

31. TRACE FOSSILS IN CORES FROM DEEP SEA DRILLING PROJECT SITES 434, 435, AND 436 (JAPAN TRENCH TRANSECT)

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ABSTRACT

Trace fossils are in places abundant in cores from DSDP Leg 56 sites. They are particularly rich in the pelagic-clay sequence at Site 436. Some significant trace fossils, including *Zoophycos*, *Teichichnus*, *Chondrites*, rind and solid burrows, and pellet-armored rods, are described. The ichnofauna, except for pellet-armored rods in diatomaceous mudstone of the landward trench slope, is characterized by cosmopolitan bathyal to abyssal forms.

INTRODUCTION

As the Deep Sea Drilling Project proceeds, data on kinds, associations, and occurrences of trace fossils in bathyal to abyssal environments have accumulated rapidly (Tracey et al., 1971, p. 424; Fullam et al., 1973; Piper and Schrader, 1973; Warme et al., 1973; van der Lingen, 1973; Ekdale, 1978; and others). Trace fossils in modern deep sea sediments are very important not only to paleontologists, but also to sedimentologists for environmental analyses of ancient sediments.

Bioturbation is a common feature of many parts of the cores from DSDP Sites 434, 435, and 436 in places (Figure 1); distinctive burrow structures are observed in places (Table 1).

This paper records some typical trace fossils for better understanding of ichnofaunas in deep-sea environments, especially in trench areas.

TRACE FOSSILS

Zoophycos

Meniscoid, tubular structures that occur usually as groups of rather straight bands of constant width (2–4 mm) are identified as *Zoophycos*. They occur either almost horizontally (Plate 1, Figure 1; Plate 2, Figure 2) or obliquely, at a small angle from the horizontal (Plate 1, Figure 2). Some are made up of small fecal pellets (about 1 mm) arranged in a crescent of slightly variable width (Plate 2, Figure 2).

The *Zoophycos* burrows are especially abundant in the sequence of pelagic clay and overlying radiolarian diatomaceous claystone at Site 436, in close association with *Teichichnus*, *Chondrites*, and rind and solid burrows.

Seilacher (1967), insisting that trace-fossil communities are mainly bathymetry-controlled, established a bathymetric zonation of fossil burrows. In it, the *Zoophycos* zone corresponds to lower-bathyal to abyssal depths. The *Zoophycos* burrows at Site 436 seem to corroborate Seilacher's paleodepth scheme.

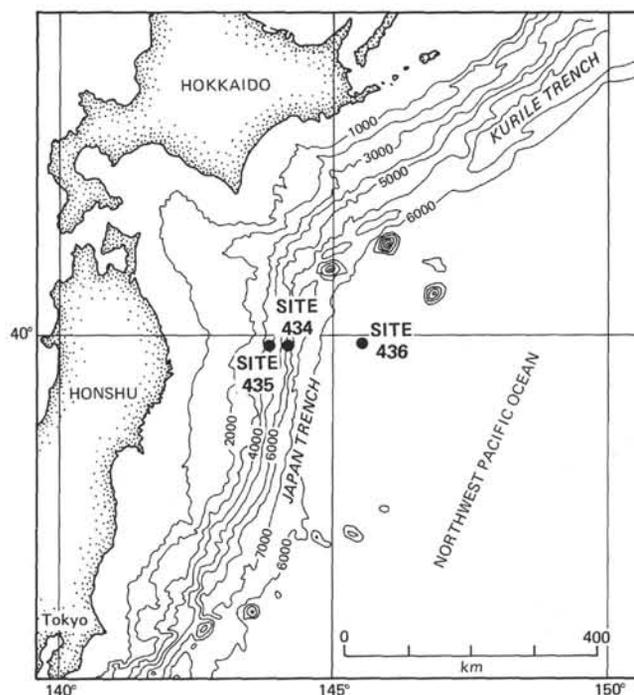


Figure 1. Locations of DSDP Leg 56 drill sites.

