X. SOFTEX-RADIOGRAPHS OF SLICED PISTON CORES FROM THE JAPAN AND SOUTHERN KURILE TRENCH AND SLOPE AREAS

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Method

Radiography has long been successfully been applied to unravel sedimentary structures in rocks that look homogenous on visual inspection (e.g. HAMBLIN, 1971). With modern marine sediments split piston cores are often used for radiography. The results, however, are generally unsatisfactory because the core halves are too thick and because of the superposition of the structures. The method has to be modified accordingly by using thin slabs of sediment sliced from the surface of the core-half rather than using the entire half core. With this modification excellent results may be obtained from little consolidated sediments revealing the internal structures in minute detail (e.g. HESSE, *et al.*, 1971).

8 mm thick sediment slices were cut from selected intervals of 9 piston cores recovered from the Japan and southern Kurile trench and slope areas during the Hakurei Maru cruise, GH 76–2. The cores were sliced using the lids of plastic boxes and a piano wire. The plastic lids were pushed into the sediment surface and undercut with the wire. The sample was then sealed with a second lid and X-ray-transparent tape. For X-raying three of the 29 cm long samples were placed at a time on Kodak Industrex M2 ready-packed X-ray film. Source-to-sample distance on an UBM type-2 X-ray unit (Softex Ltd., Tokyo) was 70 cm. Voltage ranged between 44 and 52 kV, exposure time between 7 and 15 sec. (The lower settings apply to the water-rich surface layers of the cores and to siliceous oozes). Amperage was held constant at about 3 mA.

Results

A relatively large number of radiographs from the core material is included in this report because they reveal the internal sedimentary structures with an unusual degree of detail. The radiographs are unique insofar as modern deep-sea trench sediments have to our knowledge never before been documented in comparable detail. Plates X–1 to 19 of this report have been selected for the purpose of facilitating the distinction between various types of trench and slope sediments and for assisting in future sample selection from the core material. Conclusions given in this report regarding the origin of the various sediment types are partly based on shipboard observations of smear-slides but await corroboration by further petrographic and granulometric studies and should, therefore, be considered tentative.

The core descriptions are grouped according to the major structural divisions of the sea-floor (trench floor, lower slope basins, upper continental slope) and within every group the sequence is according to geographic location proceeding from north to south. In several cores the turbidites encountered have been numbered consecutively from top

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to bottom, which does not imply that they may be correlated between cores.

Trench Floor

***Core HM* 78 (*plates X–1 to* 2)** from the southern Kuril Trench off Etorofu Island (lat. 43°09.4'N, long. 148°36.9'E) comes from a water depth (uncorrected) of 8805m and represents the deepest material recovered during this cruise. Primary sedimentary structures are well preserved. They consist predominantly of parallel laminations that result from variations in fine sand and silt content of the sediment. The darker (i.e. sandier) laminae between cm 23 and 81 (plate X–1) probably represent single ash-fall layers. Some of the fine-grained volcanogenic sand, however, is redeposited by bottom traction processes such as dilute turbidity currents as clearly shown by the occurrence of small-scale cross lamination (e.g. from cm 149 to 151, from cm 220 to 222 and possibly also from cm 271 to 276 suggesting that the entire interval from cm 249 to 276 may be redeposited). Small-scale convolute lamination in the very fine sand to silt layer at cm 183 to 189.5 may also be related to rapid deposition from a suspension current. The coarse, parallel laminated sand from cm 163 to 169 is a pumiceous tuff layer which displays only indistinct evidence (cross lamination) of redeposition.

The state of preservation of the parallel laminations throughout the core is remarkable reflecting the near-absence of bottom life in the volcanogenic sand and silt and the pelagic siliceous ooze. This suggests that bottom waters in the deepest parts of the southern Kurile Trench are (semi-) stagnant and poor in oxygen though not entirely O_2-depleted. An oxidized zone was found at the sediment surface consisting of 5 cm of olive-brown ooze. Below this depth abundant dark-gray to black reduced layers were observed throughout the core whose dark color disappeared, however, after they had been in air-contact for one or two hours. Bioturbation is not totally absent from this core, however, as blurred primary laminations at cm 106 to 107, cm 180 to 182.5, cm 201 to 205, cm 210.5 to 213.5, cm 216 to 220, cm 227 to 229, cm 233 to 236, cm 239.5 to 240.5, cm 241 to 242.5 and cm 244 to 247 indicate.

Note: The vermicular structure on plate X–2 between cm 169 and 179 is artificial.

***Core HM* 80 (*plates X–3 to* 5)** was recovered from an isolated basin at the southern end of the Kurile Trench (lat. 44°31.1'N, long. 145°40.9'E) at a water depth (uncorrected) of 7050 m. Grayish olive to olive-gray hemipelagic mud alternates with olive-gray to moderate olive-gray turbidites. The turbidites are largely mud turbidites. Their internal structures are distinctly different from the hemipelagic mud. The latter is mottled due to either intense bioturbation by small-diameter burrowing organisms or due to a special flocculation structure of the hemipelagic clay and silt. The turbidites are either parallel laminated or massive. The upper turbidite (T1: cm 36 to 44) displays some distinct burrows at the top (cm 36 to 38). The lower turbidite (T2: cm 108 to 246) is 1.38 m thick. It is parallel laminated at the top (cm 113 to 118), in the middle (cm 148 to 162) and at the base (cm 203 to 241). The convex upward shape of these laminations is due to a coring disturbance. The fine sandy portion at the very base (cm 241 to 248) of this turbidite is cross-laminated.

***Core HM* 84 (*plate X–5: right-hand column; plate X–6*)** from the northern Japan Trench (lat. 40°07'N, long. 144°21.9'E, uncorrected water depth 7330 m) contains three olive/brown mud turbidites (T1: cm 22 to 45.5; T2: cm 76 to 84; T3: cm 362 to 380). The mud turbidites contain laminae of very fine to fine sand in the bottom half best displayed by turbidite T1. Turbidite T3 contains small-scale slump structures that were not visible with the naked eye. Its basal sand appears as a black lamina (plate X–5).

Core HM 77 (plates X–7 to 9) from the Japan Trench off Sendai (lat. 38°25.8′N, long. 144°05.6′E, uncorrected water depth 7,400 m) best displays the difference in structure between the olive-gray hemipelagic mud, which is intensely bioturbated, and the moderate olive-gray to olive-brown mud turbidites (T1: cm 165 to 194; T2: cm 235 to 250; T3: cm 276 to 283.5; T4: cm 311 to 324; T5 (not shown on the plates): cm 362 to 375). Bioturbation in the hemipelagic mud includes cross-sections of some larger burrows (up to 1.5 cm in diameter, e.g. at cm 228, plate X–8) as well as some very small burrows at the top of T1 (cm 166 to 170, plate X–8) and of T2 (cm 237 to 241, plate X–8). Bioturbation is displayed most effectively by the interval from cm 100 to 118 (plate X–7) where coarser silty material (darker) was brought down in to finer clayey material (lighter) by the burrowing organisms and vice versa.

The turbidites are unaffected by bioturbation except at their top portions. T1 is parallel laminated throughout with a trace of cross-lamination in its fine sandy basal layer. T3 contains a top layer of light olive-gray to light gray nanno-fossil bearing clay (cm 276 to 279, plate X–9) clearly attesting to its allochthonous nature. This sediment originates from above the calcite compensation level and underwent a minimum downward displacement on the slope of 3.5 to 4 km. The turbidites of this and the previous core clearly show sharp bases and an overall upward decrease in grain-size (normal grading).

Core HM 75 from the southern part of the Japan Trench (lat. 36°24.6′N, long. 143° 13.0′E, uncorrected water depth of 7,300 m) was taken without a plastic liner and had to be extruded from the core barrel. The disturbing effects of sediment extrusion are clearly visible on plate X–10 and may serve as a reminder that this method be abandoned in future work. Sand layers occur at a core depth of cm 271 to 273 (lenticular), cm 316 to 320, cm 323 and 328 and cm 350 to 351, respectively, and are at least in part redeposited by turbidity currents. A thick turbidite sand (not shown here) whose top layer was penetrated occurs below cm 415 in this core. The irregular distribution of dark sediment patches in this core represents diagenetic mineral phases including sulfates and (not shown here) carbonates.

Lower Slope

Core HM 85 (plates X–11, 12) from the lower slope (uncorrected water depth of 4,770 m) of the Japan Trench off Kamaishi (lat. 39°23.7′N, long. 143°53.3′E) represents a local slope basin facies. Parallel laminated sand layers at cm 215 to 220, cm 229 to 240 and 307 to 316, respectively, pose a problem for interpretation because they show neither sharp bases nor a clear upward decrease in grain-size. They also lack cross-lamination. Instead they seem to show symmetric grading starting with inverse grading (upward increase in grain-size) at the base which is then followed by normal grading (within the parallel laminated interval). These are certainly not the characteristics of typical turbidites which one might expect in a lower slope basin. Their mode of deposition might represent a type of grain flow or sand flow but remains enigmatic at present. Alternatively, they might represent ash layers.

Pinkish-gray volcanogenic sand at cm 330 to 332, cm 360 to 361.5 and cm 354 to 366, respectively, (plate X–12) represents ash fall deposits partly affected by bioturbation. They are not redeposited while some of the afore mentioned layers clearly are as evidenced by their content of terrigenous material (e.g. plant fragment at cm 232). Bioturbation is abundant in the hemipelagic mud between the sand layers.

Upper Slope

The upper slope cores differ markedly in appearance from the lower slope and trench floor ones. They are generally enriched in sand which is usually diffusely distributed in the sediment due to intense bioturbation.

***Core HM* 81 (*plates X*–13, 14)** from the upper slope of Tomakomai (bight between Hokkaido and Honshu, lat. 42°10.0′N, long. 141°41.6′E, uncorrected water depth: 750 m) is predominantly bioturbated from cm 140 down to cm 188. Below this depth the primary laminations are largely preserved in the moderate olive-brown to moderate olive-gray, H_2S-smelling sandy mud. Distinct sand layers occur at cm 284 to 286 and cm 289 to 295. Fine sand grains are scattered throughout the core.

***Core HM* 82 (*plates X*–15 to 17)** from the upper slope off Hachinohe (lat. 40°53.7′N, long. 142°16.7′E, uncorrected water depth 1,150 m) is similar to HM 81 in displaying scattered sand grains whose size and concentration increase markedly below 90 cm of core depth. The material, which includes components of granule size, is probably—at least in part—ice-rafted. A graded volcanogenic sand layer with coarse sand at the base occurs from cm 186 to 194. At cm 197 to 201 a second coarse sand layer with whitish granules occurs, which is an ash including pumice. Below this layer the amount and size of the scattered grains drop considerably in order to increase again below cm 232. Bioturbation is moderate to abundant in this core as shown by the degree of mottling.

