

APPENDIX III-A
BRAZOS RIVER DRILLING 2005

Gerta Keller and Gerald Baum

Objectives: Drilling of the late Maastrichtian to early Danian sequences on the Brazos Rose Ranch along the Brazos River of Falls County, Texas, was undertaken to test the challenging results from northeastern Mexico and the Chicxulub impact crater well Yaxcopoil-1 on Yucatan that revealed that this impact predates the KTB mass extinction and therefore could not have been the immediate cause. The Brazos River area of Falls County was chosen for its ~ 1000 km distance from the Chicxulub impact crater, the tectonically undisturbed sequences, excellent preservation of microfossils, and the presence of a sandstone complex with Chicxulub impact spherules that permits age dating of the impact event. Drilling was supported by the National Science Foundation through the Continental Dynamics Program and Sedimentary Geology Program under NSF Grants EAR-0207407 and EAR-0447171. Drilling was undertaken by DOSECC (Drilling, Observation and Sampling of Earths Continental Crust) with Gerta Keller and Jerry Baum on site and Thom Yancey splitting cores, initial lithological descriptions of cores and taking photo logs.



Drilling was done on the Brazos Rose Ranch on which all KTB localities are located within and adjacent to the Brazos River. The sections span about 3.5 km along the Brazos River and along the Cottonmouth and Darting Minnow Creek tributaries, all located on the Brazos Rose Ranch. Wells were located to maximize recovery of the KTB sequences based on prior knowledge of outcrops and older cores from the 1980s. Mullinax-1 is located at the same GPS locality of the old well KT1. Mullinax-2 and Mullinax-3 are located about 3.5 km south and near the Darting Minnow Creek waterfall. At this locality, two overlapping wells with staggered cores were drilled to maximize core recovery. Locations of the Mullinax wells and other KTB localities are shown in Figure 2.



Figure 2. Localities of Mullinax wells and other KTB cores and outcrops along the Brazos River at the Brazos Rose Ranch.

CORE DESCRIPTIONS AND CORE PHOTOS

WELL MULLINAX-1

31°07.53' N, 96°49.148' W

Lithology descriptions and core photos by Thom Yancey, Thierry Adatte and Gerta Keller

Top of core: 4.27 m (14 feet) subsurface

Base of core: 45.57 m (-149.5 feet) depth.

0.00–4.27 m 0 to 4.27 m depth (-0 to -14 feet)

Not cored.

4.27–5.39 m 4.27 to 5.39 m depth in Part 1-1 (-14 to -17.7 feet)

No core.

5.39–5.75 m 0–36 cm in Part 1-1 (-17.7 to -18.8 feet)

Sandstone; medium gray; fine grained; quartzose, some small tan mudstone clasts, some phosphatic clasts; medium-thick bedded; not laminated; corals, bivalves; much bioturbation with many burrows; indurated; sharp basal contact.

5.75–5.79 m 36–40 cm in Part 1-1 (-18.8 to -19 feet)

Sandstone; dark gray; fine grained; quartzose, some small tan mudstone clasts, some phosphatic clasts; medium bedded; some lamination; corals, bivalves; some small horizontal burrows; indurated.

5.75–5.93 m (-19 to -19.4 feet)

No core

5.93–6.02 m 0–9 cm in Part 2-1 (-19.4 to -19.7 feet)

Sandstone; medium gray; fine grained; quartzose, some small tan mudstone clasts, some phosphatic clasts; medium-thick bedded; partly laminated; corals, bivalves; some small burrows.

6.02–6.25 m	9–32 cm in Part 2-1	(-19.7 to -20.5 feet)
Sandstone, with mudstone interbeds; sands are medium gray, mudstones are dark gray; fine grained sands; quartzose sand; sandstone beds average 2–3 cm thick, mudstone are 1–3 cm thick; common medium size distinct burrows, but sediment not completely bioturbated; includes a 1 cm diameter burrow with tan sand fill; many small framboidal pyrite masses, often replacing burrows; indurated. Part of a coarsening upward sediment interval.		
6.25–7.01 m	no core	(-20.5 to -23 feet)
7.01–7.14 m	0–11 cm in Part 3-1	(-23 to -23.4 feet)
Mudstone, sandy; dark gray, with some darker bands; some small burrows with darker fill; indurated; gradational basal contact.		
7.14–7.61 m	14–61 cm in Part 3-1	(-23.4 to -25 feet)
Mudstone, sandy; dark gray, grading upwards to medium gray; poorly sorted; weakly bedded, with irregular thin bedding; bedding more distinct towards base; a few scattered flattened shells; few small diameter, mostly horizontal burrows, with darker fill and some vertical and oblique small diameter burrows replaced with framboidal pyrite; moderately indurated.		
7.61–8.11 m	0–40 cm in Part 3-2	(-25 to -26.6 feet)
Mudstone, sandy; dark gray, grading upwards to medium gray; poorly sorted; weakly bedded, with irregular thin bedding; bedding more distinct towards base; some scattered flattened shells; few small diameter, mostly horizontal burrows, with darker fill and some vertical and oblique small diameter burrows replaced with framboidal pyrite; moderately indurated; gradational basal contact.		
8.11–8.17 m	40–46 cm in Part 3-2	(-26.6 to -26.8 feet)
Mudstone, silty; dark gray; interbedded with many thin sand layers 2–3 mm thick; variable grain size; sands laminated; several horizontal burrows to 3 cm diameter; sharp basal contact.		

8.17–8.22 m 46–60 cm in Part 3-2 and 0–1 in Part 3-3 (-26.8 to -27 feet)

Mudstone, calcareous; light gray at base grading to darker gray at top; fining upwards grain size trend; trend of upward decreasing carbonate content, grading from calcareous at base to clayey at top; all laminated; scattered dark specks of probable plant debris at base; a few large and small diameter burrows; some sand-filled burrows and some framboidal pyrite-replaced burrows; cemented and resistant.

8.22–8.345 m 1–13 cm in Part 3-3 (-27 to -27.4 feet)

Sandstone; light gray; fine grained, some thin layers of medium grained sediment, with scattered white and black coarser sand grains; finer grained at top; moderate-well sorted; some clay matrix between grains; laminated; planar bedded at top and crossbedded (hummocky) in lower part; one large diameter complex burrow present, mostly vertical; sharp basal contact.

8.345–8.40 m 13.5–19 cm in Part 3-3 (-27.4 to -27.5 feet)

Sandstone; variegated color; coarse grained; common shale clasts, white carbonate grains and shell clasts; lesser amounts of large benthic forams and black phosphatic grains and some bone fragments; contains 3 darker sand layers with more phosphatic and carbonate grains; contains some coarser light colored layers with swirled texture and light clay streaks among clay clasts; sharp basal contact.

8.40–8.425 m 19–21.5 cm in Part 3-3 (-27.5 to -27.6 feet)

Sandstone; light gray; fine grained; grain size larger than sandstone at 1–13 cm; moderately sorted; many white and black grains; some clay matrix between grains; laminated; cross bedded; not burrowed; gradational basal contact.

8.425–8.465 m 21.5–25.5 cm in Part 3-3 (-27.6 to -27.8 feet)

Sandstone; variegated color; medium-coarse grained; lower part of fining upwards grain size trend; poorly sorted; white carbonate grains and shell clasts; lesser amounts of large benthic forams and black phosphatic grains and some bone fragments; contains 3 darker sand layers with more phosphatic and carbonate grains; contains some coarser light colored layers with swirled texture and light clay streaks among clay clasts; poorly indurated, except for one thin layer of medium grained sand; sharp basal contact.

8.465–8.53 m 25.5–32 cm in Part 3-3 (-27.8 to -28.0 feet)

Sandstone, pebbly; gray; coarse grained; poorly sorted; some coarse quartz sand grains; many white carbonate grains; common shale clasts and shell fragments, especially oyster shell fragments; some phosphatic clasts; spherules?; some clay matrix; poorly indurated.

