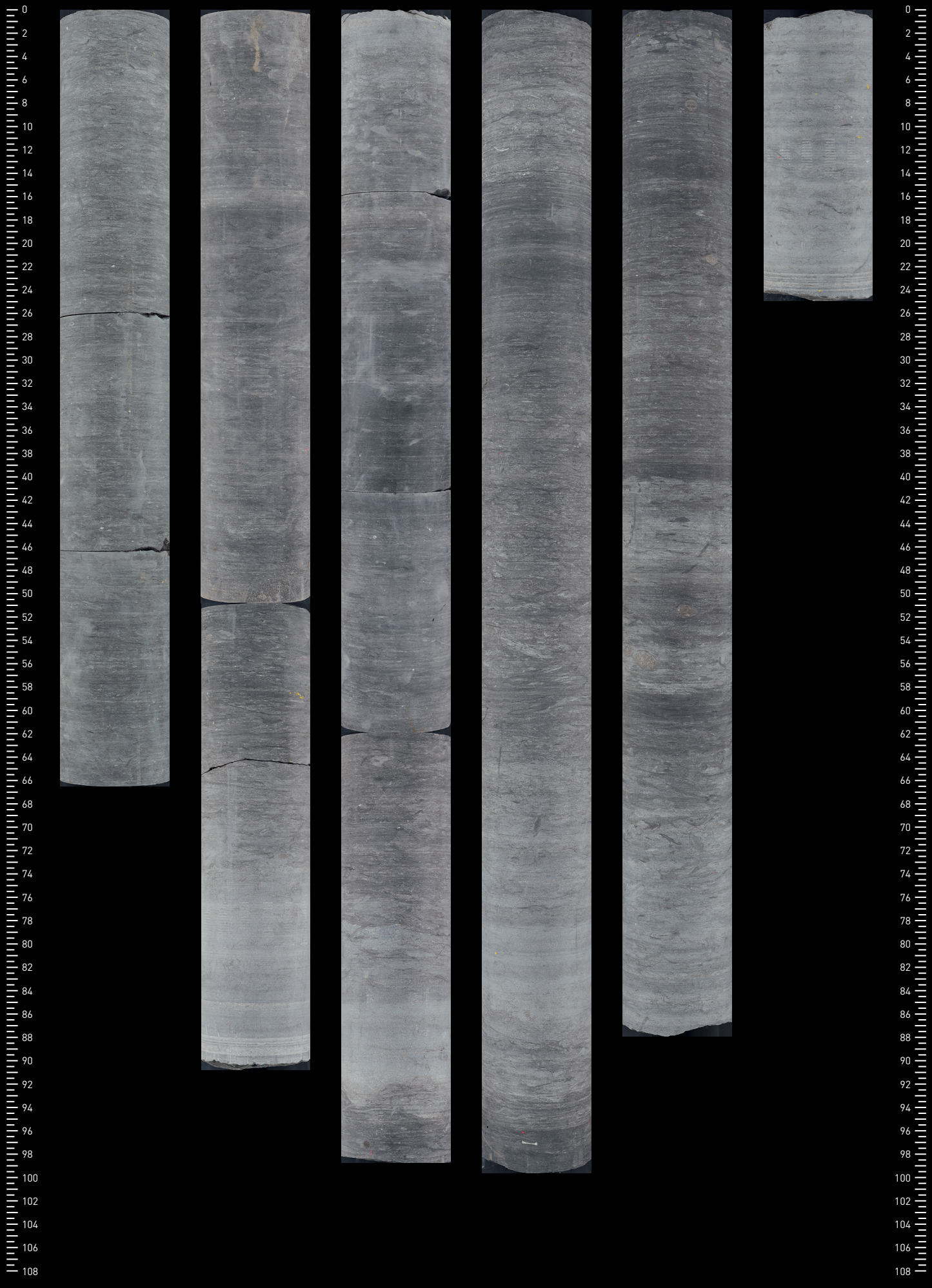
435.10m 435.99m 436.96m 437.87m 438.66m 439.01m

439.01m 439.69m 440.50m 441.30m 442.03m 443.02m



439.69m 440.50m 441.30m 442.03m 443.02m 443.58m

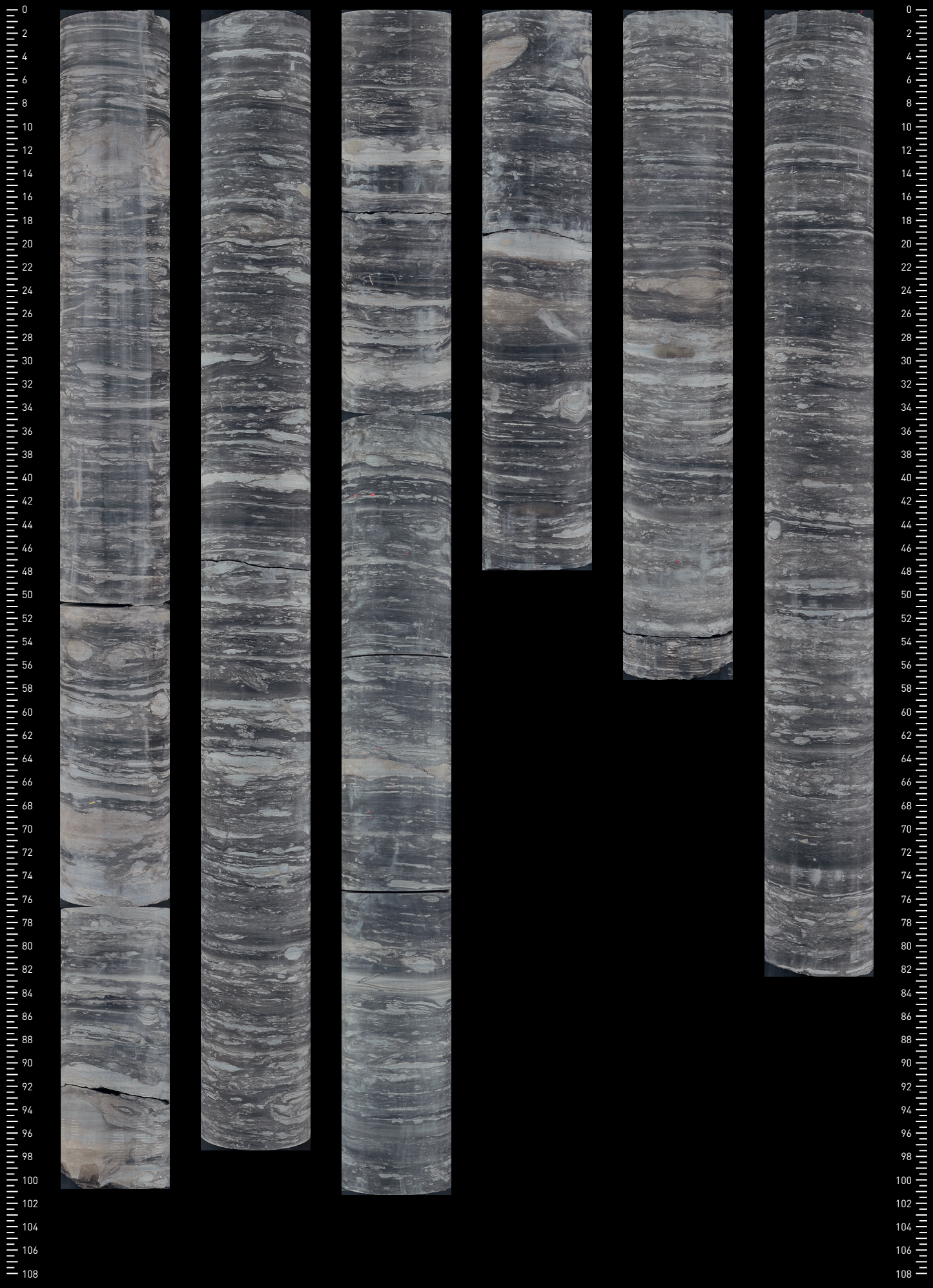
443.58m 444.23m 445.12m 446.09m 447.06m 447.91m



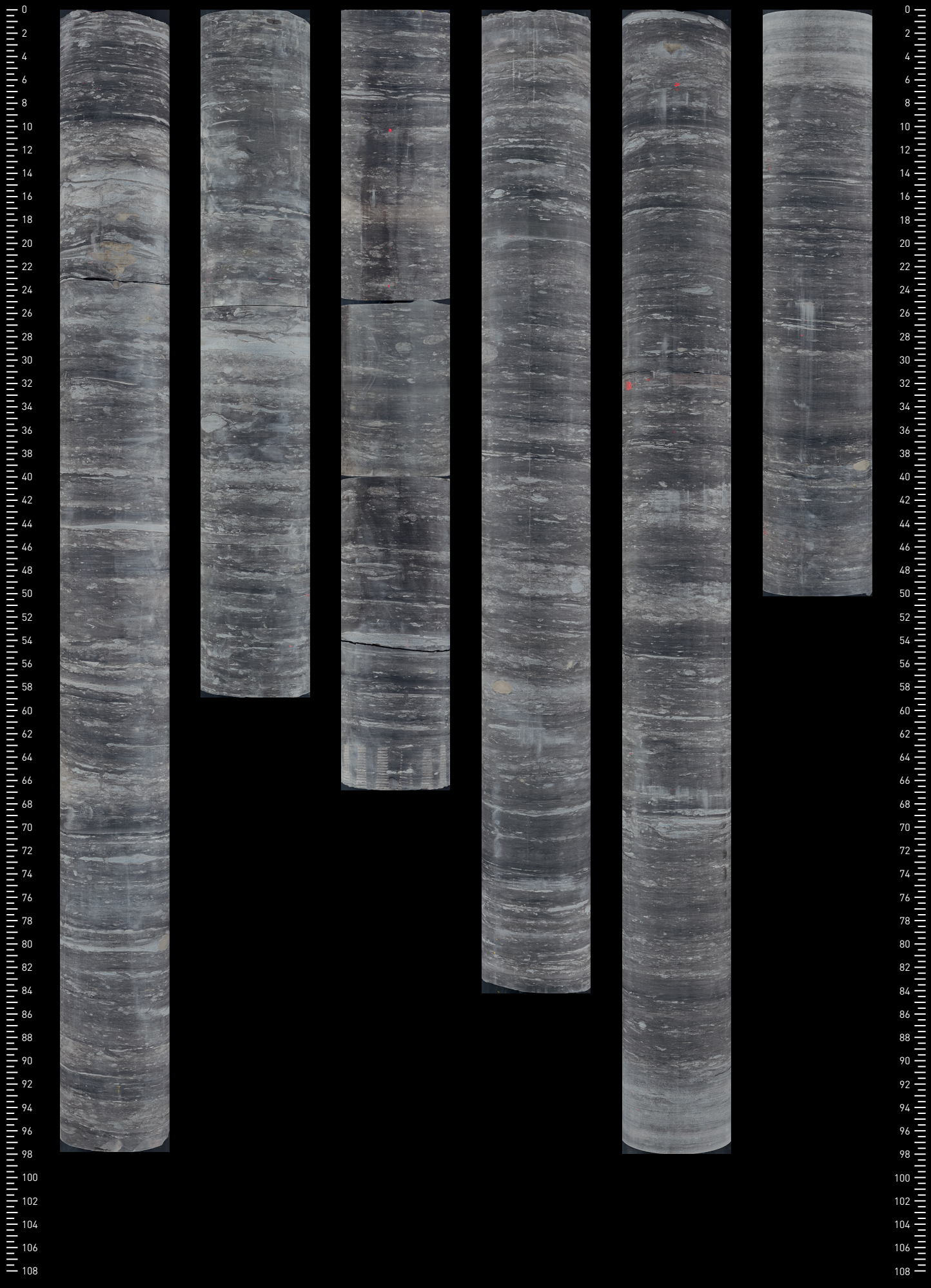
444.23m 445.12m 446.09m 447.06m 447.91m 448.15m


448.15m
449.10m
449.67m
450.57m
451.16m
452.13m
449.10m
449.67m
450.57m
451.16m
452.13m
453.09m

453.09m 454.08m 455.03m 456.01m 456.48m 457.05m



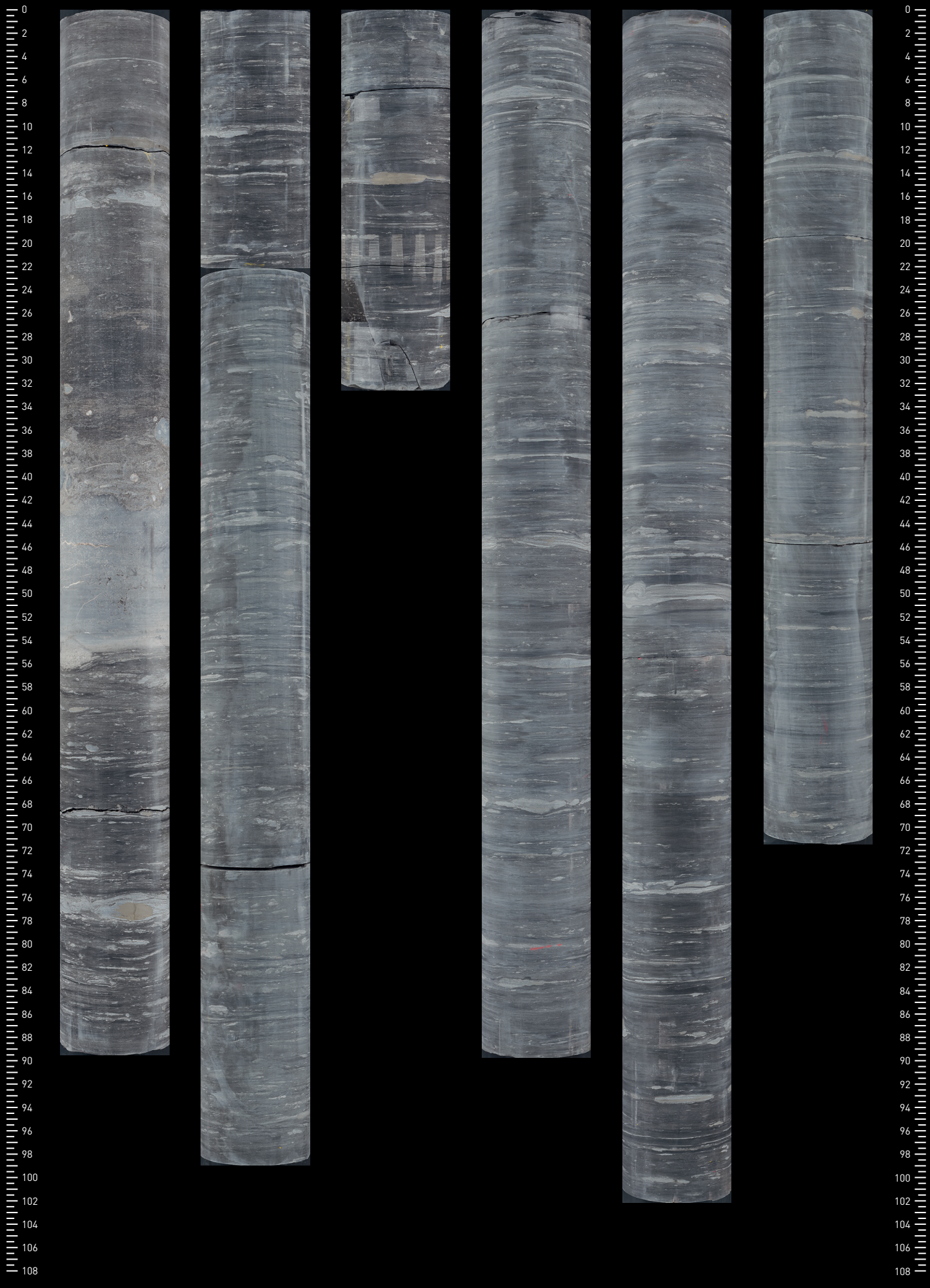
454.08m 455.03m 456.01m 456.48m 457.05m 457.85m


457.85m
458.81m
459.38m
460.05m
460.88m
461.83m
458.81m
459.38m
460.05m
460.88m
461.83m
462.32m

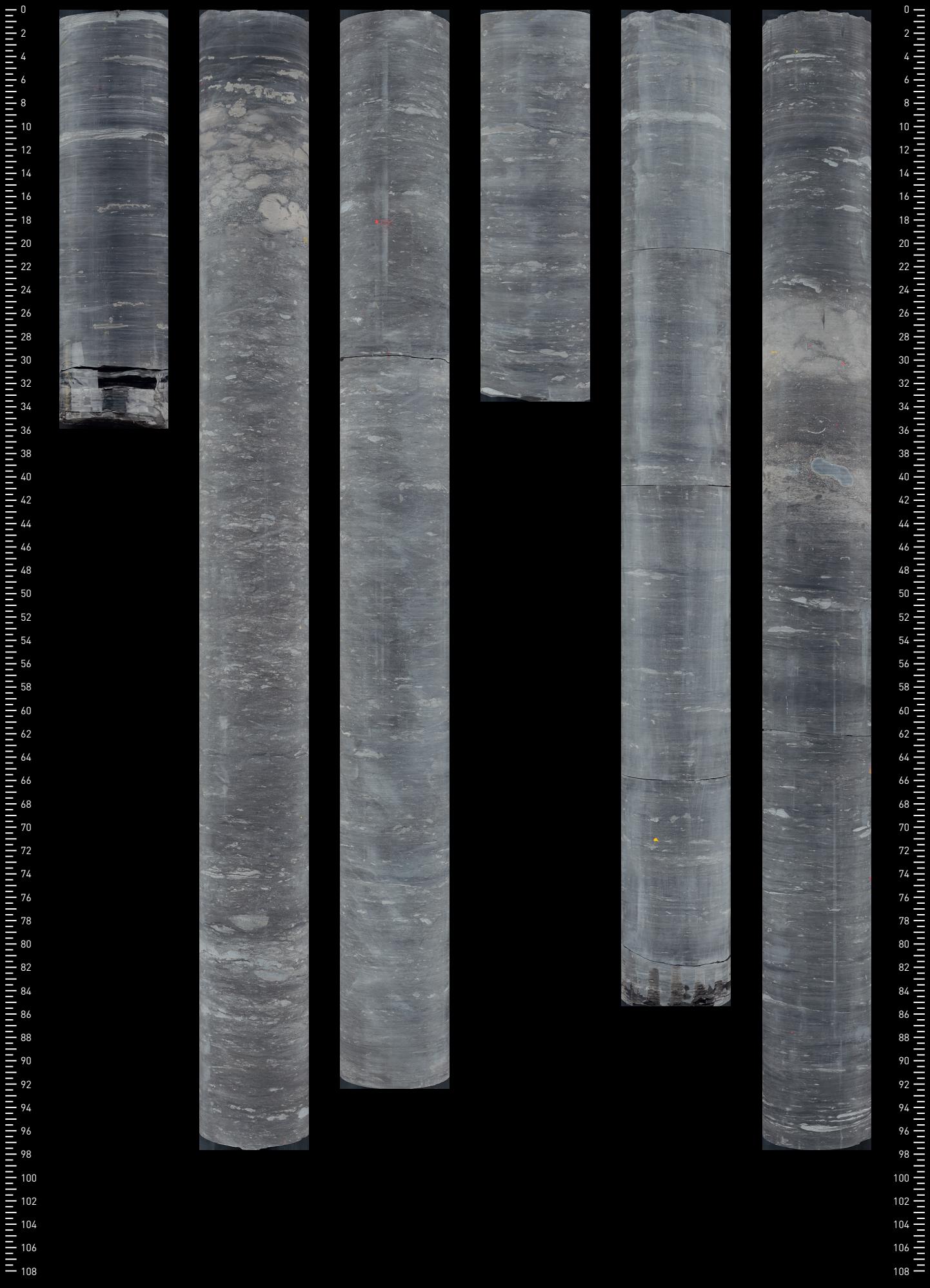
462.32m 463.15m 464.07m 464.57m 465.37m 466.08m



463.15m 464.07m 464.57m 465.37m 466.08m 467.02m

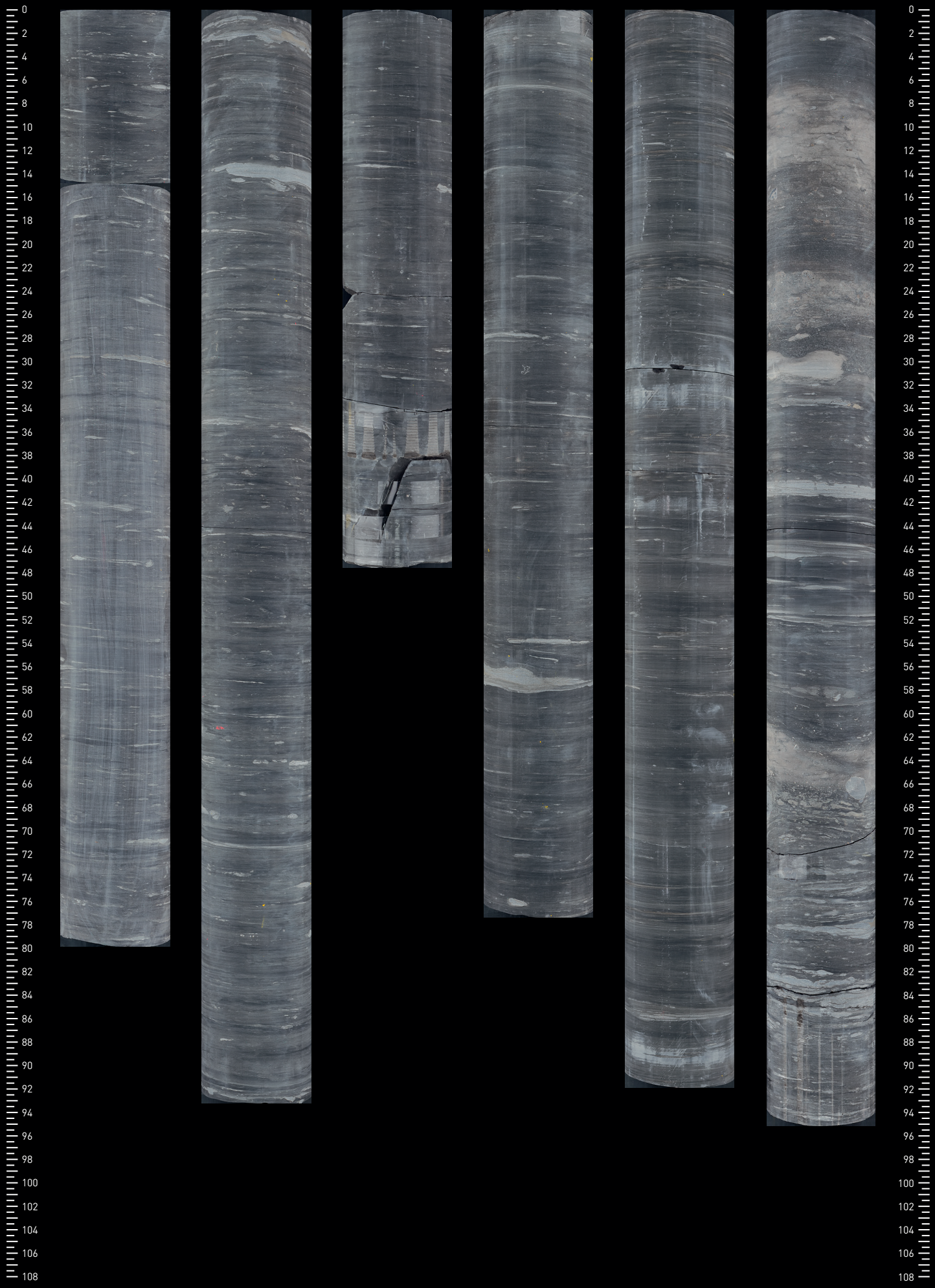

467.02m
467.89m
468.86m
469.18m
470.06m
471.05m
467.89m
468.86m
469.18m
470.06m
471.05m
471.75m

471.75m 472.10m 473.05m 473.95m 474.28m 475.12m



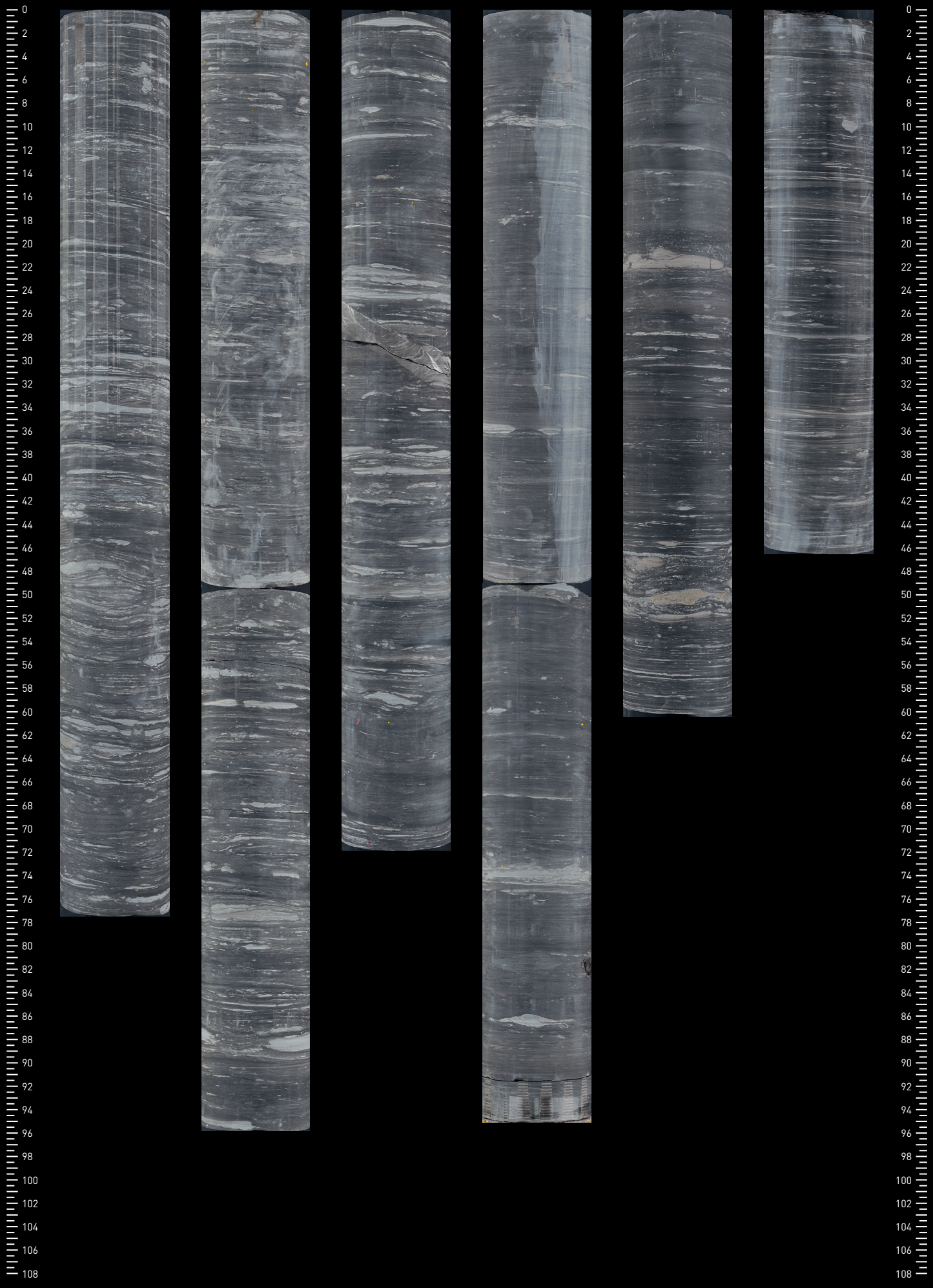
472.10m 473.05m 473.95m 474.28m 475.12m 476.07m