***Core HM* 86 (*plates X*–18, 19)** from the upper slope off Kesen-numa (lat. 39°11.2′N, long. 142°58.8′E, uncorrected water depth 1,850 m) displays principally the same sand-scattered, bioturbated facies as HM 82, however, sand concentration and size and the degree of bioturbation are greater. A rapidly emplaced layer which has retained most of its primary laminations appears to occur between cm 147 and 160 (plate X–19). A small spherical concretion is seen at cm 71.

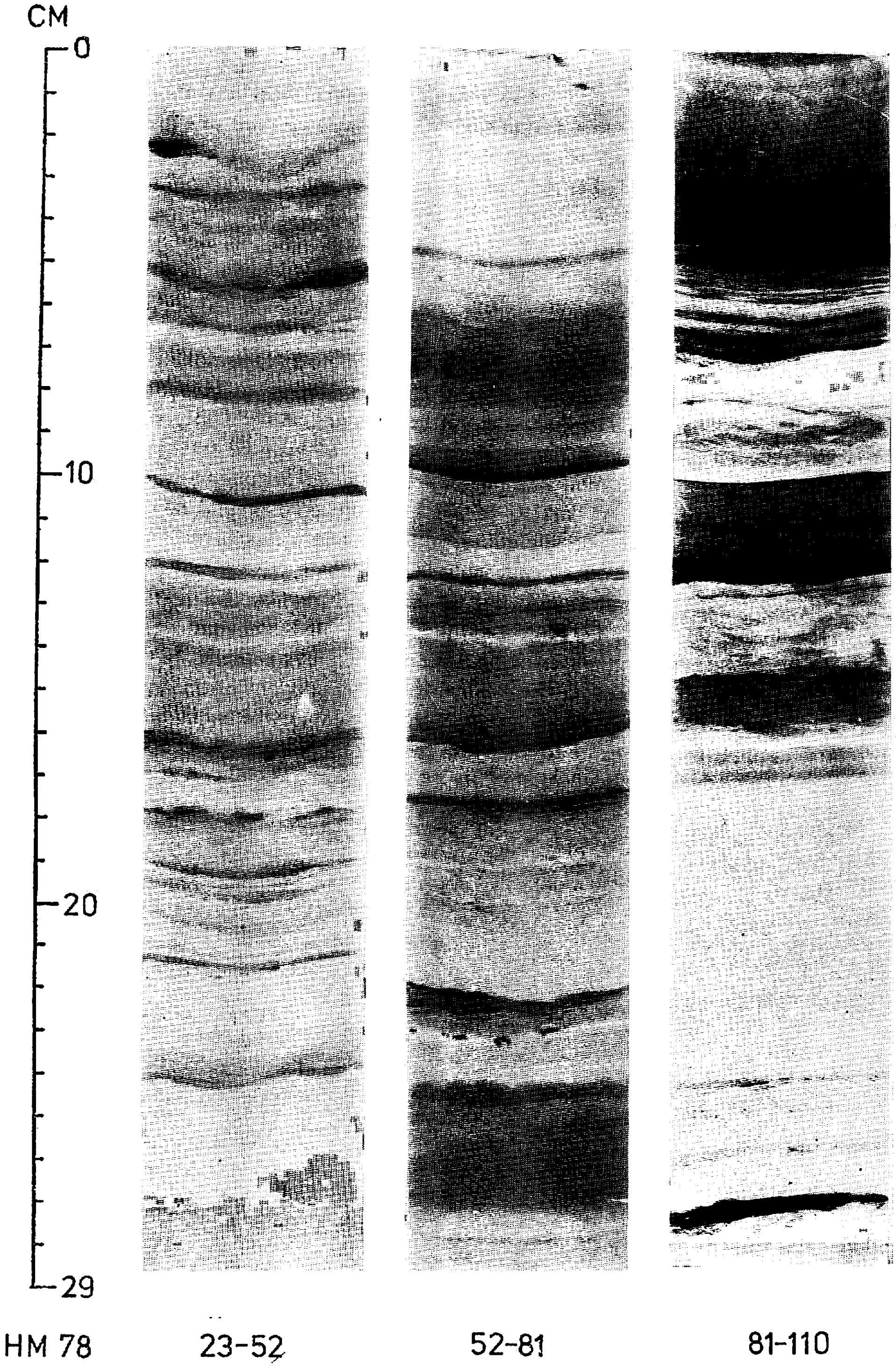


Plate X-1 Softex-radiographs of sliced piston cores. The following plates (X-2–19) are taken by the same method.