Rind Burrow

Chamberlain (1975) defines rind burrows as "cylindrical or subcylindrical burrows made of a light outer layer and a darker colored center".

The rind burrows in Leg 56 cores are tube-like, with a circular or ovoid cross-section, 10 to 20 mm in diameter (Plate 1, Figures 3, 4; Plate 2, Figure 1). They show white or tan rings of variable thickness (1–5 mm). The darker central part is similar to the sediment in which the rind burrow is found. In fact, an inspection of smear slides shows that there is no distinct difference in composition and texture between the central part, the ring, and the host sediment.

TABLE 1
Typical Trace-Fossil Occurrences in Leg 56 Cores

Core Interval	Lithology	Age
<i>Zoophycos</i>		
Hole 436		
34-5, 21-25 cm	Medium-yellowish-brown radiolarian diatomaceous vitric claystone	Late Miocene
38-1, 128-135 cm	Medium-yellowish-brown radiolarian vitric claystone	Middle Miocene
39-4, 70-90 cm	Dusky-yellowish-brown pelagic clay	Early Miocene to Eocene
<i>Teichichnus</i>		
Hole 436		
39-40, 120-130 cm	Dusky-yellowish-brown pelagic clay	Early Miocene to Eocene
<i>Chondrites</i>		
Hole 436		
38-1, 130-140 cm	Medium-yellowish-brown radiolarian vitric claystone	Middle Miocene
38-3, 20-35 cm	Medium-yellowish-brown radiolarian vitric claystone	Middle Miocene
Rind Burrow		
Hole 435A		
4, C.C. 5-10 cm	Grayish-olive muddy diatomaceous ooze	Early Pliocene
6-4, 9 cm	Medium-olive-brown spicular diatomaceous ooze	Early Pliocene
Hole 436		
38-3, 24-25 cm	Medium-yellowish-brown radiolarian vitric claystone	Middle Miocene
39-2, 95 cm	Dusky-yellowish-brown pelagic clay	Early Miocene to Eocene
39-4, 40-86 cm	Dusky-yellowish-brown pelagic clay	Early Miocene to Eocene
Solid Burrow		
Hole 436		
39-2, 35-70 cm	Dusky-yellowish-brown pelagic clay	Early Miocene to Eocene
39-4, 20-90 cm	Brownish-black pelagic clay	Early Miocene to Eocene
39-5, 45-55 cm	Brownish-black pelagic clay	Early Miocene to Eocene
39-6, 5-15 cm	Brownish-black pelagic clay	Early Miocene to Eocene
40-1, 85-150 cm	Brownish-black pelagic clay	Early Miocene to Eocene

At Site 436, rind burrows are common in the pelagic-clay sequence from Section 39-1 to Section 40-6. They are 5 to 20 mm in diameter. Similar burrows are frequently reported from ocean-bottom sediments of the Cretaceous to the Pleistocene, as reviewed by Chamberlain (1975).

Forms similar to the rind burrows reported here commonly occur in the late-Miocene Tobetsu and Morai Formations and in the Pliocene Embetsu Formation exposed in northwestern Hokkaido. These formations are characterized by homogeneous, diatomaceous mudstone deposited in continental-slope environments (Plate 2, Figure 3; Klein, 1977; Okada, 1977).

Solid Burrow

The solid burrow is defined by Ekdale (1977) as "a solid, rod-like burrow with a circular cross-section 1 to 2 cm in diameter."

Solid burrows in Leg 56 cores show a solid, light-colored (white or yellowish-brown), circular or ovoid cross-section (Plate 1, Figure 3; Plate 2, Figure 1). They range from a few to 30 mm across. The burrows occur in soft, dusky-yellowish-brown to brownish-black pelagic clay from Section 39-2 to Section 40-6 at Site 436, ranging in sub-bottom depth from 361 to 378 meters. This sequence is assigned to the Miocene.

These forms are closely associated with the rind burrows. Therefore, the genesis of the solid burrow may be much the same as that of the rind burrow. As Ekdale

(1977) suggested, the solid burrow may represent final products in a chemical-reduction process.