8.53–8.84 m 0–31cm in Part 4-1 (-28 to -29 feet)

Mudstone; dark gray; thick bedded; sparse fossils, except for a few layers of shell fragments; a few zones of broken shale (usually in zones with more shell, which may be matrix zone between mudstone clasts).

8.84–9.05 m 0–21cm in Part 4-2 (-29 to -29.7 feet)

Fractured mudstone likely due to drilling disturbance, dark gray; mudstone clasts set in a matrix of shelly mud; thick bedded; sparse fossils in clasts; shells and shell fragments concentrated in mud matrix between clasts; some fish bone and phosphate concretion clasts in matrix.

9.05–9.45 m 21–61 cm in Part 4-2 (-29.7 to -31 feet)

Mudstone; dark gray; thick bedded; uncommon fossils.

9.45–10.06 m 61cm in Part 4-3 (-31 to -33 feet)

Mudstone; dark gray; thick bedded; uncommon fossils.

10.06–10.65 m 0–61 cm in Part 5-1 (-33 to -35 feet)

Mudstone; dark gray; thick bedded; uncommon fossils.

10.65–11.14 m 0–49 cm in Part 5-2 (-35 to -36.6 feet)

Mudstone; medium–dark gray; massive-thick bedded; common small fossils; sharp basal contact.

11.14–11.26 m 49–61 cm in Part 5-2 (-36.6 to -37 feet)

Mudstone; dark gray; thick bedded; some lamination and faint bedded interval 2–3 cm thick; few fossils; more indurated.

11.26–11.58 m	0–32 cm in Part 5-3	(-37 to -38 feet)
Mudstone; dark gray; thick bedded; scattered small fossils; one large fossil (ammonite?) present near base.		
11.58–12.19 m	0–61 cm in Part 6-1	(-38 to -40 feet)
Mudstone; dark gray; thick bedded; some lamination.		
12.19–12.80 m	0–61 cm in Part 6-2	(-40 to -42 feet)
Mudstone; medium–dark gray; thick bedded; uncommon fossils.		
12.80–13.11 m	0–17 cm in Part 6-3	(-42 to -43 feet)
Mudstone; medium gray; thick bedded; uncommon fossils.		
12.80–13.08 m	17–28 cm in Part 6-3	(-42 to -43 feet)
Mudstone; medium gray; thick bedded; uncommon fossils.		
13.08–13.11 m	3 cm in core catcher?	
13.11–13.41 m	0–30 cm in Part 7-1	(-43 to -44 feet)
Mudstone; medium–dark gray; some small fossils.		
13.41–14.02 m	61.5 cm in Part 7-2	(-44 to -46 feet)
Mudstone; dark gray; some small fossils; swirled fabric and lower organic content at 46–47 cm—probable echinoid burrow.		
14.02–14.63 m	0–61 cm in Part 7-3	(-46 to -48 feet)
Mudstone; dark gray; some scattered macrofossils.		
14.63–15.245 m	0–61.5 cm in Part 8-1	(-48 to -50 feet)
Mudstone; dark gray; thick bedded; faint laminations; sparse fossils.		

15.245–15.865 m 0–62 cm in Part8-2 (-50 to -52 feet)
Mudstone; dark gray; thick bedded; faint laminations; sparse fossils.

15.865–16.175 m 0–31 cm in Part8-3 (-52 to -53 feet)
Mudstone; dark gray; thick bedded; faint laminations; sparse fossils.

16.175–16.475 m 0–30 cm in Part 9-1 (-53 to -54 feet)
Mudstone; dark gray; thick bedded; faint lamination; some small and larger compressed fossils.

16.475–17.09 m 0–61.5 cm in Part 9-2 (-54 to -56 feet)
Mudstone, silty and sandy; dark gray; thick bedded; faint laminations; sparse fossils.

17.09–17.705 m 0–61.5 cm in Part 9-3 (-56 to -58 feet)
Mudstone, silty and sandy; dark gray; thick bedded; faint laminations; sparse fossils.

17.705–18.315 m 0–61 cm in Part 10-1 (-58 to -60 feet)
Mudstone silty and sandy; dark gray; thick bedded; contains 2 ammonites at least 4 cm in diameter, at 7 and 10 cm levels; gradational basal contact.

18.315–18.29 m 47–57 cm in Part 10-1 (-58 to -60 feet)
Mudstone, sandy and silty; medium gray; thick bedded; some irregular wispy lamination in 1–2 cm zones, of sand laminae; scattered sand-filled burrows to 1 cm diameter; phosphatic(?) gastropod steinkern at 55 cm level.

18.27–18.32 m 57–59 cm in Part 10-1 and 0–2 cm in Part 10-2 (-58 to -60.1 feet)
Sandstone, argillaceous; medium gray; poorly sorted; quartzose and calcareous grains; medium bedded; some small diameter sand-filled burrows.

18.32–18.52 m 2–23 cm in Part 10-2 (-60.1 to -60.7 feet)

Sandstone, silty; gray; very fine grained; well sorted; coarsening upwards grain size trend; thick bedded; laminated; a mass of poorly preserved shell material at 11 cm, located in a vertical burrow; small diameter burrows; cemented and indurated; gradational basal contact.

18.52–18.57 m 23–28 cm in Part 10-2 (-60.7 to -60.9 feet)

Sandstone, argillaceous; thick bedded; vague lamination, but more varied texture; scattered shell fragments; small diameter burrows present; one small area with carbonate cement; gradational basal contact.

18.315–18.91 m 28–61.5 cm in Part 10-2 (-60.9 to -62 feet)

Mudstone, silty and sandy; dark gray; thick bedded; some small shells and shell fragments present.

18.91–19.245 m 0–31.5 cm in Part 10-3 (-62 to -63 feet)

Mudstone; dark gray; thick bedded; some sandy laminae in upper part; some large shells.

19.245–19.56 m 0–31.5 cm in Part 11-1 (-63 to -64 feet)

Mudstone; dark gray; thick bedded; minor lamination; few fossils or fossil fragments; a few sand-filled burrows; layer with framboidal pyrite concentration at 29 cm level.

19.56–20.18 m 0–62 cm in Part 11-2 (-64 to -66 feet)

Mudstone, silty and sandy; dark gray; thick bedding; minor lamination; few medium size shells and shell fragments, including a fish otolith on edge of core; scattered small sand-filled burrows.

20.18–20.78 m 0–62 cm in Part 11-3 (-66 to -68 feet)

Mudstone, silty and sandy; dark gray; thick bedding; minor lamination; some flattened small shells; scattered small sand-filled burrows.

20.78–21.36 m 0–57 cm in Part 12-1 (-68 to -70 feet)

Mudstone, silty and sandy; medium gray; thick bedded; some irregular laminae and thin sand laminae; some small fossils and fossil fragments; a few small diameter sand-filled burrows.

21.36–21.49 m	0–15 cm in Part 12-2	(-70 to -70.5 feet)
Mudstone, silty and sandy; medium gray; thick bedded; some irregular laminae and thin sand laminae; some small fossils and fossil fragments; a few small diameter sand-filled burrows.		
21.49–21.52 m	15–18 cm in Part 12-2	(-70.5 to -70.6 feet)
Concretion; light gray; carbonate cement; irregular margins with mudstone; indurated; sharp margins.		
21.52–21.64 m	18–30 cm in Part 12-2	(-70.6 to -71 feet)
Sandstone, argillaceous; dark gray; very fine grained; moderately sorted; quartzose; thick bedded; little lamination; not indurated; gradational basal contact.		
21.64–21.96 m	30–59 cm in Part 12-2	(-71 to -72 feet)
Mudstone, silty and sandy; dark gray; thick bedded; some thin sand laminae; a few small fossils; a zone of small diameter sand-filled burrows at 57 cm level.		
21.96–22.22 m	0–26 cm in Part 12-3	(-72 to -73 feet)
Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; a few small fossils; a few small diameter sand-filled burrows.		
22.22–22.55 m	0–33 cm in Part 13-1	(-73 to -74 feet)
Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; a few small fossils; a few small diameter sand-filled burrows.		
22.55–23.16 m	0–61 cm in Part 13-2	(-74 to -76 feet)
Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; a few small fossils.		
23.16–23.58 m	0–41 cm in Part 13-3	(-76 to -77.5 feet)
Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; much wispy lamination; a few small fossils; a few small diameter sand-filled burrows.		
23.58–24.19 m	0–61 cm in Part 14-1	(-77.5 to -79.5 feet)

Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; much wispy lamination; a few small fossils.