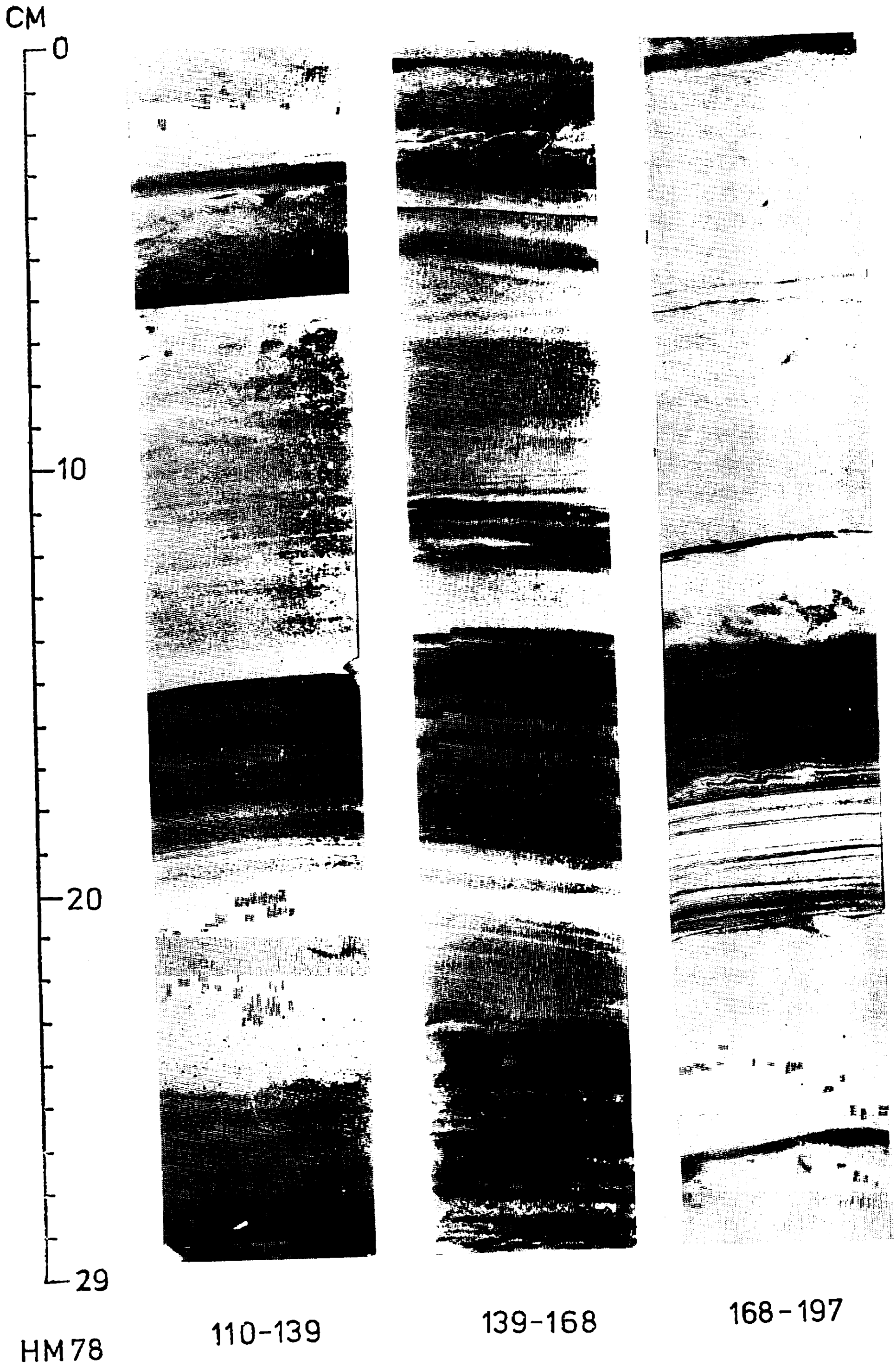


Plate X-2

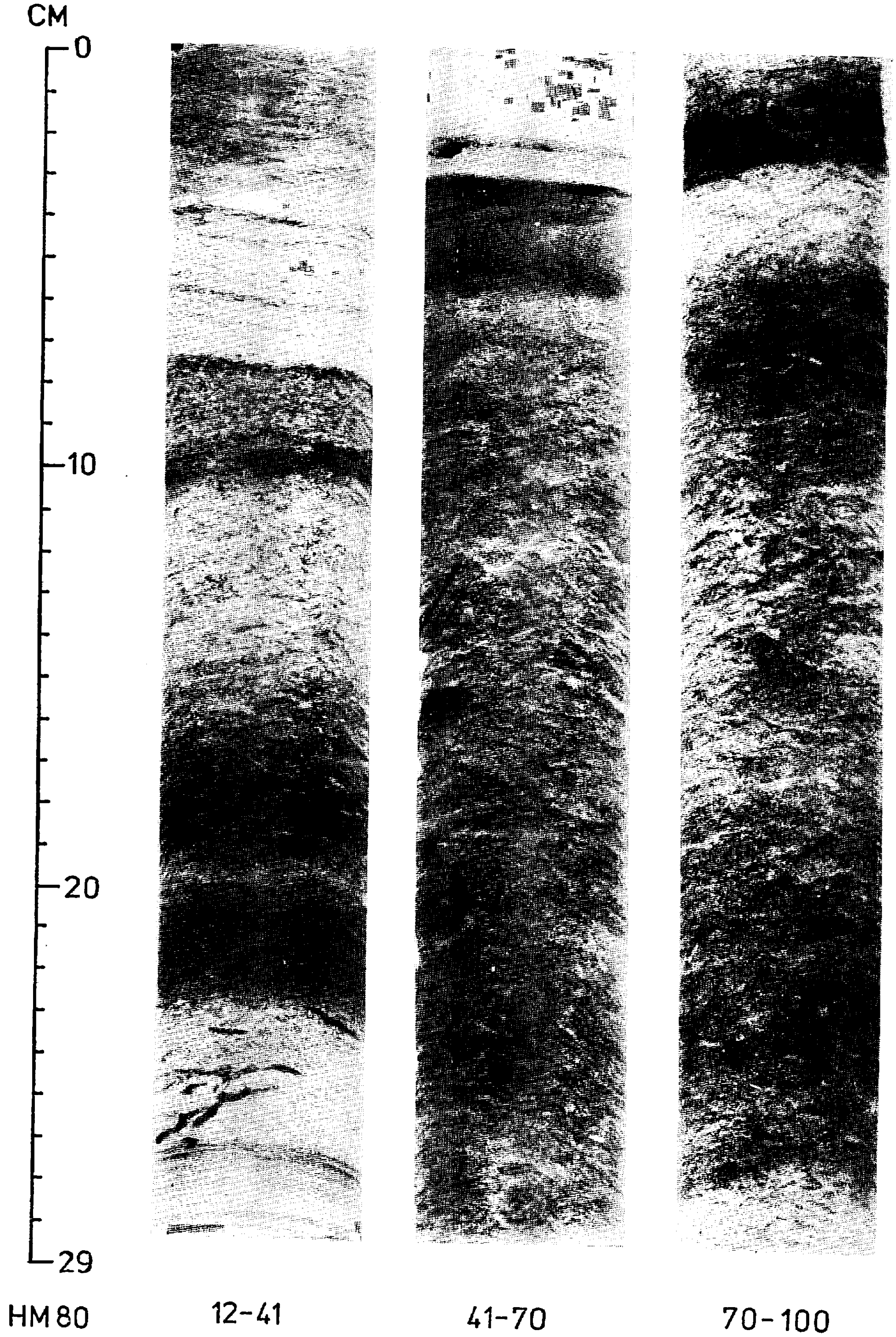


Plate X-3

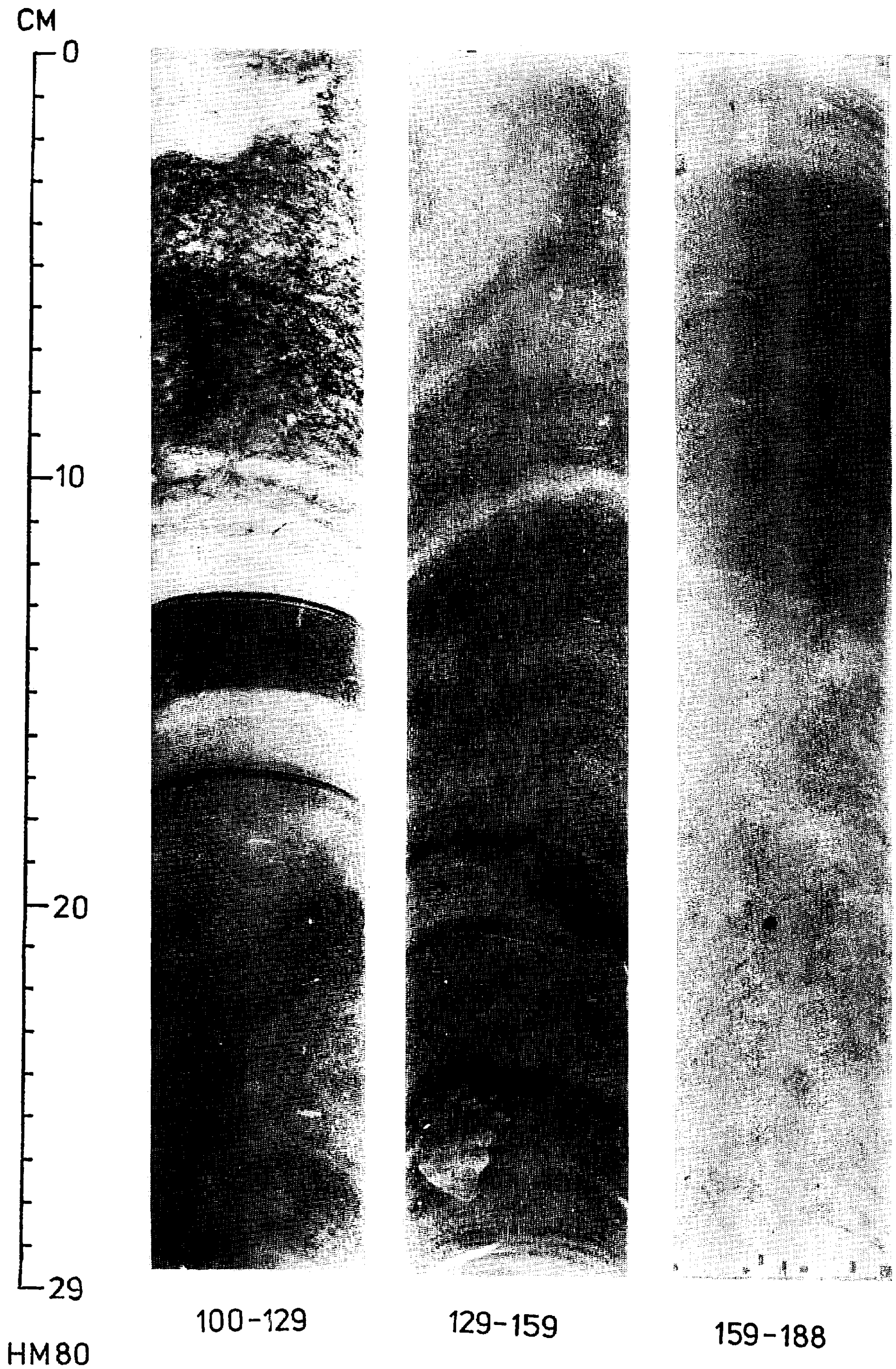


Plate X-4

