OCEAN DRILLING PROGRAM

LEGS 127 AND 128 SCIENTIFIC PROSPECTUS

JAPAN SEA

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ABSTRACT

The Japan Sea is one of the best known backarc basins in the western Pacific. It is composed of a number of smaller basins formed by extension and multiple rifting events initiated during late Oligocene and early Miocene time. The multifaceted drilling program of ODP Legs 127 and 128 is designed to better constrain the tectonic, sedimentary, and paleoceanographic history of this basin in terms of the following objectives:

(1) Three sites (J1b, J1d, J1e) are designed to provide information on the nature and age of the basement of the basins. These sites will provide better constraints on the age of rifting of the Japan Sea and help to better understand the kinematics of the entire region. In addition, the emplacement of a borehole seismometer at J1b is planned to provide long-term monitoring of seismicity off western Japan.

(2) Drilling at one site (J3) is aimed at constraining the timing of initiation of convergence in an area where the obduction of oceanic crust may be occurring.

(3) The sediment sections to be cored at all proposed sites will provide a detailed depositional and paleoceanographic record of the Japan Sea. Detailed faunal and floral analyses of these sections should provide high-resolution records of the depositional and paleoceanographic evolution of the sea, including variations in rate of surface productivity, intensity of the oxygen minimum, and the origin of deep and intermediate water masses within the Japan Sea.

(4) One site (J2a) will drill in a sedimented failed backarc rift which represents an ideal setting for massive sulfide mineralization. Drilling this site should add to our understanding of backarc environments associated with metallogeny and permit a comparison with similar sedimentary environments now exposed in land sections, including the Kuroko deposits.

1. INTRODUCTION AND GOALS

The Japan Sea is one of the most intensively studied marginal seas in the western Pacific region (Tamaki, 1988). The sea consists of several deep basins (water depths in excess of 3000 m) which appear to be floored by oceanic-type crust and separated by ridges underpinned by continental material (Fig. 1). This general picture has been developed from an extensive marine geophysical data base but suffers from a lack of hard geological data on the acoustic basement aside from that gained from dredging operations. In 1973, four sites were drilled in the Japan Sea during DSDP Leg 31 to determine the nature and composition of acoustic basement and to characterize the sedimentary history. Unfortunately, the presence of ethane in recovered cores and a medical emergency cut the drilling short, leaving the deeper objectives unrealized.

Tectonic scenarios for the development of the Japan Sea have been deduced from the wealth of marine geophysical and geological data and from onshore work in Japan, particularly geologic mapping and paleomagnetic studies. Most models consider the sea to represent a backarc basin initiated by multiple rifting probably during the late Oligocene-early Miocene. The spreading ultimately relates to the complex plate interactions during the last 30 m.y. In all cases, better data on the age and nature of the basement in the Japan Sea are necessary to constrain the style, timing and kinematics of these interactions and to investigate more topical and local problems such as the nature and age of anomalously thick oceanic crust, the style and history of multiple rifting and obduction, and rates and character of basin subsidence and sedimentation.

The overall goals of the drilling program for ODP Legs 127 and 128 include documentation of the tectonic, depositional, and paleoceanographic development of the Japan Sea in terms of the following objectives (Fig. 2):

1.1 Nature and age of basement of the basins (Site J1b, J1d, J1e). Drilling to basement will help date a newly mapped set of magnetic anomaly lineations that suggest frequent ridge propagation during basin spreading in the Japan Sea Basin. Basement drilling will also provide hard evidence of the anomalous oceanic crust documented by recent ocean bottom seismometer (OBS) data in the Yamato Basin, and allow evaluation of a proposed fast spreading history for the Japan Sea suggested by paleomagnetic data from southwestern Japan.

1.2 Style of multiple rifting (Sites J2a, J1b, J1d, J1e). The influence of complex multiple rifting events associated with continental crustal extension, a complex pseudo-fault pattern, and an anomalously thick oceanic crustal structure, will be examined to constrain backarc extension tectonics of the continental arc and to compare backarc-type to Atlantic-type extension tectonics. The influence of arc crust and mantle upon the generation of backarc volcanism will also be examined.

1.3 Obduction of oceanic crust (Site J3). Cumulative evidence indicates that the Eurasian-North American (EURA-NOAM) plate boundary shifted to the western margin of the Japan Sea from the central Hokkaido suture line during Quaternary time, effectively transferring northeast Japan to NOAM. Seismic reflection profiles in the eastern Yamato Basin illustrate that incipient obduction as well as subduction of oceanic crust is ongoing along this new plate boundary which shifted from the central Hokkaido suture line. Drilling at proposed site J3b is aimed at constraining the timing of initiation of this convergence and yielding data regarding the origin of ophiolites and obduction of oceanic crust.