Pellet-Armored Rod

Two pieces of pellet-armored rods were found in grayish-olive-green, diatomaceous claystone from Section 19-2 and Section 23-3 at Site 434.

Both the pieces show straight, tubular form, with elliptical cross-section. In Section 19-2, they are less than 25 mm across and 29 mm long; in Section 23-3, they are 22 by 13 mm across and 38 mm long. These rods are covered wholly with small lumpy or pellet-like sculptures. Single sculptures, 1 to 5 mm long and 0.5 to 1 mm wide, are protruded and arranged almost parallel to the length of the rod. Larger sculptures are seen on broad sides.

The internal part of the rod is a little darker than the marginal part, but no distinct structural and compositional differences are recognized. The rods consist of diatomaceous, micritic limestone or marlstone (Plate 3, Figures 3, 4), in places with scattered fecal pellets (Plate 3, Figure 3). This lithology is similar to that of carbonate nodules frequently found in Site 434 cores (Okada, this volume).

These lithified burrows look like *Ophiomorpha* of Häntzschel (1952), but are not identical, in that *Ophiomorpha* is characterized by transversely arranged, lumpy sculptures on the surface and a well-defined, thick wall.

These structures may be autochthonous, but their occurrence is obscured by drilling disturbance; most carbonate nodules with similar lithology nature are interpreted as autochthonous (Okada, this volume).

Other Trace Fossils

Other distinct burrows found in Leg 56 cores are *Teichichnus* and *Chondrites*. *Teichichnus* occurs in dusky-yellowish-brown clay at Site 436 as a short, vertical burrow, 5 mm wide, with tightly packed, concave-down, crescentic laminae (Plate 1, Figure 2). *Chondrites* is observed as groups of circular or elongated, dark-colored dots (Plate 1, Figures 1, 4). It is also found in radiolarian vitric claystone at Site 436 (Table 1).

Color mottling and bioturbation are also common in many cores from Sites 434, 435, and 436, and bioturbation is remarkable below 304 meters sub-bottom at Site 436.

CONCLUDING REMARKS

Trace fossils in Leg 56 cores are *Zoophycos*, *Teichichnus*, *Chondrites*, rind burrow, solid burrow, pellet-armored rod, and others. These trace fossils, except for the pellet-armored rod, are common in diatomaceous clay and brownish-black pelagic clay cored at Site 436. They seem to be confined to a very slowly deposited sequence. This trace fossil assemblage is in good accord with the deep-sea fossil community of Chamberlain (1975). Pellet-armored rods found in diatomaceous claystone at Site 434 are difficult to evaluate.

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PLATE 1

- Figure 1 Vertical section through two *Zoophycos spreiten* (Z) and *Chondrites* burrows (C) in vitric radiolarian claystone. Interval 436-38-1, 129-141 cm. Water depth at Site 436 is 5240 meters.
- Figure 2 Vertical section through a *Teichichnus* burrow (T) and many *Zoophycos*-type burrows in the lower half of the photograph. The sediment is pelagic clay. Interval 436-39-4, 118-132 cm.
- Figure 3 Vertical section through two solid burrows (S), and rind burrows in the lower part. The sediment is pelagic clay. Interval 436-39-5, 44-56 cm.
- Figure 4 Vertical section through rind burrows (R), and *Chondrites* burrows in the lower part, in vitric radiolarian claystone. Interval 436-38-3, 20-35 cm.

