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Preliminary Results from the R. V. *Tansei-maru* Cruise KT99-14 in the Central and Northeastern Marginal Parts of the Japan Sea (Part II: Depositional Faces of P-9 Core from the Yamato Bank)

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1. INTRODUCTION

Four piston cores, KT99-14 P-8, -9, -10 and -11, were obtained from the flat top, the upper part of the eastern slope and the lower part of the southern slope of the Yamato Bank in the central Japan Sea (Fig. 1) during the R. V. *Tansei-maru* cruise KT99-14 (Tsukawaki *et al.*, 2001) from the 13th to 21st of September, 1999. Palaeoceanographic investigations have already started for the core P-9, recovered from the uppermost eastern slope of the bank (Latitude: 39° 37.2'N, Longitude: 135° 58.5'E, Water depth: 694 m) to recon-

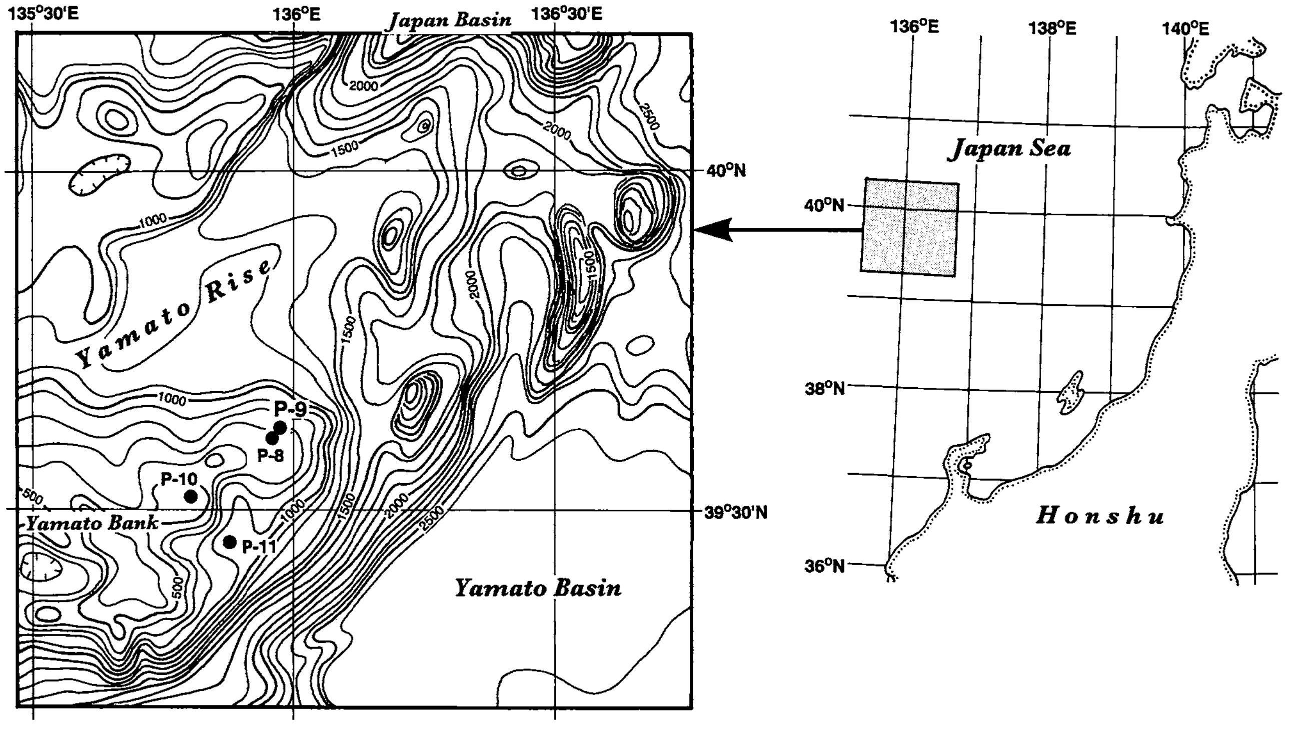

Fig. 1: Submarine topography and sampling site of the core KT99-14 P-9 and other cores obtained from the Yamato Bank in the central part of the Japan Sea (based on Hydrographic Department, M. S. A., Japan, 1980).