476.07m 476.85m 477.76m 478.22m 478.98m 479.88m



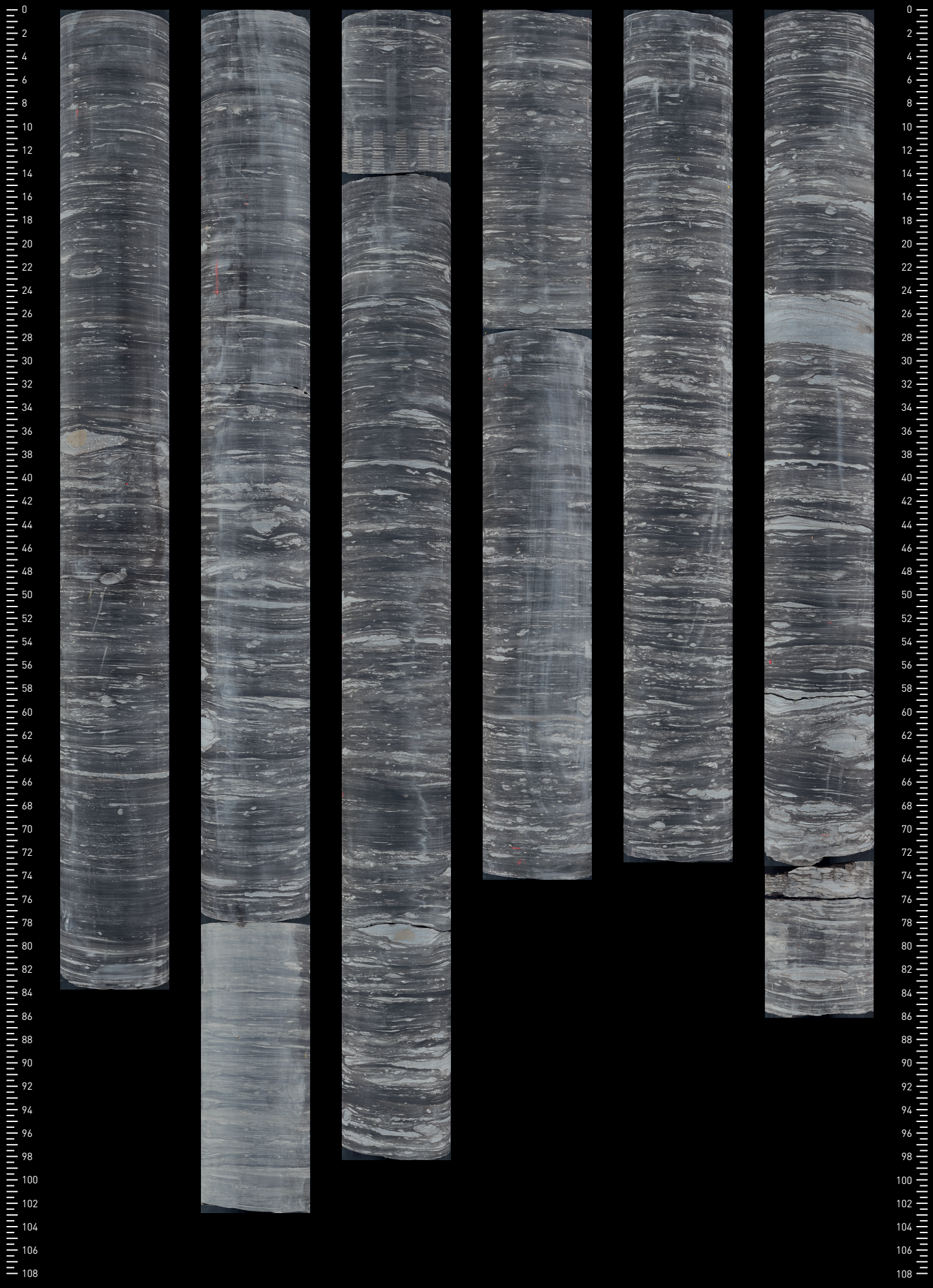
476.85m 477.76m 478.22m 478.98m 479.88m 480.79m

480.79m 481.55m 482.48m 483.19m 484.10m 484.70m



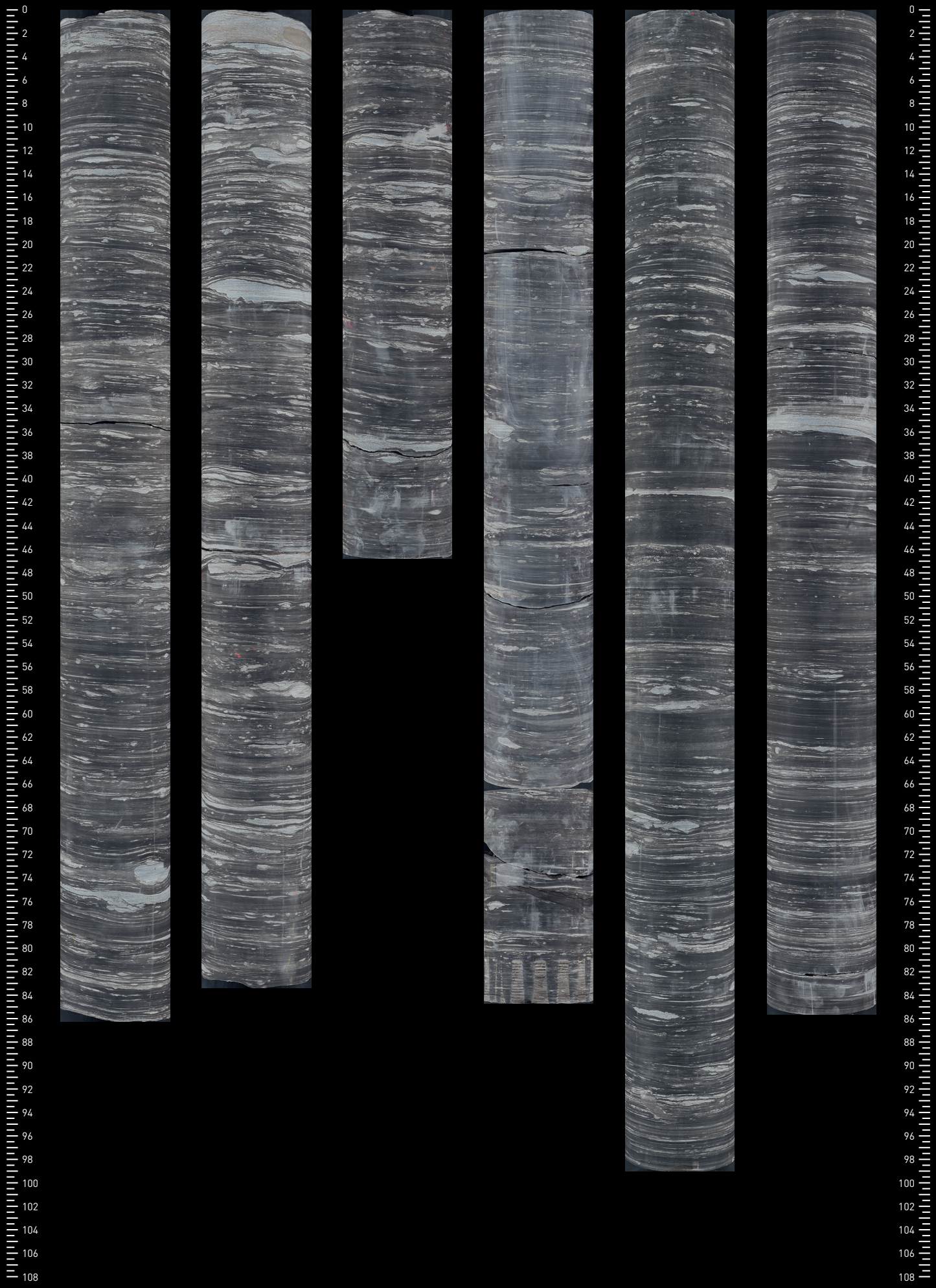
481.55m 482.48m 483.19m 484.10m 484.70m 485.15m

485.15m 485.97m 486.97m 487.92m 488.64m 489.35m



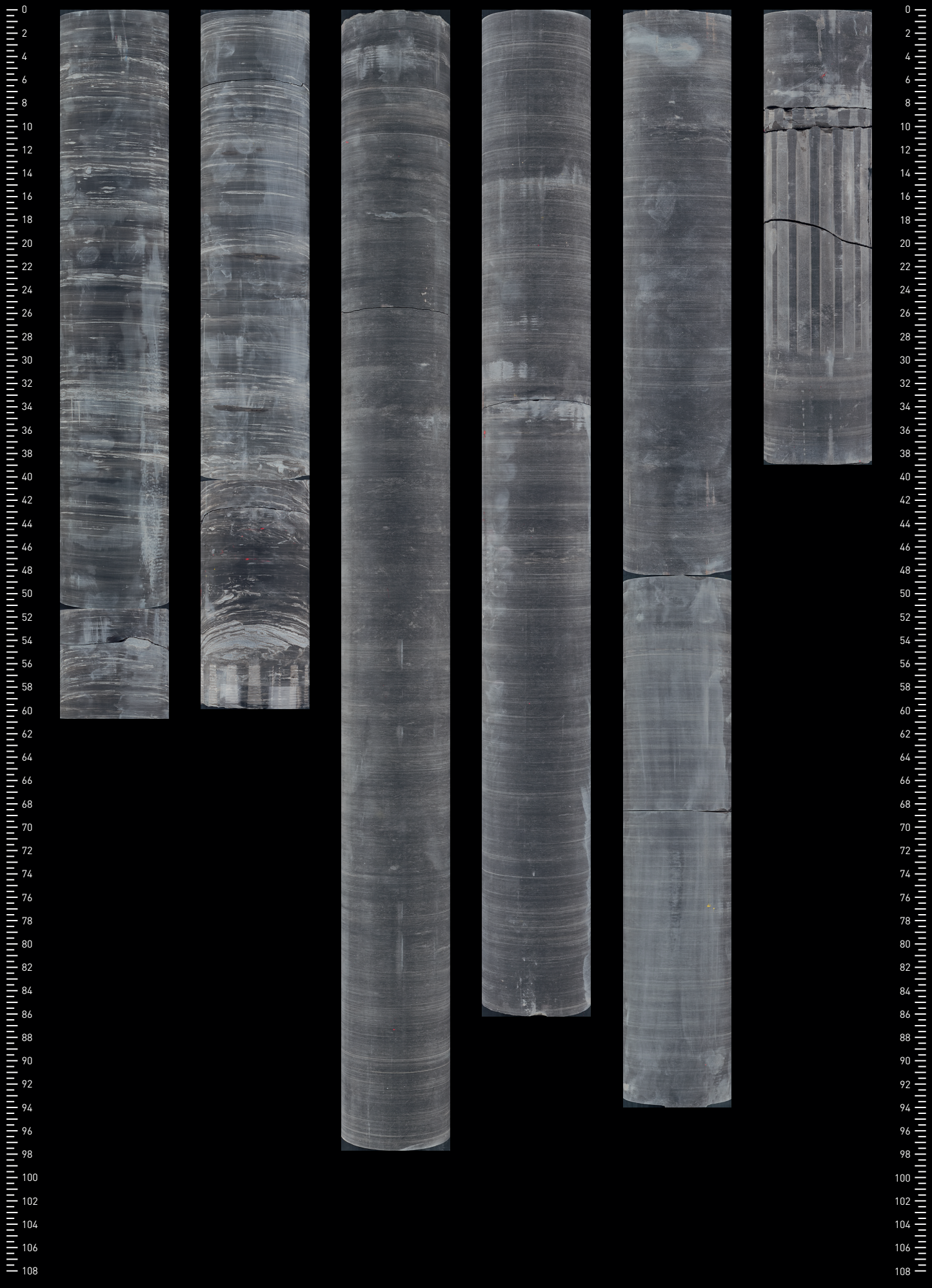
485.97m 486.97m 487.92m 488.64m 489.35m 490.19m

490.19m 491.04m 491.84m 492.30m 493.13m 494.09m



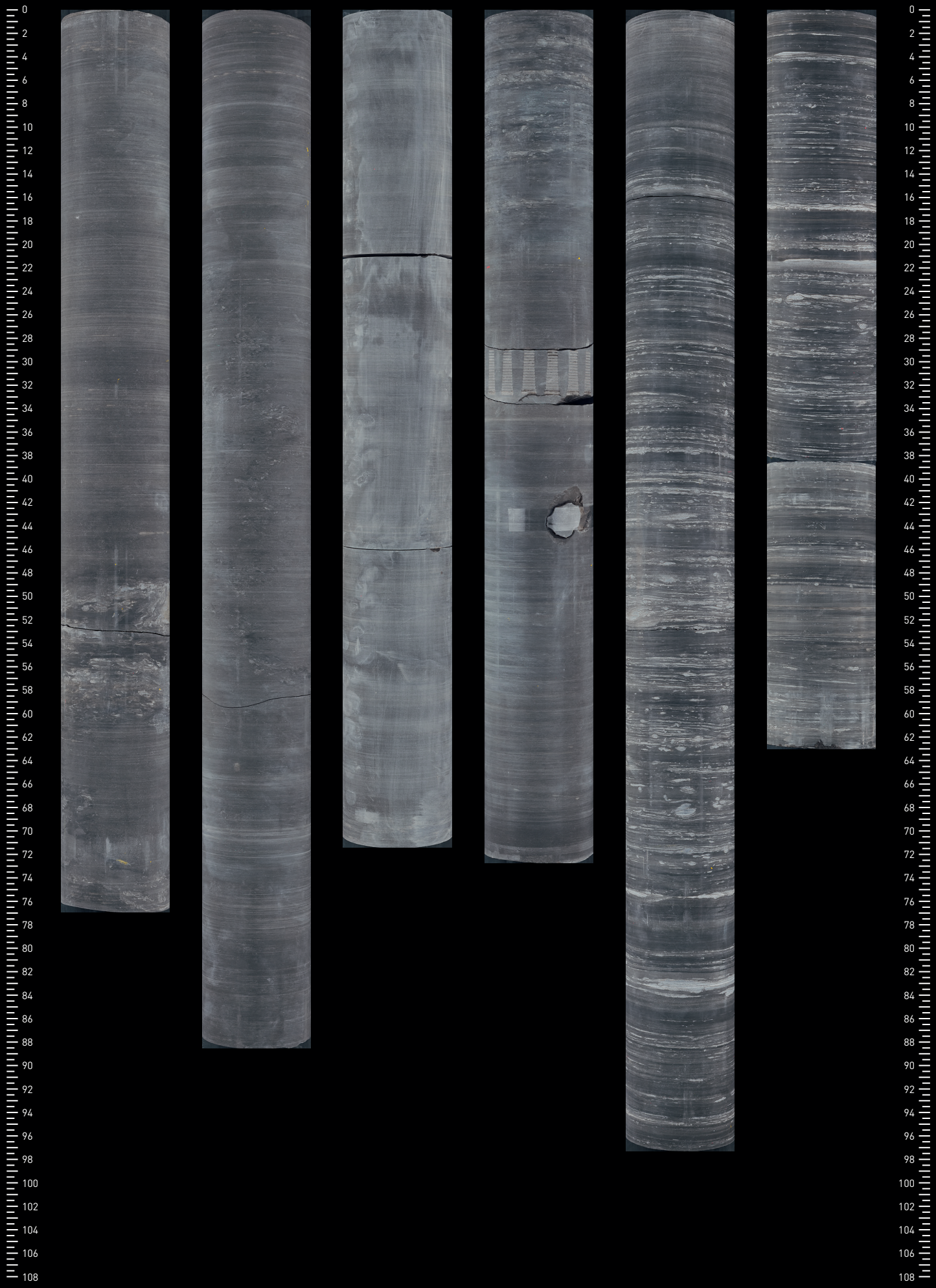
491.04m 491.84m 492.30m 493.13m 494.09m 494.93m

494.93m 495.53m 496.12m 497.07m 497.91m 498.83m



495.53m 496.12m 497.07m 497.91m 498.83m 499.22m

499.22m 499.97m 500.83m 501.53m 502.25m 503.20m



499.97m 500.83m 501.53m 502.25m 503.20m 503.82m

503.82m 504.58m 505.17m 505.74m 506.20m 507.18m



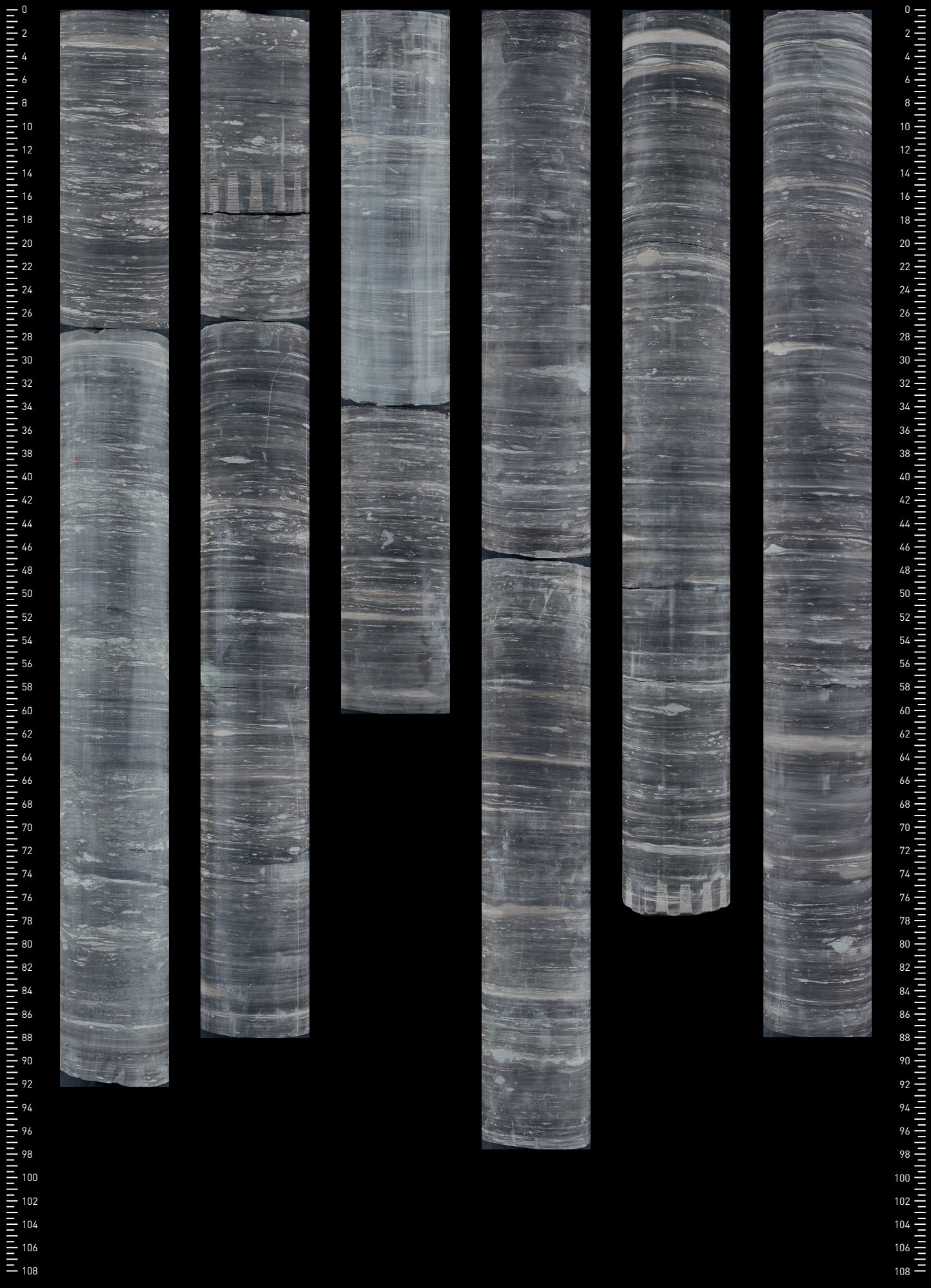
504.58m 505.17m 505.74m 506.20m 507.18m 508.17m

508.17m 509.12m 510.02m 510.70m 511.22m 512.17m



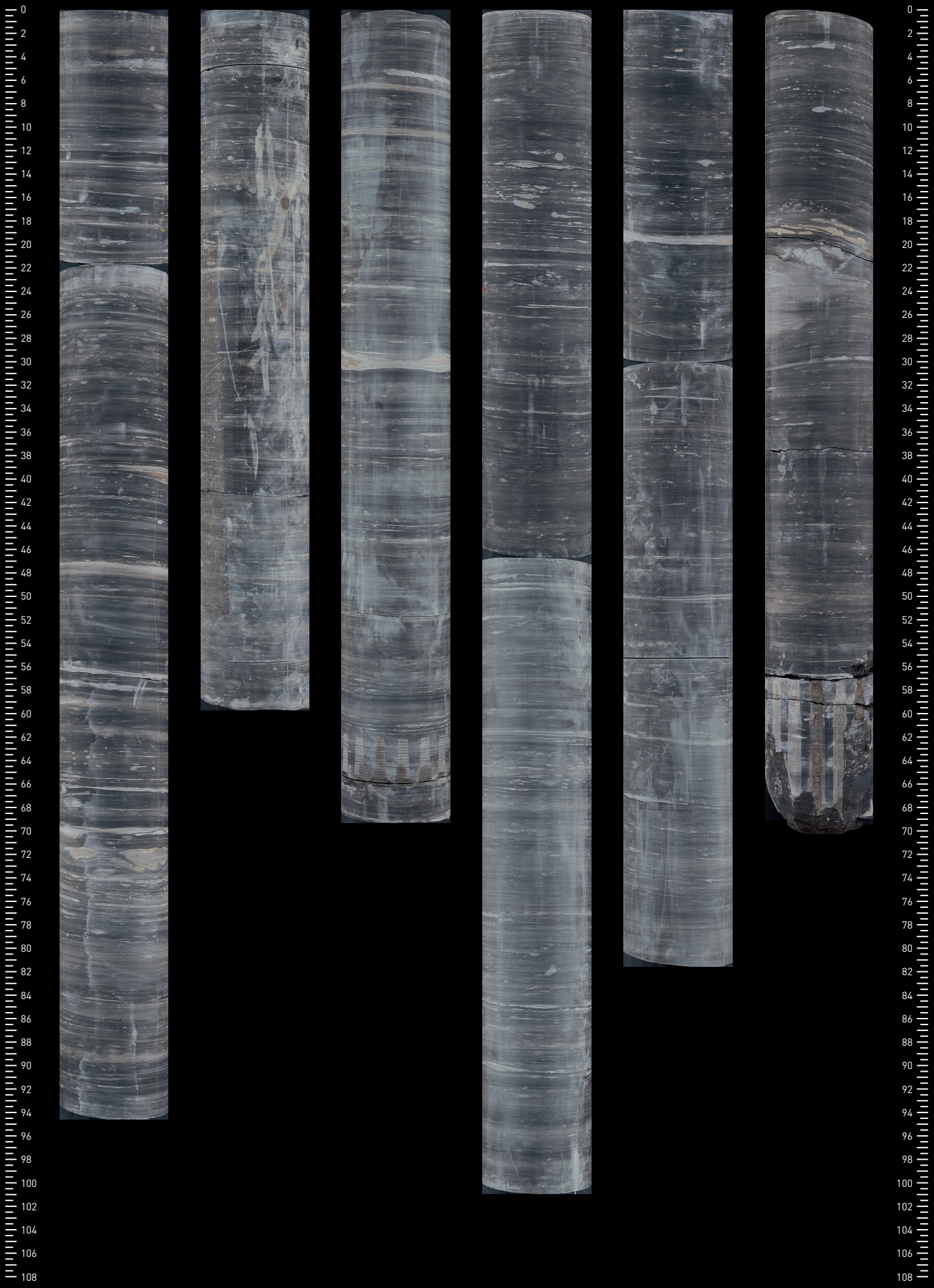
509.12m 510.02m 510.70m 511.22m 512.17m 513.16m

513.16m 514.06m 514.91m 515.49m 516.44m 517.20m



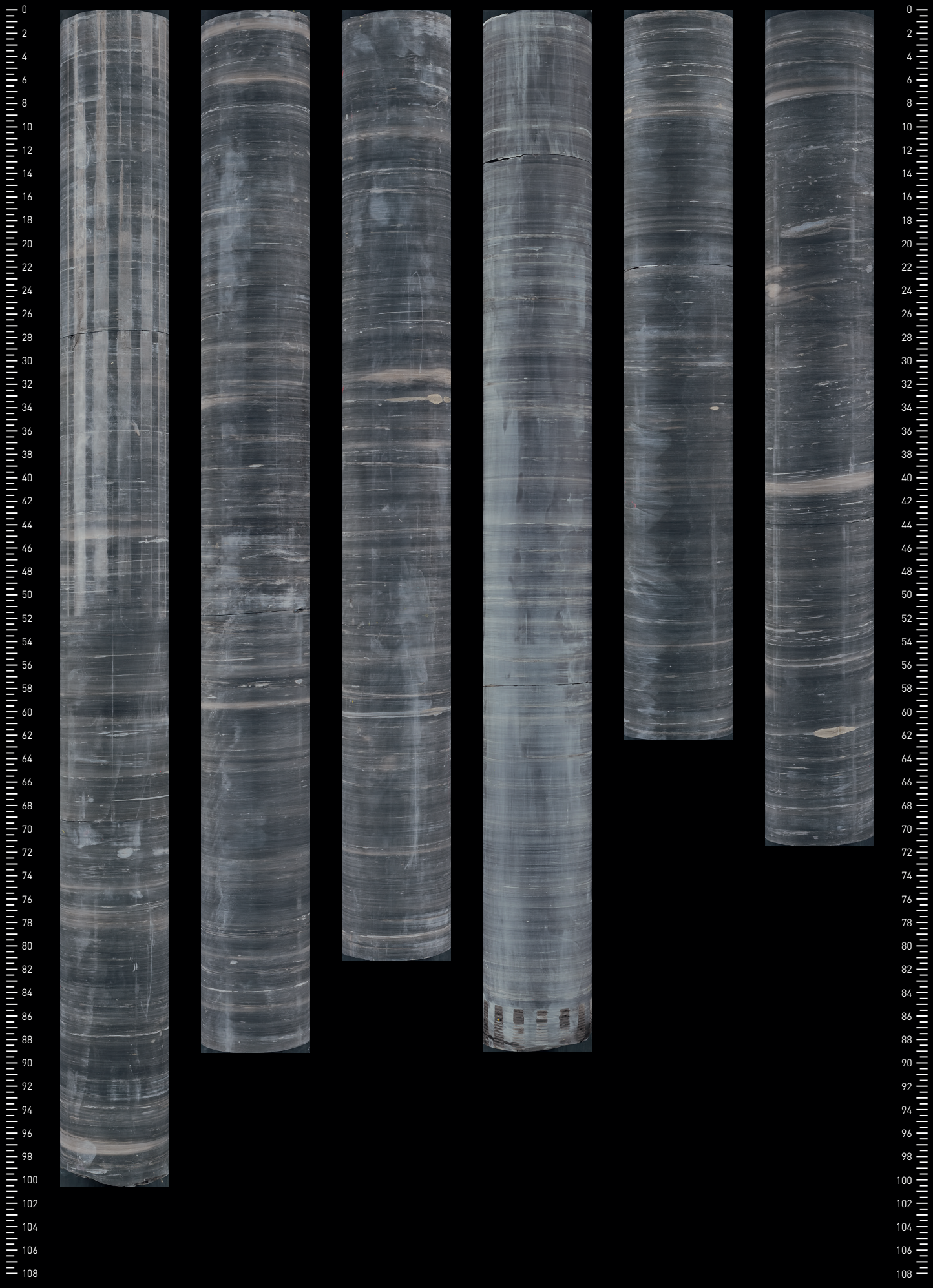
514.06m 514.91m 515.49m 516.44m 517.20m 518.06m