1.4 Paleoceanography. Stratigraphic columns to be sampled at all six proposed sites will yield important new faunal, isotopic, and lithologic data regarding the water mass and sediment history of the Japan Sea. ODP results should allow effects of local tectonic control on basin sills to be separated from effects of global eustatic and climatic events. Quantitative faunal and floral analyses at all sites are expected to yield data on variations in rates of productivity, intensity of oxygen minima, origin of deep intermediate and surface water masses within the sea, and rates and mode of basin subsidence. In particular, proposed site JS-2, located on a local high above the basin CCD, is aimed at yielding a detailed faunal and isotopic record of paleoclimatic-paleoceanographic events within the sea during the critical late Miocene period of globally intensified vertical circulation and lowered sea levels.

1.5 Metallogeny in a failed backarc rift (Site J2a). The Kitayamato Trough is thought to represent an ideal setting for massive sulfide mineralization within a failed backarc basin similar to the depositional and tectonic environments of ancient massive sulfide deposits now being mined within continental margin, arc, and backarc settings. Drilling proposed site J2a to basement will further our understanding of potentially metalliferous backarc environments and permit detailed comparison with similar environments now exposed on land. The thick sediment sequence at site J2a also has the potential to provide detailed paleoceanographic data including possible evidence of low-oxygen water masses during initial formation of the backarc rift.

1.6 Downhole measurements. All sites will be logged with the standard Schlumberger suite of tools and with the formation microscanner (FMS). In addition, borehole televiewer (to estimate stress) and magnetometer/susceptibility data are planned for proposed sites J1e, J3b, and J1b. Heat flow measurements and temperature logging at several of the sites will address the controversial problem of heat generation within the sedimentary column of the basin. Crustal permeability will be measured with a packer at sites J1b, J3b, and J2a. During Leg 128, site J1b will be revisited for an oblique seismic experiment, borehole seismometer deployment, and a geoelectrical experiment. The oblique seismic and geoelectrical experiments will present critical data for understanding the anomalously thick oceanic crust of the Yamato Basin. Emplacement of the borehole seismometer will permit long-term monitoring of seismicity off western Japan.

2. GEOLOGIC FRAMEWORK

2.1 Tectonics and structure. The Japan Sea is one of several marginal seas and backarc basins which lie between two of the most dynamic regions of the Earth's lithosphere: the subduction zones of the western Pacific and the Himalayan convergence. At least four major plates and several microplates converge in this area (Fig. 3). The Japan Sea lies principally on the Eurasian plate (or Amurian microplate) and is separated from the North American plate (or Okhotsk microplate) on the east-northeast by a young plate boundary characterized by active thrust faulting and large (M>7), compressional earthquakes (Fukao and Furumoto, 1975; Kimura and Tamaki, 1986).

Patterns of faulting and the shallow structure of the Japan Sea have been known for some time from seismic reflection data (Tamaki, 1988). At least three structural provinces exist: (1) basinal areas, such as the Japan and Yamato basins, containing mostly flat-lying sediments over a moderately irregular acoustic basement surface; (2) block-faulted ridges having rough surface and acoustic basement topography underpinned by continental and rifted continental rocks typified by the Yamato Rise, Korea Plateau, Ullung Rise, and Oki Bank; and (3) a northeastern margin displaying complex folding and uplifted tectonic ridges bounded by young thrust faults. Based on DSDP drilling, upper Miocene hemipelagic sediments drape the block-faulted acoustic basement of the Yamato Rise, indicating that the initial extension is probably no younger than about 10 Ma. In contrast, the thrust faults and folds occurring along the eastern margin of the Japan Sea are very young. Seismic stratigraphic data indicate that much of the folding probably occurred in the late Pliocene-Pleistocene, and modern seismicity demonstrates that thrust and strike-slip faults are still active (Seno and Eguchi, 1983; Kimura and Tamaki, 1986; Yamazaki et al., 1985).