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struct oceanic environmental changes of the sea during the last 90,000 years (*e. g.* Abe, 2002MS ; Henmi, 2002MS). The main purpose of this short article is to describe depositional facies and volume magnetic susceptibility of the P-9 core to provide basic information for the palaeoenvironmental studies in the central part of the sea.

2. TOPOGRAPHY OF THE SAMPLING SITE

The Yamato Bank, 230 km long and 55 km wide with an E-W trend, is situated in the southern part of the Yamato Rise, which is the largest and most conspicuous topographic high in the Japan Sea. The shallowest part, 236 m deep, is situated in the central part of the bank (Iwabuchi, 1968). Several topographic highs with flat tops and depressions are recognised on the bank. The bank is divided into the West, Central and East Banks roughly by the longitudinal lines of 134°40'E and 135°35'E (Iwabuchi, 1968). The core P-9 was obtained from the eastern margin of the East Bank at a water depth of 694m.

3. SAMPLING METHODS AND ANALYTICAL PROCEDURES

A six-metres-long stainless-steel pipe piston core sampler with a 600 kg weight and a 70-cm-long Nasu type pilot core sampler were utilized to obtain cored sediments. Volume magnetic susceptibility were measured first at 1 cm intervals by using a Barrington pass through the type magnetic susceptibility system model MS-2. Then, each sediment that had been kept at about 4°C since its recovery was cut vertically into two halves by a nylon fishing line. One of these was processed for sedimentological investigations at a laboratory of the General Education Hall, Kanazawa University, and the other was processed for palaeoceanographic investigations in Tohoku University. The cutting surface of the former was shaved first by a stainless-steel spatula, and then brushed well by spraying a water atomiser for detailed visual observations. After visual observations and core descriptions were made, an 8 mm thick, 7 cm wide and 20 cm long sliced sediment was cased in a plastic box from the cutting surface for soft X-ray radiograph observation through the core. For X-raying, the boxed samples were placed on Fuji industrial X-ray film type IX-100. The source-to-sample distance on a X-ray unit, SOFTEX type M-60, was 70 cm. Voltage, amperage and exposure time were hold constant at 50 kVp, 4 mA and 60-90 seconds, respectively. The exposed X-ray films were immediately processed by the EK type D-19 film developer for five minutes. Microscopic observations using a number of smear slides for fine-grained sediments and thin sections for coarse-grained sediments conduced to the textural and compositional description of a certain number of horizons for cored sediments.

4. DEPOSITIONAL FACIES OF KT99-14 P-9 CORE

Figure 2 shows the columnar diagram of the KT99-14 P-9 core based on visual observation. The core, 328 cm long, is divided lithologically into the upper bioturbated muds (0 - 203 cm below the sea-floor), middle alternating beds of thin laminated mud and rather massive mud (203 - 288 cm), and lower compact muds (288 - 328 cm). Two volcanic ash layers are intercalated at 75 - 76 cm and 310 - 327 cm. Selected soft X-ray radiographs are shown in Plates 1 and 2.