518.06m 518.98m 519.57m 520.24m 521.22m 522.02m



518.98m 519.57m 520.24m 521.22m 522.02m 522.71m

522.71m 523.69m 524.56m 525.35m 526.22m 526.83m



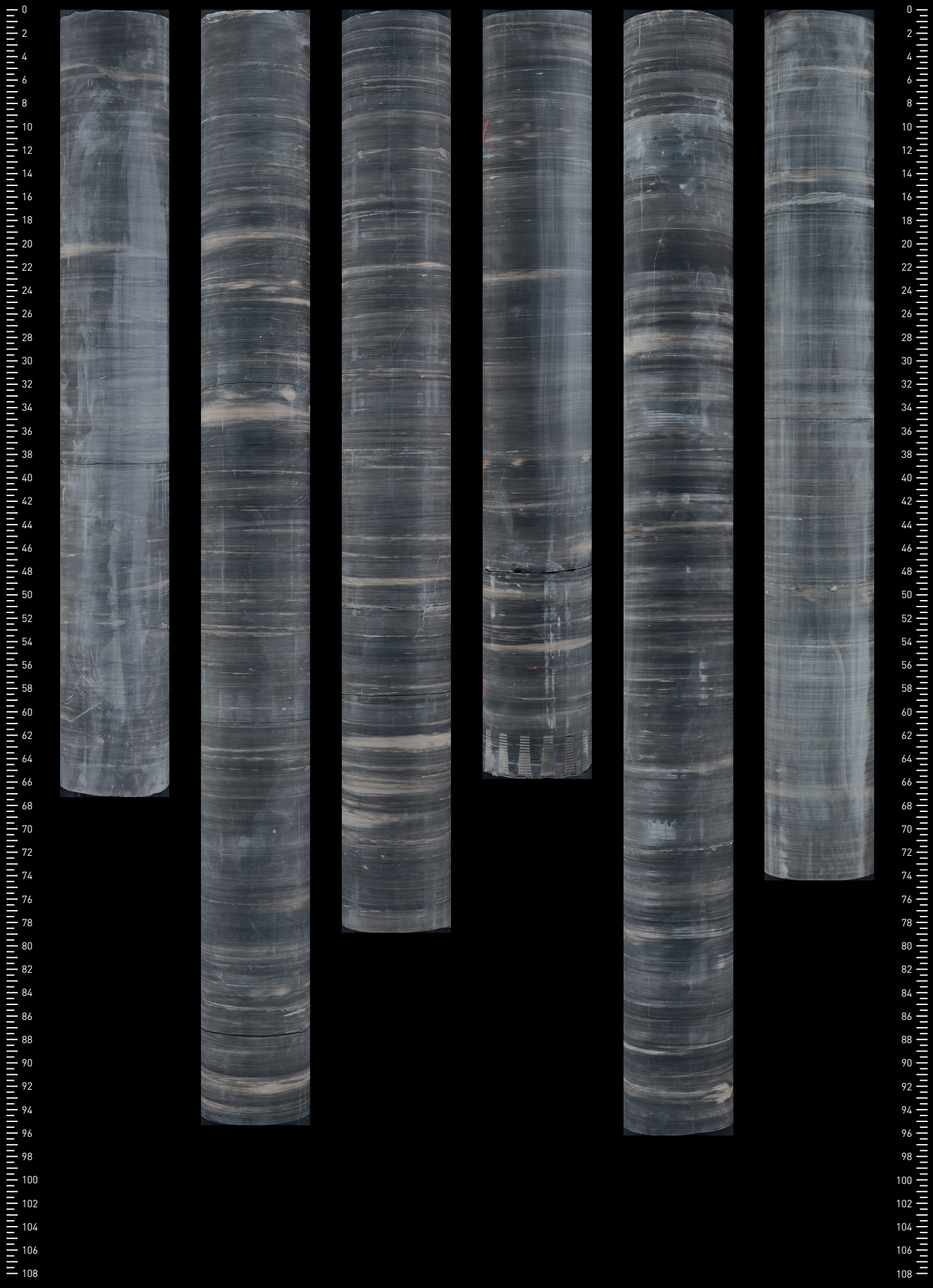
523.69m 524.56m 525.35m 526.22m 526.83m 527.52m

527.52m 528.49m 529.33m 530.11m 530.70m 531.26m



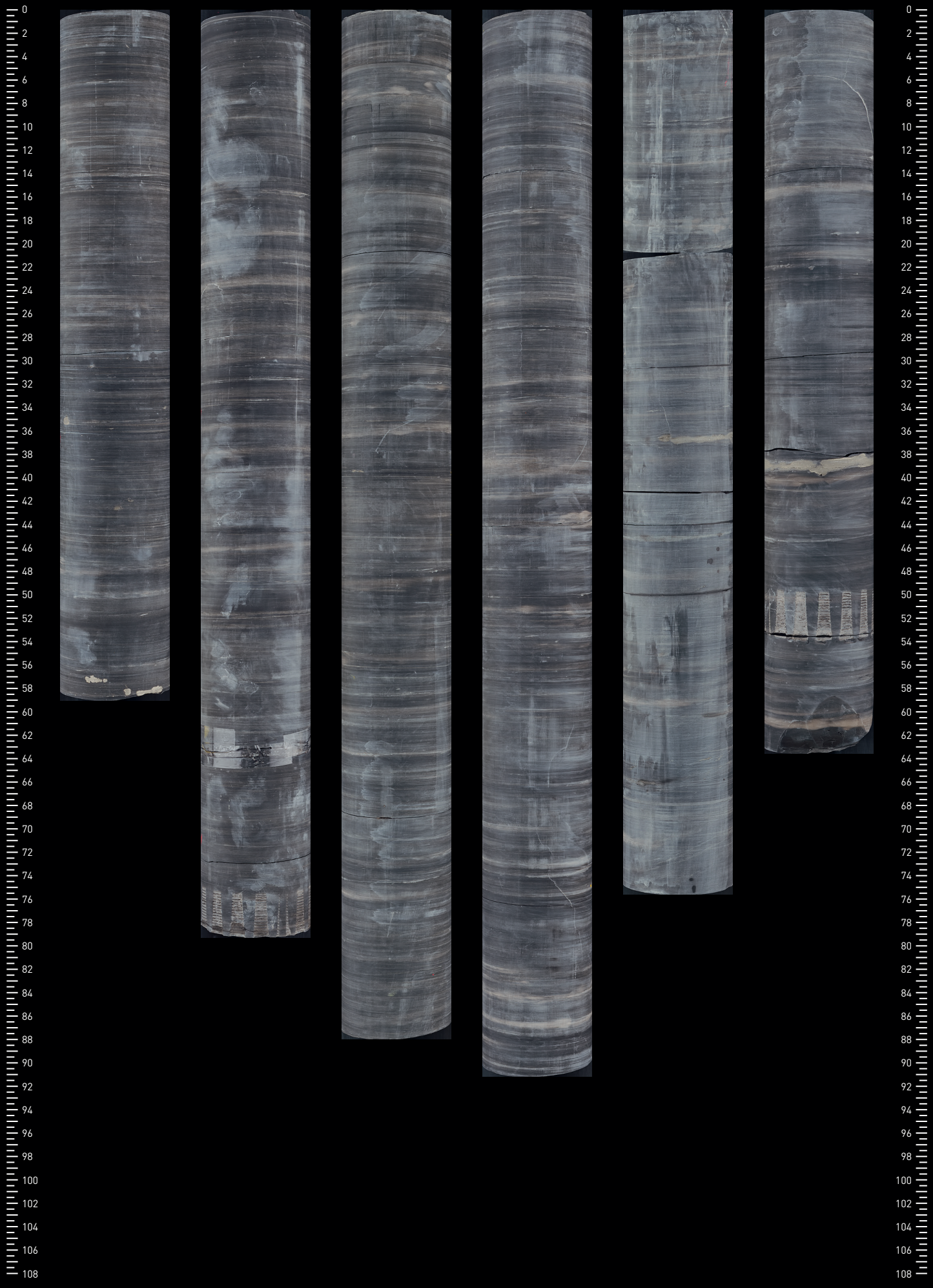
528.49m 529.33m 530.11m 530.70m 531.26m 532.24m

532.24m 532.89m 533.82m 534.59m 535.23m 536.17m



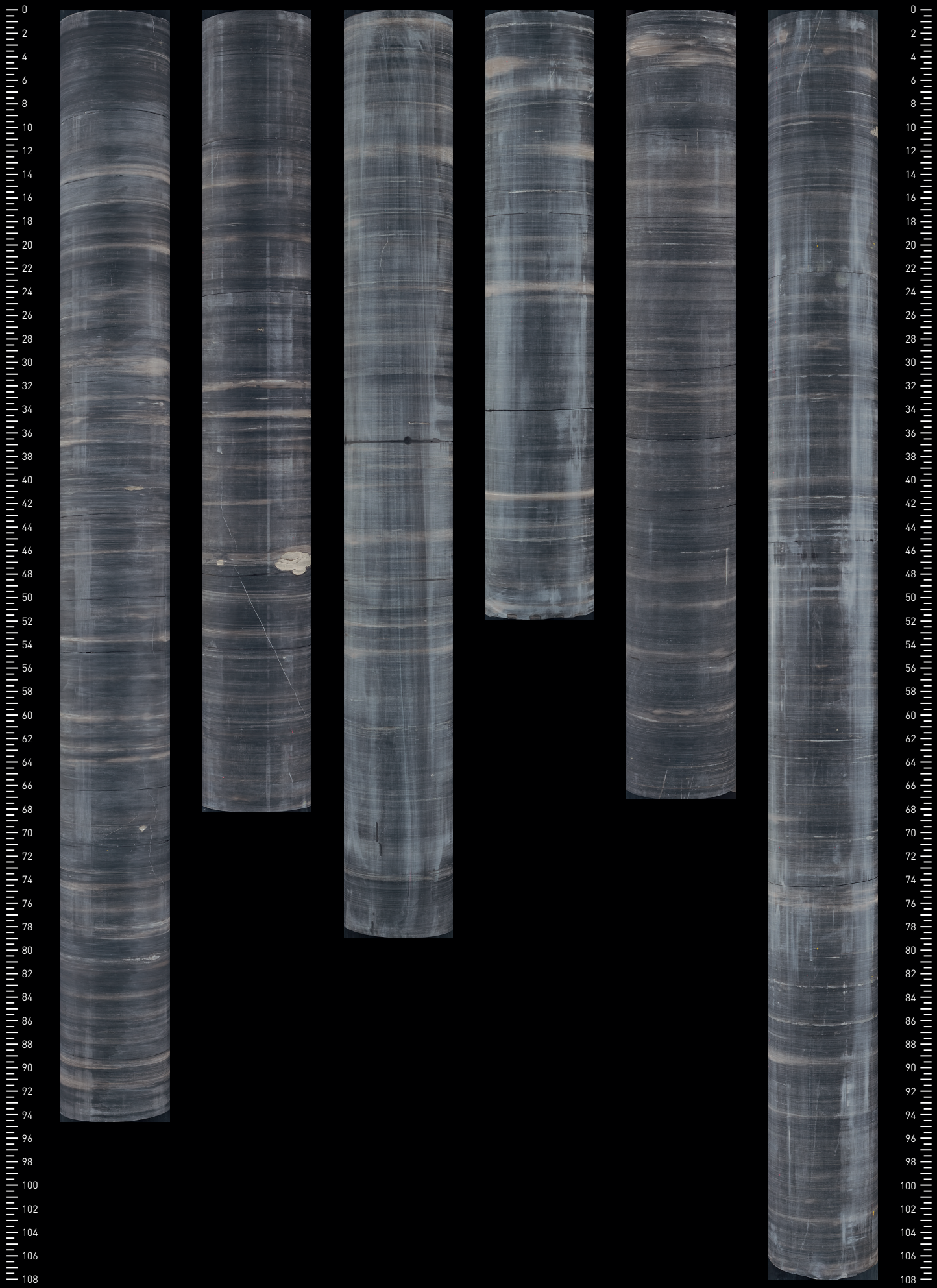
532.89m 533.82m 534.59m 535.23m 536.17m 536.89m

536.89m 537.46m 538.23m 539.08m 539.97m 540.71m



537.46m 538.23m 539.08m 539.97m 540.71m 541.33m

541.33m 542.25m 542.92m 543.69m 544.22m 544.87m



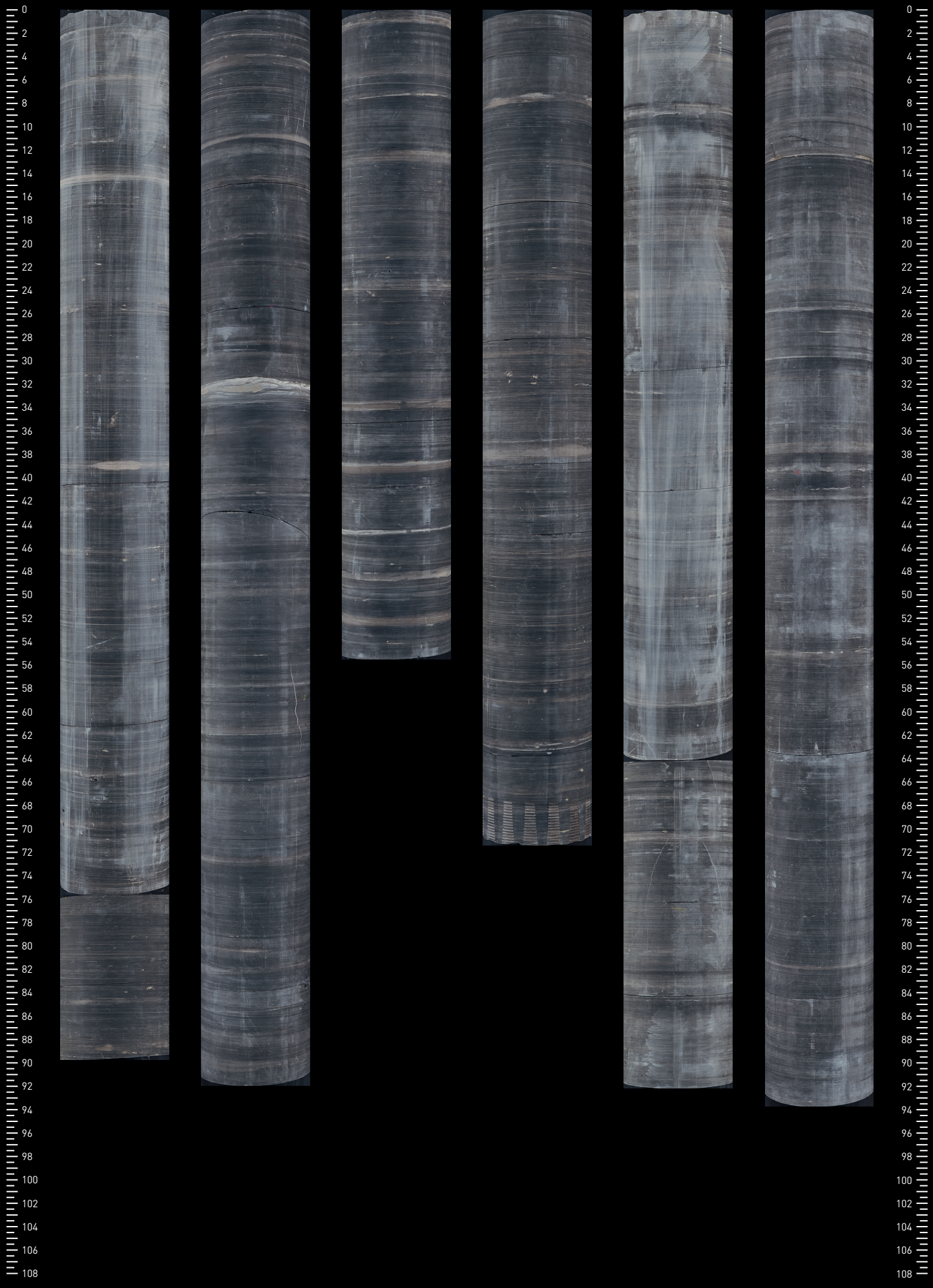
542.25m 542.92m 543.69m 544.19m 544.87m 545.91m

545.91m 546.82m 547.72m 547.99m 548.85m 549.58m



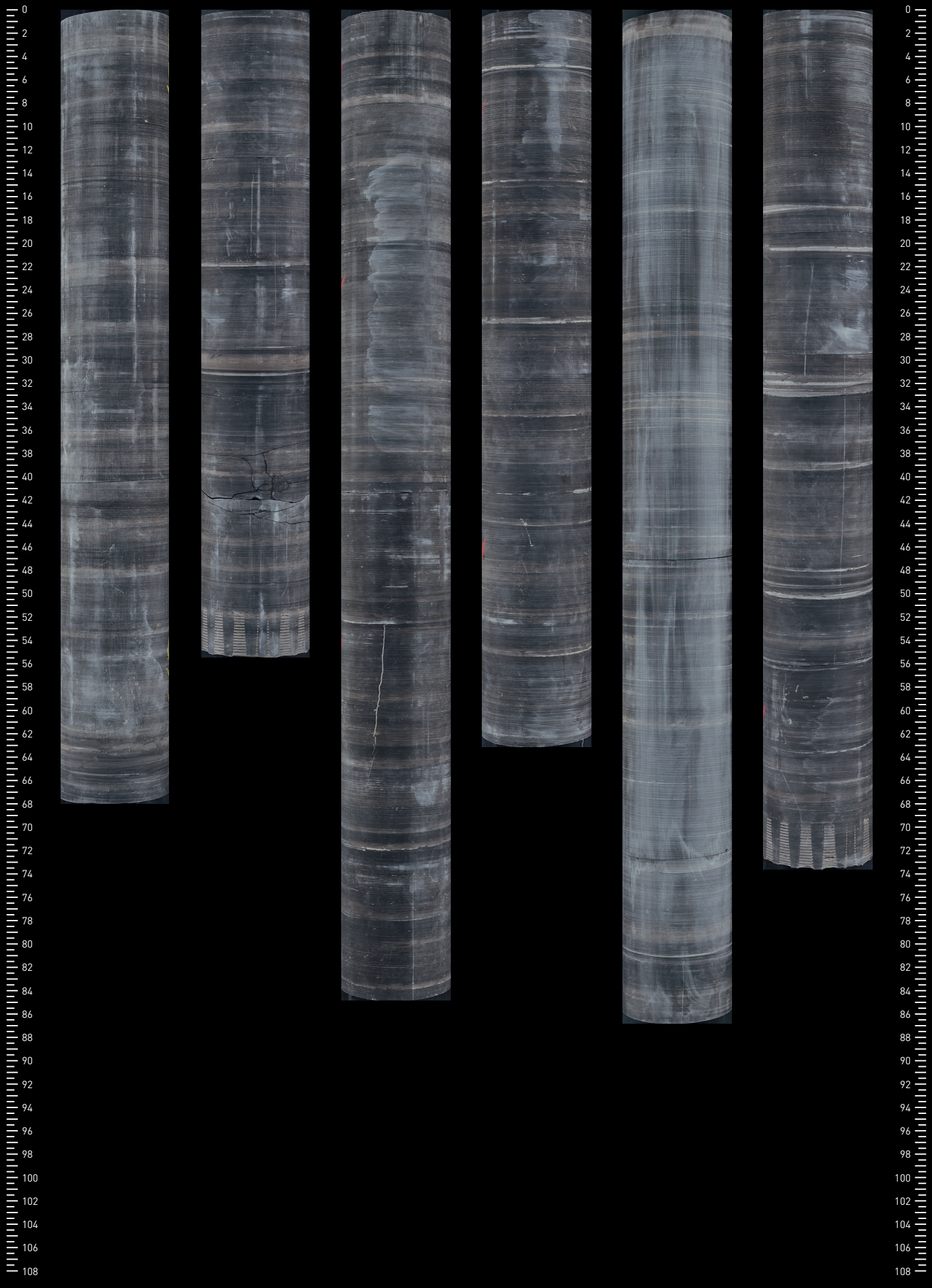
546.82m 547.72m 547.99m 548.85m 549.58m 550.21m

550.21m 551.08m 551.98m 552.52m 553.21m 554.10m



551.08m 551.98m 552.52m 553.21m 554.10m 555.01m

555.01m 555.68m 556.22m 557.04m 557.66m 558.50m



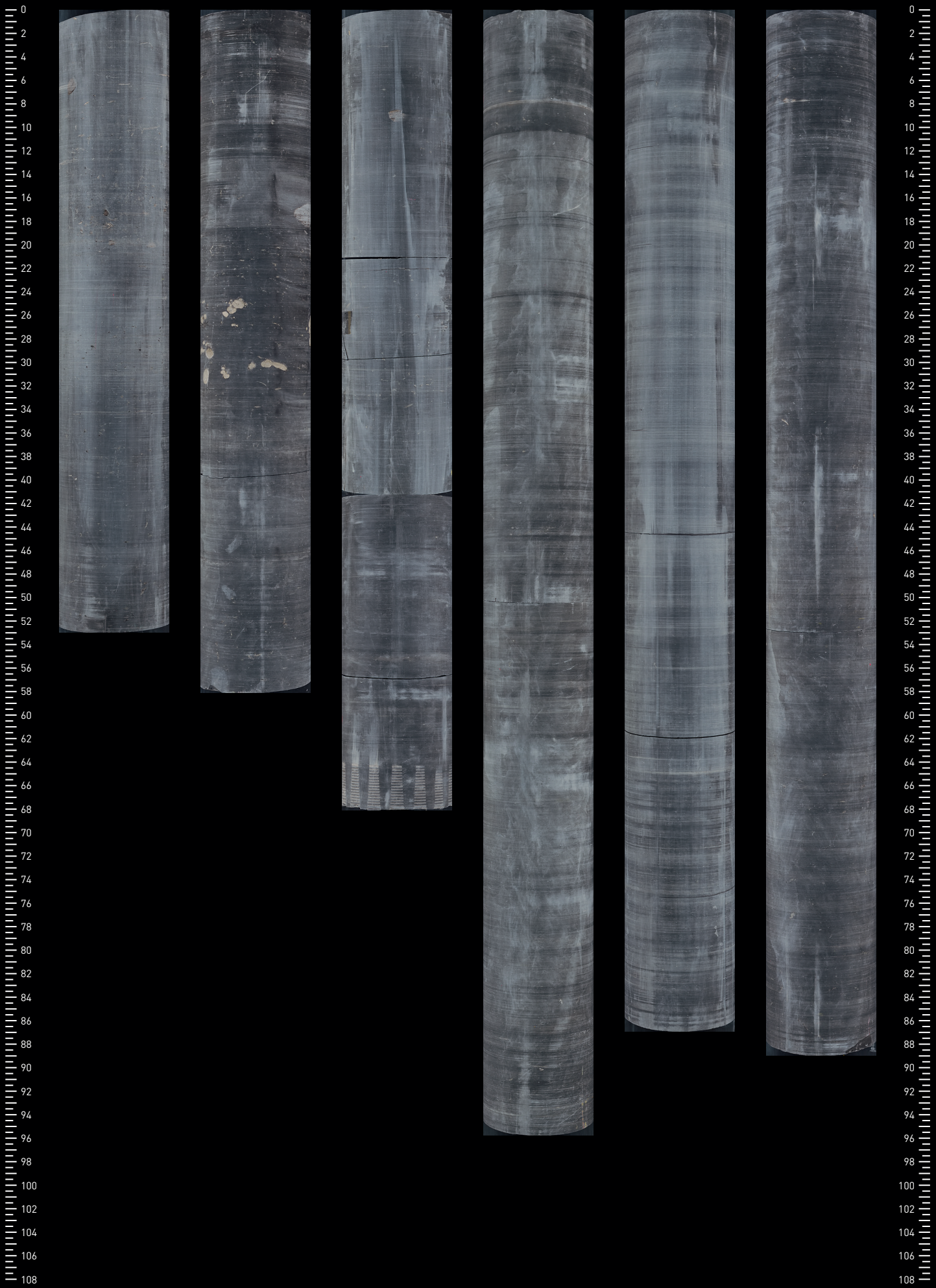
555.68m 556.22m 557.04m 557.66m 558.50m 559.22m

559.22m 559.91m 560.69m 561.60m 562.26m 563.00m



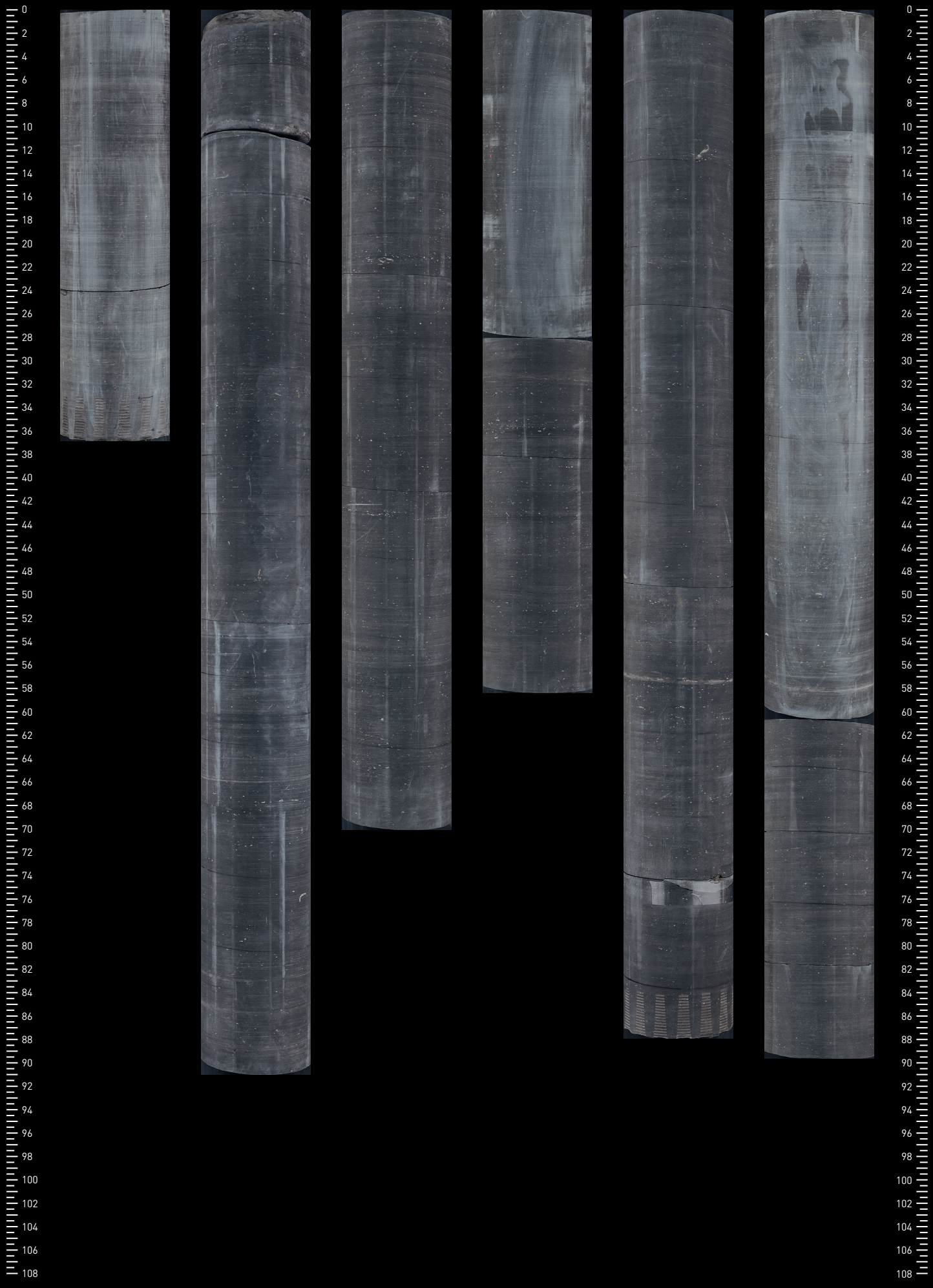
559.91m 560.69m 561.60m 562.26m 563.00m 563.53m