24.19–24.81 m 0–61 cm in Part 14-2 (-79.5 to -81.5 feet)

Mudstone, sandy; sandier in mid interval of section; medium–dark gray; thick bedded; wispy sand laminae and bundles of fine sand laminae; a few small fossils.

24.81–25.125 m 0–31.5 cm in Part 14-3 (-81.5 to -82.5 feet)

Mudstone, silty and sandy; dark gray; thick bedded; some sand laminae; much wispy lamination; some small fossils and a few larger fossils at 9 cm interval.

25.125–25.435 m 0–31 cm in Part 15-1 (-82.5 to -83.5 feet)

Mudstone, silty and sandy; dark gray; thick bedded; common sand laminae, with bundle of sand laminae near top; some small fossils and a few larger fossils at 8 cm interval; small pieces of mother-of-pearl aragonite shell at 28 cm level; some small diameter sand-filled burrows.

25.435–26.055 m 0–61 cm in Part 15-2 (-83.5 to -85.5 feet)

Mudstone, silty and sandy; dark gray; thick bedded; common sand laminae; very few fossils; some small diameter sand-filled burrows.

26.055–26.675 m 0–62 cm in Part 15-3 (-85.5 to -87.5 feet)

Mudstone, silty and sandy; dark gray; thick bedded; common sand laminae; a few small fossils, mostly at 47 cm level; a few small horizontal sand-filled burrows; framboidal pyrite concretions at 33 cm level.

26.675–27.235 m 0–56 cm in Part 16-1 (-87.5 to -88.8 feet)

No core. Mass of drilling mud and surficial quartzose pebbles.

27.235–27.29 m 56–61 cm (-88.8 to -89 feet)

Mudstone, silty; dark gray; thick bedded.

27.29–27.905 m	0–61 cm in Part 16-2	(-89 to -91 feet)
Mudstone, silty; dark gray; thick bedded; some sand laminae; a few small fossils.		
27.905–28.21 m	0–30.5 cm in Part 16-3	(-91 to -92 feet)
Mudstone, silty; dark gray; thick bedded; some sand laminae; a few small fossils and a beautiful iridescent nodose ammonite at 22.5 cm level.		
28.21–28.525 m	0–31.5 cm in Part 17-1	(-92 to -93 feet)
Mudstone; dark gray; thick bedded; some sand laminae; a few scattered small shells.		
28.525–29.145 m	0–62 cm in Part 17-2	(-93 to -95 feet)
Mudstone; dark gray; thick bedded; some sand laminae; a few small shells; a few small diameter burrows.		
29.145–29.475 m	0–33 cm in Part 17-3	(-95 to -96.1 feet)
Mudstone; dark gray; thick bedded; many sand laminae; some small fossils; some small diameter burrows; sharp basal contact.		
29.475–29.505 m	33–36 cm in Part 17-3	(-96.1 to -96.2 feet)
Mudstone; dark gray; medium bedded; laminated; zones of framboidal pyrite concretions at top and bottom, with top zone containing larger framboidal pyrite masses roughly parallel to bedding; relatively well indurated; sharp basal contact.		
29.505–29.755 m	36–61 cm in Part 17-3	(-96.2 to -97 feet)
Mudstone; dark gray; thick bedded; many sand laminae; some small fossils; some small diameter burrows.		
29.755–29.935 m	0–18 cm in Part 18-1	(-97 to -97.6 feet)
No core. Consists of drilling mud packed with surficial quartzose pebbles.		
29.935–30.665 m	18–31 cm in Part 18-1	(-97.6 to -98 feet)

Mudstone, sandy; dark gray; medium bedded; common sand laminae; distinct sand lens at 20 cm level—probably a sand-filled burrow.

30.055–30.665 m 0–61 cm in Part 18-2 (-98 to -100 feet)

Mudstone, sandy; dark gray, with a spotty appearance from sand grains; medium bedded; common sand laminae; some small compressed fossils, but fewer fossils below 40 cm level; a coral seen at 8 cm level; some small diameter sand filled burrows.

30.665–31.275 m 0–61 cm in Part 18-3 (-100 to -102 feet)

Mudstone, sandy; dark gray, with a spotty appearance from sand grains; thick bedded; laminated, with many sand laminae; a few compressed fossils; some small diameter sand filled burrows.

31.275–31.89 m 0–61.5 cm in Part 19-1 (-102 to -104 feet)

Mudstone, sandy; dark gray, with light colored speckles of sand grains; sand content increases downward; thick bedded; some sand laminae; few fossils, apart from one ammonite at 31 cm level; some small diameter sand-filled burrows.

31.89–32.51 m 0–62 cm in Part 19-2 (-104 to -106 feet)

Mudstone, sandy; dark gray, with light colored speckles of sand grains; sand content increases downward; thick bedded; some sand laminae; few fossils, apart from one ammonite at 31 cm level; some small diameter sand-filled burrows.

32.51–32.835 m 0–32.5 cm in Part 19-3 (-106 to -107.5 feet)

Mudstone, sandy; dark gray, with light colored speckles of sand grains; thick bedded; some sand laminae; few fossils; some small diameter sand-filled burrows.

32.835–32.985 m 0–15 cm in Part 20-1 (-107.5 to -108 feet)

No core. Mixture of drilling mud and surficial quartzose pebbles.

32.985–33.115 m 15–28 cm in Part 20-1 (-108 to -108.5 feet)

Mudstone, sandy; dark gray, with light colored speckles of sand grains; thick bedded; some sand laminae; few fossils; some small diameter burrows.

33.115–34.807 m 0–61.5 cm in Part 21-1 (-110 to -112 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; some sand laminae; some small diameter sand-filled burrows.

34.187–34.807 m 0–62 cm in Part 21-2 (-112 to -114 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; common sand laminae and some quartzose sand laminae of sorted sand that is whitish in color; few fossils; some sand-filled burrows.

34.807–35.127 m 0–17 cm in Part 21-3 (-114 to -115.5 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; common sand laminae and some quartzose sand laminae of sorted sand that is whitish in color; few fossils; some sand-filled burrows.

35.127–35.044 m 17–31 cm in Part 21-3 (-115.5 to -118 feet)

Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; interbedding of abundant sand laminae composed of very fine sand and mud laminae of darker color; some sand-filled burrows. Missing 94.55cm.

35.13–36.955 m depth (-118 to -121 feet)

No core. Missing 91.5 m.

36.955–37.165 m 0–20 cm in Part 22-1 (-121 to -121.7 feet)

No core.

37.165–37.575 m 20–60 cm in Part 22-1 (-121.7 to -123 feet)

Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; interbedding of abundant sand laminae composed of very fine sand and mud laminae of darker color; some sand-filled burrows.

37.575–37.695 m 0–12 cm in Part 23-1 (-123 to -123.3 feet)

No core.

37.695–38.185 m 12–61 cm in Part 23-1 (-123.3 to -125 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; abundant sand laminae, composed of very fine sand, and mud laminae of darker color; some sand-filled burrows.

Condition: Poor. Broken core, consisting of "biscuit" pieces of mudstone rotated and shifted in position and surrounded by drilling mud. Not in place, but roughly at proper strat level.

38.185–38.625 m 0–44 cm in Part 23-2 (-125 to -126.9 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; thick bedded; abundant sand laminae, composed of very fine sand, and mud laminae of darker color; some sand-filled burrows.