The upper half of the upper part of the core, 96 cm thick, is composed of planktonic foraminiferal test rich olive grey or light olive grey coloured soft mud in the uppermost 20 cm in which greyish green small burrows are developed. Below the soft muds, rather compact light olive grey mud, about 15 cm thick, in which rather large burrows are recognised (Plate 1,

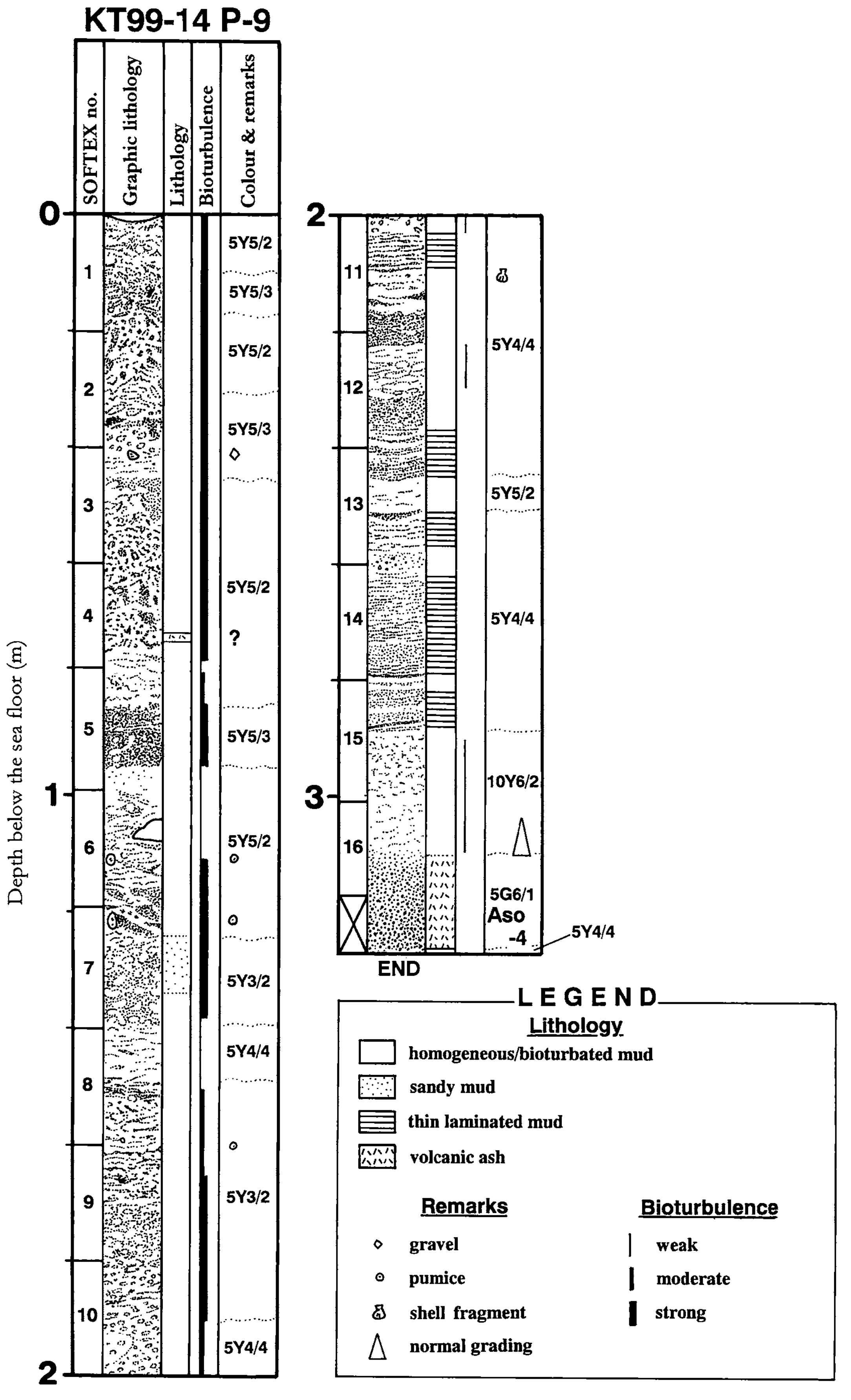

Fig. 2: Columnar diagram of the core KT99-14 P-9.

fig. 1) overlies an about 20 cm thick strongly bioturbated light olive grey mud, followed by an about 40 cm thick bioturbated light olive grey mud (Plate 1, fig. 2). Olive grey mud, about 10 cm thick, is present at the bottom and pale olive grey large burrows are developed in the mud. Each boundary between these muds is transitional. Planktonic foraminiferal tests are rich in part through the horizons that were described above. A basaltic rock gravel is identified at about 41 cm below the sea-floor. The horizon between 55 and 62 cm is soft. An about one centimetre thick very fine-grained volcanic glass shard-rich pale olive coloured mud is intercalated at 75 - 76 cm.