563.53m 564.05m 564.62m 565.27m 566.20m 567.04m



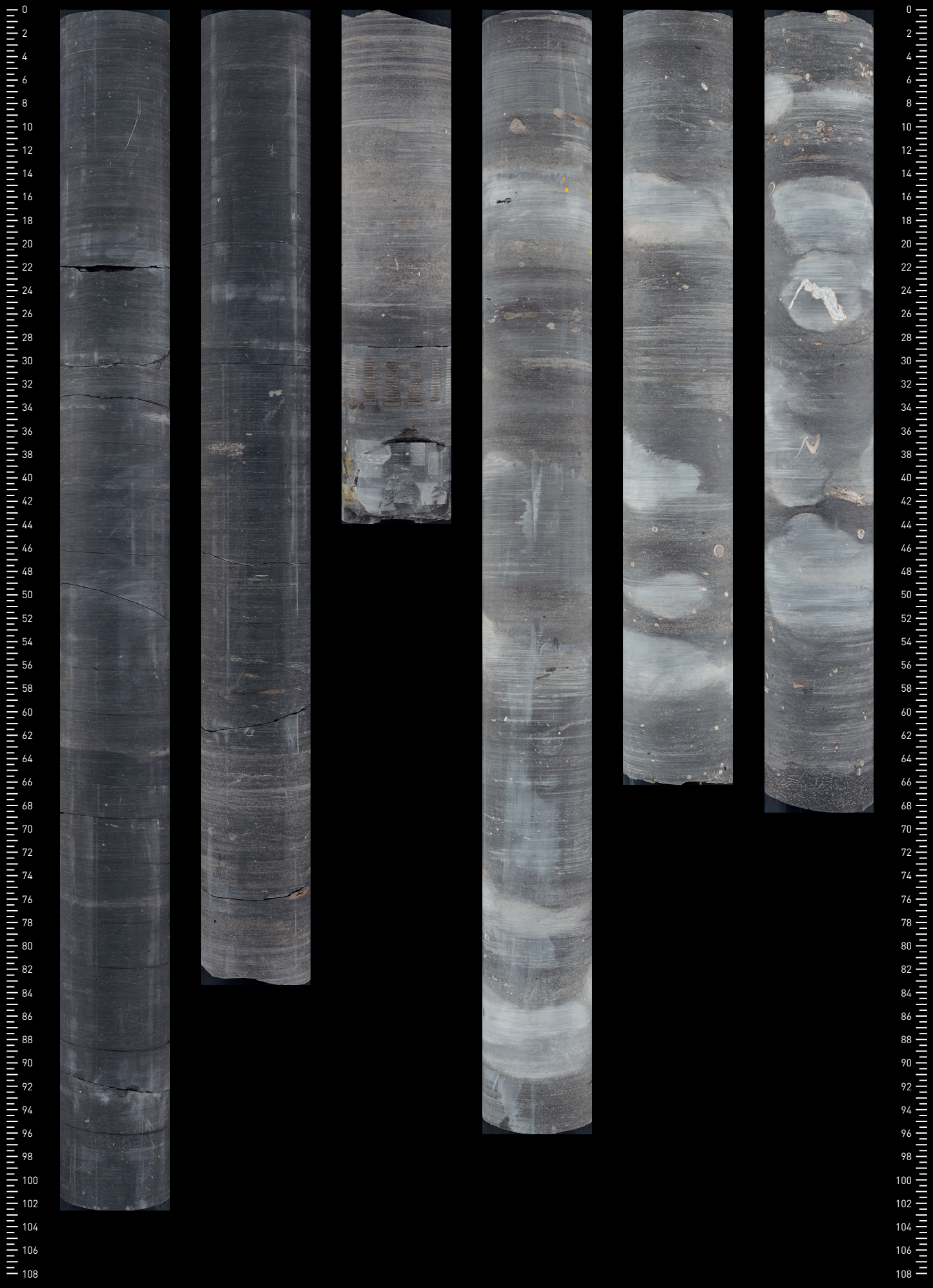
564.05m 564.62m 565.27m 566.20m 567.04m 567.91m

567.91m 568.27m 569.16m 569.84m 570.41m 571.26m



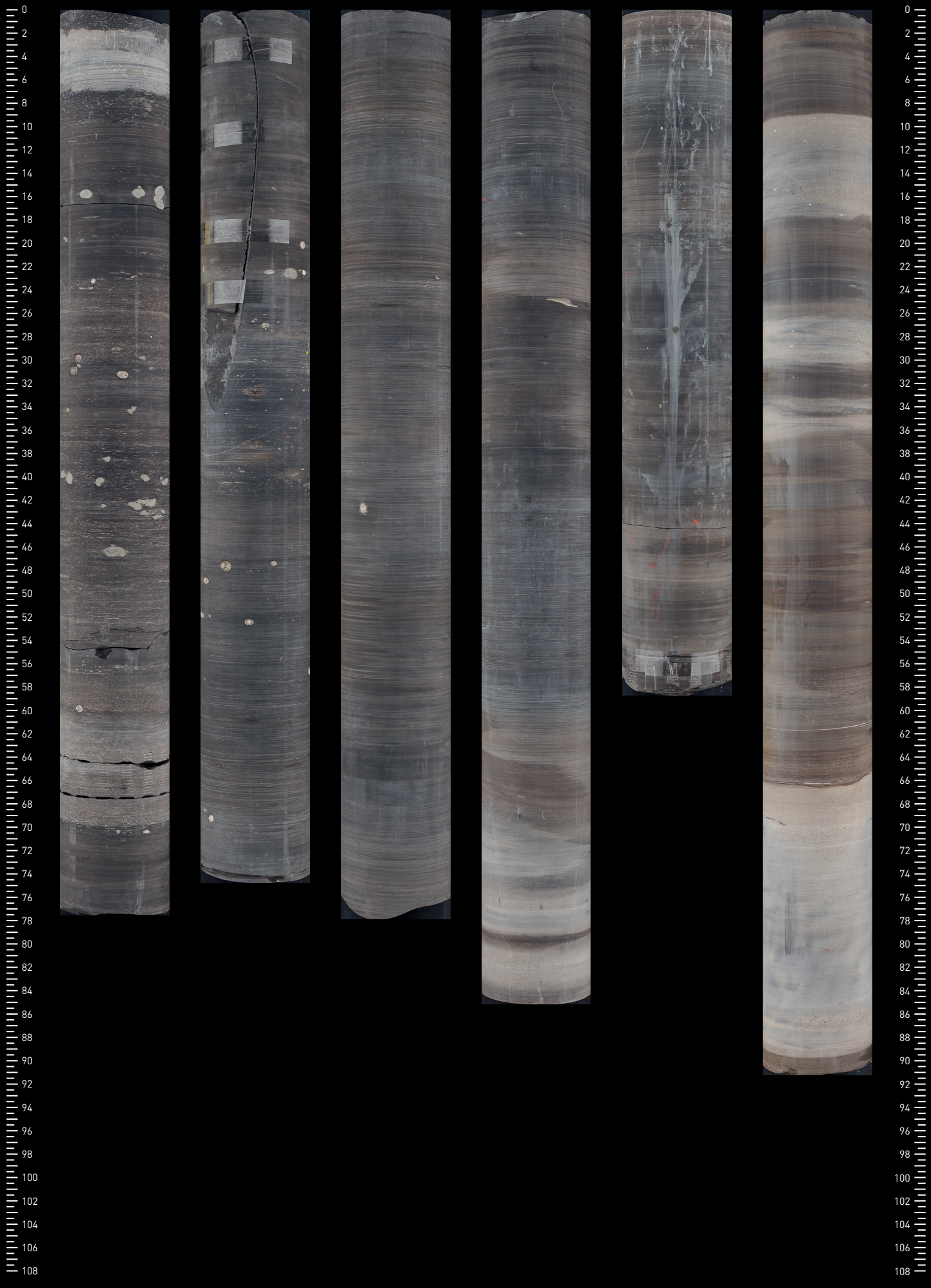
568.27m 569.16m 569.84m 570.41m 571.26m 572.13m

572.13m 573.13m 573.94m 574.36m 575.29m 575.95m



573.13m 573.94m 574.36m 575.29m 575.95m 576.60m

576.60m 577.36m 578.09m 578.84m 579.67m 580.24m

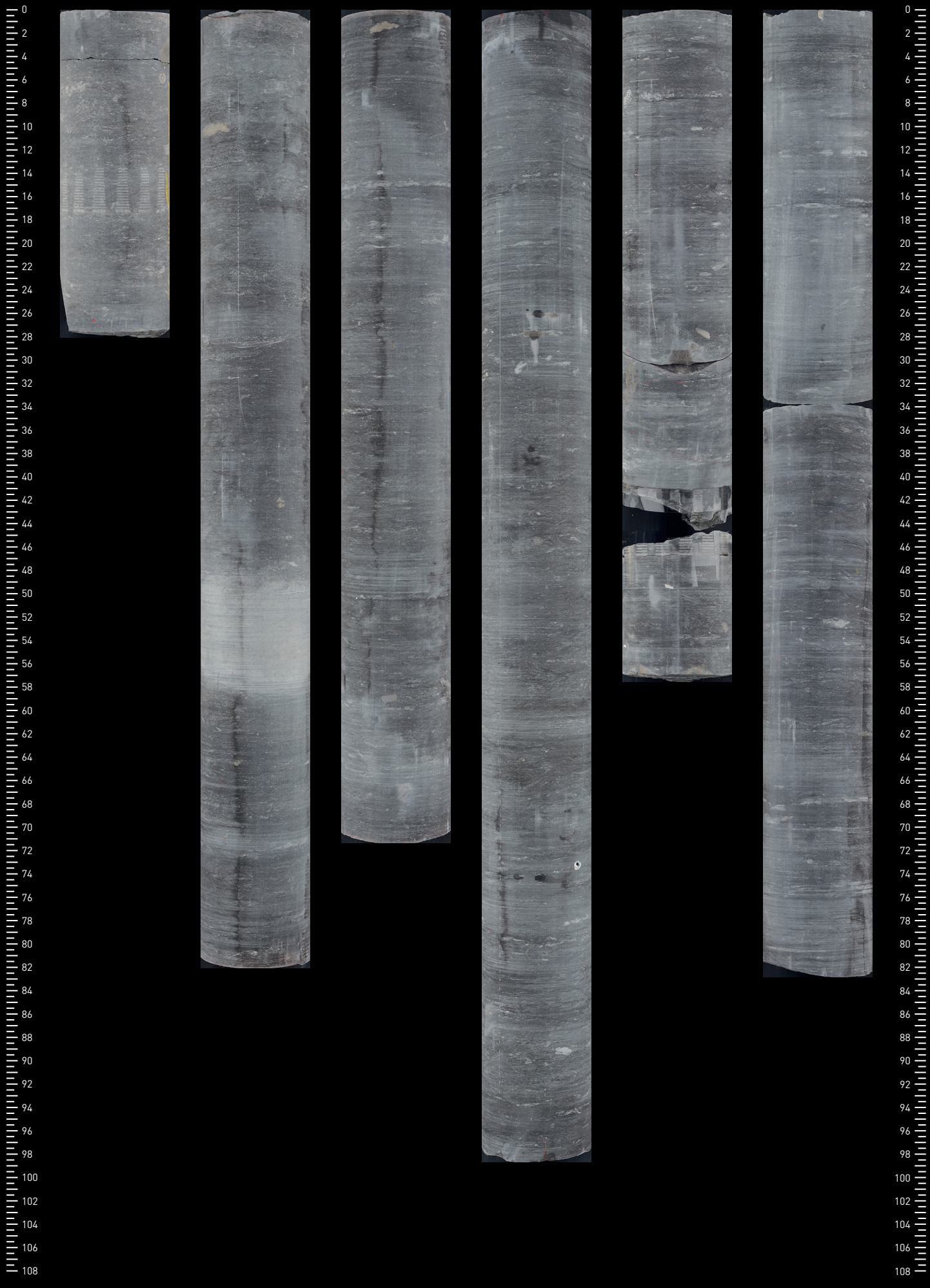


577.36m 578.09m 578.84m 579.67m 580.24m 581.12m

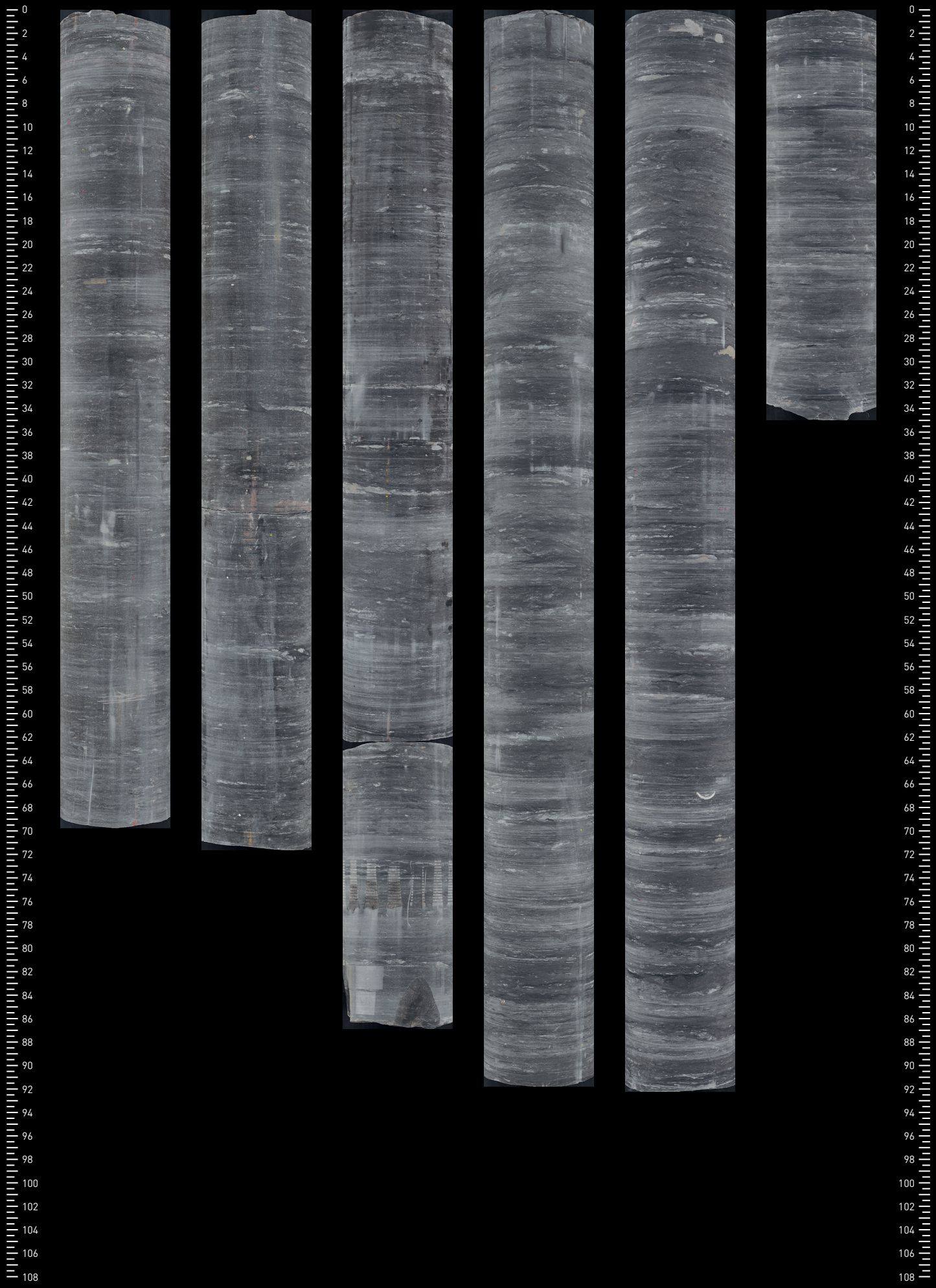
581.12m 582.08m 582.78m 583.30m 584.28m 585.26m



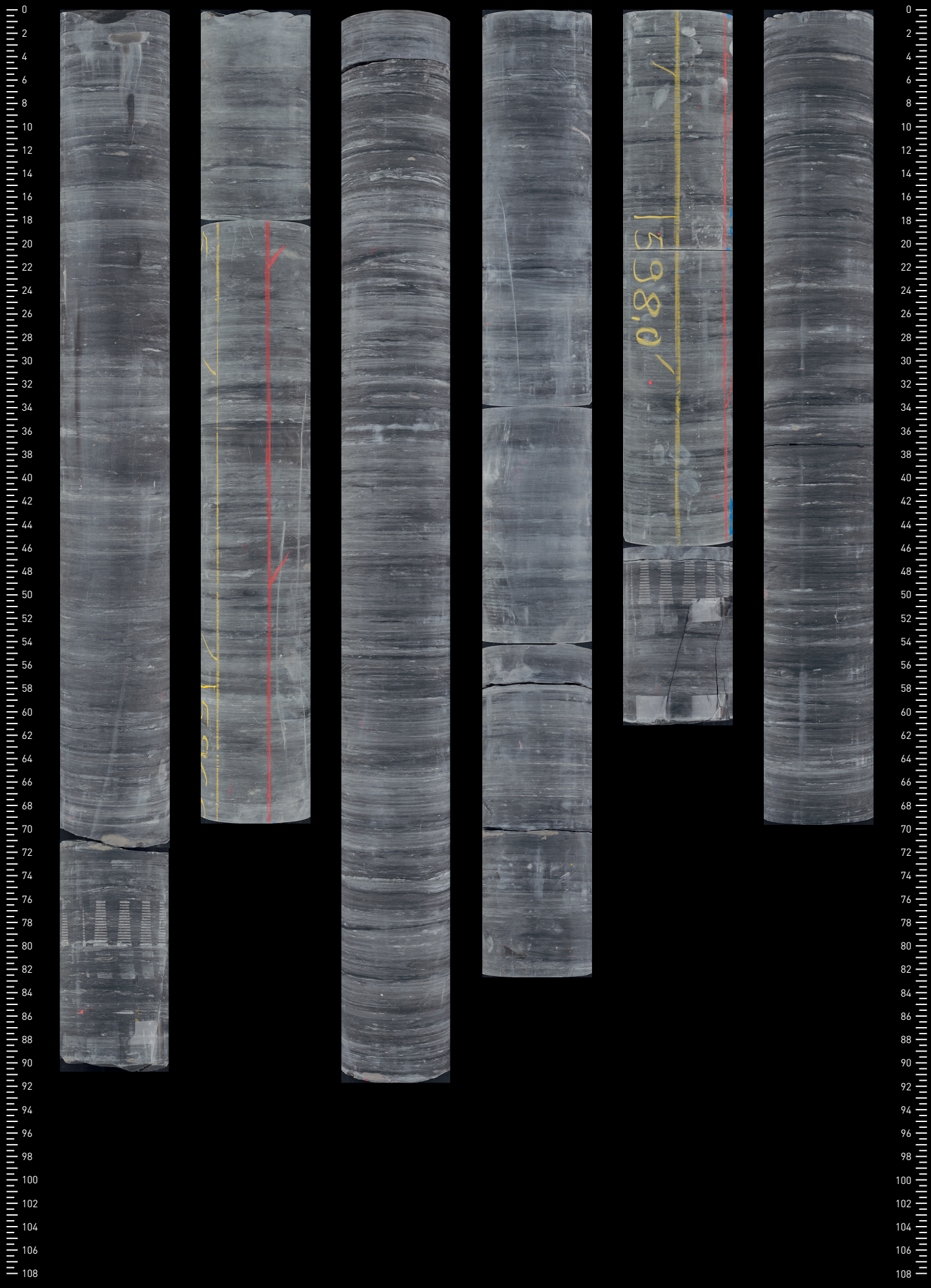
582.08m 582.78m 583.30m 584.28m 585.26m 586.15m


586.15m
586.42m
587.22m
587.93m
588.89m
589.42m
586.42m
587.22m
587.93m
588.89m
589.42m
590.23m

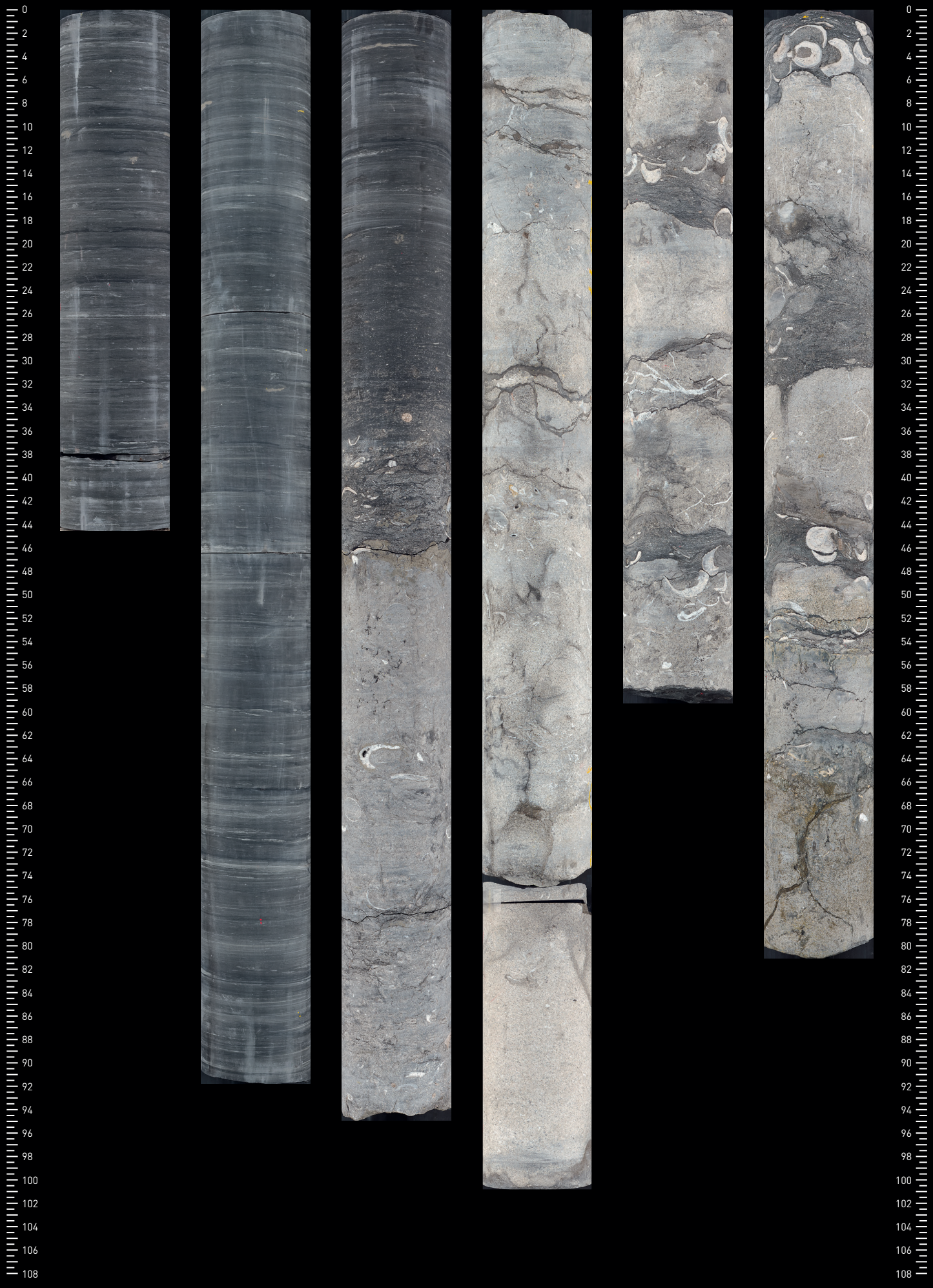
590.23m 590.90m 591.60m 592.43m 593.33m 594.23m