38.625–38.795 m 44–61 cm in Part 23-2 (-126.9 to -127.5 feet)

Disturbed: Mudstone, sandy; medium gray, with light colored speckles of sand grains; high sand content, with some distinct thin sand layers; thick bedded; abundant sand laminae, composed of very fine sand, and mud laminae of darker color; some sand-filled burrows.

38.795–38.965 m 0–17 cm in Part 23-3 (-127.5 to -128.1 feet)

Disturbed: Mudstone, silty and sandy; medium gray, with light colored speckles of sand grains; very fine sand; thick bedded; interbedding of abundant sand laminae composed of very fine sand and mud laminae of darker color.

38.965–39.10 m 17–30 cm in Part 23-3 (-128.1 to -128.5 feet)

Mudstone, silty and sandy; medium gray, with light colored speckles of sand grains; very fine sand; thick bedded; interbedding of abundant sand laminae and thin sand layers composed of very fine sand and mud laminae of darker color; some sand layers have lensing form, as a low amplitude ripple; small amount of shell fragments, but most are tiny pieces.

39.10–39.41 m 0–31 cm in Part 24-1 (-128.5 to -129.5 feet)
Mudstone, silty and sandy; medium gray, with speckled appearance due to light colored sand grains; contains many interlayers of dark mud; much irregular lamination; interlayers and laminae are mostly planar; a few thin sand lenses; a large flattened fossil at 1 cm level; common sand-filled burrows, mostly horizontal.

39.41–40.03 m 0–62 cm in Part 24-2 (-129.5 to -131.5 feet)
Mudstone, silty and sandy; medium gray, with speckled appearance due to light colored sand grains; contains many interlayers of dark mud; much irregular lamination; interlayers and laminae are mostly planar; a few thin sand lenses; common sand-filled burrows, mostly horizontal.

40.03–40.65 m 0–61 cm in Part 24-3 (-131.5 to -133.5 feet)
Mudstone, argillaceous; medium gray, with speckled appearance due to light colored sand grains; contains many interlayers of dark mud; abundant planar lamination and interlayers; common sand-filled burrows, mostly horizontal.

40.65–40.73 m 0–8 cm in Part 25-1 (-133.5 to -133.7 feet)
Mudstone, sandy; dark gray; medium bedded; common sand laminae; sharp basal contact.

40.73–41.265 m 8–61 cm in Part 25-1 (-133.7 to -135.5 feet)
Sandstone, argillaceous; medium gray, with speckled appearance due to light colored sand grains; poorly sorted, with much mud matrix; quartzose; contains many thin and thick interlayers of lighter colored fine grained sand; abundant planar lamination and interlayers; thin layers commonly of irregular thickness; a few sand layers of better sorted sand, to 1 cm thick; common small diameter sand-filled burrows, mostly horizontal.

41.265–41.88 m 0–61 cm in Part 25-2 (-135.5 to -137.5 feet)
Sandstone, argillaceous; medium gray, with speckled appearance due to light colored sand grains; poorly sorted, with much mud matrix; quartzose; contains many thin and thick interlayers of lighter colored fine grained sand; abundant planar lamination and interlayers; thin layers



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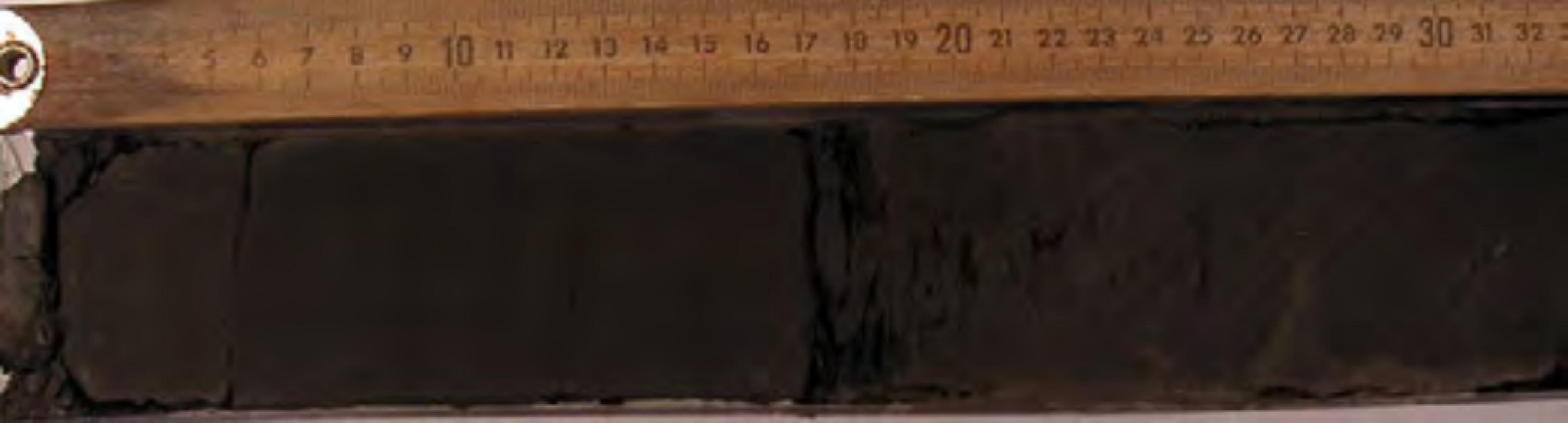


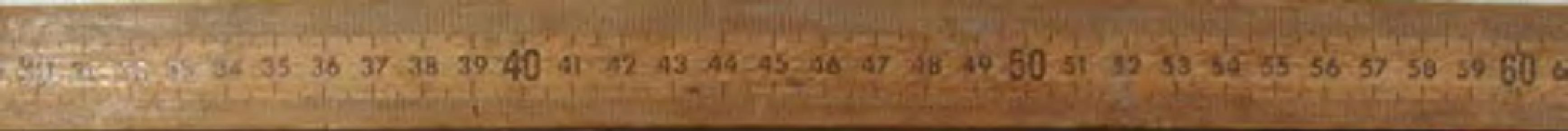




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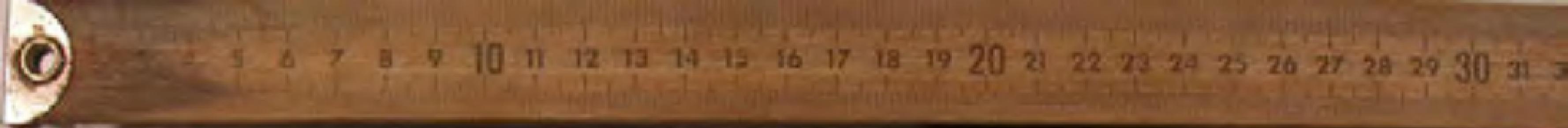
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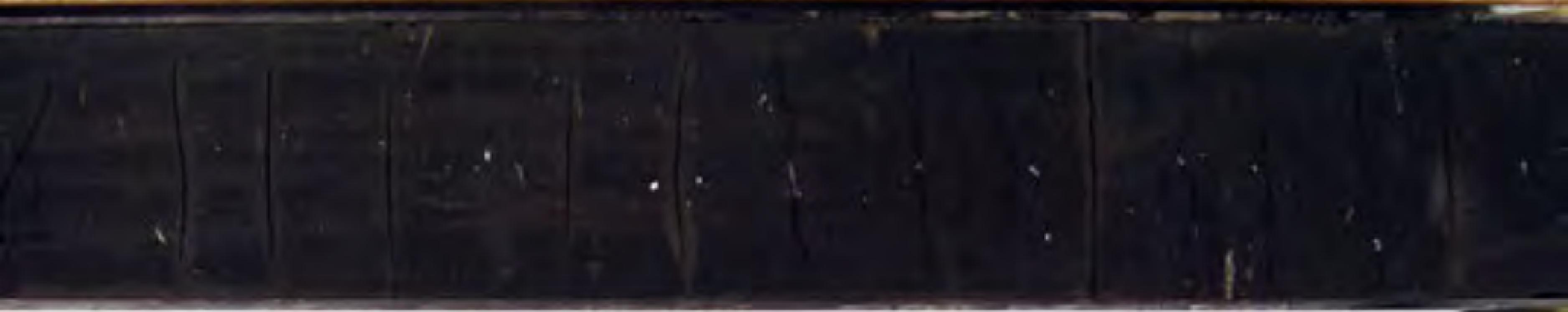