The deeper crustal structure of the Japan Sea is constrained by seismic refraction data obtained using two ships, sonobuoys, and ocean bottom seismometers (OBS) (Fig. 4; Ludwig et al., 1975). Velocities and thicknesses fairly typical of oceanic crust prevail beneath the Japan Sea Basin. In contrast, Layer 2 in the Yamato Basin is thickened by a 3.5 km/s unit that could represent consolidated sediment or volcanics, possibly Miocene "Green Tuff" equivalents. In addition, Layer 3 beneath the Yamato Basin is thicker than would be expected for a typical oceanic column. This somewhat anomalous crustal structure may continue beneath the Yamato Rise. The shallower portion of the rise appears to be a complex of rifted Mesozoic continental fragments and Upper Cretaceous to Lower Tertiary volcanic rocks (Tamaki, 1988).

Quaternary volcanism is largely confined to the Japanese Islands and eastern Japan Sea margin and is a consequence of continued westward underthrusting by the Pacific and Philippine plates (Tamaki, 1988). Seaward of this broad arc lie several chains of andesitic seamounts, mostly of Miocene age (Fig. 1). Heat flow in the Japan Sea ranges from 1.25 to 3.25 HFU (53-138 mW/m^2) with the bulk of values lying between 1.75 and 2.55 HFU (74-115 mW/m^2) (Yoshii and Yamano, 1983; Tamaki, 1986, 1988). By comparison with data from other marginal seas, the range in heat flow values for the Japan Sea suggests an age of initial rifting of about 10-30 Ma (Tamaki, 1988).

The various tectonic scenarios proposed for the development of the Japan Sea generally consider the sea to have formed by multiaxial backarc spreading and rifting of a former continental arc (Tamaki, 1985), ultimately reflecting the complex interactions of the lithospheric plates during the past 30 m.y., perhaps longer. In detail, the specific models for how this was effected differ considerably. The proposed mechanisms include: (1) a double scissor-shaped opening during the late Oligocene-early Miocene based on land paleomagnetic data, accommodating clockwise rotation of southwestern Japan and counterclockwise rotation of northeastern Japan (Otofuji and Matsuda, 1983; Otofuji et al., 1985; Celaya and McCabe, 1987; Tosha and Hamano, 1988); (2) regional trench roll back resulting in the concurrent opening of the Kuril Basin, Japan Sea, and Shikoku-Parece Vela Basin (Seno and Maruyama, 1984); (3) a pull-apart origin caused by right lateral shear over a broad zone (Lallemand and Jolivet, 1985; Jolivet, 1986; Jolivet et al., 1987); and (4) extension caused by the eastward retreat of the Amurian plate during Cenozoic time, ultimately related to the collision between India and Eurasia (Savostin et al., 1983; Zonenshain and Savostin, 1981; Kimura and Tamaki, 1986; Tamaki, 1988). In addition, the zone of convergence marked by thrust faults along the northeastern margin of the Japan Sea has suggested to some that a new subduction zone is currently forming there (Kobayashi, 1985; Nakamura, 1983; Seno and Eguchi, 1983; Tamaki and Honza, 1985). This zone may mark the boundary between the Eurasian and North American plates.

2.2 Sedimentary and paleoceanographic summary. Neogene and Quaternary sediments present in basinal areas of the Japan Sea locally reach thicknesses of 1500-2000 m (Ludwig et al., 1975; Gnibidenko, 1979; Tamaki, 1988) with Pleistocene and Holocene patterns reflecting topographic control of sediment dispersal systems. Seismic data together with limited stratigraphic data from DSDP Leg 31 sites (Karig, Ingle, et al., 1975) illustrate that a similar stratigraphic sequence characterizes most basinal areas despite significant differences in sediment thickness (Ishiwada et al., 1984; Kobayashi, 1985) with a typical basinal sequence consisting of (1) an upper well-stratified and highly reflective unit composed of Pliocene-to-Holocene siliciclastic sands, silts, and/or clays which overlies (2) a seismically transparent unit of lower Pliocene to Miocene hemipelagic diatomaceous silts and clays (Fig. 5). In contrast, the well-stratified Pliocene-to-Holocene unit is thin or absent over many topographic highs with a typical ridge sequence consisting of a thin transparent layer of Pliocene-Quaternary diatomaceous clay overlying a more stratified and reflective unit of Miocene clays, diatomaceous clays, and volcaniclastic sediments (Fig. 5). With some exceptions, this persistent vertical sequence represents a major change from wide-spread deposition of Miocene-lowermost Pliocene hemipelagic sediments to a basin-filling facies involving rapidly deposited Pliocene-to-Holocene siliciclastic turbidites (Ingle, 1975a).