590.90m 591.60m 592.43m 593.33m 594.23m 594.55m

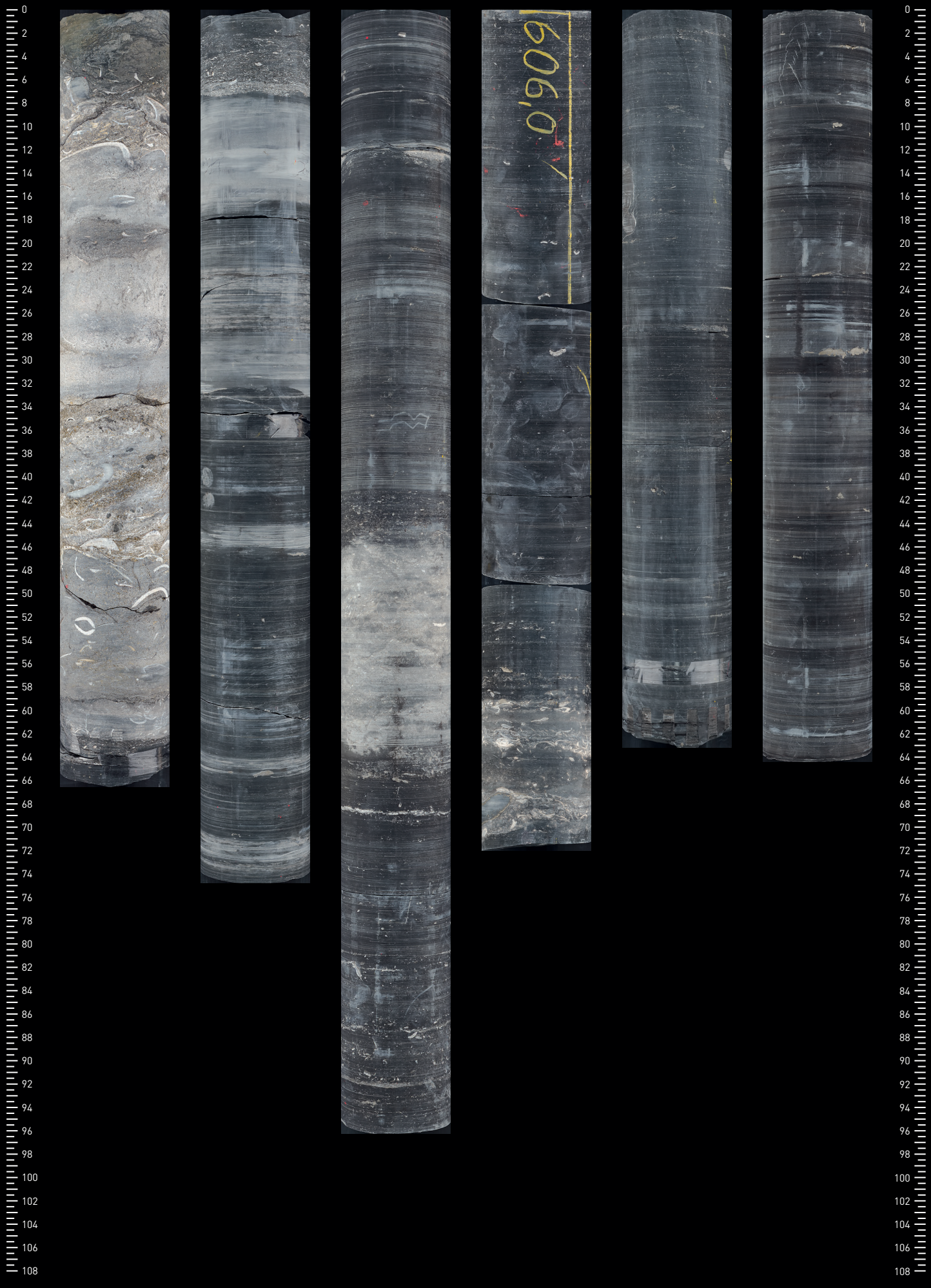

594.55m
595.43m
596.10m
597.00m
597.83m
598.42m
598.0'
595.43m
596.10m
597.00m
597.83m
598.42m
599.10m

599.10m 599.54m 600.44m 601.36m 602.35m 602.94m



599.54m 600.44m 601.36m 602.35m 602.94m 603.70m

603.70m 604.32m 605.06m 606.00m 606.68m 607.29m



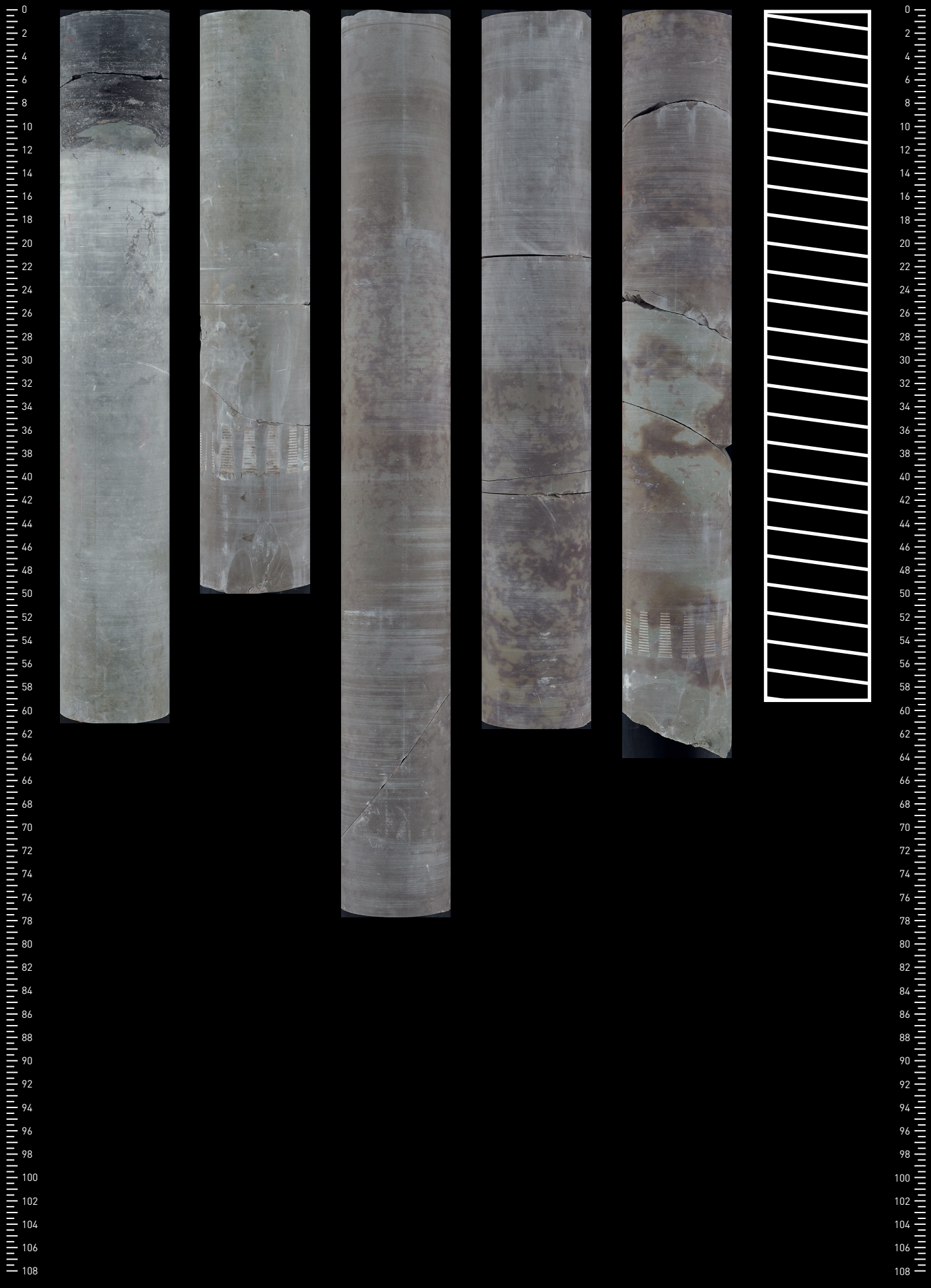
604.32m 605.06m 606.00m 606.68m 607.29m 607.91m

607.91m 608.70m 609.61m 610.43m 611.07m 611.60m



608.70m 609.61m 610.43m 611.07m 611.60m 612.35m

612.35m 612.95m 613.43m 614.19m 614.79m 615.40m



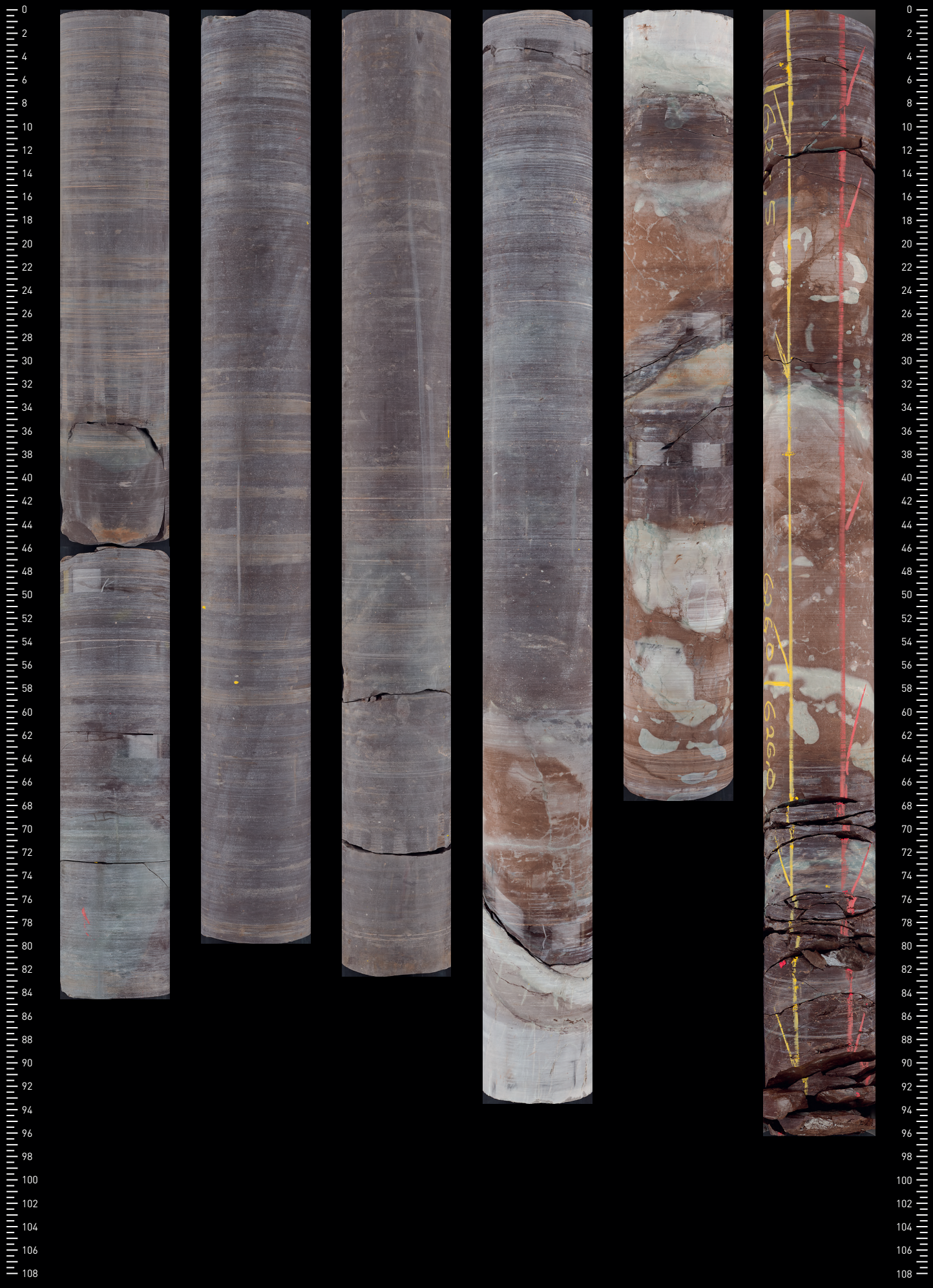
612.95m 613.43m 614.19m 614.79m 615.40m 616.00m

616.00m 617.00m 617.98m 618.86m 619.66m 620.54m



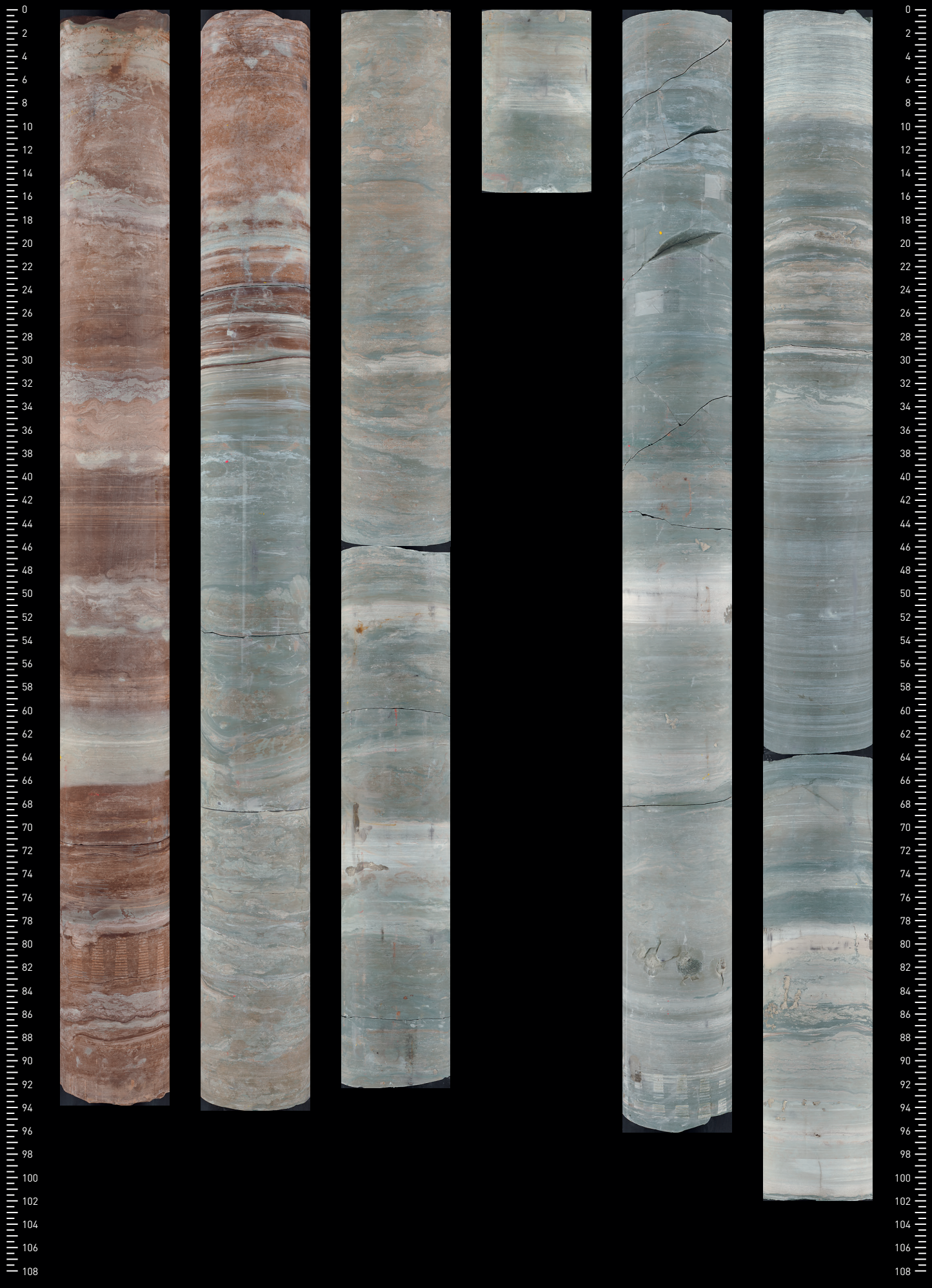
617.00m 617.98m 618.86m 619.66m 620.54m 621.45m

621.45m 622.30m 623.08m 623.89m 624.80m 625.45m



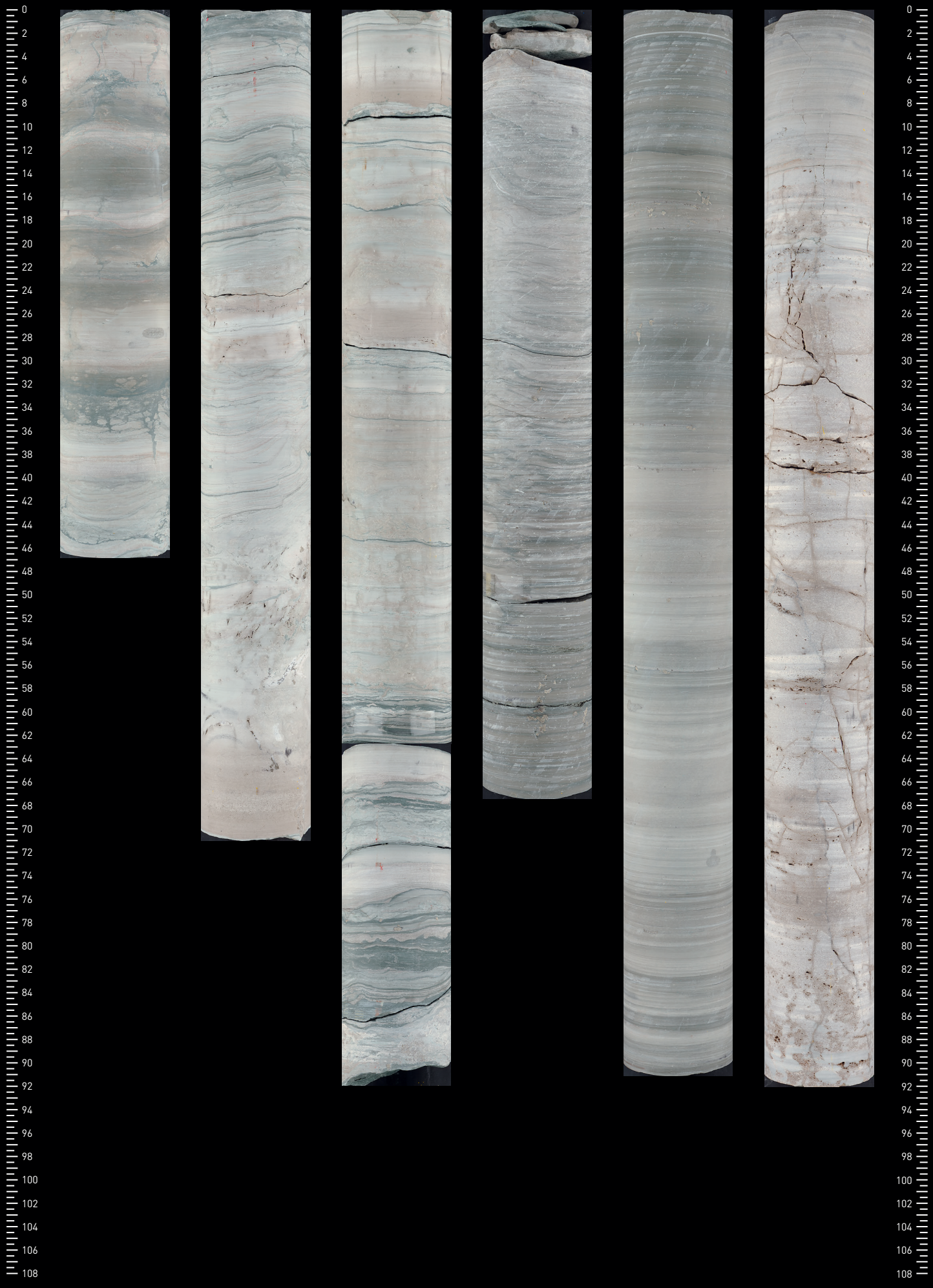
622.30m 623.08m 623.89m 624.80m 625.45m 626.36m

626.36m 627.29m 628.20m 629.11m 629.26m 630.20m



627.29m 628.20m 629.11m 629.26m 630.20m 631.19m

631.19m 631.64m 632.35m 633.23m 633.87m 634.75m



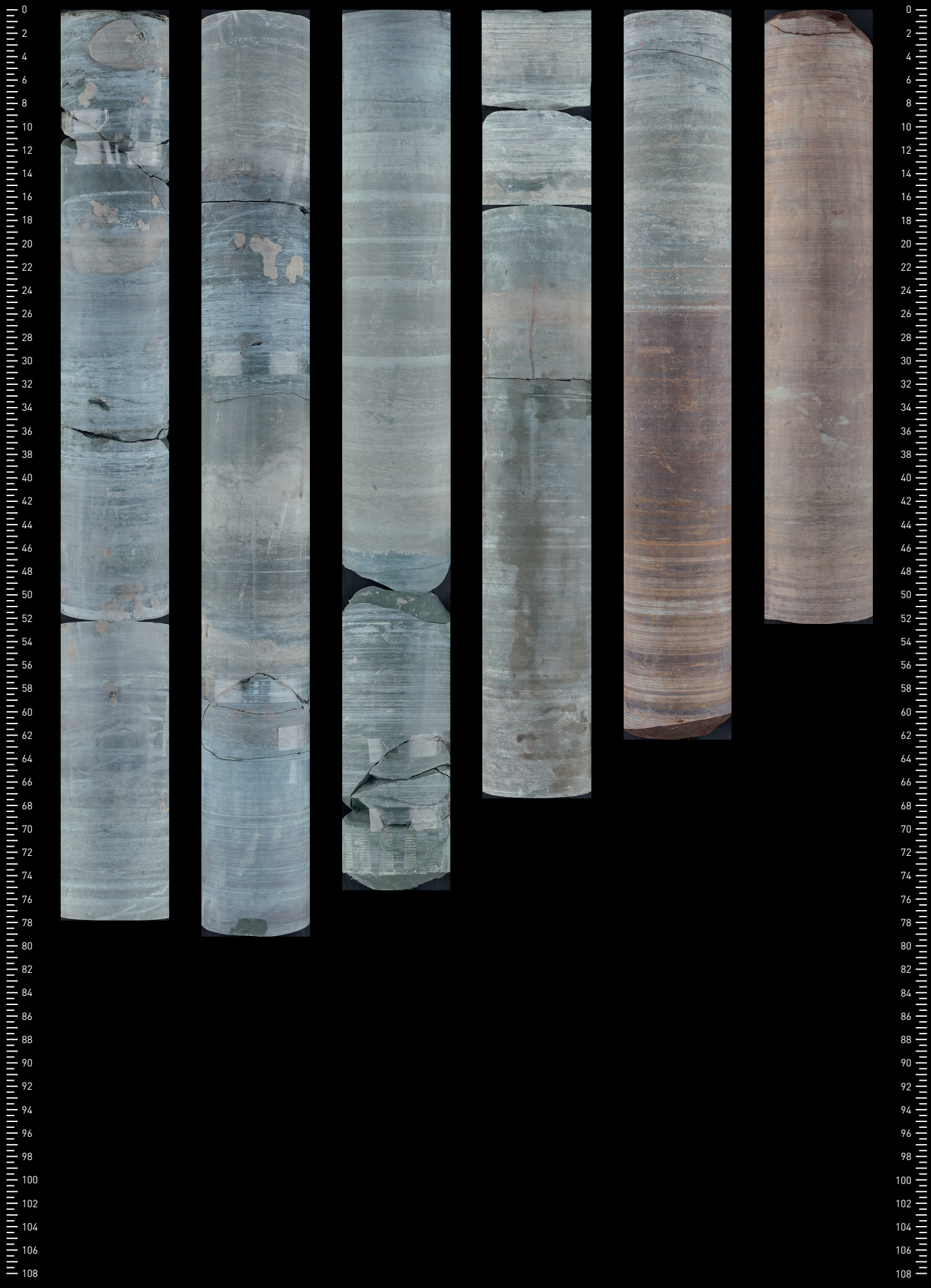
631.64m 632.35m 633.23m 633.87m 634.75m 635.65m

635.65m 636.23m 637.13m 637.99m 638.68m 639.21m



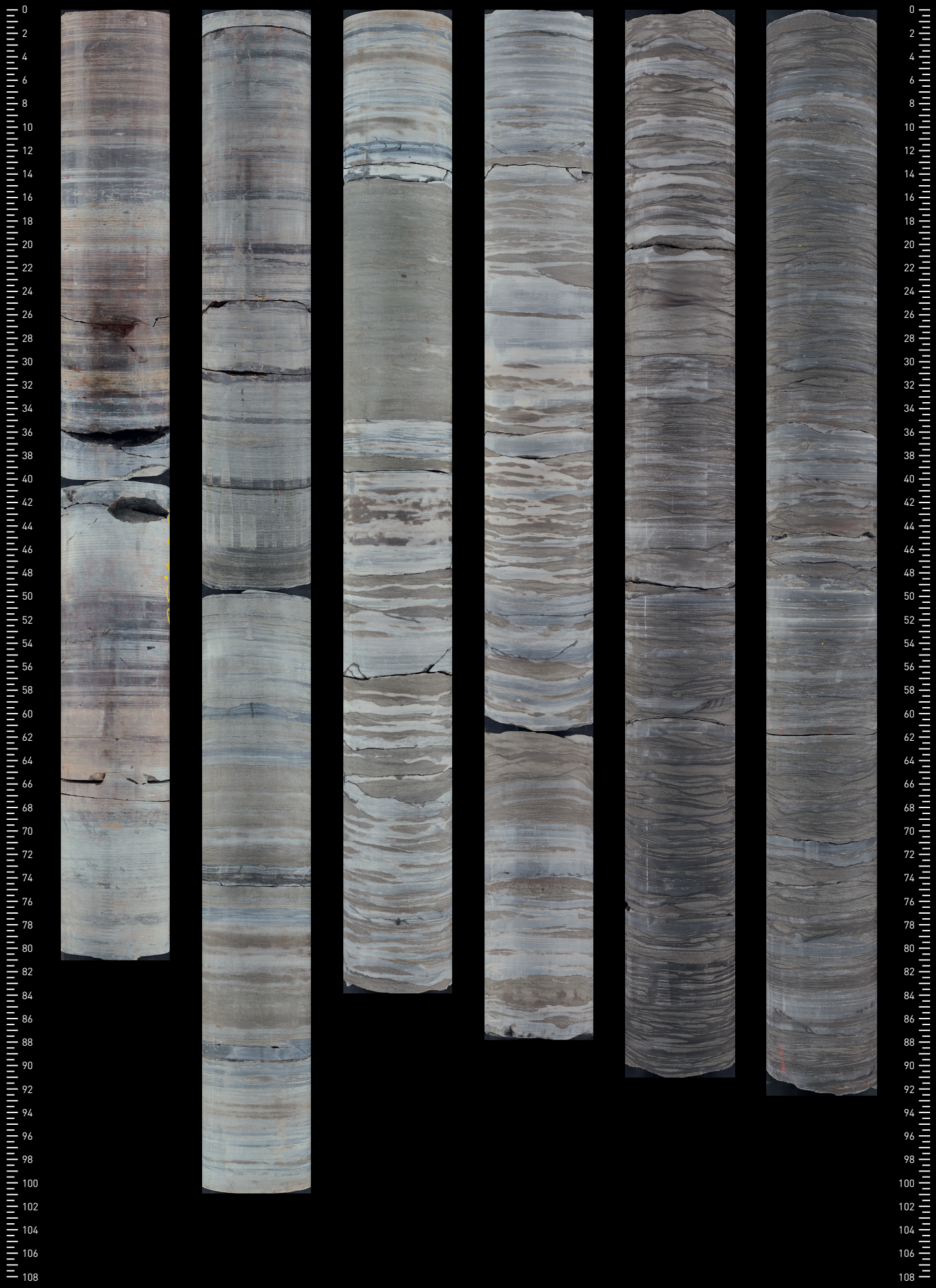
636.23m 637.13m 637.99m 638.68m 639.21m 640.03m