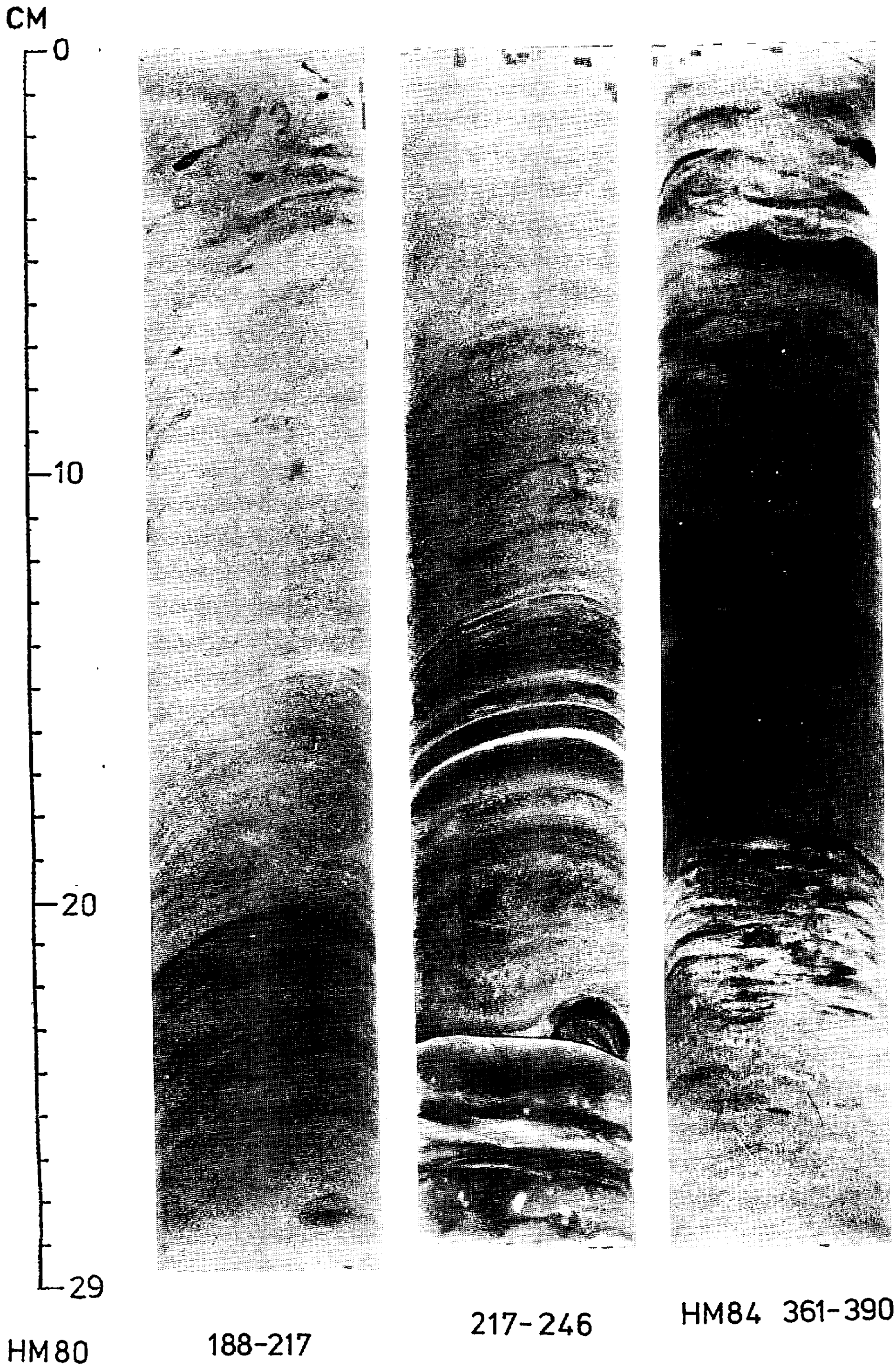


Plate X-5

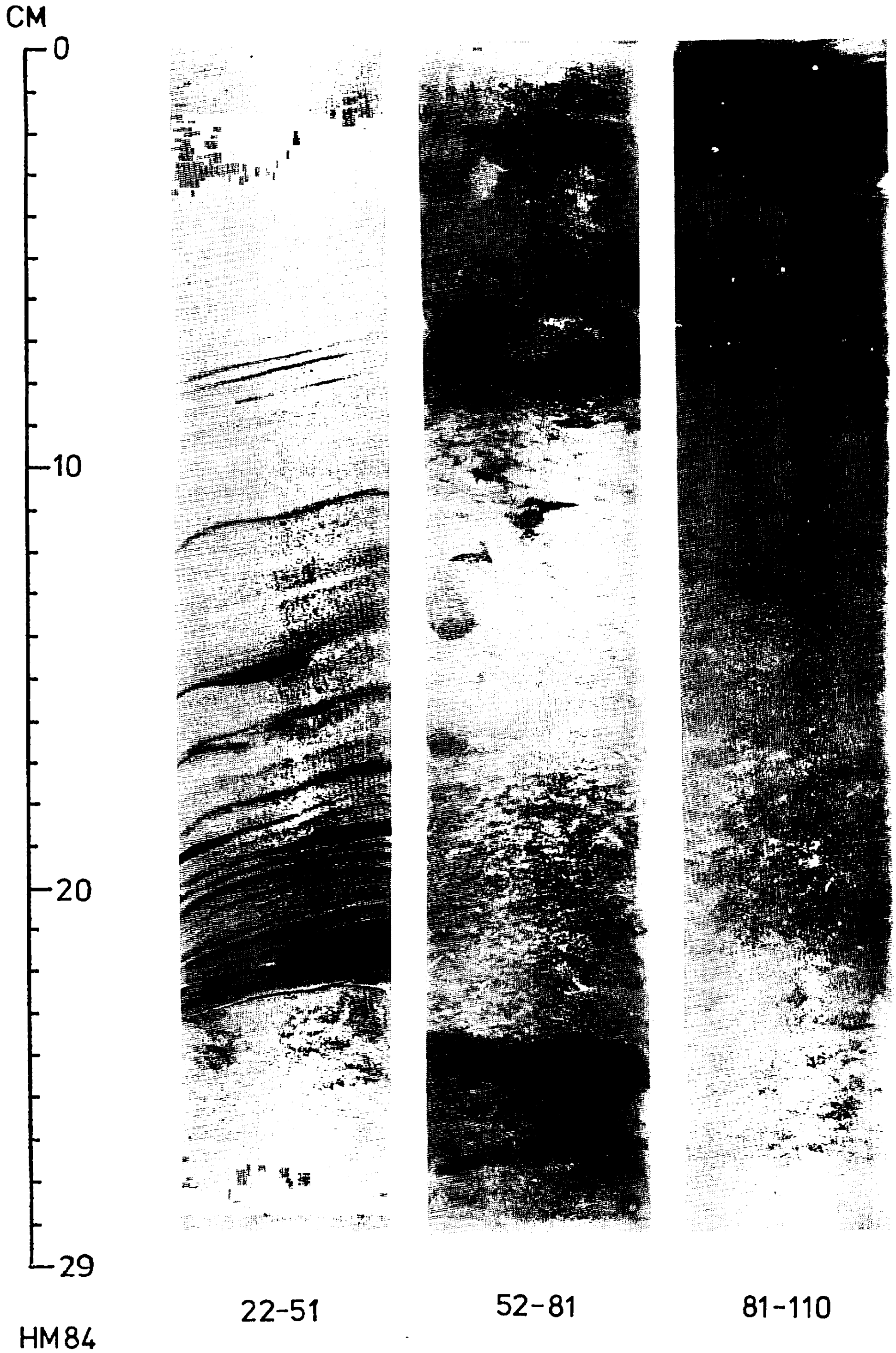


Plate X-6

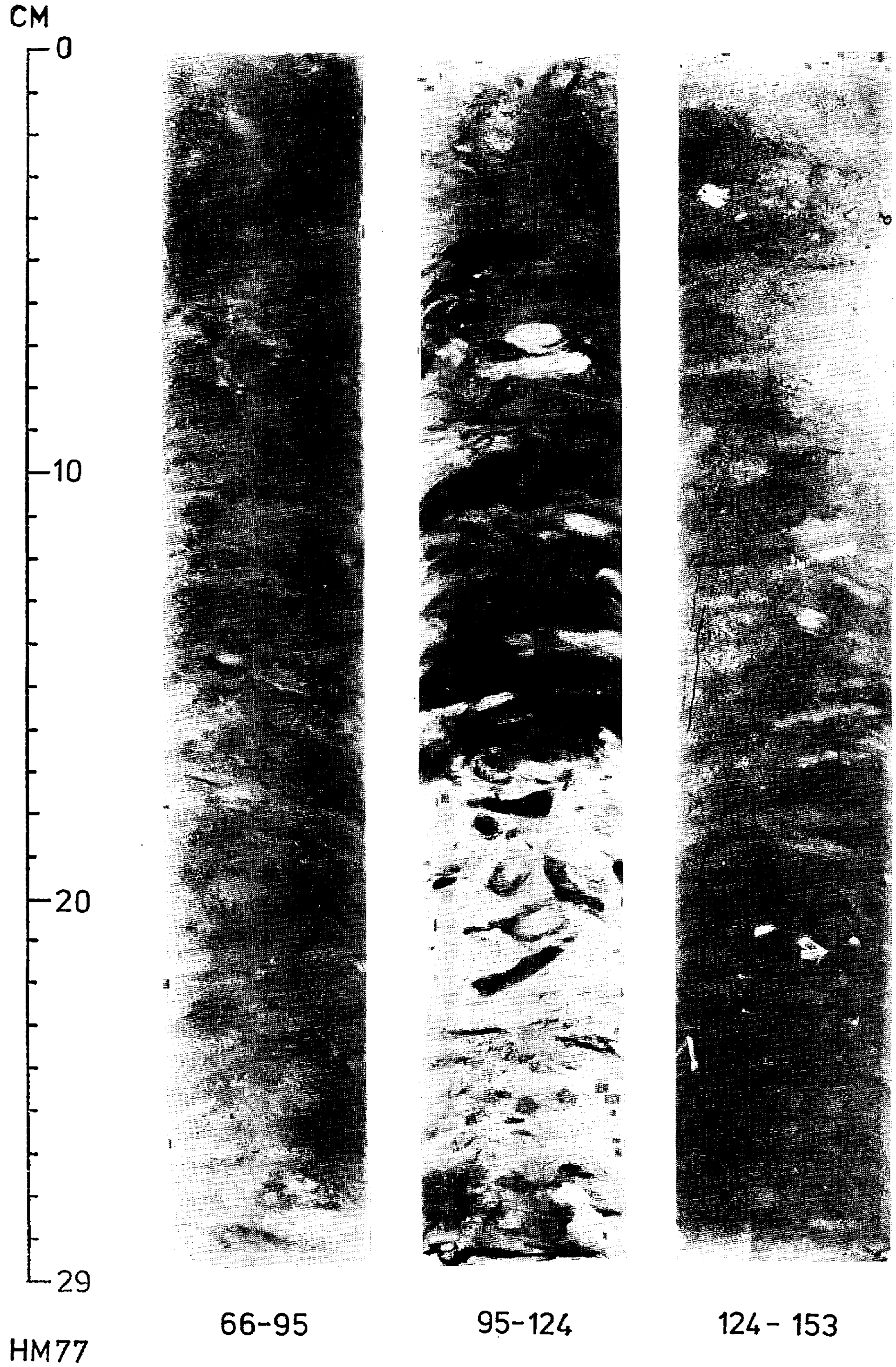


Plate X-7