On the other hand, the lower half of the upper part, 107 cm thick (96 - 203 cm below the sea floor), a less bioturbated light olive grey soft mud, 15 cm thick, overlies a 15 cm thick light olive grey bioturbated mud, followed by an about 10 cm thick olive grey basaltic sandy mud in which large burrows are strongly developed (Plate 1, fig. 3). Greyish white pumice, about one centimetre in diameter, is found at 110 cm and 122 cm. Foraminiferal test rich and less bioturbated light olive grey coloured mud, 10 cm thick, and moderate olive brown mud, 10 cm thick, underlie the sandy mud, followed by strongly bioturbated olive grey mud, about 30 cm thick (Plate 1, fig. 4 upper). An about 14 cm thick moderate olive brown mud in which small burrows are moderately developed is situated in the base of the upper part of the core (Plate 1, fig. 4 lower).

The middle part of the core, 203 - 288 cm below the sea floor, consists of alternating layers of light olive grey or moderate olive brown massive rather compact mud, 3 to 30 cm in thickness, and moderate olive brown thinly laminated mud, 8 to 18 cm thick (Plate 2, figs. 1, 2 and 3). Within the former, the horizons of 216 - 222 and 231 - 237 cm show slightly dark in colour and biogenic disturbance is weakly developed in the horizon of 223 - 231 cm (Plate 2, fig. 1). Planktonic foraminiferal tests are particularly rich in the horizon of 253 - 265 cm. On the other hand, the latter is unrhythmically alternating thin, 1 - 3 mm thick, layers of moderate olive brown and light olive grey muds (Plate 2, fig. 3).

The lower part of the core, 288 - 328 cm below the sea floor, underlies the middle part of the core with a sharp boundary, and is composed of the upper pale olive mud, 288 - 300 cm (Plate 2, fig. 4), and middle pale olive transitional layer from the lower to the upper parts, 300 - 310 cm, and lower greenish grey volcanic ash layer, 17 cm thick, occupying the base of the core. Tiny black burrows are developed in the upper mud. An upward grading is recognised through the middle transitional layer. The volcanic ash layer consists of medium- to coarse-grained bubble wall type volcanic glass shards with a little amount of hornblende and clinopyroxene. A very thin moderate olive brown mud, 5 mm thick, underlies the tephra layer.

5. MAGNETIC SUSCEPTIBILITY

Figure 3 shows vertical fluctuations in volume magnetic susceptibility (VMS) through the core P-9. The VMS of the upper 190 cm is rather high around 10×10^{-6} c.g.s. with a broad trough around 80 cm below the sea floor, a sharp trough and a following sharp peak from 70 to 90 cm, and a broad peak from 100 to 130 cm that corresponds to the horizon of sandy mud. On the other hand, the middle part of the core is generally low in VMS, 3×10^{-6} c.g.s., but it increases gradually from 225 cm to 305 cm with a broad trough around 275 cm, in turn and forms a clear peak at the bottommost. The high VMS, about 20×10^{-6} c.g.s., at the bottom of the core corresponds to the horizon of the lower tephra layer.