640.03m 640.79m 641.55m 642.27m 642.92m 643.53m



640.79m 641.55m 642.27m 642.92m 643.53m 644.04m

644.04m 644.84m 645.83m 646.64m 647.49m 648.38m



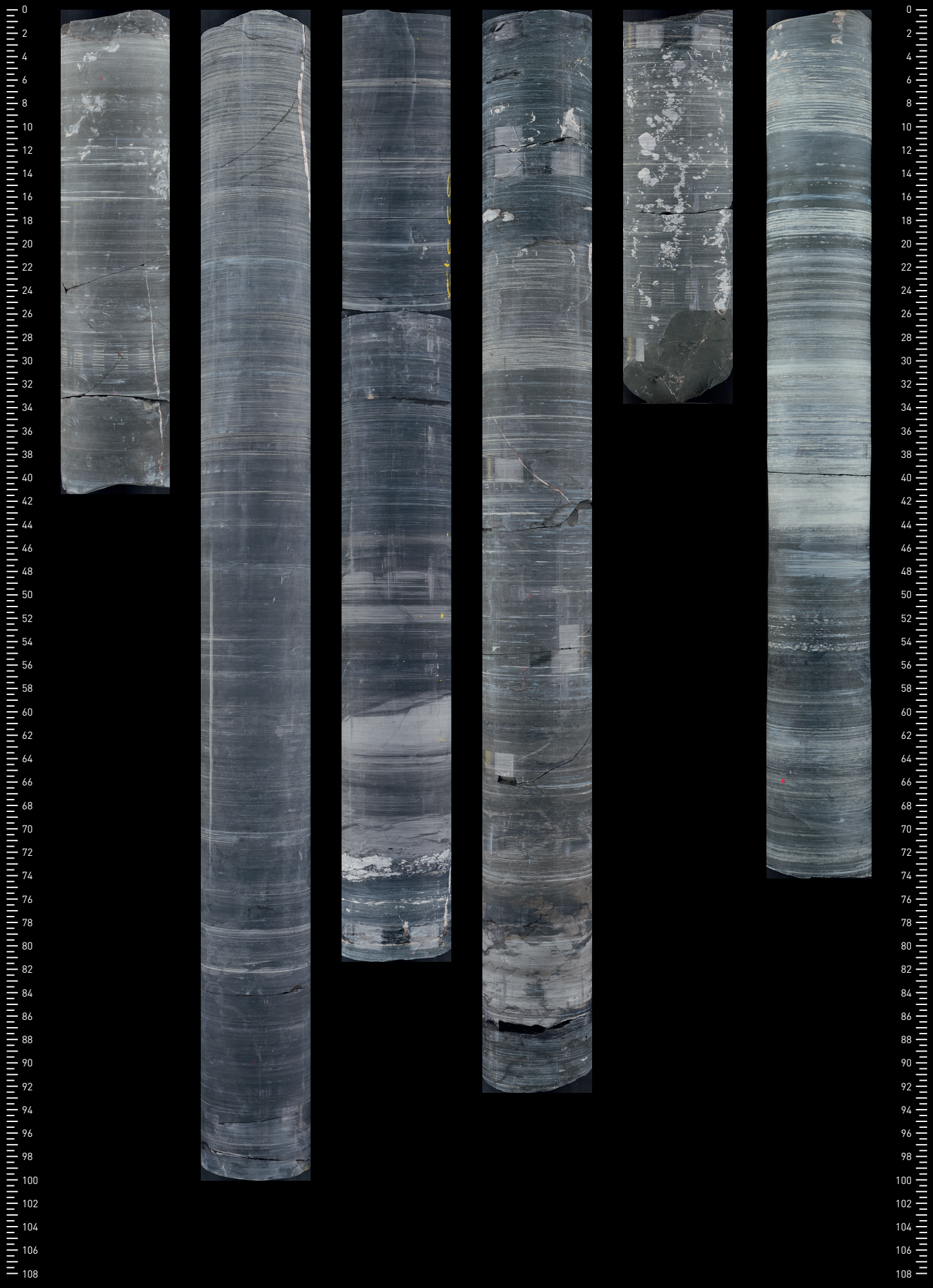
644.84m 645.83m 646.64m 647.49m 648.38m 649.28m

649.28m 650.19m 650.86m 651.39m 652.32m 653.07m



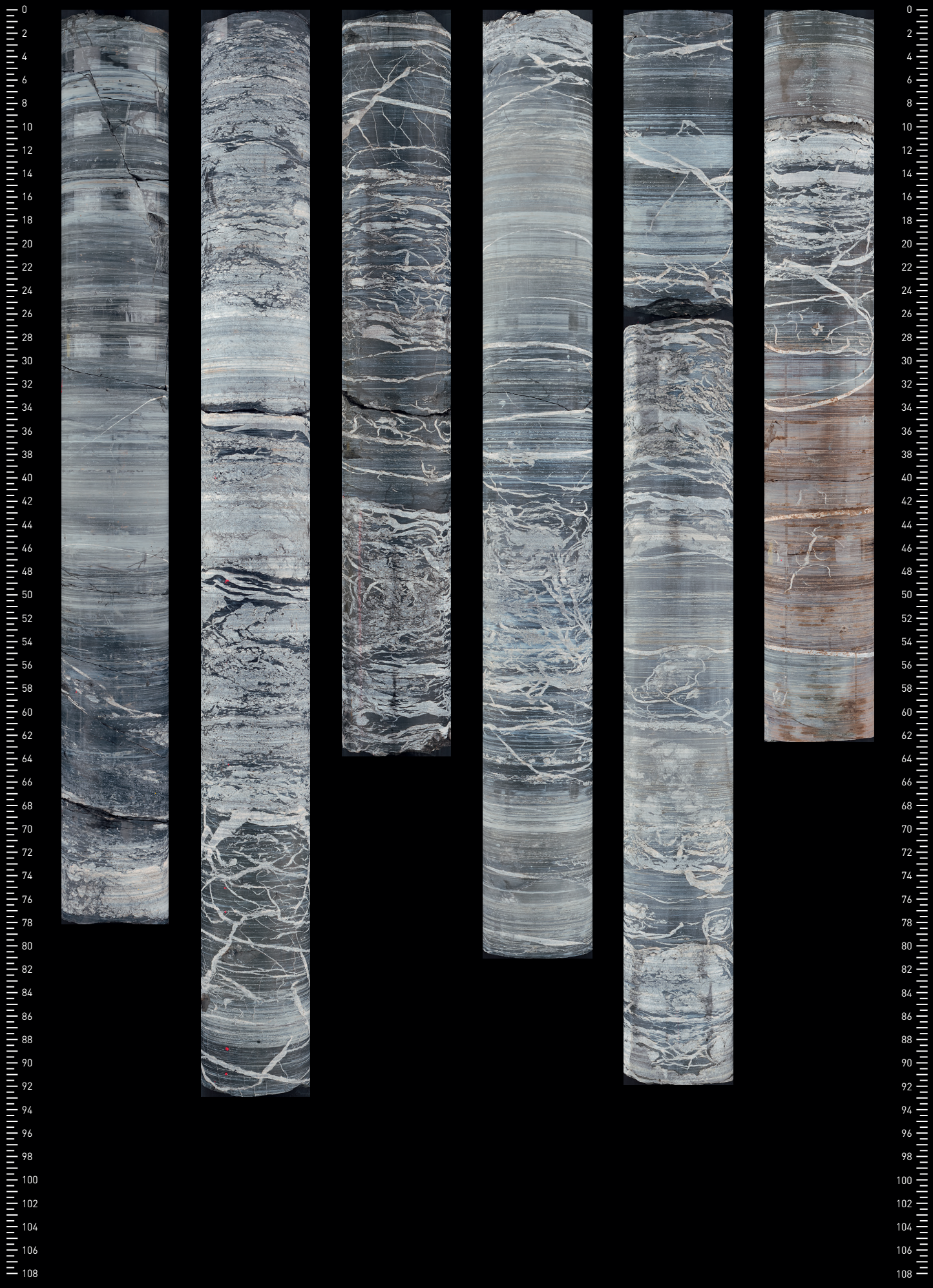
650.19m 650.86m 651.39m 652.32m 653.07m 654.01m

654.01m 654.41m 655.37m 656.17m 657.06m 657.39m



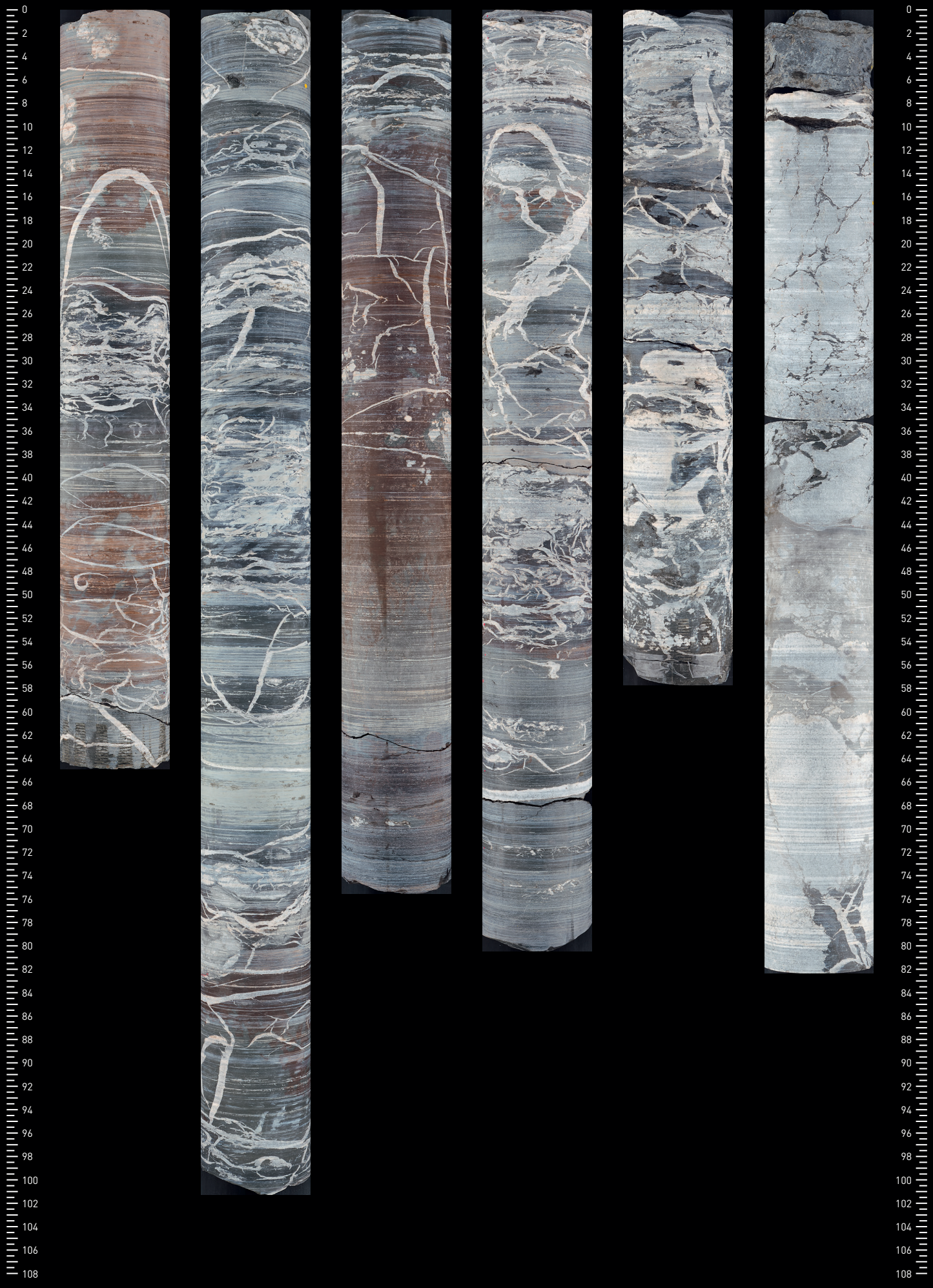
654.41m 655.37m 656.17m 657.06m 657.39m 658.12m

658.12m 658.88m 659.80m 660.40m 661.19m 662.07m



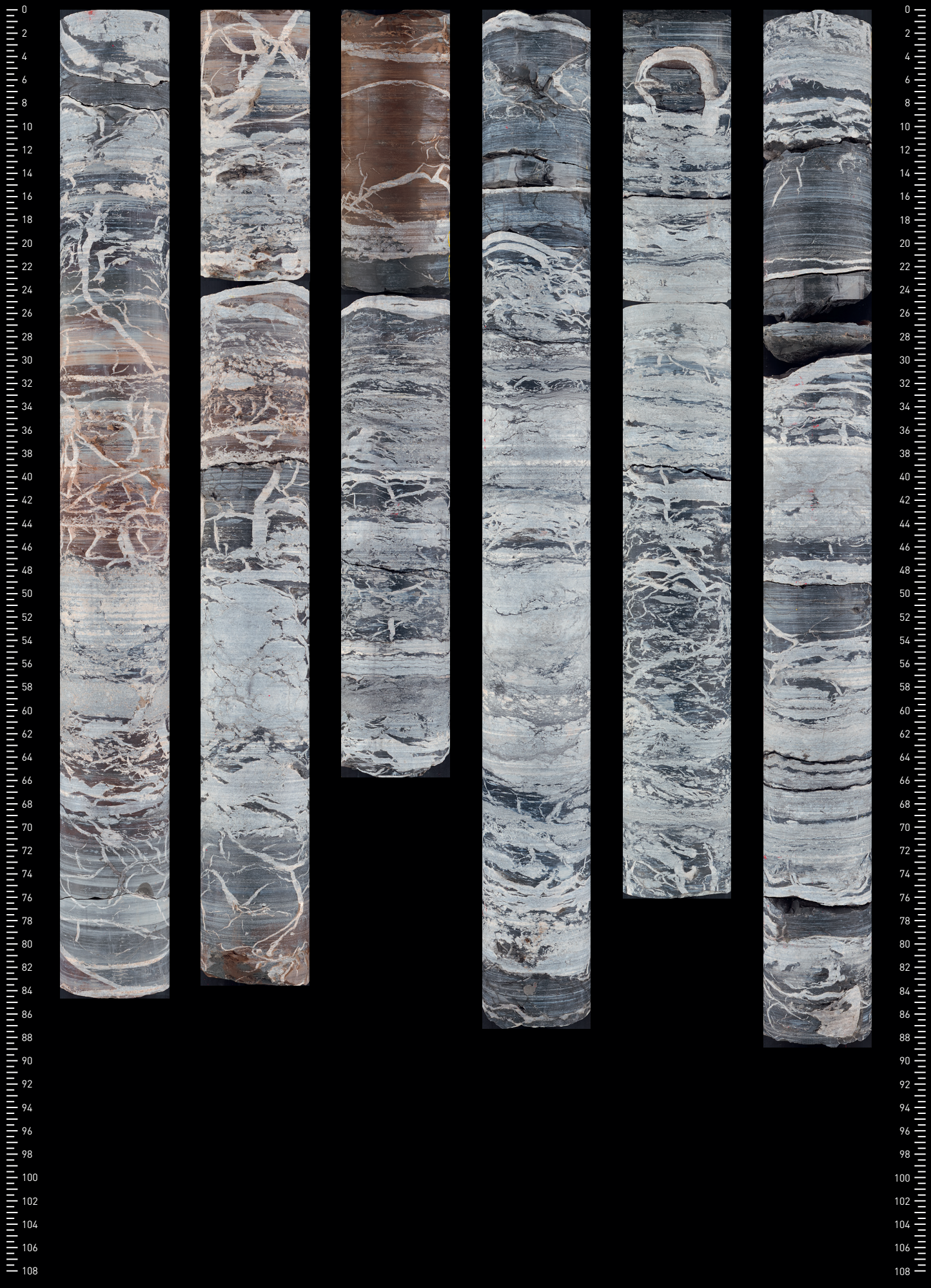
658.88m 659.80m 660.40m 661.19m 662.07m 662.69m

662.69m 663.32m 664.29m 665.03m 665.82m 666.35m



663.32m 664.29m 665.03m 665.82m 666.35m 667.16m

667.16m 668.00m 668.83m 669.44m 670.25m 671.00m

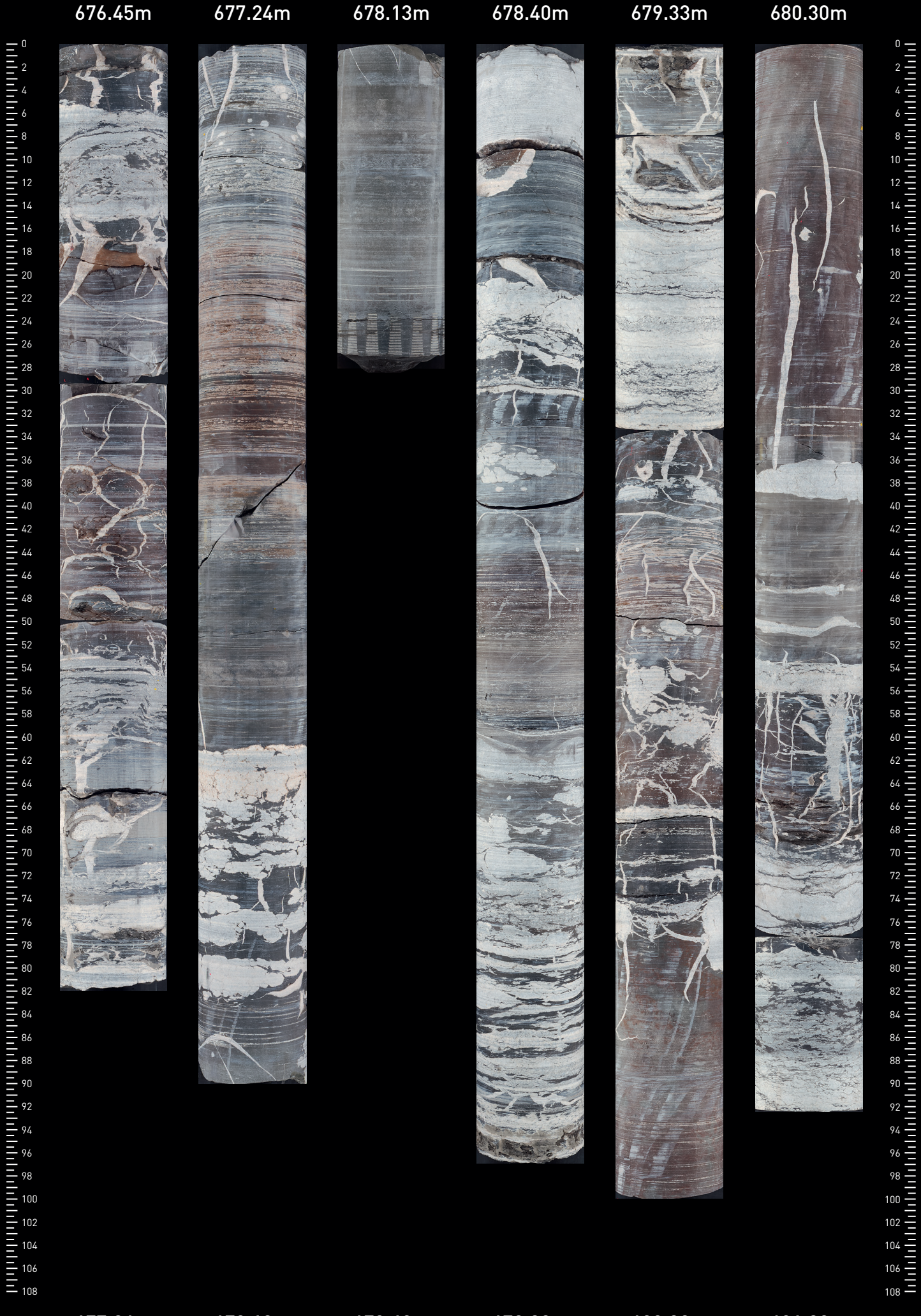


668.00m 668.83m 669.44m 670.25m 671.00m 671.83m

671.83m 672.44m 673.15m 674.12m 674.96m 675.52m



672.44m 673.15m 674.12m 674.96m 675.52m 676.45m


676.45m
677.24m
678.13m
678.40m
679.33m
680.30m
677.24m
678.13m
678.40m
679.33m
680.30m
681.20m

681.20m 682.09m 682.95m 683.87m 684.78m 685.73m



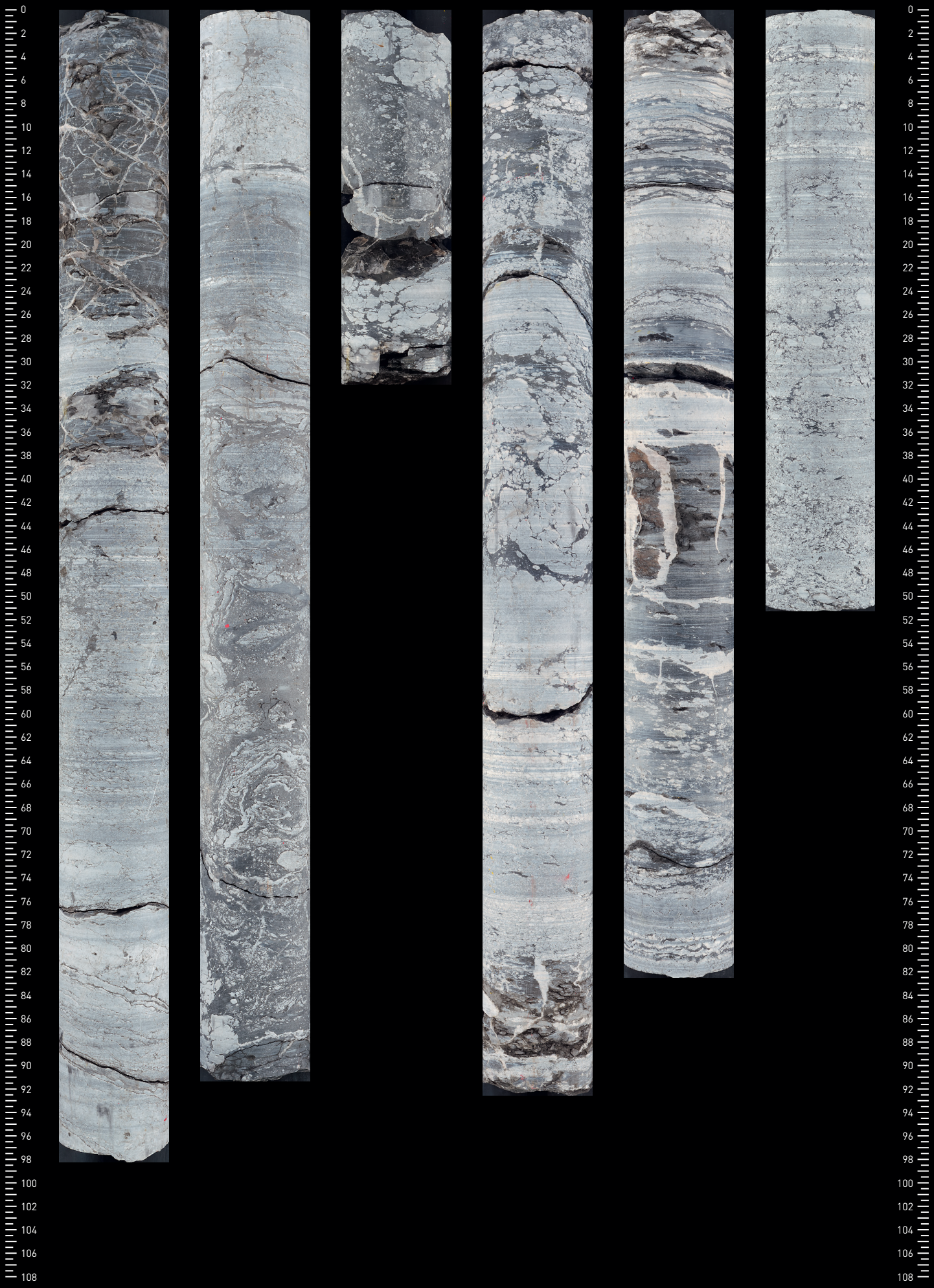
682.09m 682.95m 683.87m 684.78m 685.73m 686.59m

686.59m 687.40m 688.33m 689.20m 690.16m 690.47m



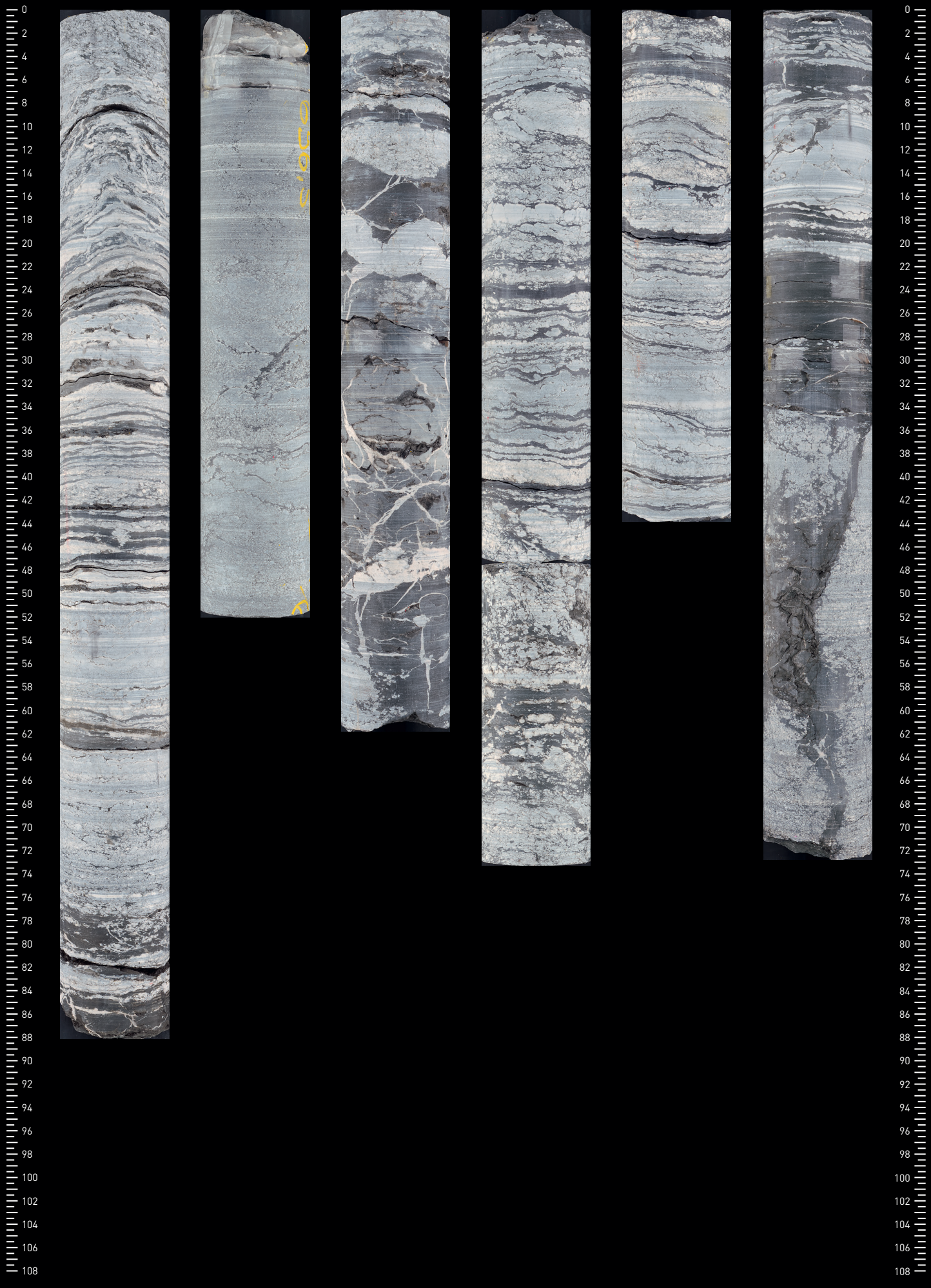
687.40m 688.33m 689.20m 690.16m 690.47m 691.27m