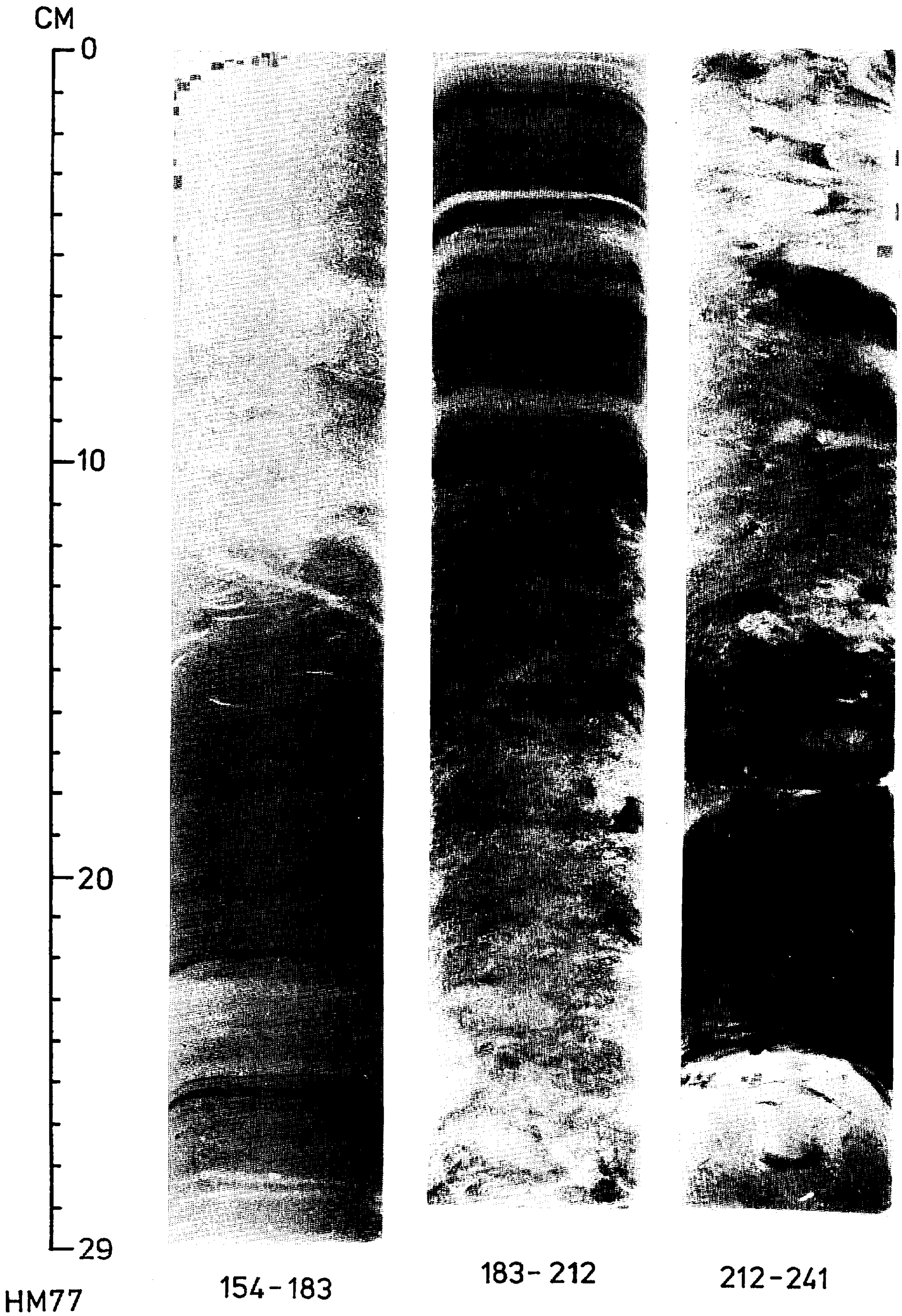


Plate X-8

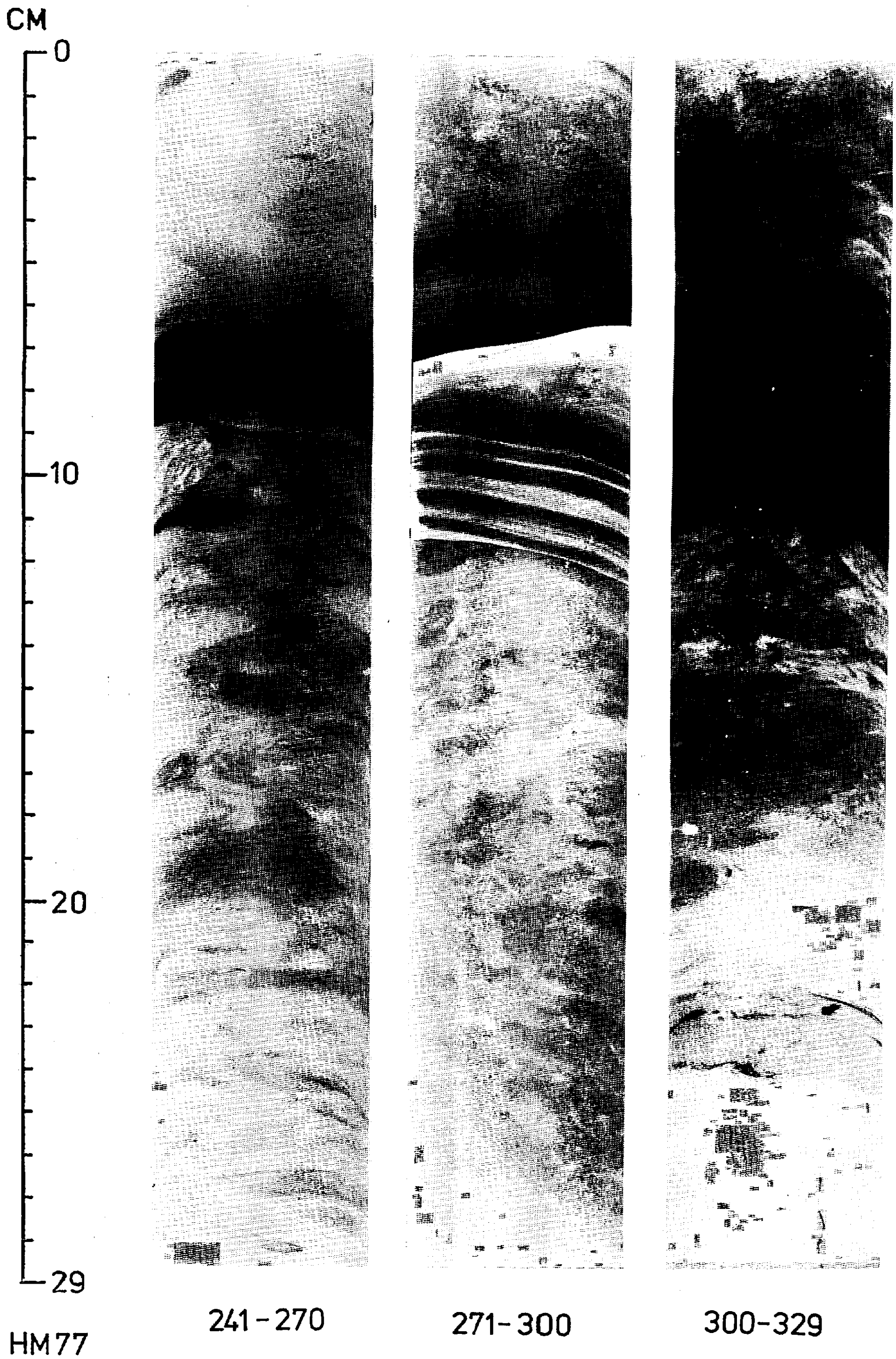


Plate X-9

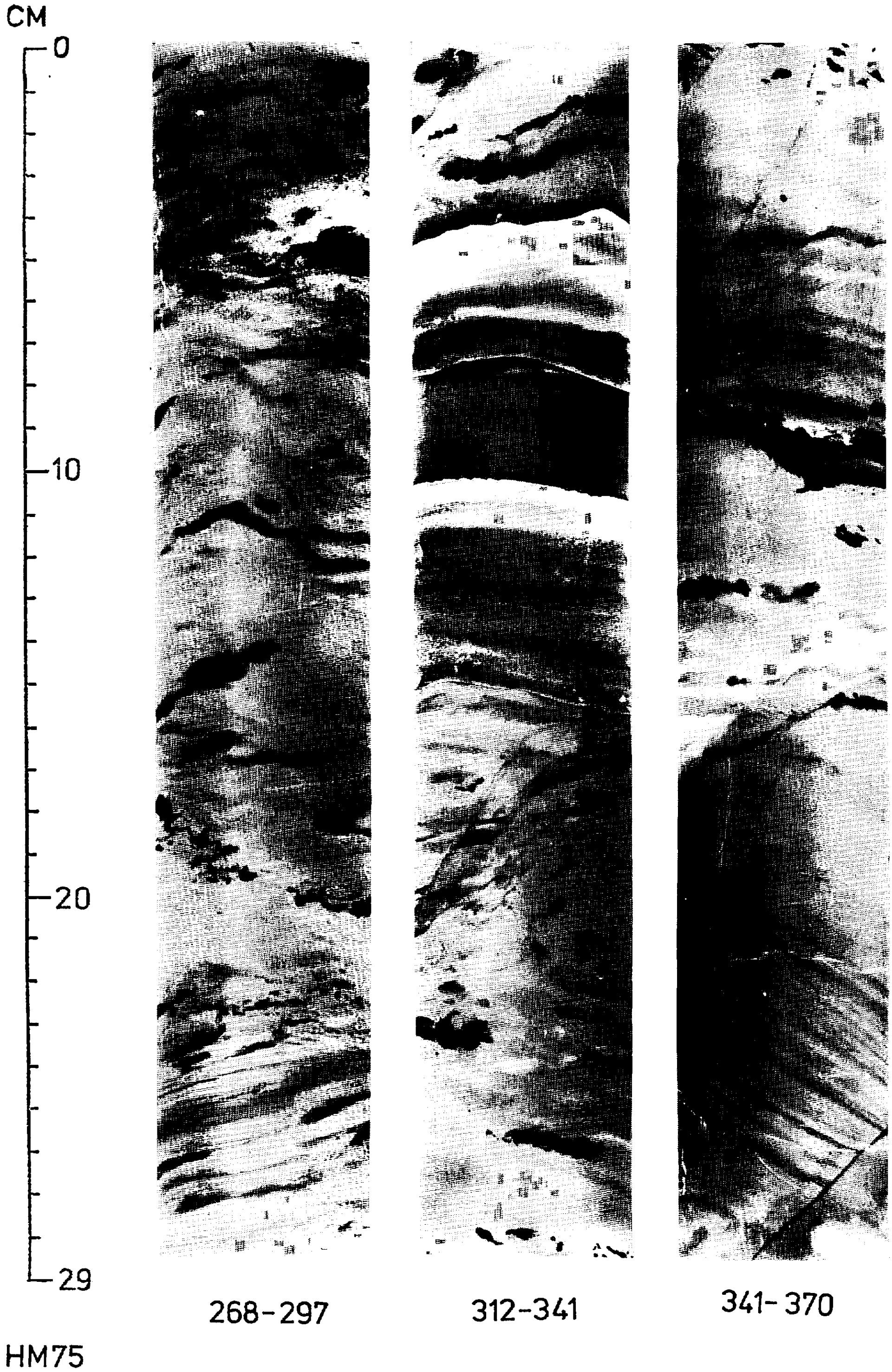


Plate X-10