The oldest sediment recovered from DSDP Leg 31 sites consists of upper Miocene diatomaceous clays. However, Leg 31 drilling did not penetrate the entire sedimentary sequence in the Japan Sea. Unsampled lower portions of the stratigraphic column (Fig. 5) likely include middle Miocene and older diatomaceous, siliciclastic, carbonate, and volcaniclastic sediments that represent early phases in the evolution of the sea. Some support for this interpretation is provided by Barash (1986), who reports recovery of middle and upper Miocene diatomaceous and phosphatic mudrocks from the flank of the Yamato Rise. Additional insights regarding the possible nature of older sedimentary units come from studies of onshore Neogene sequences present around the rim of the Japan Sea.

Filled and uplifted Neogene sub-basins are arrayed along the eastern and southern margins of the Japan Sea from Sakhalin to the Korean Peninsula (Ingle, 1975a). They reflect late Pliocene and Pleistocene deformation in the Japan Sea region. All of the onshore Neogene deposits display a similar sequence of lithofacies, and so provide a broad outline of the Oligocene to Pleistocene depositional, paleoceanographic, and paleogeographic evolution of this region. The Oga Peninsula surface section in northwestern Honshu represents one of the best studied of the various onshore Neogene sequences (Takayasu and Matoba, 1976) and when combined with subsurface data from the adjacent Akita Basin (Tsuchi et al., 1981) forms a reference section of special significance for ODP Leg 127 and Leg 128 drilling (Fig. 6).

Biostratigraphic, paleomagnetic, and radiometric age data from the Oga section and other sequences along the western margin of Japan provide a well-constrained chronology for the Japan Sea region as a whole (Asano et al., 1975; Tsuchi, 1981). In particular, diatom zonations offer an unusually reliable means of dating and correlation within the widespread diatomaceous sediments and genetically related porcellanites which characterize Miocene deposition in the Japan Sea as well as other margin basins around the rim of the North Pacific (Burckle and Opdyke, 1977; Koizumi, 1978, 1985; Barron, 1981).

The repetitive lithofacies patterns present within the onshore sequences together with biofacies evidence of variations in paleobathymetry and paleoceanography (Asano et al., 1969; Ingle, 1975a, 1981; Koizumi, 1983, 1988; Matoba, 1984), recent advances in dating of these sequences (Tsuchi, 1981), and offshore evidence from the Japan Sea proper (e.g., DSDP Leg 31 sites and isolated dredges and cores) collectively point to six stages or phases in the Neogene sedimentary history of this region as outlined below:

1. Late Oligocene-early Miocene. Initial extension and rifting in the Japan Sea region marked by widespread volcanism and deposition of volcaniclastic, nonmarine, and lacustrine sediments representing the so-called early "Green Tuff" unit (Takayasu and Matoba, 1976; Koizumi, 1988).

2. Early middle Miocene. Tectonic production of a widespread unconformity possibly associated with clockwise rotation of southwestern Japan as backarc extension continued (Hayashida and Ito, 1984). Deposition of the later "Green Tuff" unit, composed of volcaniclastic and nonmarine sediments commonly assigned to the Daijima Group (Fig. 6), followed by the initial deposition of marine deposits in subtropical littoral and neritic environments under the influence of the proto-Kuroshio Current system (IGCP-114 National Working Group of Japan, 1981).

3. Late middle and late Miocene. Accelerating rates of basin subsidence accompanied by widespread deposition of diatomaceous and organic-rich muds (Onnagawa and lower Funakawa formations; Fig. 6) at bathyal depths under oxic and suboxic water masses, reflecting increasing rates of primary productivity as the Neogene climate cooled and episodic reductions in the flux of terrigenous sediments occurred; deposition of phosphatic sediments.

4. Latest Miocene and earliest Pliocene. Accelerating flux of redeposited siliciclastic sediments resulting in dilution of diatomaceous hemipelagic sediments (middle Funakawa Formation; Fig. 6) enhanced by abruptly lowered sea levels in latest Miocene time with the possibility of the creation of a lago mare owing to silling (Burckle and Akiba, 1978).

5. Early Pliocene to Early Pleistocene. Major deposition and progradation of submarine fan systems into sub-basins and initiation of rapid basin-filling by coarse terrigenous clastics (Kitaura and Wakimoto formations; Fig. 6) modulated by eustatic low and high stands of sea level; episodic exclusion of Pacific Deep Water and basin silling (Matoba, 1984).