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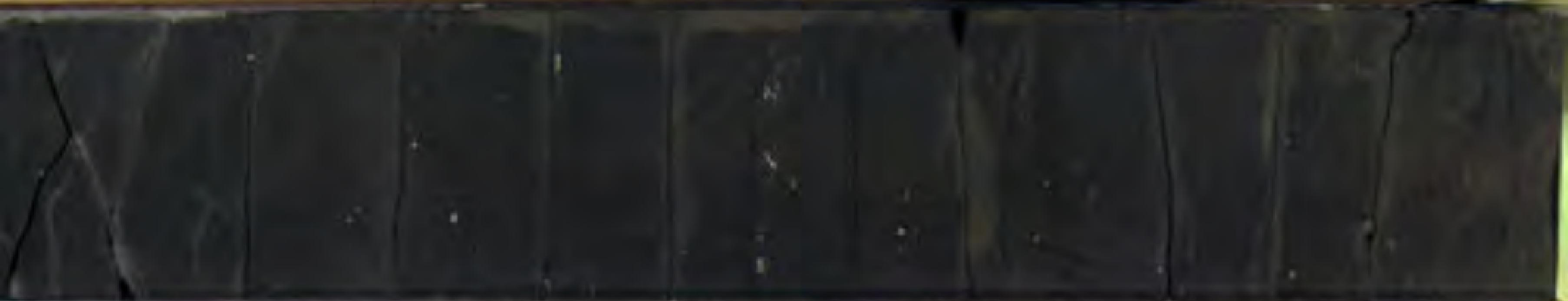
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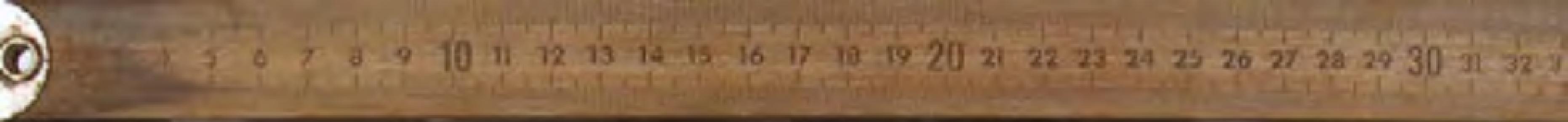




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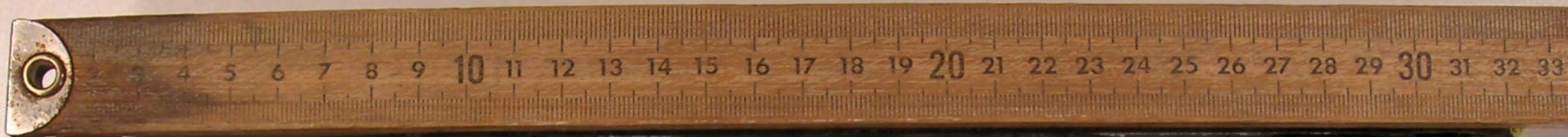
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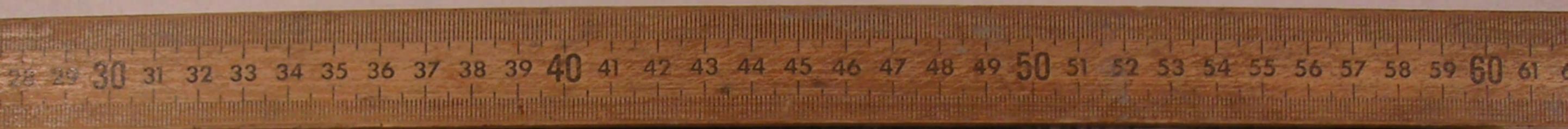
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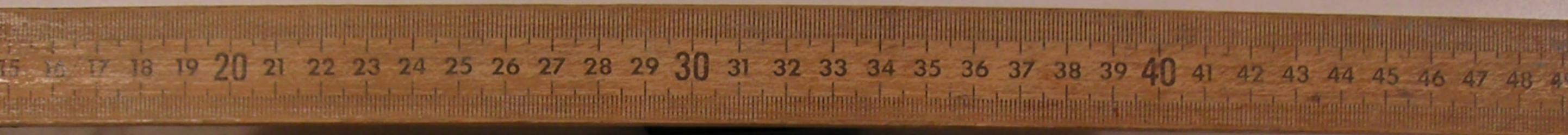