691.27m 692.22m 693.12m 693.40m 694.31m 695.10m



692.22m 693.12m 693.40m 694.31m 695.10m 695.60m

695.60m 696.46m 696.95m 697.55m 698.25m 698.68m



696.46m 696.95m 697.55m 698.25m 698.68m 699.39m

699.39m 700.20m 700.98m 701.65m 702.39m 703.24m



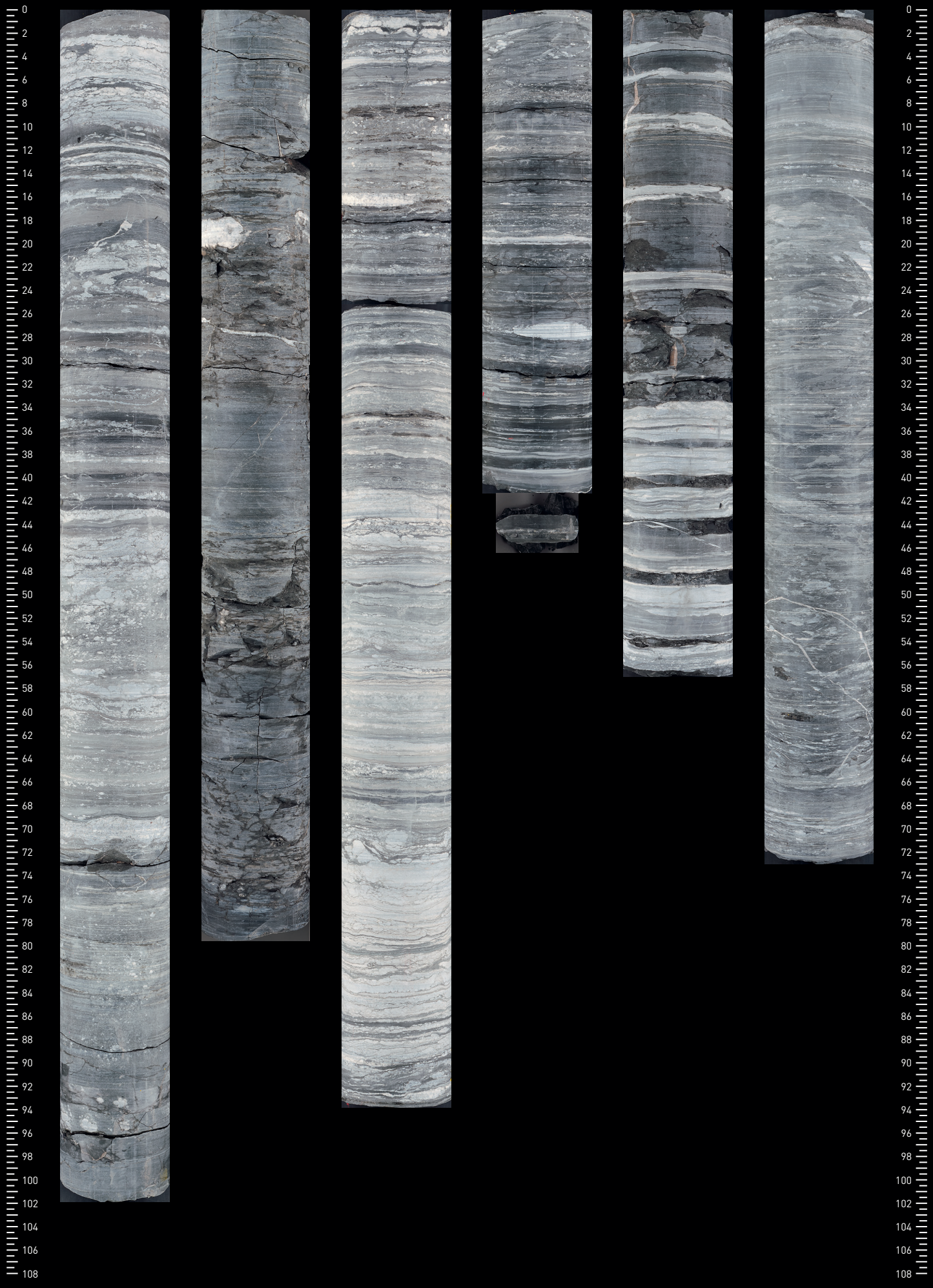
700.20m 700.98m 701.65m 702.39m 703.24m 704.04m

704.04m 704.75m 705.38m 706.27m 707.03m 707.54m



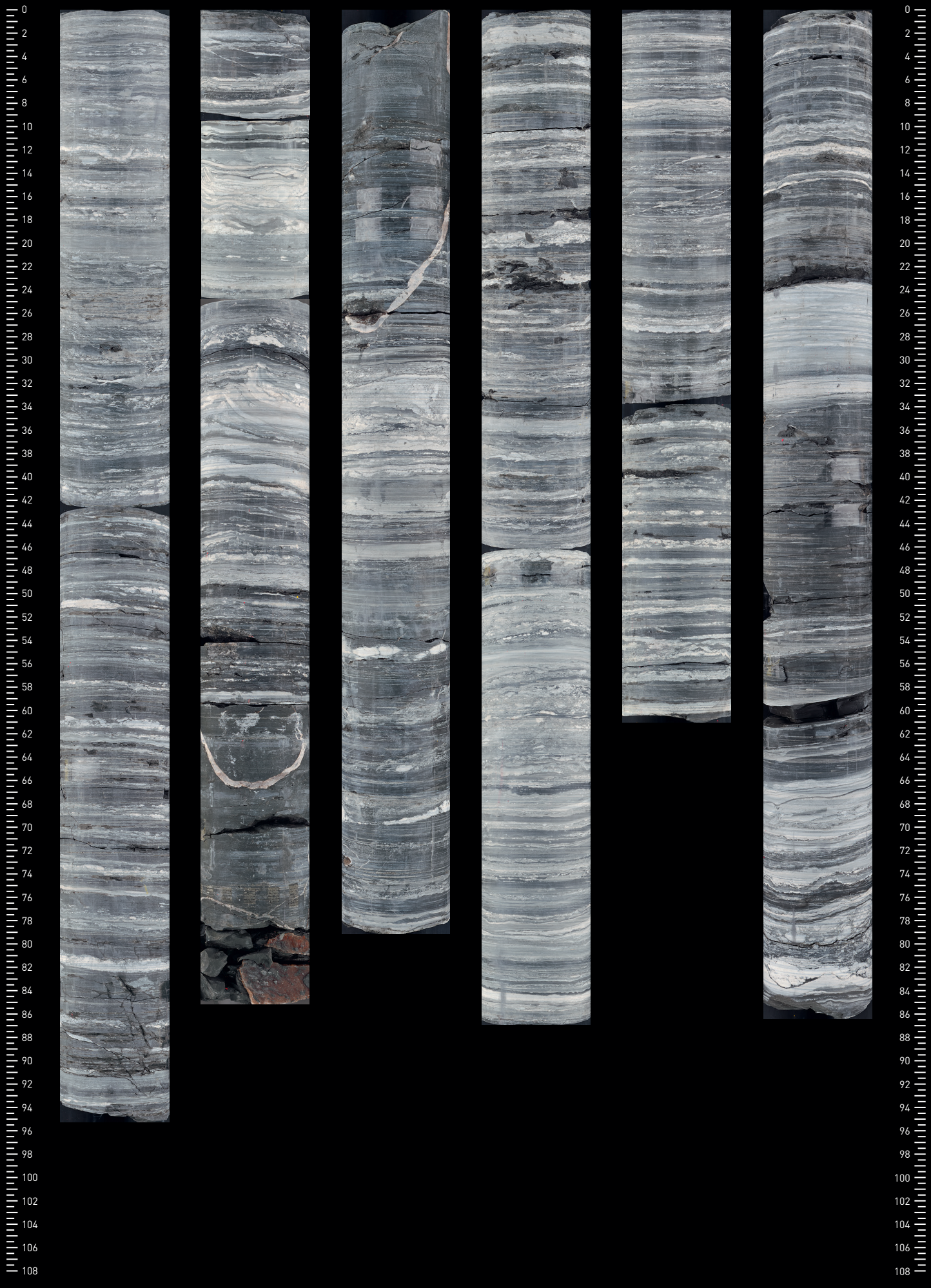
704.75m 705.38m 706.27m 707.03m 707.54m 708.39m

708.39m 709.37m 710.14m 711.06m 711.47m 712.03m



709.37m 710.14m 711.06m 711.47m 712.03m 712.73m

712.73m 713.65m 714.49m 715.25m 716.09m 716.68m



713.65m 714.49m 715.25m 716.09m 716.68m 717.53m

717.53m 718.44m 719.00m 719.76m 720.70m 721.65m



718.44m 719.00m 719.76m 720.70m 721.65m 722.60m

722.60m 723.43m 724.27m 725.19m 725.91m 726.52m



723.43m 724.27m 725.19m 725.91m 726.52m 727.10m

727.10m 727.98m 728.68m 729.43m 729.98m 730.49m



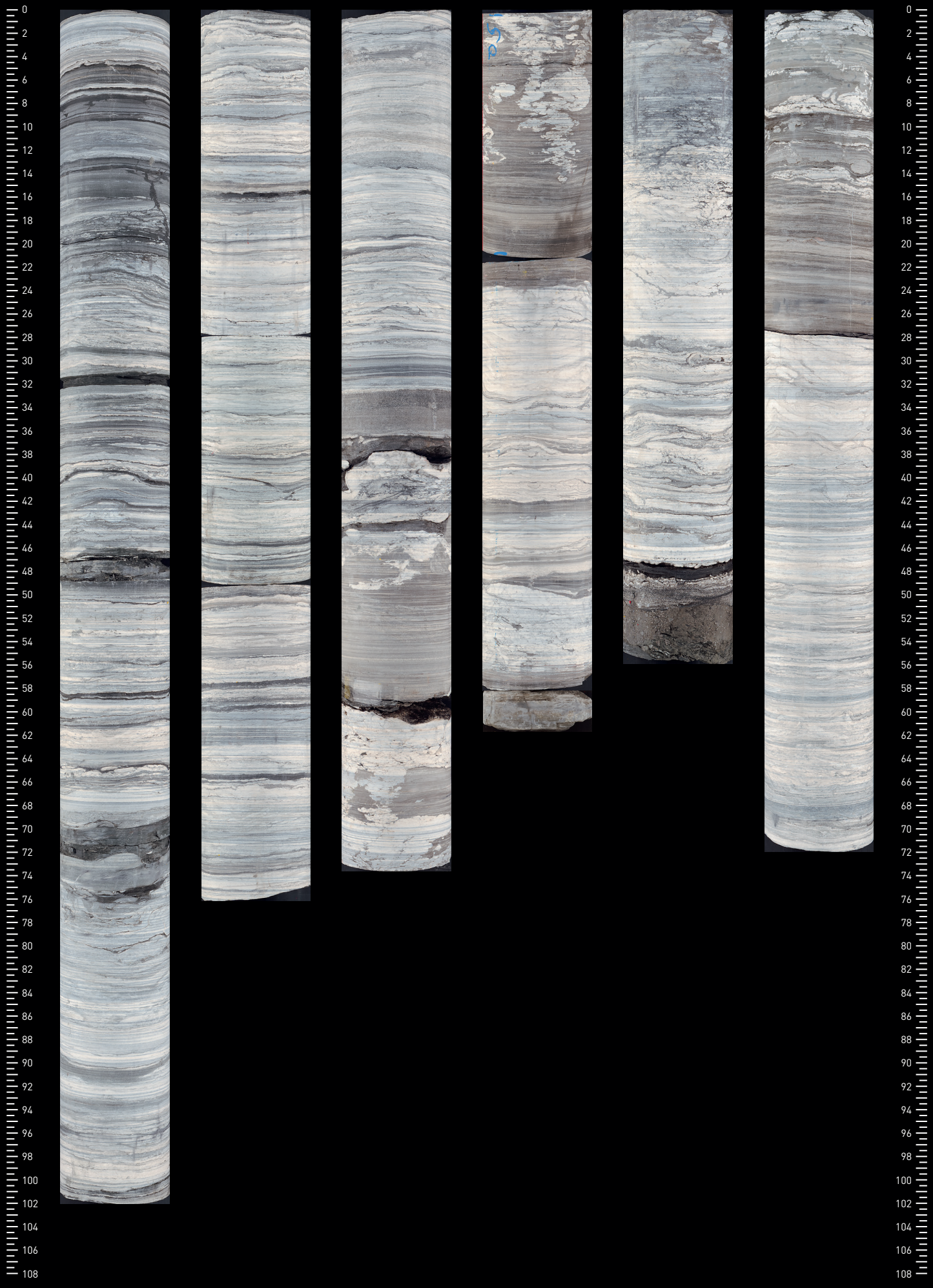
727.98m 728.68m 729.43m 729.98m 730.49m 731.34m

731.34m 731.97m 732.44m 733.35m 733.95m 734.70m



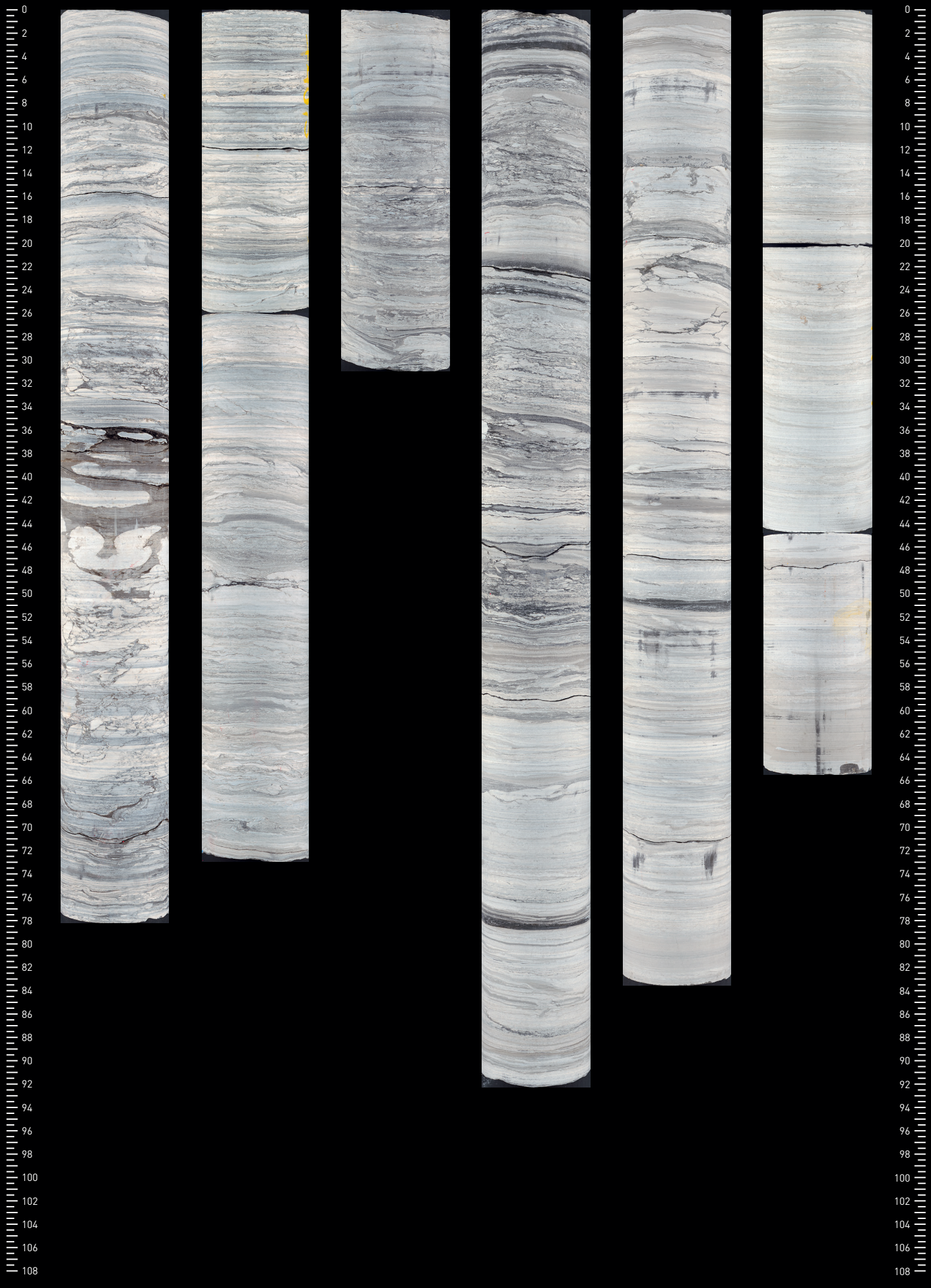
731.97m 732.44m 733.35m 733.95m 734.70m 735.47m

735.47m 736.46m 737.21m 737.92m 738.50m 739.06m



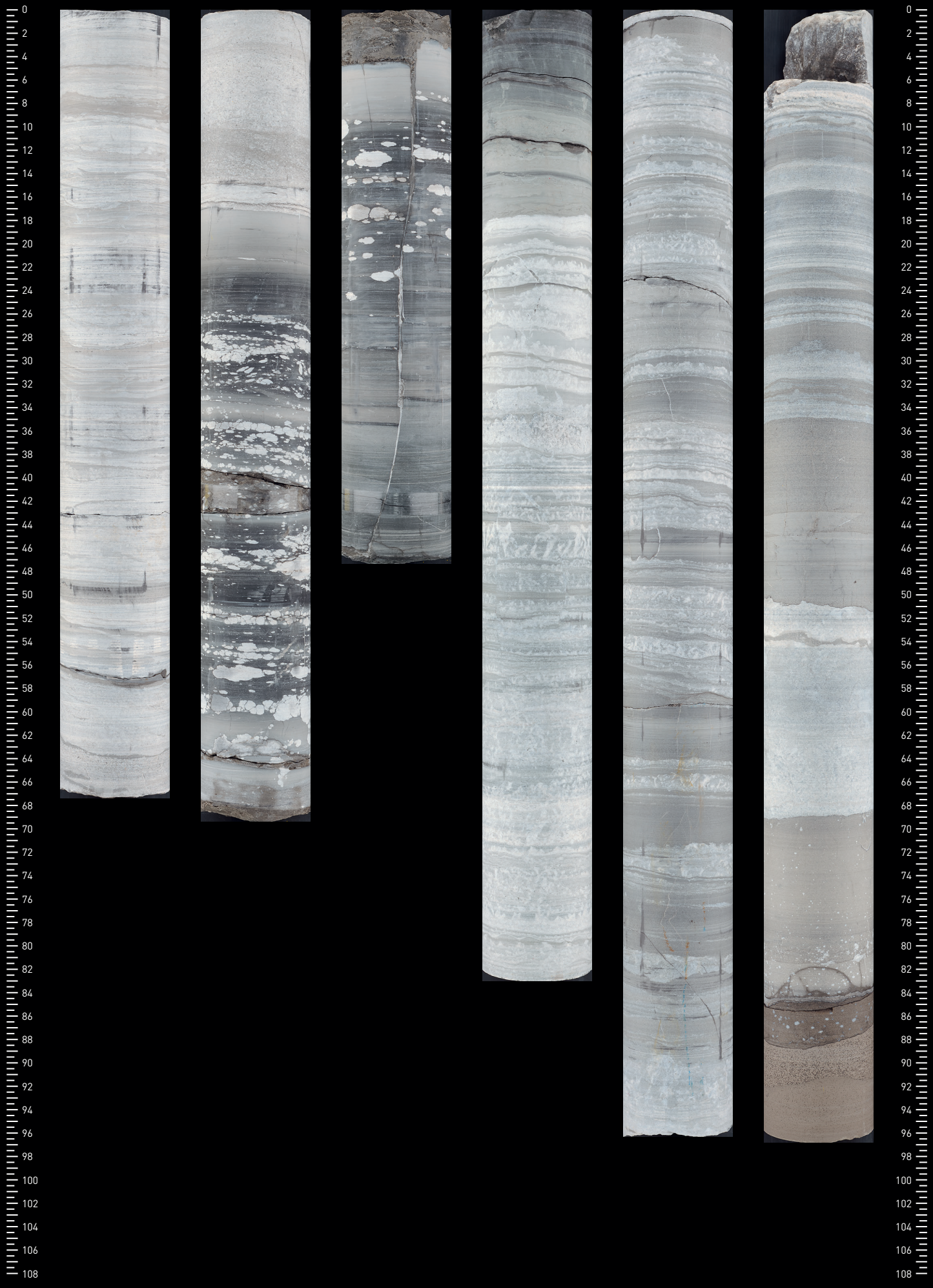
736.46m 737.21m 737.92m 738.50m 739.06m 739.75m

739.75m 740.50m 741.20m 741.54m 742.44m 743.24m



740.50m 741.20m 741.54m 742.44m 743.24m 743.87m

743.87m 744.55m 745.21m 745.67m 746.48m 747.44m



744.55m 745.21m 745.67m 746.48m 747.44m 748.40m

748.40m 749.12m 749.92m 750.52m 751.18m 751.98m



749.12m 749.92m 750.52m 751.18m 751.98m 752.73m

752.73m 753.56m 754.30m 755.16m 755.71m 756.51m



753.56m 754.30m 755.16m 755.71m 756.51m 757.30m


757.30m
758.14m
758.90m
759.55m
760.28m
761.00m
758.14m
758.90m
759.55m
760.28m
761.00m
761.75m

761.75m 762.49m 763.35m 764.32m 765.00m 765.57m



762.49m 763.35m 764.32m 765.00m 765.57m 766.50m

766.50m 767.31m 768.21m 768.63m 769.55m 770.41m



767.31m 768.21m 768.63m 769.55m 770.41m 771.26m

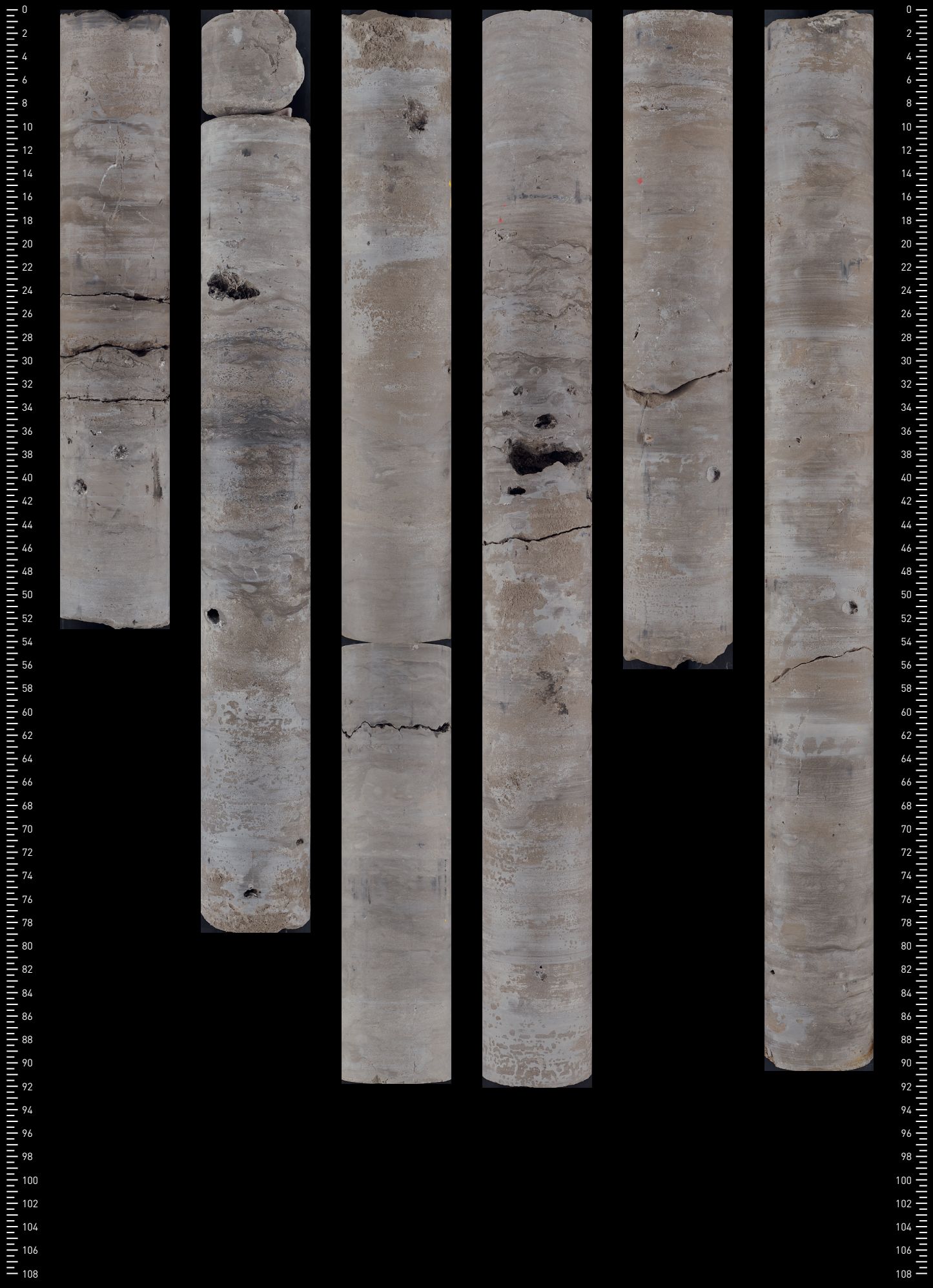
771.26m 771.70m 772.59m 773.32m 773.97m 774.68m