6. Mid-Pleistocene to Holocene. Mid-Pleistocene tectonic reorganization of the Japan Sea marked by a widespread unconformity in both onshore and offshore sequences with continued rapid deposition of coarse- and fine-grained turbidites in basinal areas and hemipelagic deposition of diatomaceous muds on newly created highs; deformation and uplift of numerous filled sub-basins along the eastern and southern margins of the sea.

In addition to the events noted above, late Pliocene and Pleistocene eustatic lowstands and synchronous paleoclimatic and paleoceanographic changes apparently created unusual oceanographic conditions in the Japan Sea during periods when the sea was essentially isolated from the open Pacific. The limited evidence available suggests that these latter events created anoxic deep water and geochemically distinct sediments (Miyake et al., 1968; Ujiie and Ichikawa, 1973; Ingle, 1975b; Matoba, 1984), which stand in contrast to the unusually well-mixed and oxic deep, intermediate, and shallow water masses in the Holocene Japan Sea (Hidaka, 1966). Clearly, the tectonic evolution of the Japan Sea backarc basin played a major role in governing the paleoceanographic evolution of the sea through control of paleobathymetry and gateways to the open Pacific (Matoba, 1984; Chiji et al., 1988) with each depositional phase reflecting a complex interplay among tectonic, eustatic, paleoclimatic, and paleoceanographic events.

Finally, sediments and organic matter in the Japan Sea have been affected extensively by diagenesis. DSDP drilling demonstrated that biogenic methane, generated by the decomposition of organic matter, and associated ethane, are widespread in the Japan Sea (Karig, Ingle, et al., 1975; Erdman et al., 1975; Rice and Claypool, 1981; Claypool and Kvenvolden, 1983). The recovery of porcellanite at DSDP Site 302 (Garrison et al., 1975) and the common occurrence of cherts and porcellanites in siliceous strata in Neogene basins of Honshu and Hokkaido (Iijima and Tada, 1981; Tada and Iijima, 1983) suggest that the alteration of diatomaceous sediments through burial diagenesis may be widespread in the Japan Sea. Zeolitization of volcaniclastic units is also likely to be quite common, as this type of alteration affects many of the Tertiary volcanic units on the Japanese islands (Tada et al., in press; Iijima, in press). The diagenetic alterations add a special complexity to interpretation of the Neogene record (e.g., Kano, 1979; Lee and Devries Klein, 1986).

3. DRILLING SITE-SPECIFIC OBJECTIVES

3.1 Sites J1b-1/J1b-2/J1b-3/J1a/J1c (Yamato Basin). Site J1b-1, located in the northern Yamato Basin, is a reentry hole designed to penetrate 620 m of sediment and continue at least 100 m into acoustic basement (Figs. 1 and 2). Reentry is planned to ensure maximum basement penetration and to provide an open hole for later downhole experiments during

Leg 128. The principal objective of this site is to determine the nature and age of the basement rocks. Recent OBS refraction data indicate an anomalously thick oceanic crust throughout much of the Yamato Basin, and a detailed magnetic survey suggests a complex pseudofault pattern indicative of frequent ridge propagation during spreading of the basin. Basement sampling at proposed site J1b-1 will permit a determination of the age and nature of the anomalous crust and improve our understanding of the style and mechanisms of backarc extension in this area. These data will also provide constraints on the timing of regional plate interactions in East Asia.

In addition to the basement sampling at this site, continuous coring of the sedimentary section will complement the findings at DSDP Site 299 where the lower part of the sedimentary section was not penetrated. These data will provide facies and paleoceanographic information at a basinal site in the Japan Sea and, through regional seismic correlations, will be useful in understanding the style and evolution of sedimentation in this backarc setting.

Alternate sites J1b-2 and J1b-3 are located just north of J1b-1. Site J1a is located in the Yamato Basin just northwest of DSDP Site 299 (Fig. 1). This site serves as an alternate should successive attempts at the other two J1b sites fail. The sediment thickness at J1a, about 580 m, is comparable to that at J1b-1, about 620 m.

Site J1c is a twin of DSDP Site 302, and is an alternate to the J1b and J1a sites. It lies southeast of and slightly updip of Site 302, which was stopped just before reaching acoustic basement by a medical emergency. Also, Site 302 was not cored continuously. Thus J1c will provide a more complete sedimentary history than previously acquired and will penetrate and sample more of the acoustic basement. Further, because no ethane was encountered during Site 302 drilling, no safety concerns are anticipated at site J1c.