PLATE 1

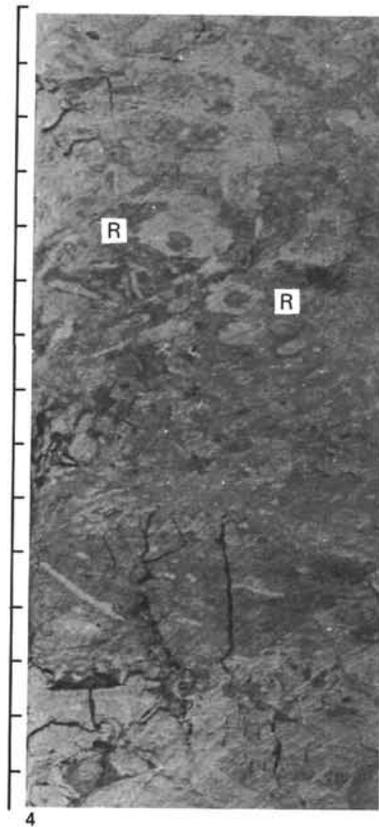
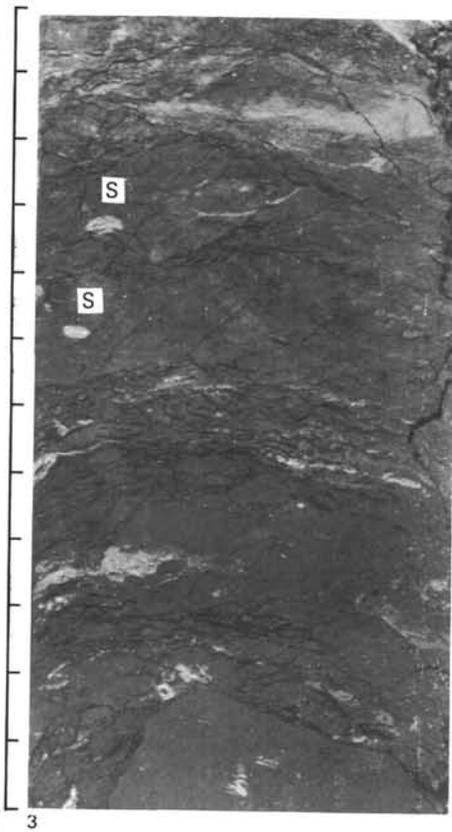
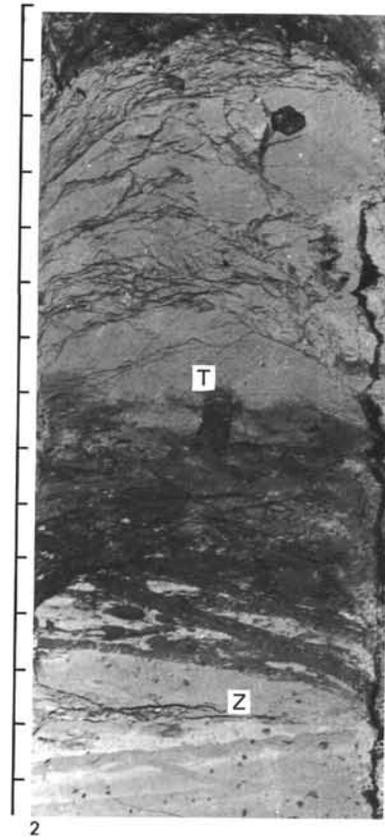
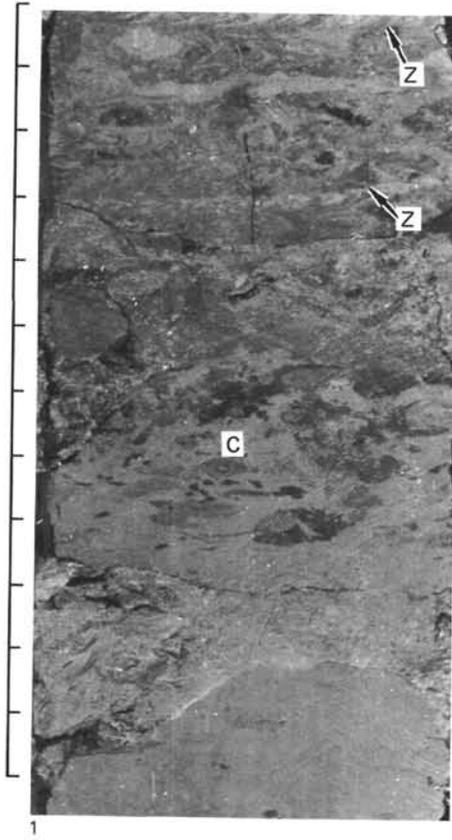