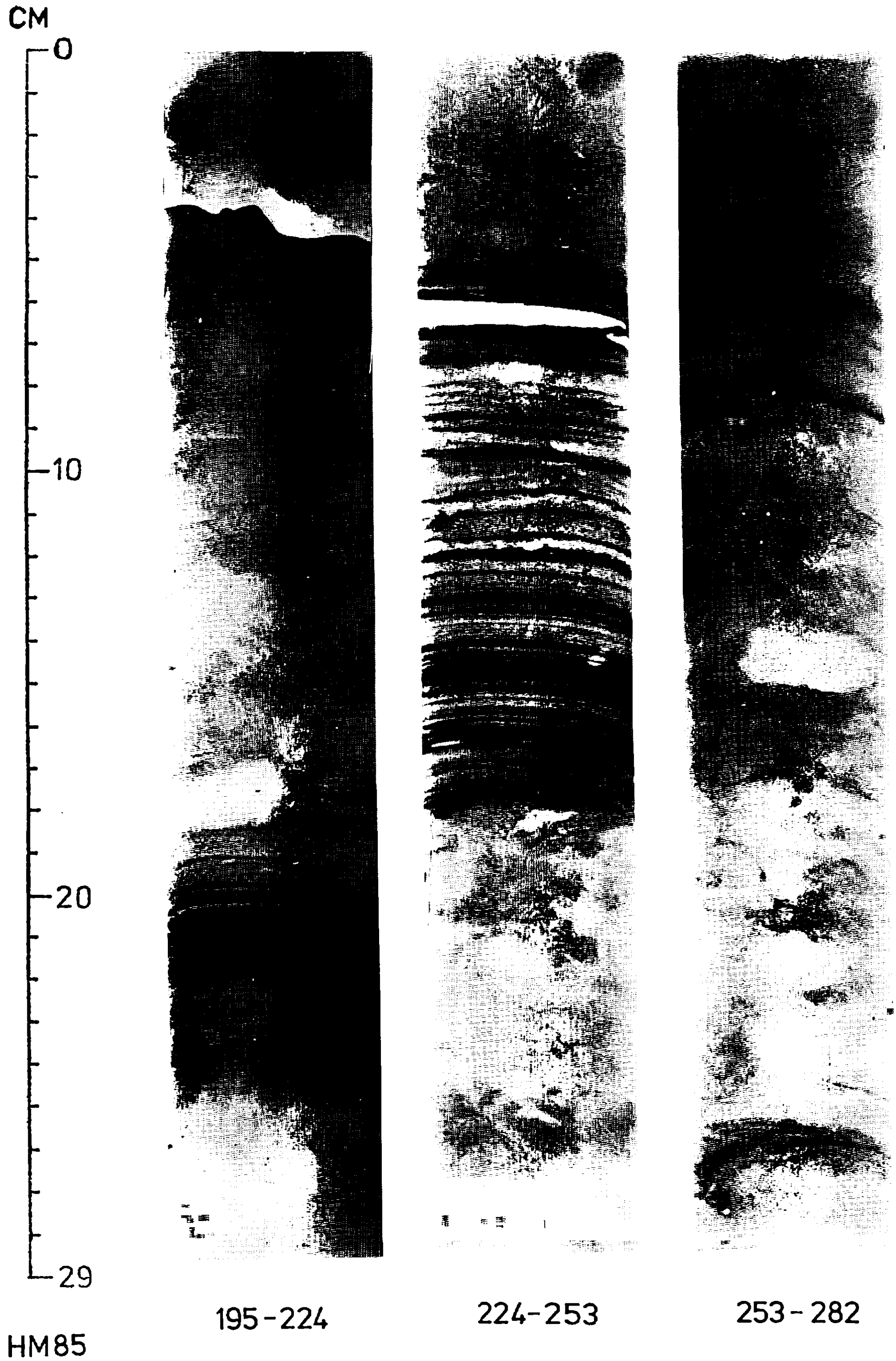


Plate X-11

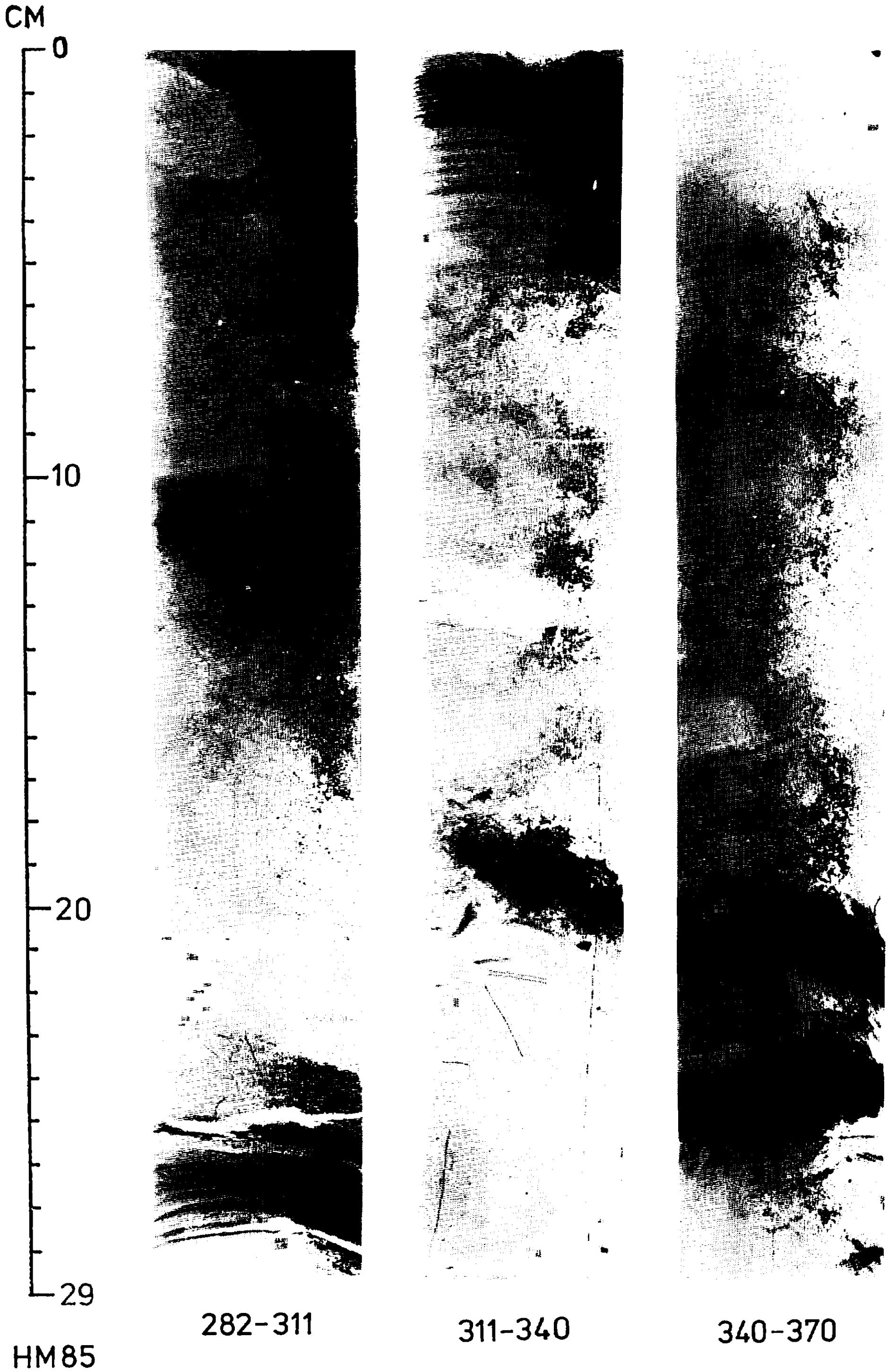


Plate X-12

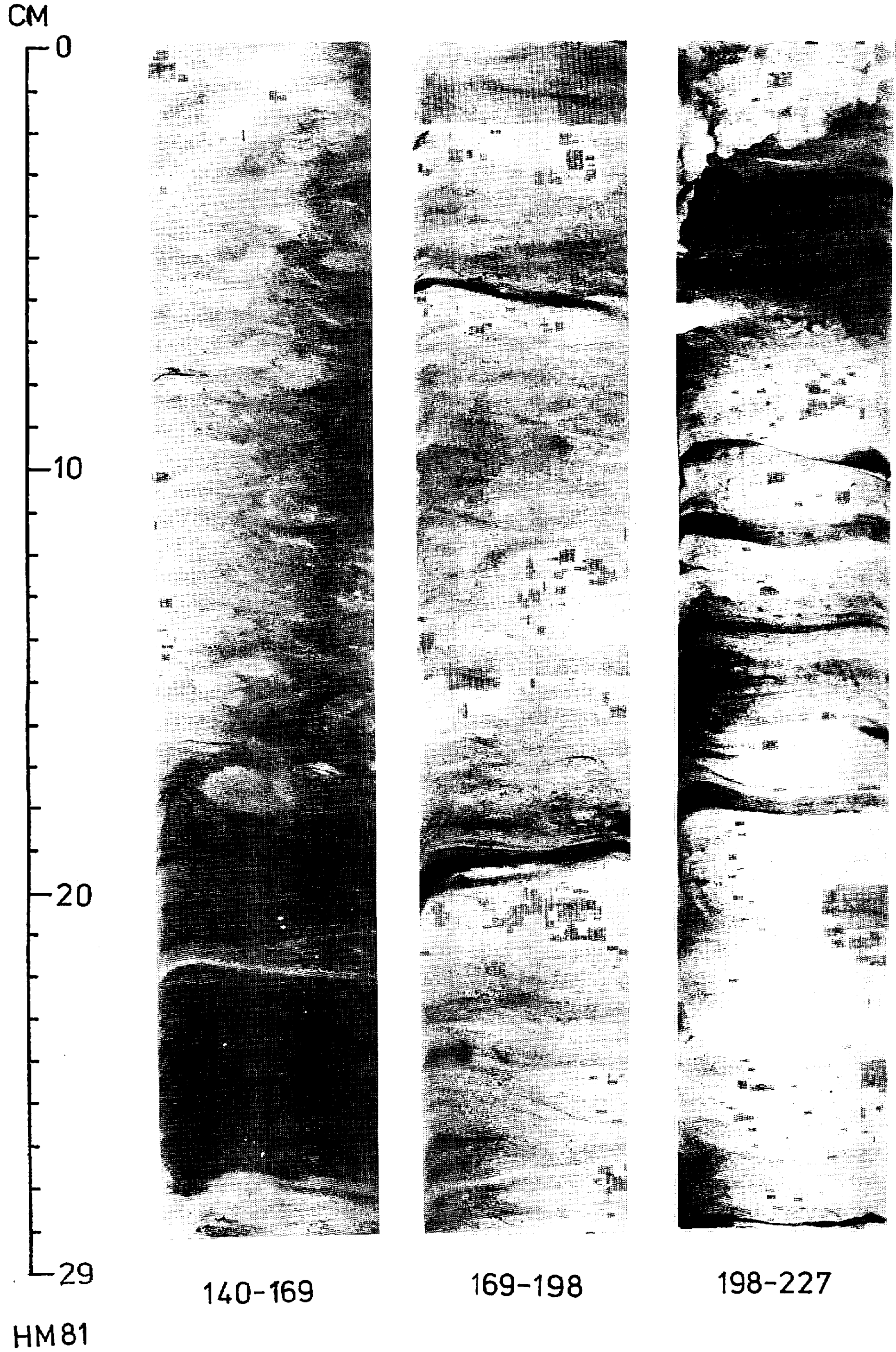


Plate X-13

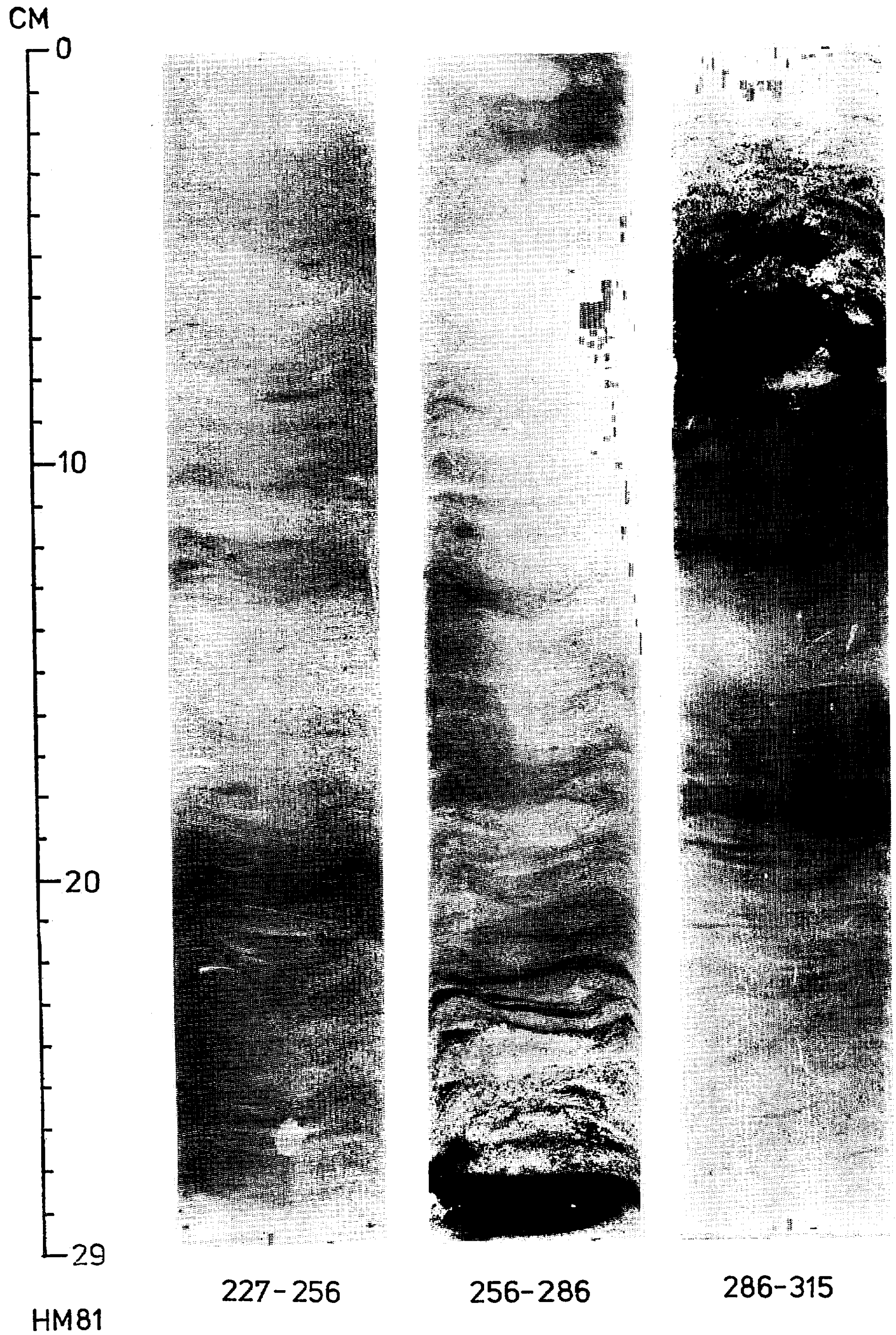