6. DISCUSSION

Two tephra layers were recognised in the core P-9

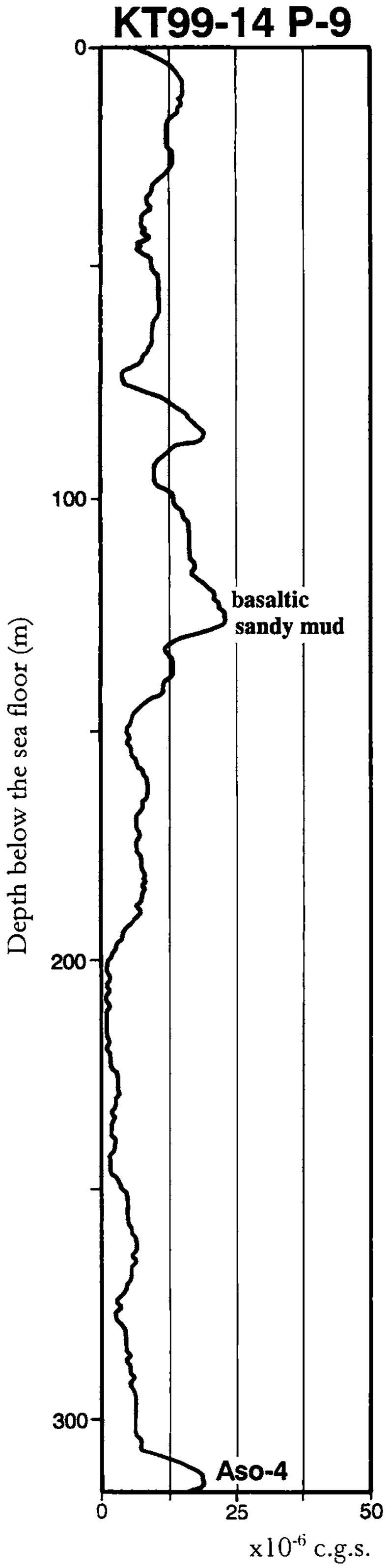

Fig. 3 : Volume magnetic susceptibility of the core KT99-14 P-9.

at 75 - 76 and 310 - 327 cm below the sea floor, respectively. The lower tephra layer consisting of medium- to coarse-grained pale brown to pale grey bubble wall type volcanic glass shards with a little amount of hornblende and clinopyroxene is markedly thick, about 17 cm in thickness. Although distribution of numerous numbers of the Late Quaternary tephras has been reported from the Japan Sea, only three tephras such as Baegdu-Tomakomai (B-Tm), Aira -Tn (AT) and Aso-4 exceed 10 cm in thickness in the central part of the sea (Machida and Arai, 1992).

The B-Tm tephra is composed mainly of pumice type volcanic glass shards with a very small amount of phenocrysts (*e. g.* Machida *et al.,* 1990). The AT tephra distributed in the sea consists chiefly of fine- to medium-grained clear and colourless bubble wall type volcanic glass shards and rarely includes phenocrysts such as orthopyroxene and clinopyroxene (Machida and Arai, 1992). On the other hand, the Aso-4 tephra (Machida and Arai, 1985) in the sea is composed mainly of medium- to coarse-grained pale brown bubble wall type volcanic shards with comparatively rich phenocrysts such as hornblende, clinopyroxene and orthopyroxene (Machida and Arai, 1985). These lithological features of major tephras in the sea suggests that the lower thick tephra layer of the core P-9 can be lithologically correlative with the Aso-4 tephra. Abe (2002MS) also assigned the lower tephra layer of the core to the Aso-4 tephra, on the basis of the result of chemical examination for its volcanic glass shards by an electron-probe microanalyser. Accordingly, the lower tephra layer can be convincingly attributed to the Aso-4 tephra erupted about 85,000 - 90,000 years BP (Machida and Arai, 1992). On the other hand, the volcanic glass shards of the upper thin tephra layer are so small that their shape is not clearly recognisable and phenocrysts are not detected even under the microscope. Thus, the correlation of this tephra layer should be left pending.