3.1.a. Borehole seismometer. Emplacement of a newly developed wide frequency range/wide dynamic range three-component downhole seismometer will take place at site J1b-1. The instrument is to be installed in a fully cased hole. A real-time, controlled-source seismic experiment will be performed first to obtain the local crustal structure. For this purpose, air guns and ocean bottom seismometers will be deployed by a supporting vessel. The long-term measurements at the site will be made with off-line digital recording at the ocean floor. Accumulation of data from natural earthquakes will be used to establish the crust/mantle 3D seismic structure beneath the backarc basin. Furthermore, the combination of seismic data obtained from the basin with data from land stations will be valuable for our understanding of the dynamics of the trench-arc system. At present, very little seismic data have been obtained at ocean-based stations.

3.1.b. Electrical experiments. Electrical resistivity is a sensitive indicator of temperature changes, and the presence of fluids or partial melts. Measurements of natural electromagnetic disturbances allow determination of resistivity down to about 300 km in depth. However, the presence of a deep water column restricts resistivity determinations at shallow depths. This lack of information also limits resolution at greater depths.

The electromagnetic structure in and around the Japanese Islands has been obtained by observing the variation of the electric and magnetic fields. Beneath the Japan Sea, comparatively resistive structure is found, as low as 0.001 S/m down to about 100 km depth. This seems inconsistent with the high heat flow and young crustal age, as well as with the thin lithosphere inferred from seismic studies (Abe and Kanamori, 1970; Evans et al., 1978). Data from a controlled source experiment designed to reveal the resistivity structure of the top 10 km will aid in explaining these observations.

At site J1b-1, an uncased, dedicated hole will be drilled to perform large scale and oblique resistivity experiments. The large-scale electrical resistivity experiment is designed to establish a high-resolution resistivity structure for the hole. Similar experiments have been performed in DSDP holes (Francis, 1982; Von Herzen et al., 1983; Becker, 1985). The oblique electrical resistivity experiment is aimed at establishing the resistivity structure for a 10-km depth section. This is a novel approach in which the vertical current source will be supplied by a supporting vessel, and the vertical electric field in the hole will be measured by downhole tools deployed from JOIDES Resolution.

3.2 Site J1e-1 (Yamato Basin). Site J1e-1 is located in the west central Yamato basin just east of the Yamato Rise (Fig. 1). The "double scissor-shaped" opening model suggests that this site is related to clockwise rotation of southwestern Japan. The objectives at this site are the same as at Site J1b-1, namely (1) determination of the age and nature of basement, (2) style of multiple rifting, and (3) characterization of the sedimentary history. Drilling is proposed to a total depth of 720 m, which includes 50 m of basement penetration. This is not a reentry site.

3.3 Sites J1d-1/J1d-2 (Japan Basin). Site J1d-1 is located at the northern end of the Japan Basin just off the flank of what appears to be a buried remnant spreading ridge (Figs. 1, 2). We expect to penetrate 630 m of sediment and 50 m of acoustic basement. As at the previous sites, the objectives are to determine the nature and age of the basement in this area for tectonic interpretations and to characterize the sedimentation history. This site represents the first deep sea drilling site in this part of the Japan Sea and as such will complement the results from the southern sites.

Site J1d-2 is an alternate site located just east of the primary site in an area of similar structure and sediment thickness.

3.4 Sites J3b-1/J3b-2/J3b-3/J3c (Okushiri Ridge). Site J3b-1 is located on the Okushiri Ridge, a complex, thrust-faulted structure along the northeastern flank of the Japan Basin. It is possible that this ridge represents an obducted block formed by compression associated with backarc spreading (Tamaki, 1988). Based on nearby dredge hauls and seismic correlations, faulting and uplift occurred after the Pliocene. The principal goals of the drilling at this site are (1) to constrain the timing of uplift and compressional tectonics in this area, (2) to provide data on the nature and age of the uplifted basement, and (3) to characterize the sedimentary history for paleoceanographic reconstructions. This site differs considerably from the previous three prime sites in that it is the only site to address the origin of compressional tectonic features which are prevalent along the eastern margin of the Japan Sea (Tamaki, 1988).

Sites J3b-2 and J3b-3 are alternate sites located slightly north and west of the primary site. Site J3c is the third alternate site. It lies on the western flank of the northern extension of Okushiri Ridge well north of and on a different ridge segment from the J3b sites. Only a thin sedimentary cover is present at this site and basement penetration of 100 m is planned.