Plate X-14

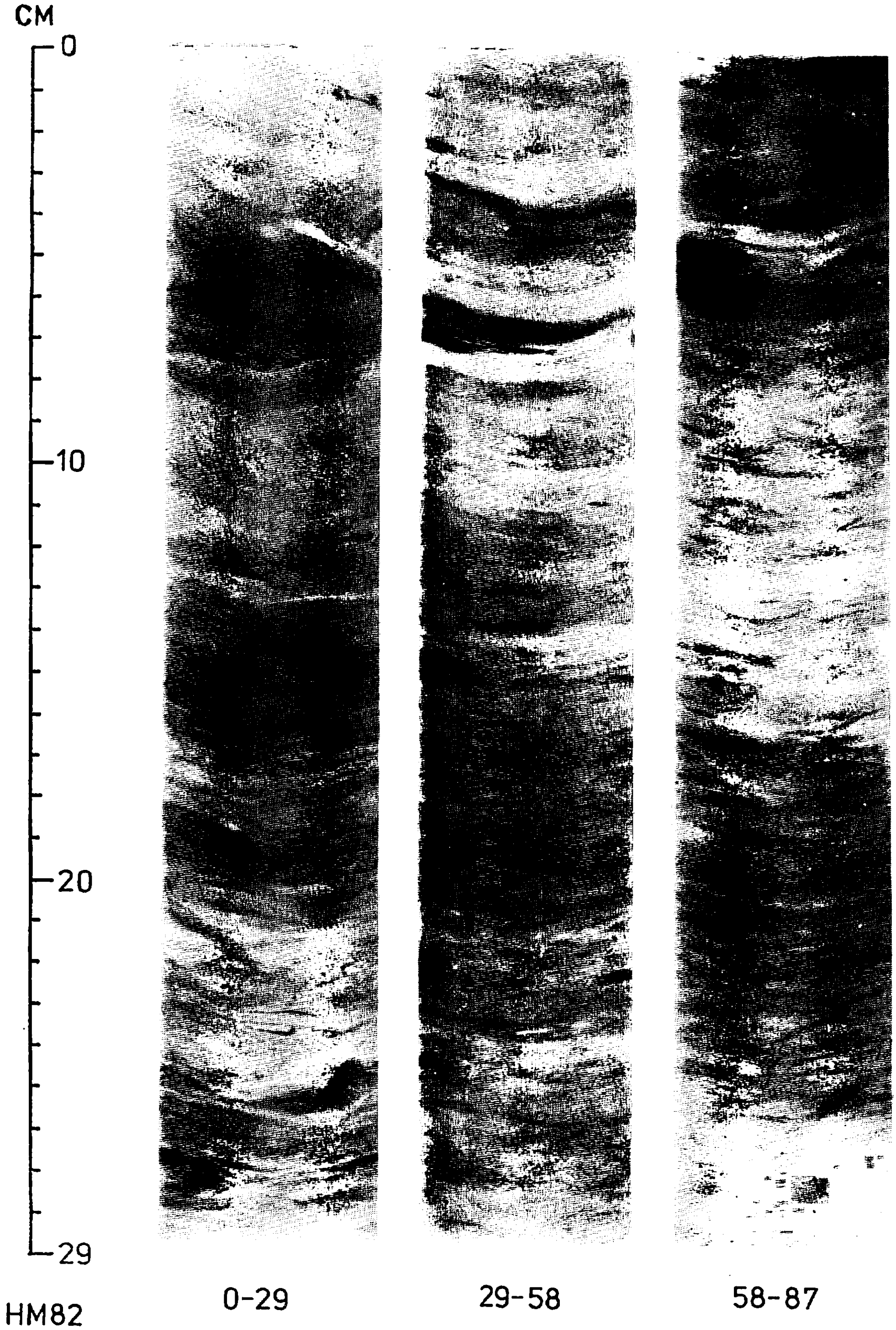


Plate X-15

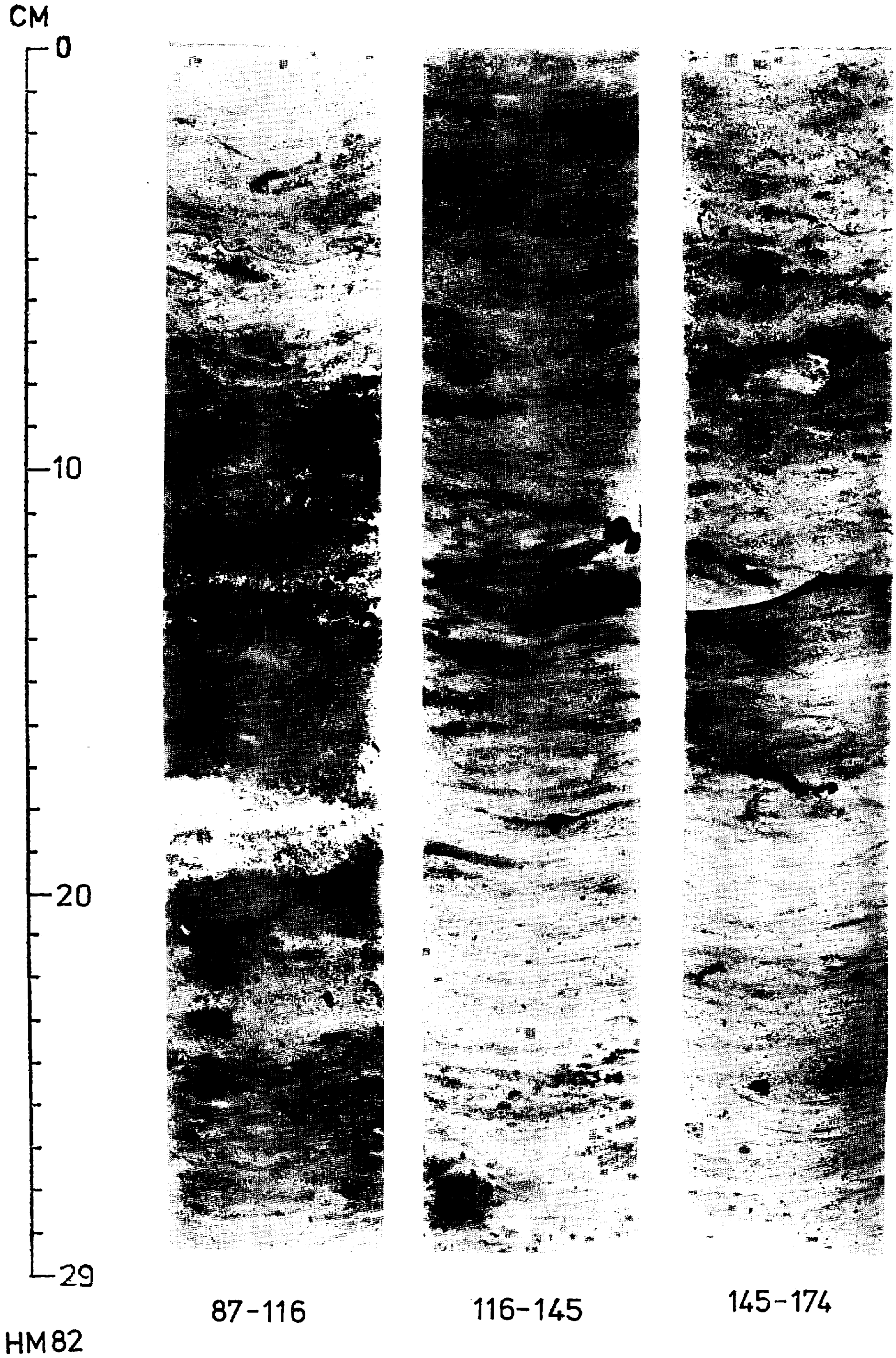
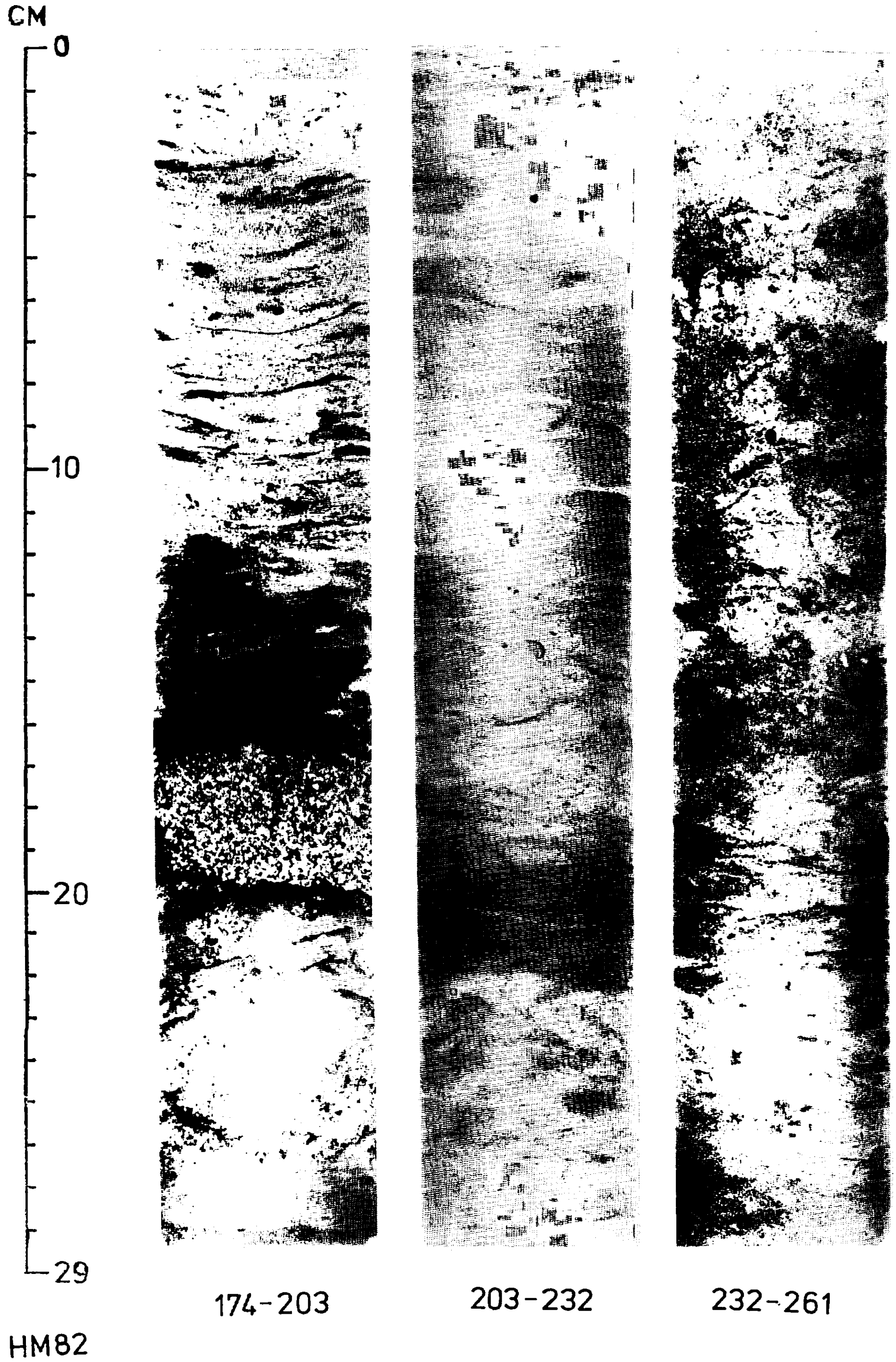