In spite of the Aso-4 tephra erupted about 90,000 years BP was identified in the bottommost of the core P-9, no major younger tephras such as the AT (21,000

日本海中央部ならびに北東縁部における淡青丸 KT 99-14 次航海の予察的成果（第 2 部：大和堆で採取された P-9 コアの堆積相）

塚　脇　真　二[1]

要　　旨

1999 年 9 月に日本海中央部の大和堆東部の海底（北緯 39 度 37.2 分，統計 135 度 58.5 分，水深 694 m）から採取されたKT 99-14 P-9 コアについて，肉眼観察ならびに軟 X 線透視観察にもとづきその堆積相を記載した。全長 328 センチの本コアは，堆積相にもとづき淡緑灰色あるいは緑灰色泥の上部（海底面下 0 -203 cm），塊状緑灰色泥と葉理の発達する泥とが互層する中部（同 203-288 cm），および緻密な淡灰色の泥からなる下部（同 288-328 cm）に三区分される。

本コア上部をなす淡緑灰色あるいは緑灰色泥には，著しい生物擾乱が全体をとおして確認されるもののその発達の程度には強弱が認められる。層厚約 10 cm の緑灰色砂質泥が挟在する。また全体をとおして浮遊性有孔虫殻に富む。本コア中部は層厚 3 ～30 cm の塊状緑灰色泥と層厚 8 ～18 cm の葉理の発達する泥とが互層する。前者には生物擾乱のわずかな発達が認められる。一方，後者に発達する葉理とは 1 ～ 3 ㎜厚の緑灰色泥と緑褐色泥との細互層でありこれらに有律性は認められない。

緻密な淡灰色泥からなる本コア下部は中部とは明瞭な境界をもって接する。基底に層厚数㎜の緑灰色泥があるもののその直上には細粒の火山ガラスからなる火山灰層が位置し，この火山灰層は上位へ向かって細粒化しながら塊状の灰白色泥へと移行する。なお，この火山灰層は含有鉱物や火山ガラスの形状から阿蘇 4 火山灰と判断され，本コア全体をとおして明瞭な不連続面が観察されないこと，上位に AT 火山灰などが認められないこと，ならびにコア採集地点の地形にもとづき，本コア採集地点では表層部が海底地辷りなどによって削剥されている可能性が指摘される。

本コアの帯磁率は全体をとおして低いが，上部約 200 cm がやや高い帯磁率を示すのに対し，中部から下部にかけての帯磁率はきわめて低い。しかし，阿蘇 4 火山灰層に対比される層準の帯磁率はやや高くなる。

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Explanation of Plate 1

Selected soft X-ray radiographs of the upper part of the core KT99-14 P-9.