PLATE 2

- Figure 1 Vertical section through solid burrows (S) and a rind burrow in pelagic clay. Interval 436-39-4, 69-90 cm.
- Figure 2 Vertical section through two *Zoophycos spreiten* (Z) filled with fecal pellets, in siliceous vitric claystone. Interval 436-34-5, 8-25 cm.
- Figure 3 Rind burrows from Pliocene diatomaceous mudstone in northwestern Hokkaido (Embetsu Formation exposed south of Embetsu).

PLATE 2

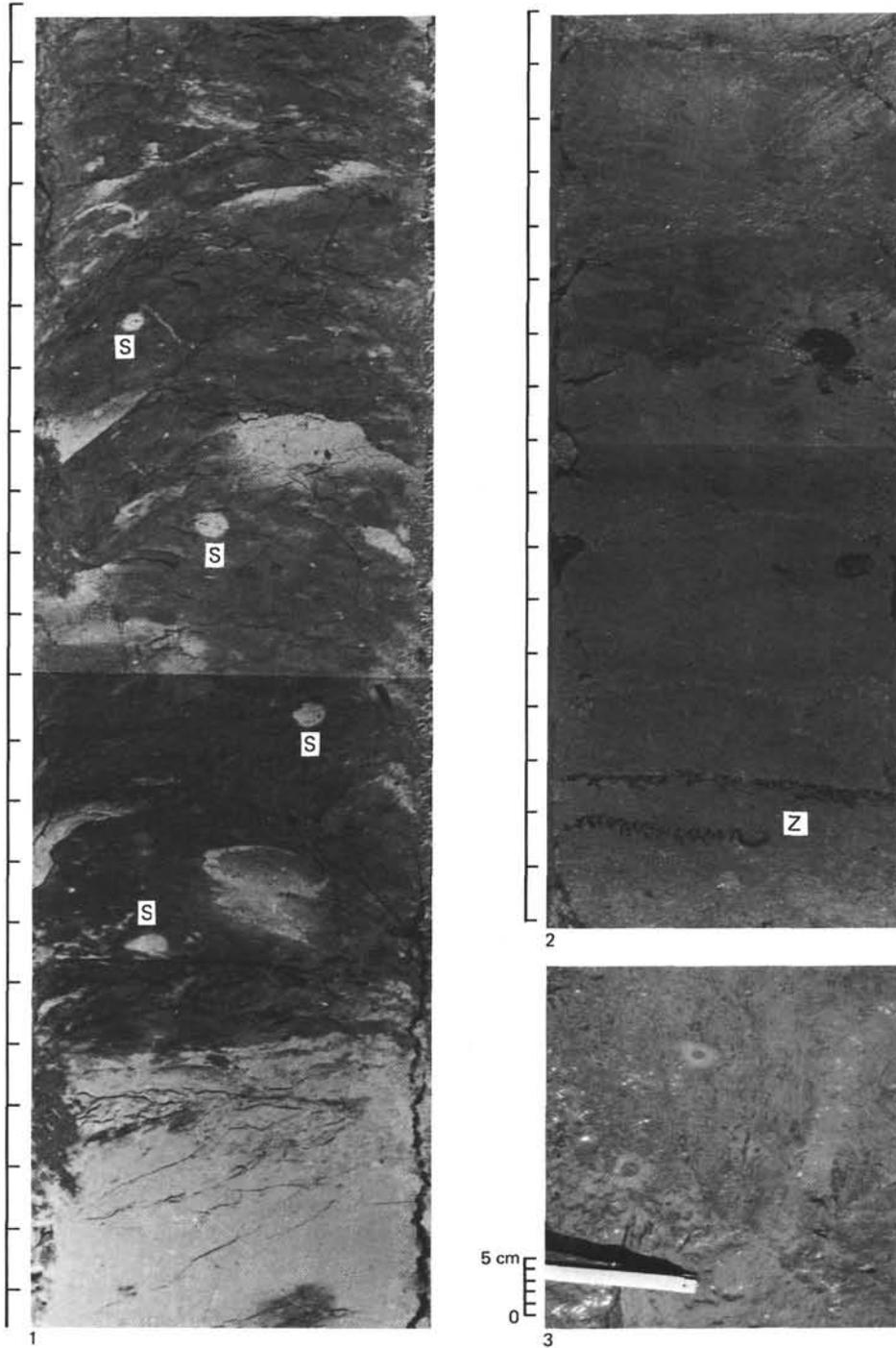


PLATE 3

- Figures 1, 2 Pellet-armored rods. Figure 1 shows a rod from clayey diatomite to diatomaceous claystone from