Plate X-16



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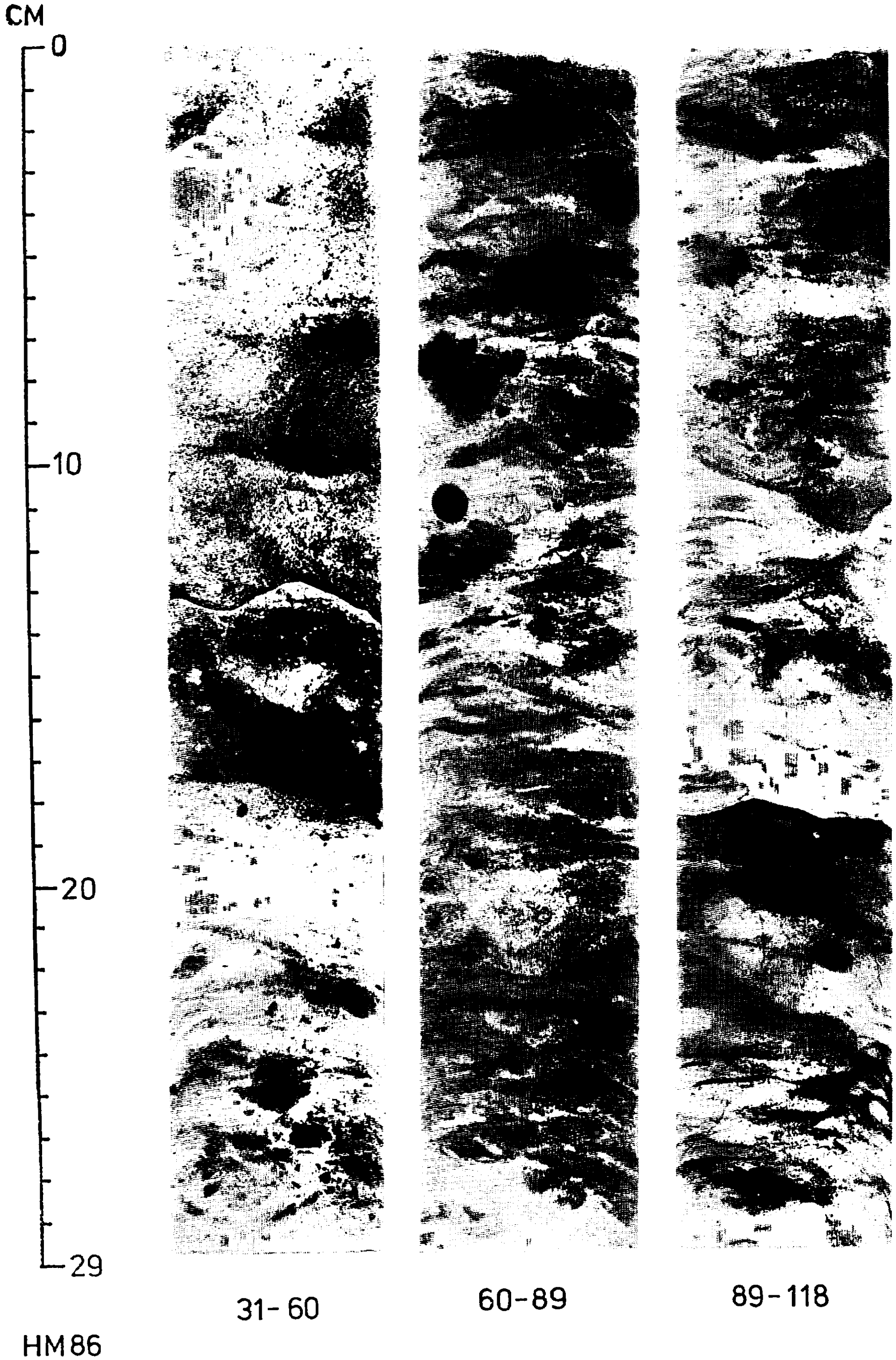

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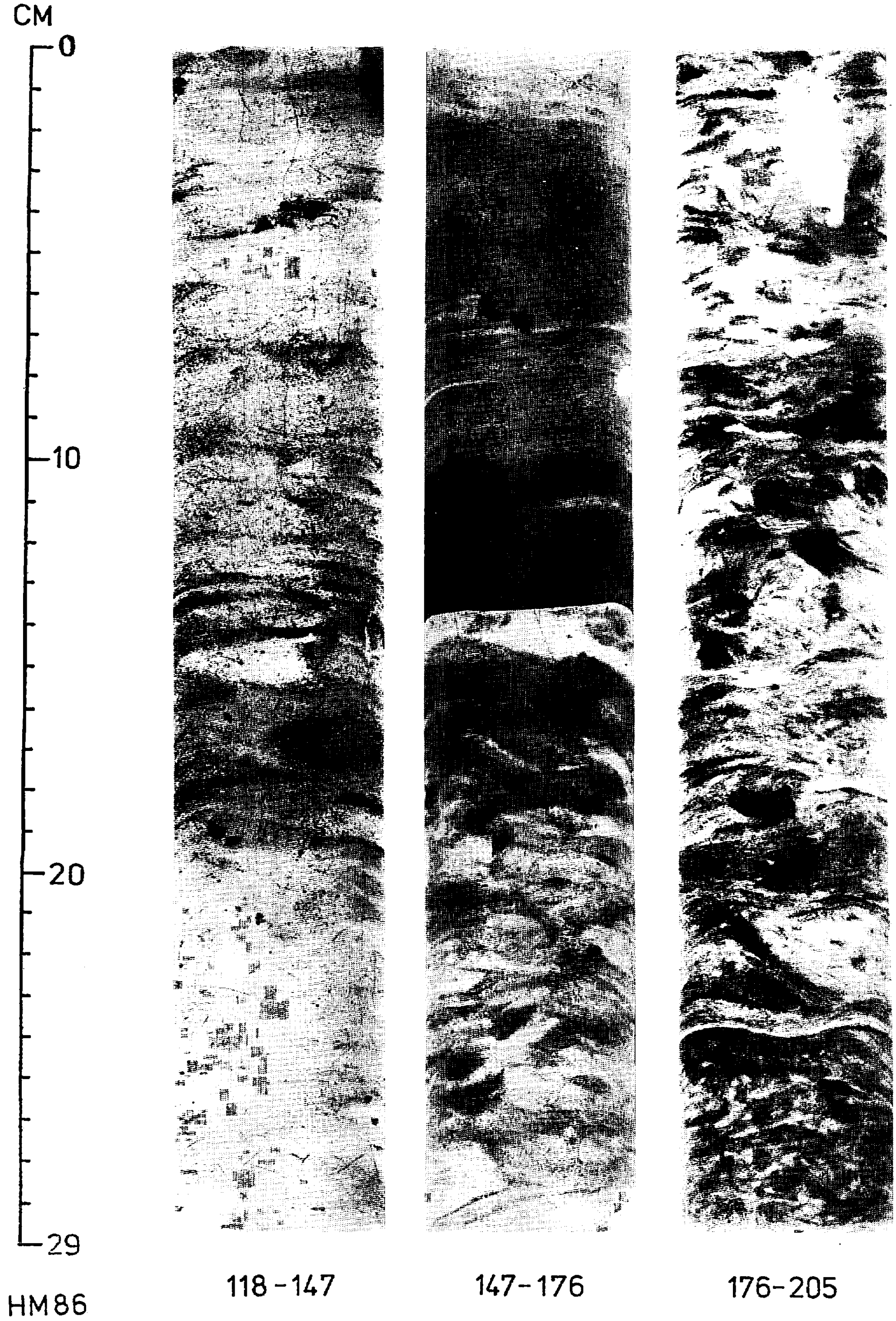

Plate X-19