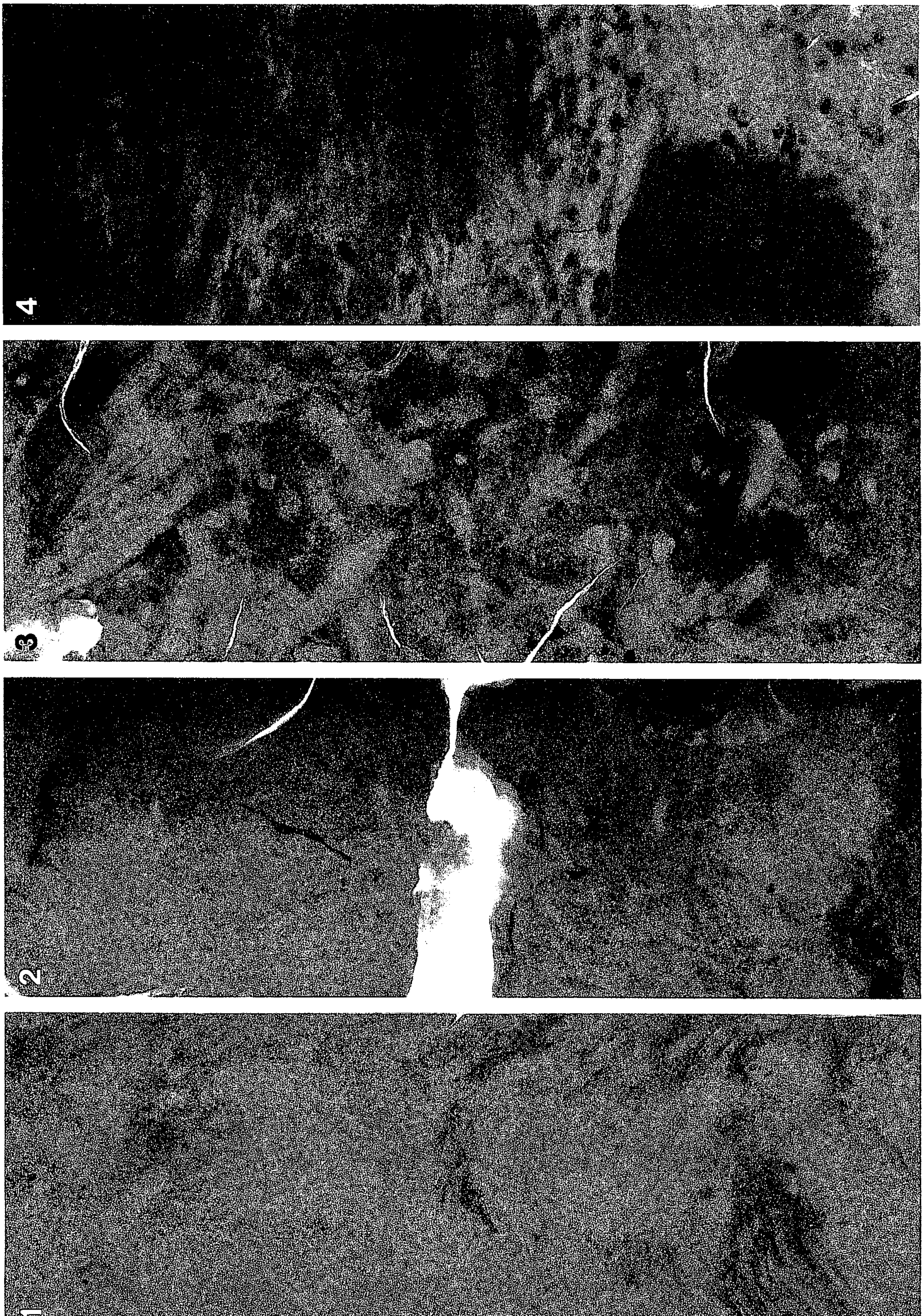
fig. 1 :　Strongly bioturbated light olive grey mud at 21 - 38 cm below the sea floor.

fig. 2 :　Moderately bioturbated light olive grey mud at 61 - 78 cm.

fig. 3 :　Strongly bioturbated olive grey mud in the upper and lower parts of the view, and bioturbated sandy mud in the middle at 121 - 138 cm.

fig. 4 :　Bioturbated olive grey mud in the upper part of the view and moderate olive brown mud in the lower at 181 - 198 cm.

Plate 1



Explanation of Plate 2

Selected soft X-ray radiographs of the upper part of the core KT99-14 P-9.

fig. 1 : Bioturbated moderate olive brown mud in the upper 2 cm, thinly laminated mud in the middle, and weakly bioturbated moderate olive brown homogeneous mud in the lower at 201 - 218 cm below the sea floor. The transitional boundary between the upper and middle parts of the core is recognisable in this radiograph.

fig. 2 : Thinly laminated mud in the upper and lower parts of the view, and weakly bioturbated moderate olive brown homogeneous mud in the middle at 241 - 258 cm.

fig. 3 : Thickly developed thinly laminated mud at 261 - 278 cm.

fig. 4 : Thinly laminated mud in the upper part of the view and weakly bioturbated pale olive compact mud in the lower at 281 - 298 cm. The sharp boundary between the middle and lower parts of the core is recognisable in this radiograph.

Plate 2