771.70m 772.59m 773.32m 773.97m 774.68m 775.39m

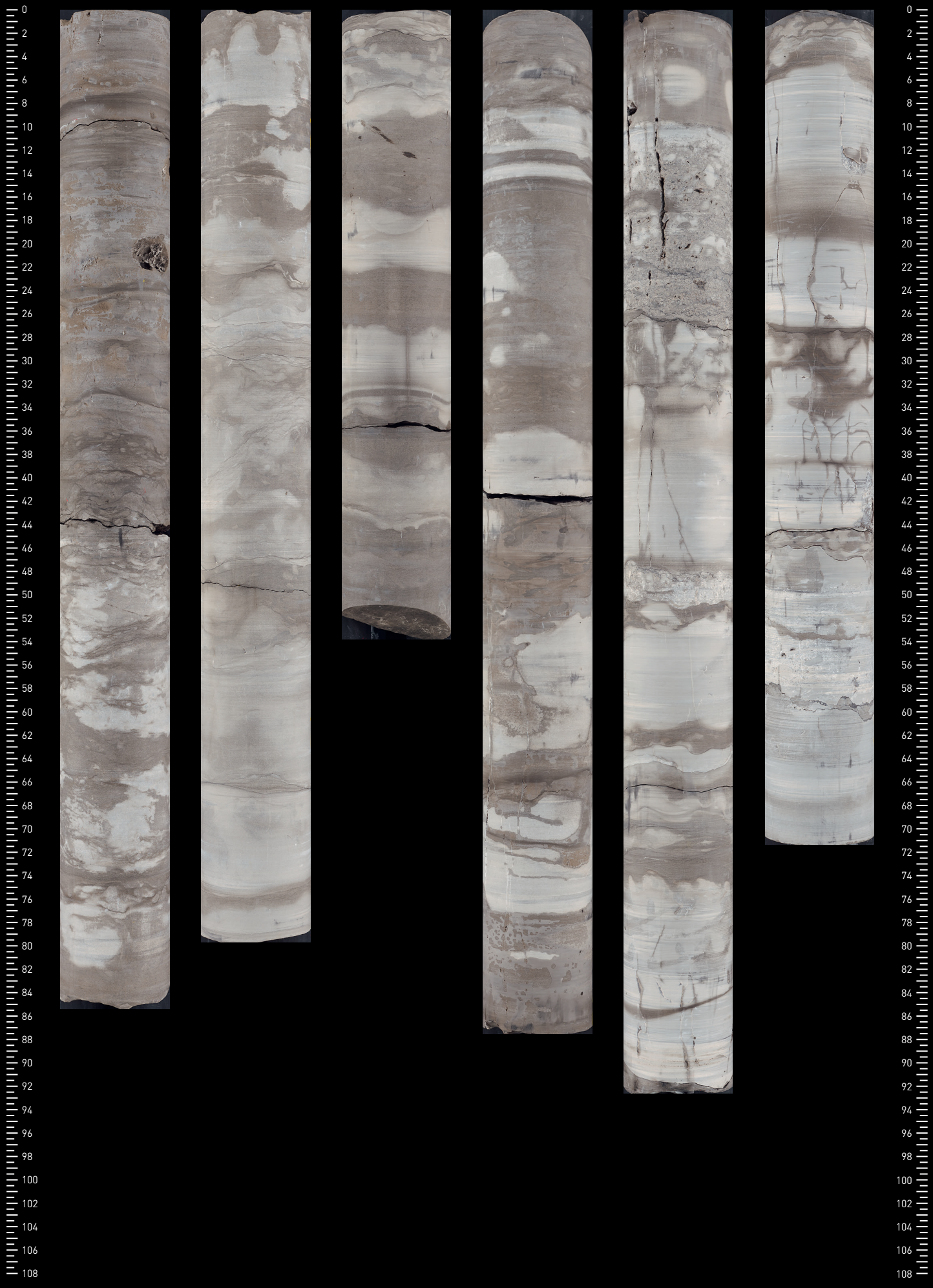

775.39m
776.29m
777.15m
777.60m
778.42m
779.32m
776.29m
777.15m
777.60m
778.42m
779.32m
780.05m

780.05m 780.56m 781.33m 782.23m 783.13m 783.66m



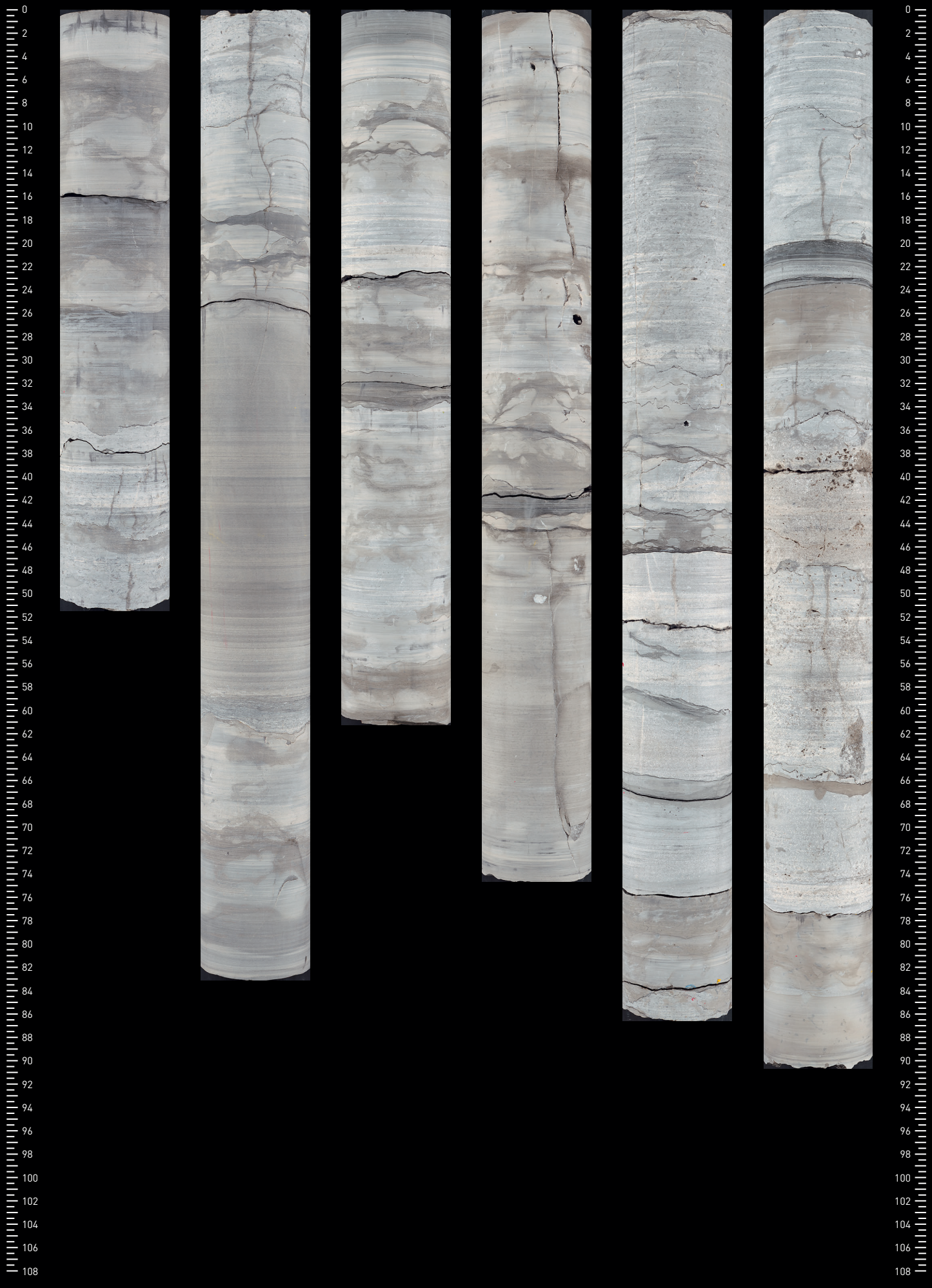
780.56m 781.33m 782.23m 783.13m 783.66m 784.56m

784.56m 785.38m 786.16m 786.68m 787.51m 788.41m



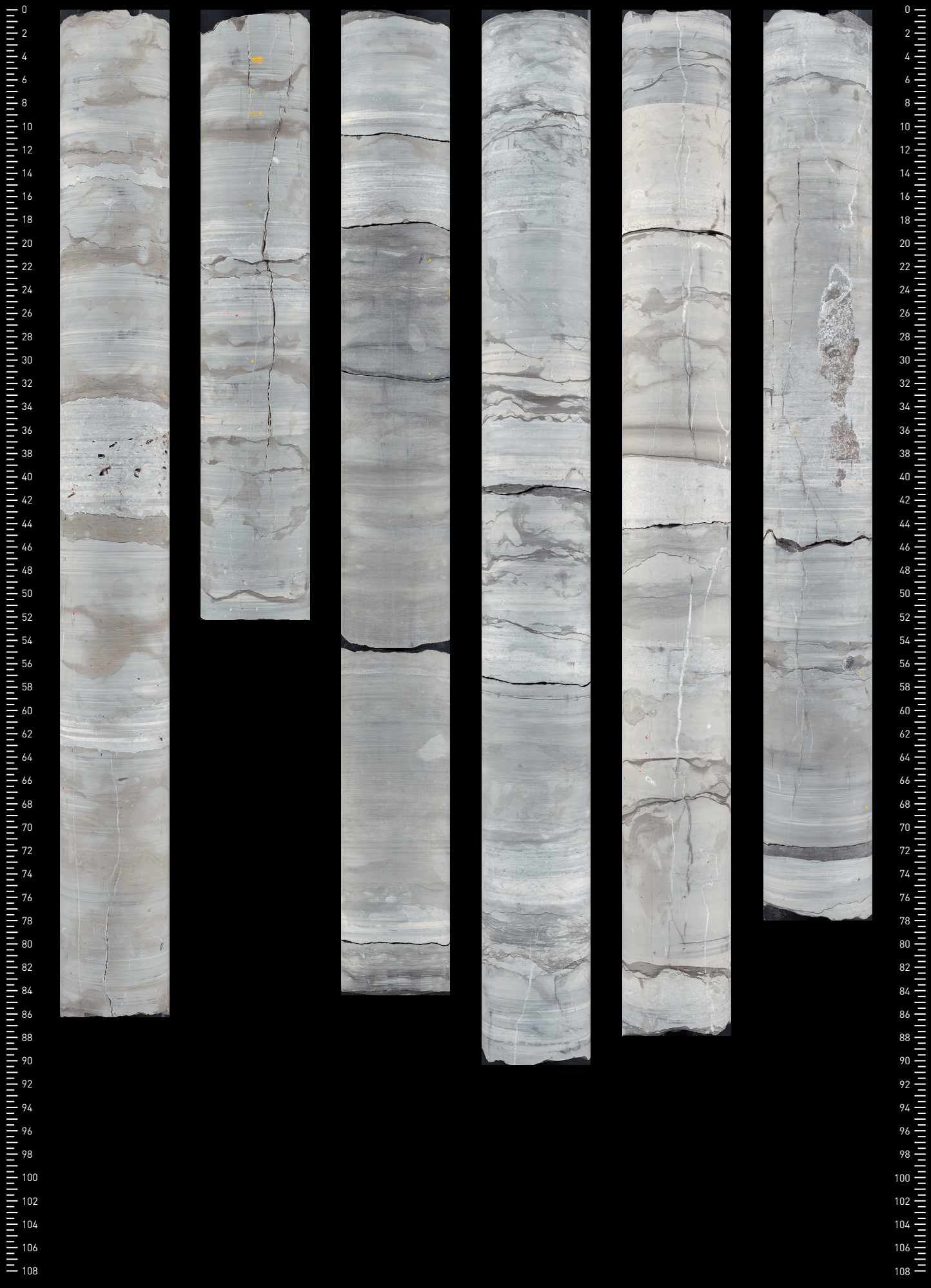
785.38m 786.16m 786.68m 787.51m 788.41m 789.10m

789.10m 789.61m 790.42m 791.02m 791.74m 792.59m

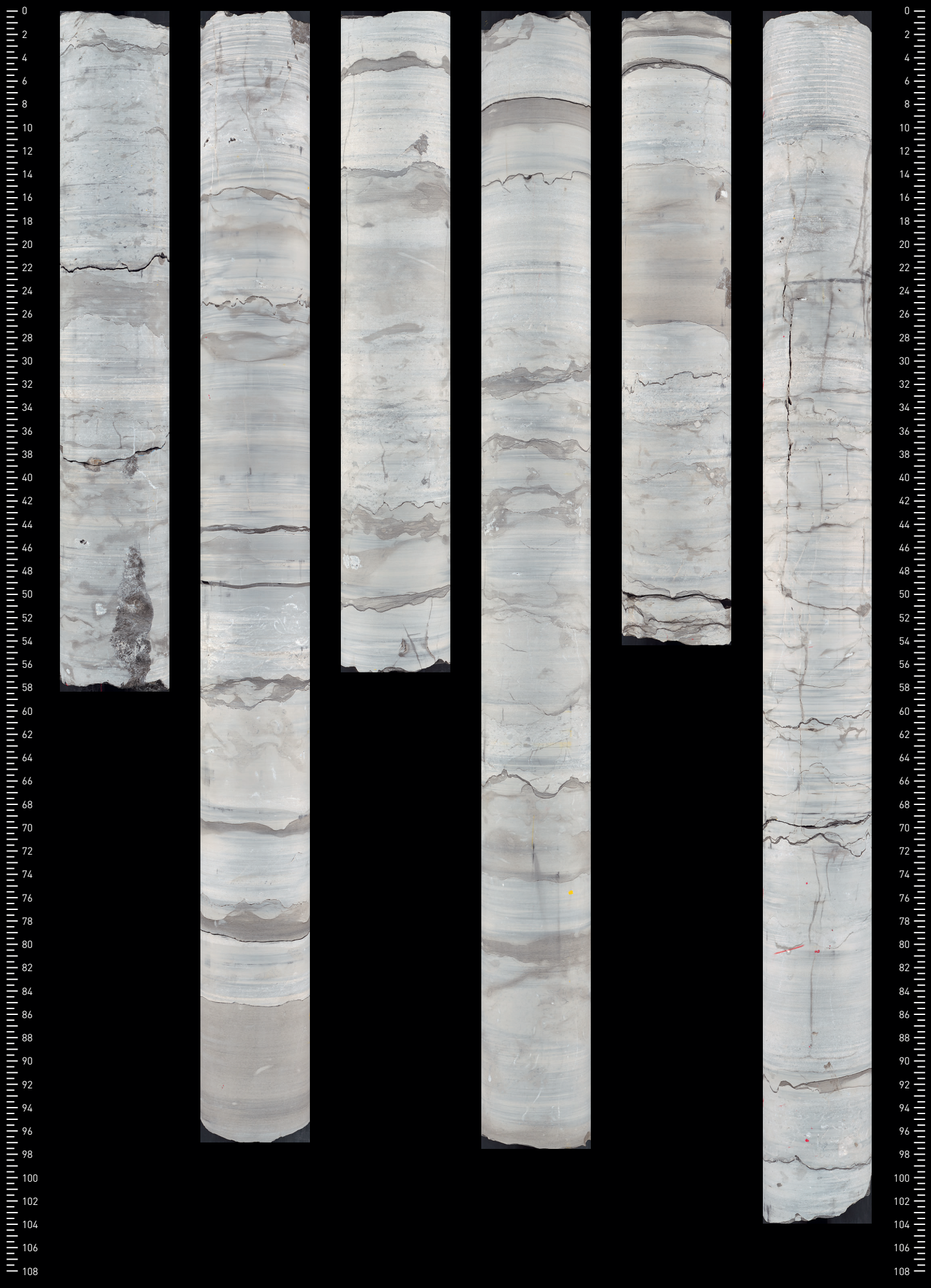


789.61m 790.42m 791.02m 791.74m 792.59m 793.47m

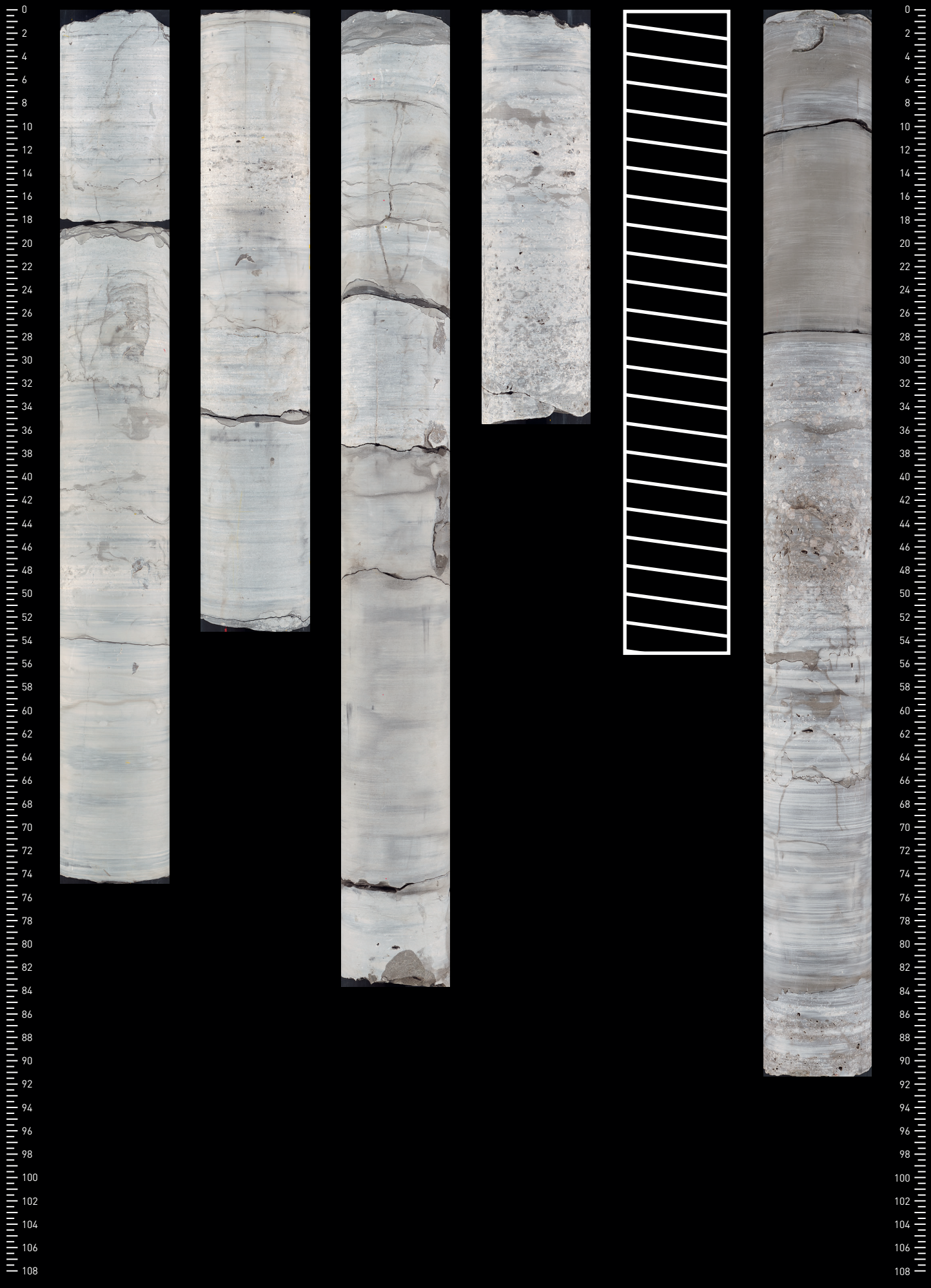
793.47m 794.32m 794.83m 795.63m 796.52m 797.37m



794.32m 794.83m 795.63m 796.52m 797.37m 798.12m

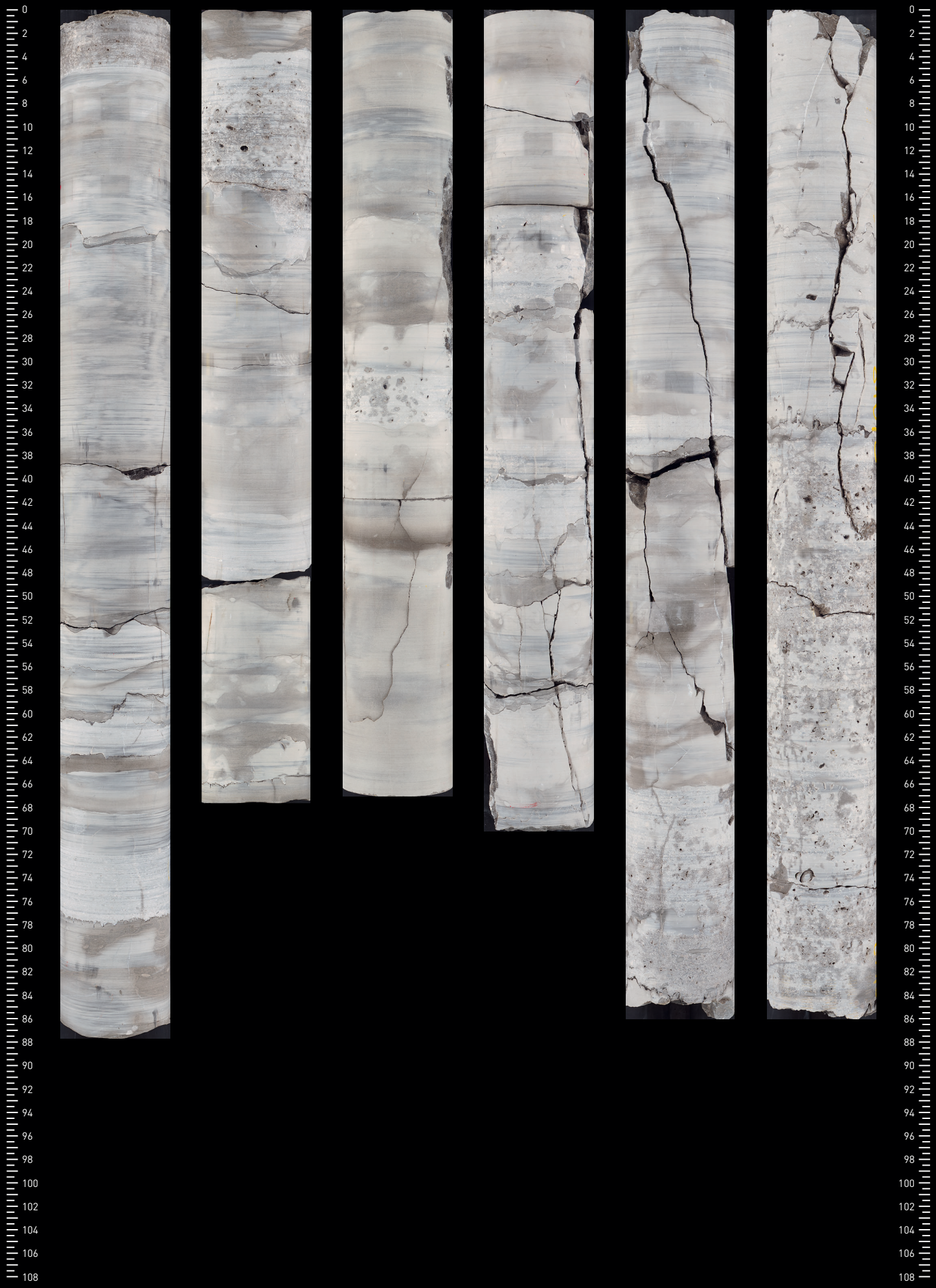

798.12m
798.69m
799.62m
800.18m
801.13m
801.64m
798.69m
799.62m
800.18m
801.13m
801.64m
802.64m

802.64m 803.35m 803.87m 804.70m 805.04m 805.60m



803.35m 803.87m 804.70m 805.04m 805.60m 806.49m

806.49m 807.34m 808.00m 808.66m 809.35m 810.17m



807.34m 808.00m 808.66m 809.35m 810.17m 811.00m

811.00m 811.58m 812.43m 813.30m 814.07m 814.64m



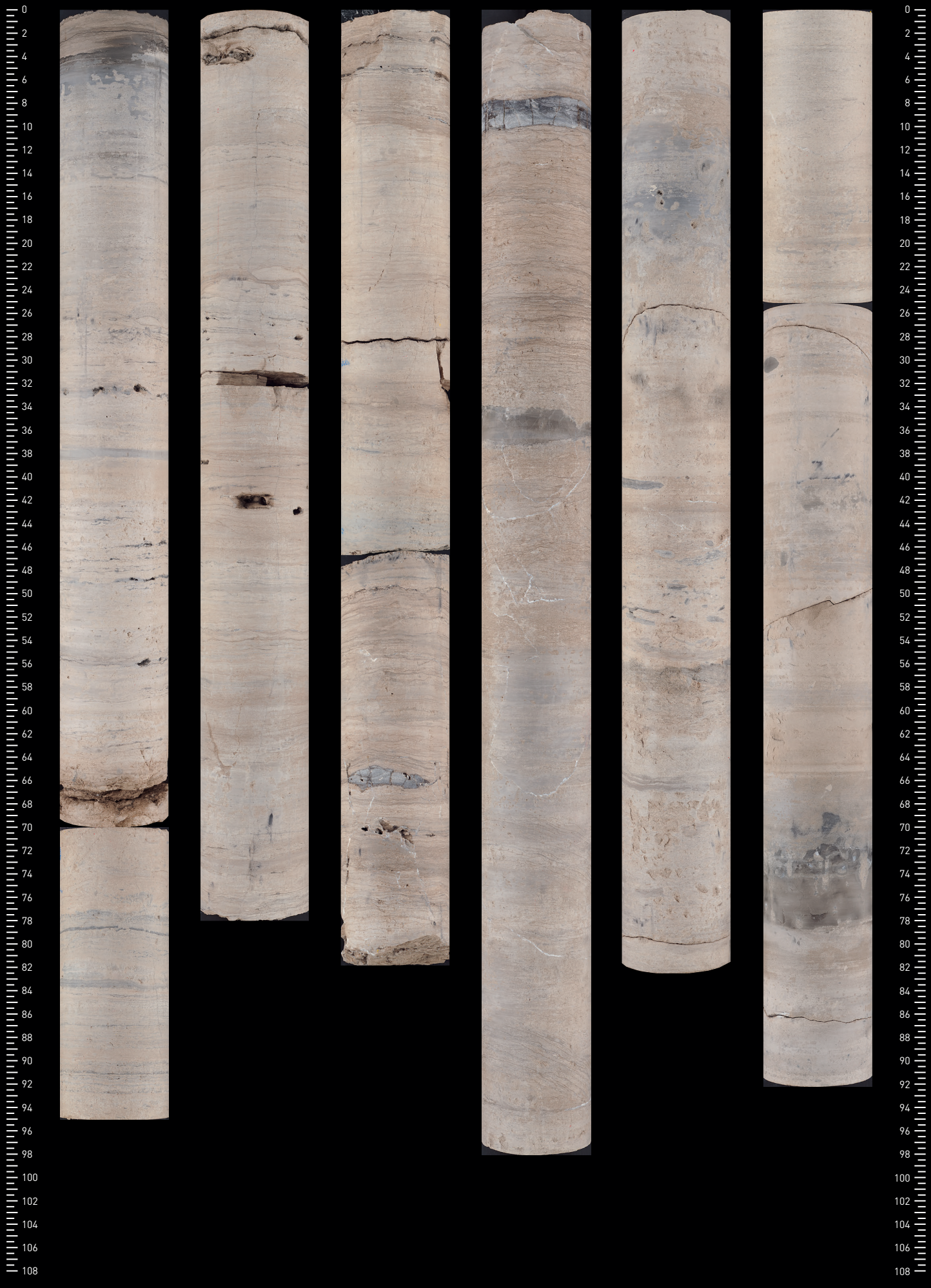
811.58m 812.43m 813.30m 814.07m 814.64m 815.28m

815.28m 816.26m 817.05m 817.94m 818.76m 819.66m



816.26m 817.05m 817.94m 818.76m 819.66m 820.63m

820.63m 821.56m 822.33m 823.12m 824.05m 824.87m



821.56m 822.33m 823.12m 824.05m 824.87m 825.77m

825.77m 826.63m 827.48m 828.32m



826.63m 827.48m 828.32m 829.11m

4 References

Isler, A., Pasquier, F. & Huber, M. (1984): Geologische Karte der zentralen Nordschweiz 1:100'000. Herausgegeben von der Nagra und der Schweiz. Geol. Komm.

Nagra (2014): SGT Etappe 2: Vorschlag weiter zu untersuchender geologischer Standortgebiete mit zugehörigen Standortarealen für die Oberflächenanlage. Geologische Grundlagen. Dossier II: Sedimentologische und tektonische Verhältnisse. Nagra Technischer Bericht NTB 14-01.

Pietsch, J. & Jordan, P. (2014): Digitales Höhenmodell Basis Quartär der Nordschweiz – Version 2013 (SGT E2) und ausgewählte Auswertungen. Nagra Arbeitsbericht NAB 14-02.