3.5 Sites J2a-1/J2a-2 (Kita-Yamato Trough). Site J2a-1 is a primary site on Leg 128 and aimed at drilling a failed-rift sequence thought to represent an ideal setting for mineralization of massive sulfide deposits of the Kuroko or shale-hosted type. The thick sediment column at this site will also provide valuable biofacies and lithofacies evidence of depositional and paleoceanographic events during early rifting phases in the evolution of the Japan Sea, including possible evidence of suboxic water masses accompanying middle Miocene subsidence and silling.

3.6 Site JS2 (Oki Ridge). This site is aimed specifically at recovery of a Miocene to Holocene paleoceanographic reference section in sediments thought to have been deposited above the local calcite compensation depth (CCD). It is anticipated that this sequence will yield both quantitative microfossil data and a stable isotope record of late Neogene paleoceanographic and paleoclimatic events.

Alternate sites are J1a and J1c, which are also lower priority alternates on Leg 127 as discussed above.

4. OPERATIONS PLAN

Leg 127

Leg 127 is scheduled to depart Tokyo on 24 June 1989 and return to Niigata on 21 August 1989, after 59 operational days (Table 1a; Table 2a). The proposed sites will be drilled in the order: J1b, J1d, J3b, and J1e. Basement penetration of ≥50 m is anticipated at all sites. The largest penetration into the basement (~100 m) is planned at Site J1b. A standard reentry cone will be set at Site J1b in preparation for the seismic instruments that will be installed in the basement rock section during Leg 128. The casing at the site will be through the whole sediment column.

Proposed site J1b-1 is located in the northern Yamato Basin on Tansei-maru KT-88-9 line 108 at shotpoint 1262. Alternate sites are J1b-2, J1b-3, J1a and J1c. The drilling plan for Leg 127 consists of three holes: Hole A will be cored with a combination of advanced piston coring (APC) and extended core barrel coring (XCB) to approximately 300 meters below seafloor (mbsf). A comprehensive heat flow measurement and *in situ* water sampling program will be performed during the APC-cored interval. For this purpose, the ODP water sampler, temperature and pressure tool (WSTP) will be deployed after each piston core. Hole B, an exploratory hole, will be drilled with the rotary core barrel (RCB) to 300 mbsf, and cored to approximately 20 m into basement. The sediment section will then be logged. For the basement objectives, a third hole (Hole C) will be RCB drilled to basement. A minimum of 100 m of basement will be cored after casing the sediment section. This hole will be used for logging basement.

A comprehensive logging program is planned for this site. The standard Schlumberger logging (two strings), formation microscanner (FMS), borehole televiewer (BHTV), magnetometer/susceptibility, packer/hydrofracture, and vertical seismic profile (VSP) measurements will be performed.

Proposed site J1d-1 is located at the northern end of the Japan basin on Tansei-maru KT-87-6 line MC1 at shotpoint 543. We anticipate penetrating 630 mbsf using APC/XCB coring. Temperature and fluid samples will be taken with the WSTP after each APC core. Drilling to basement will then be accomplished using the RCB on a second hole for a total penetration of 680 mbsf (including 50 m of basement). This will be followed by standard Schlumberger logging (two strings), FMS, BHTV and magnetometer/susceptibility runs. The alternate site is J1d-2.

Proposed site J3b-1 is located on the Okushiri Ridge on Hakuho-maru KH-86-2 line 5, at shotpoint 821. The drilling strategy will be a combination of APC and XCB coring to XCB refusal (estimated at 560 mbsf), followed by a second hole which will be RCB cored to a total penetration of 610 mbsf (includes 50 m of basement). At the conclusion of drilling, standard Schlumberger logs, BHTV, FMS and packer/hydrofracture experiments will be run. J3b-2, J3b-3 and J3c are alternate sites.

Proposed site J1e-1 is located in the west central Yamato Basin on the Geological Survey of Japan line J1e, at time 08:53. We anticipate penetration to XCB refusal (at approximately 600 mbsf) using APC/XCB coring. The WSTP tool will be deployed after every APC core. This will be followed by RCB coring for a total penetration of 720 mbsf (including 50 m of basement). The logging plan includes the standard Schlumberger suite, FMS, BHTV and magnetometer/susceptibility runs.

Proposed site J3b-3 may be APC-cored if time is available, to detect the age of initiation of uplift of the Okushiri Ridge from facies changes in the upper sedimentary section.

Leg 128

Leg 128 is scheduled to leave Niigata on 26 August 1989 and return to an as yet undetermined port on 7 October 1989, after 42 operational days (Table 1b; Table 2b). The proposed sites will be drilled in the order: JS2, J2a, followed by downhole experiments at J1b.