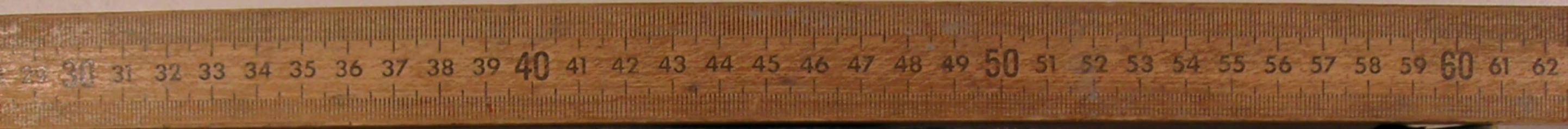










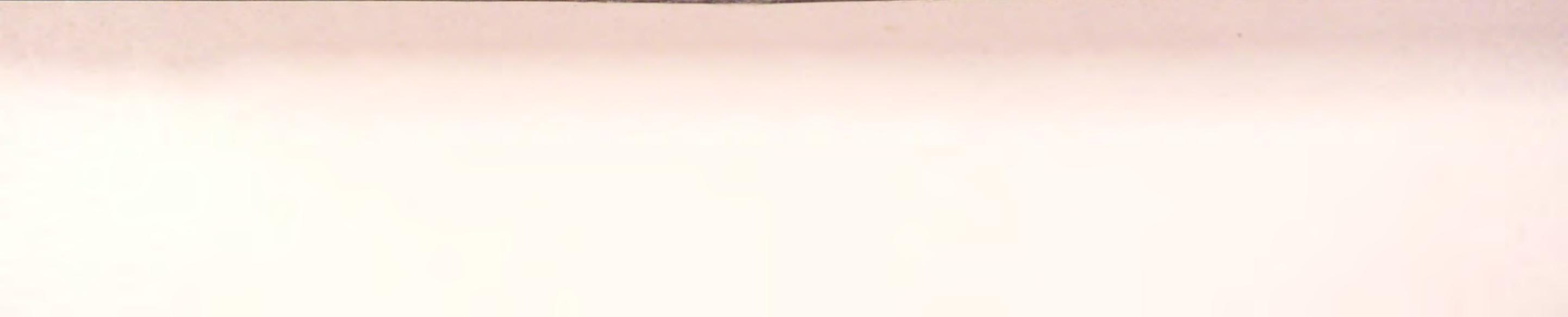


















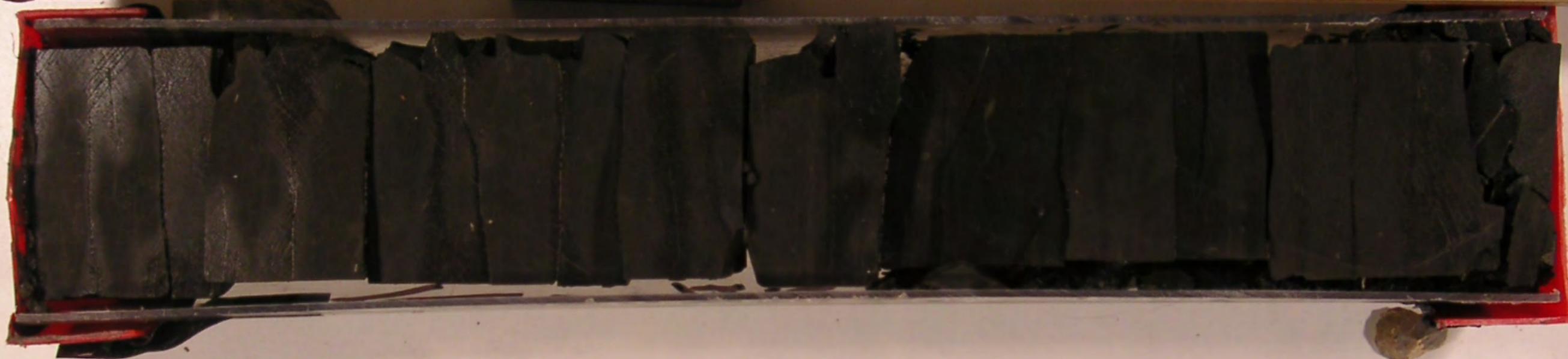


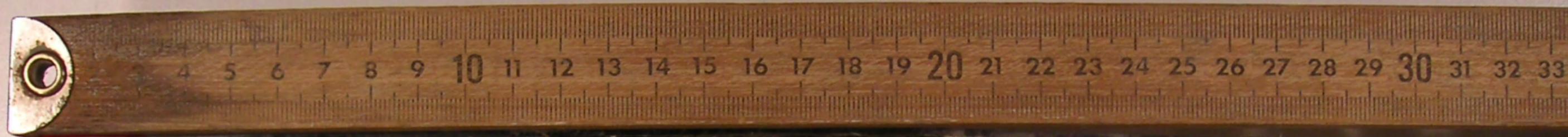




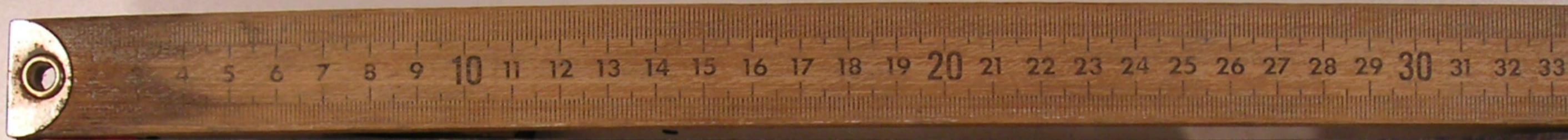








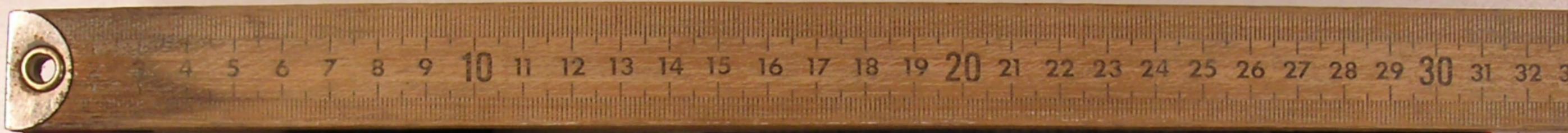






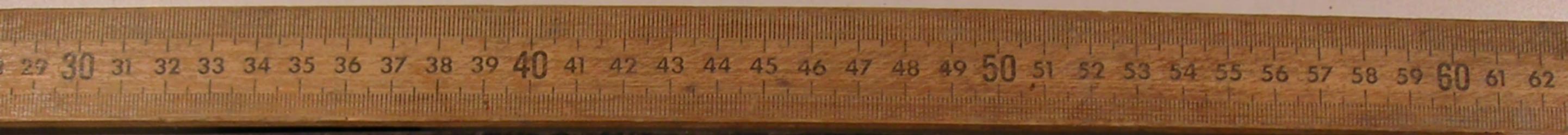












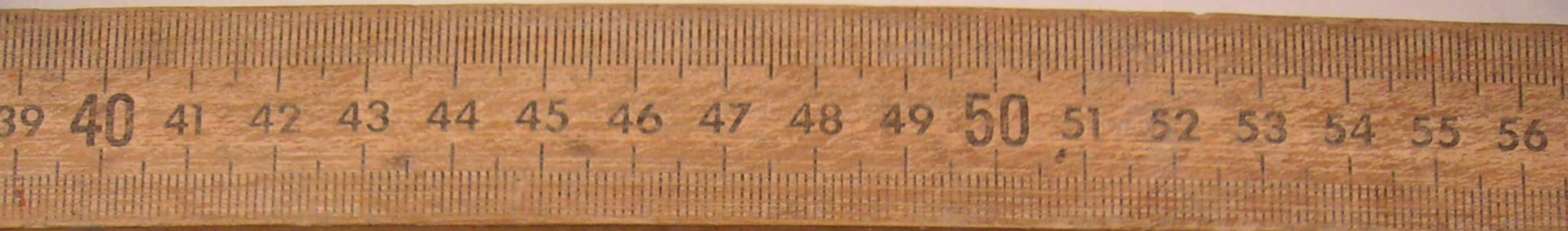






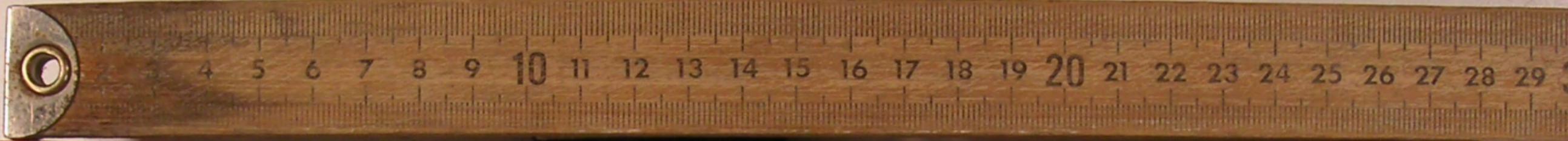














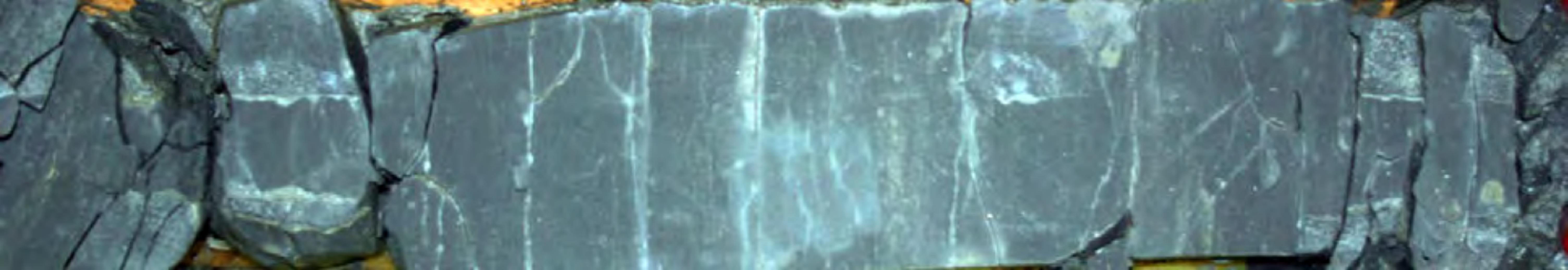






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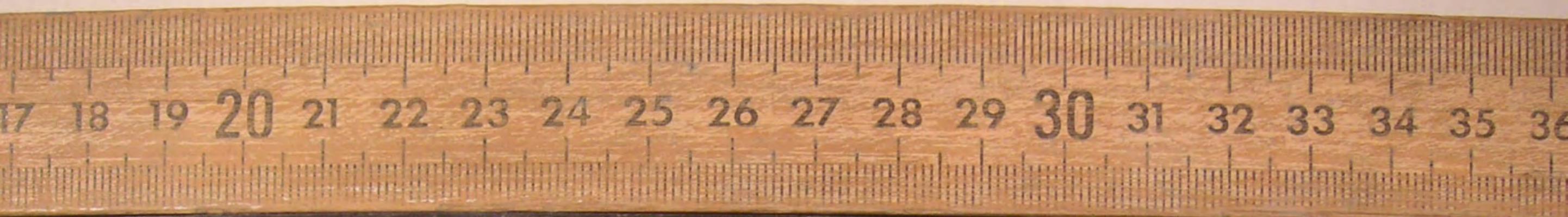