Section 434-23-3. Figure 2 shows a rod from diatomaceous claystone from Section 434-19-2. Water depth at Site 434 is 5986 meters.
- Figures 3, 4 Photomicrographs of a thin-section of a rod from Section 434-23-3, showing carbonate minerals with microcrystalline texture. Note geopetal situation of pyrite in diatom host cavities (Figure 3) and scattered fecal pellets (Figure 4). Plane polarized light.

PLATE 3



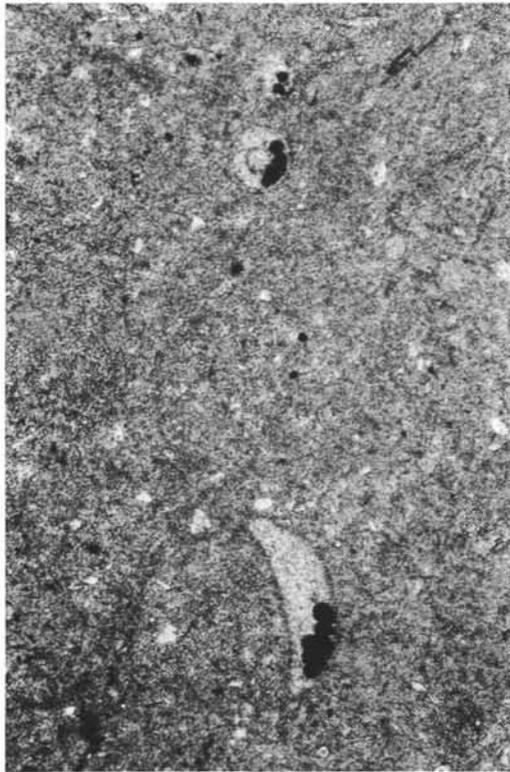
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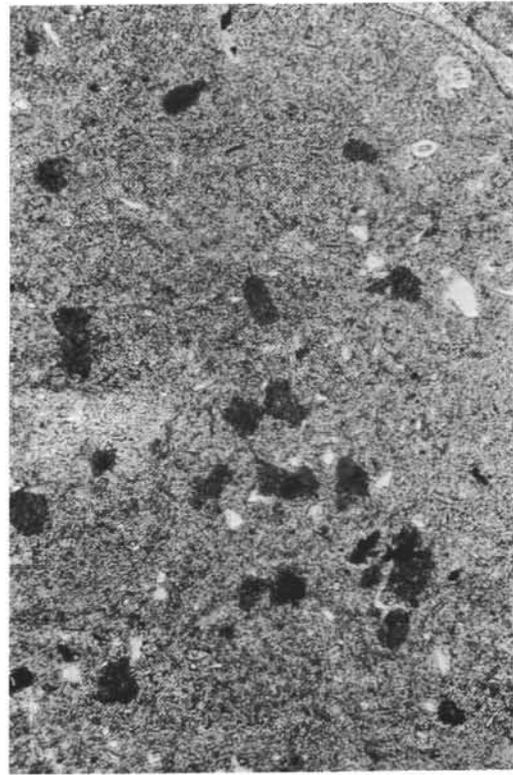
2

2 cm



3

0.2 cm



4

0.2 cm