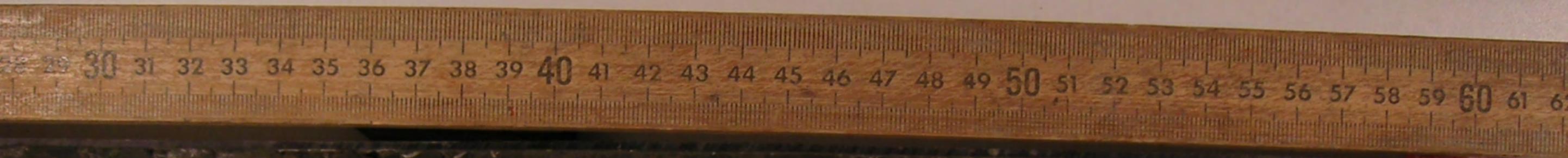


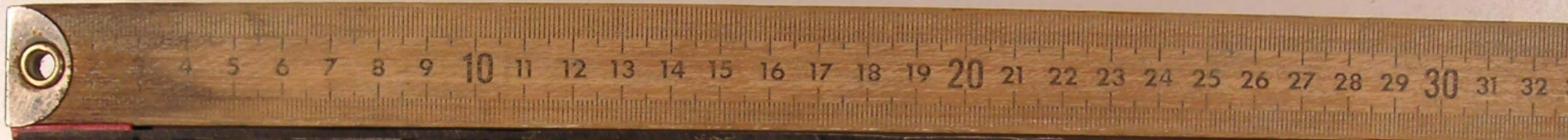






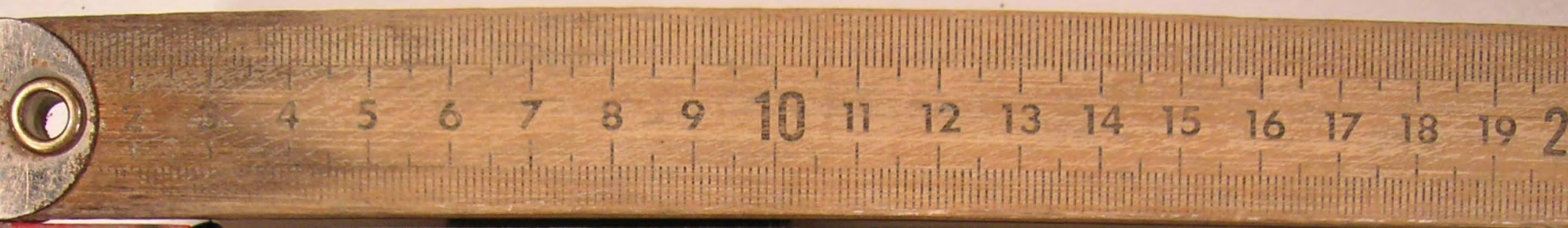


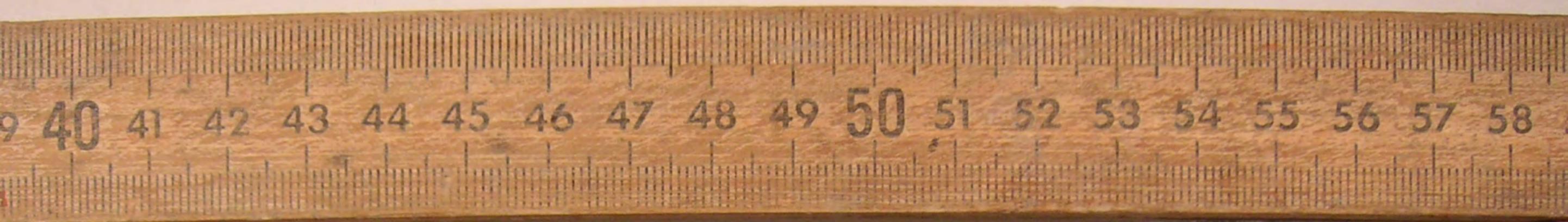




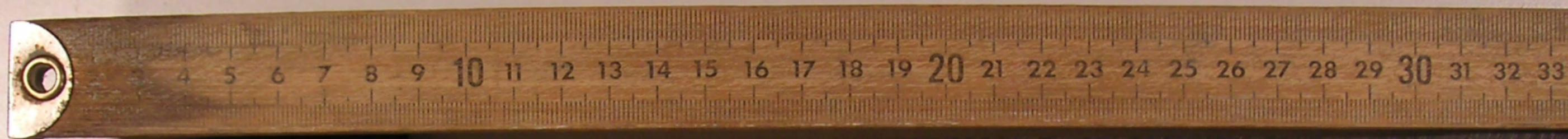




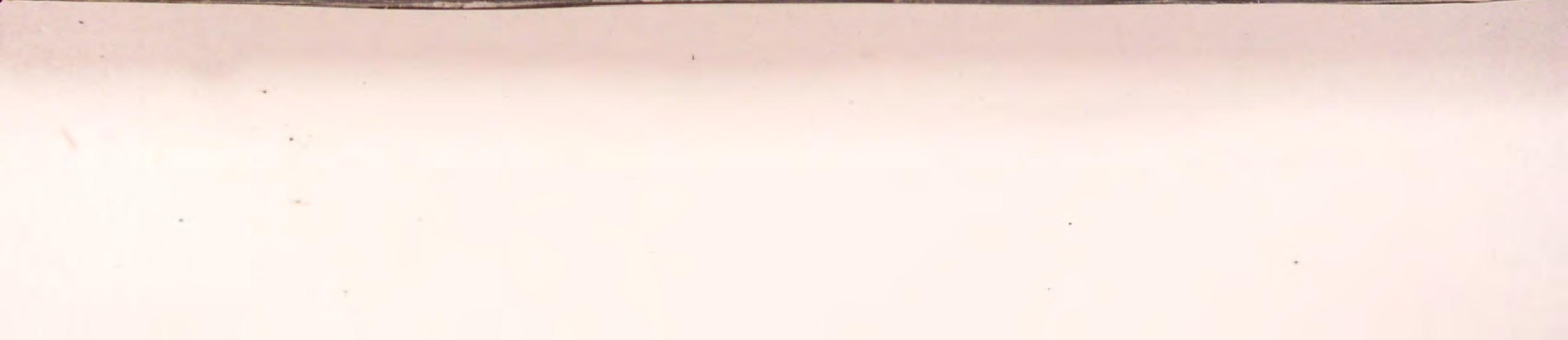
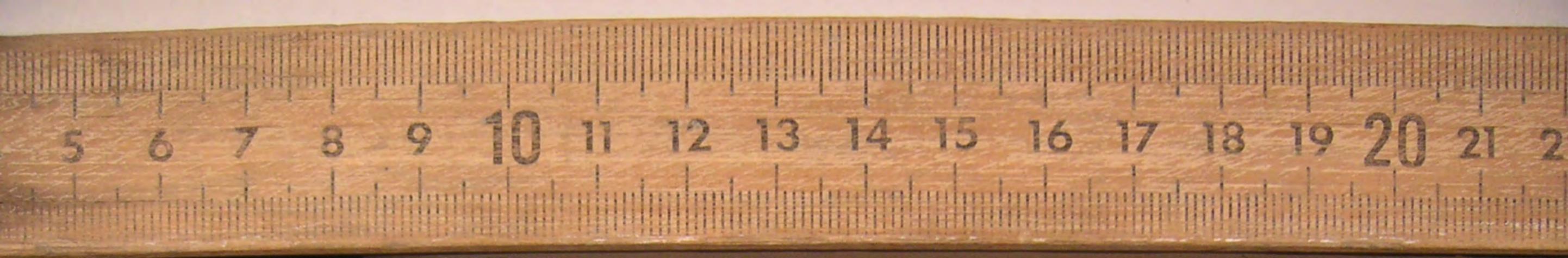




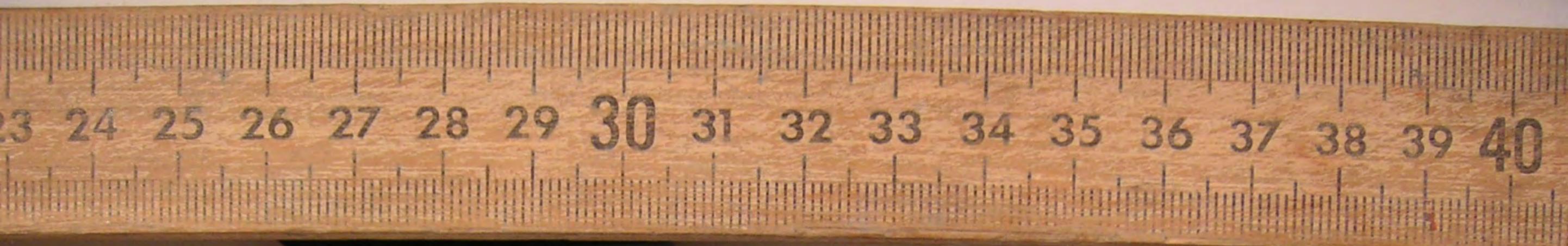


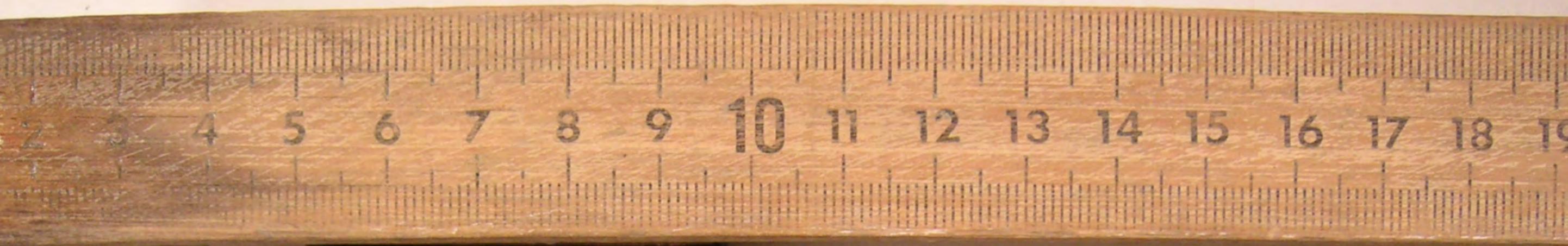




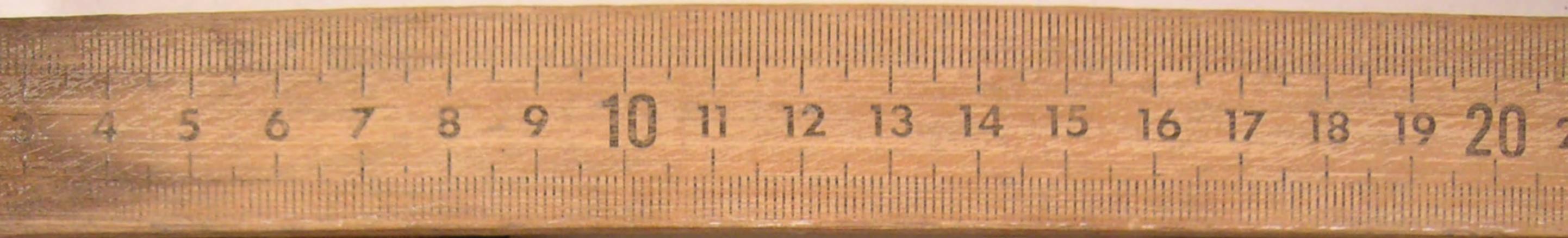














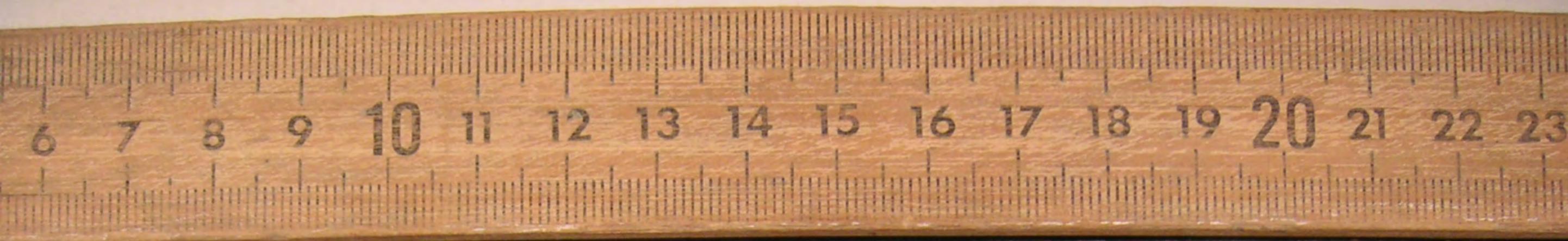




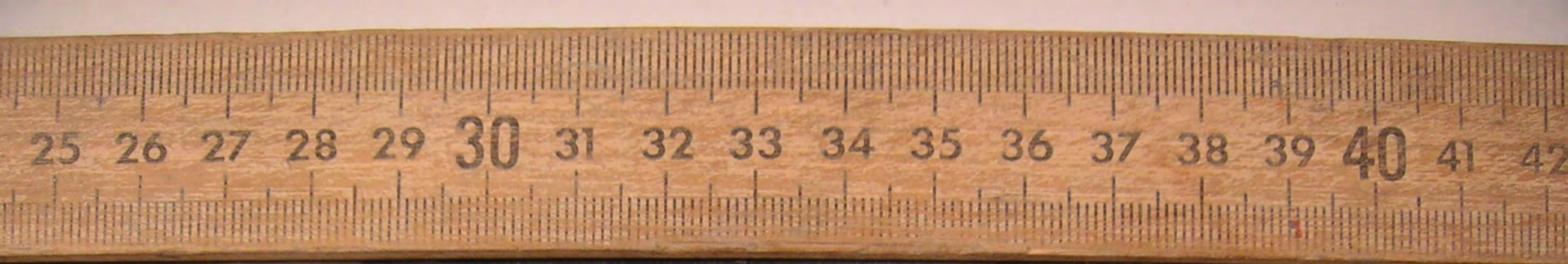


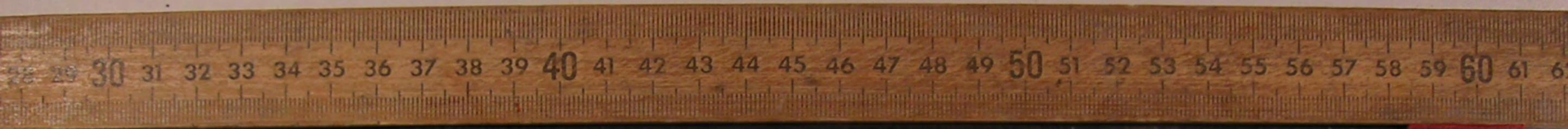














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