Proposed site JS2 is located on the Oki Ridge on the Geological Survey of Japan line JS2, shot 20480. The first 80 mbsf at this site will be triple APC cored to allow whole-round samples to be dedicated to the analysis of bacterial biomass and activity. The first hole will be 80 mbsf, the second hole will penetrate to 120 mbsf, and the third hole will be continued using the APC/XCB combination to refusal. Temperature and fluid samples will be taken with the WSTP after every other APC core in one of the holes. At the conclusion of drilling, standard Schlumberger logs and the FMS will be run.

Proposed site J2a-1 is located in the Kita-Yamato Trough, on JNOC line 13-4 at shotpoint 7120. We anticipate penetrating 600 mbsf (or until XCB refusal) using APC/XCB coring. Temperature and fluid samples will be taken with the WSTP after each other APC core. Drilling to basement will then be accomplished using the RCB on a second hole for a total penetration of 1610 mbsf (including 50 m of basement). A standard reentry cone will be set. This will be followed by standard Schlumberger logging (two strings), FMS, and VSP runs. The alternate site is J2a-2.

After completing these two sites, we will return to site J1b-1, which will have been drilled during Leg 127, to conduct a series of downhole experiments. Seismic instruments will be installed in the basement rock section of the reentry hole that will have been cased through the sediment column. A new RCB hole will then be drilled to perform electrical conductivity measurements that require an uncased hole.

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Table 1a. Summary Site Information, Leg 127

Site	Lat./Long.	Water Depth (m)	Penetr. (m) Sed.	Bsmt.	Drill	Log (days)	Total	Cum.
Leg 127 departs Tokyo on 24 June 1989								
J1b-1	40°11'N 138°15'E	2825	620	100	13.5	5.4	18.9	18.9
J1d-1	44°00'N 138°52.7'E	3374	630	50	9.0	2.1	11.1	30.0
J3b-1	42°50'N 139°25'E	2223	560	50	6.8	3.2	10.0	40.0
J1e-1	38°36.7'N 134°32.6'E	2945	670	50	9.3	2.3	11.6	51.6
Transit time							6.4	58.0
Alternate Sites:								
J1b-2	40°13'N 138°14'E	2800	610	100	12.6	5.9	18.5	
J1b-3	40°17.6'N 138°16.0'E	2892	490	100	11.7	5.8	17.5	
J3b-2	43°00'N 139°22.2'E	2312	920	50	10.9	5.0	15.9	
J3b-3	42°50'N 139°18'E	2700	250	0	2.5	0	2.5	
J3c	44°00'N 139°15'E	1168	246	100	4.9	5.0	9.9	
J1d-2	44°00'N 138°57.5'E	3406	760	50	10.4	2.0	12.4	
J1a	39°50'N 137°25'E	2530	580	100	9.0	5.6	14.6	
J1c	40°19'N 136°54'E	2400	720	50	9.3	1.7	11.0	

Table 1b. Summary Site Information, Leg 128

Site	Lat./Long.	Water Depth (m)	Penetr. (m) Sed.	Bsmt.	Drill	Log (days)	Total	Cum.
Leg 128 departs Niigata on 26 August 1989								
JS2	37°02.2'N 134°48.6'E	880	710	20	5.2[a]	1.4	6.6	6.6
J2a-1	39°13'N 133°52'E	2085	1379	50	17.9	3.0	20.9	27.5
J1b-1	40°11.4'N 138°14.2'E	2861	620	100	1.0	6.0[b]	7.0	34.5
Transit time							5.5	40.0
Contingency time							3.0	43.0
Alternate sites:								
J2a-2	39°07.6'N 133°58.6'E	1860	880	100	13.2	4.5	17.4	
J1a	39°50'N 137°25'E	2530	580	100	9.0	5.6	14.6	
J1c	40°19'N 136°54'E	2400	720	50	9.3	1.7	11.0	

[a]Includes triple APC coring (first 80 mbsf) for bacterial biomass/activity experiment.
[b]Borehole seismometer and oblique electric resistivity experiments.

Table 2a. Proposed Site Occupation Schedule, Leg 127

	Date	Time on Station[a] (days)	Transit Time (days)
Leg 127 departs Tokyo on June 24, 1989			
Transit Tokyo to J1b-1			2.7
AR J1b-1 LV J1b-1	27 June 5 July	18.9 (5.4)	
Transit J1b-1 to J1d-1			1.0
AR J1d-1 LV J1d-1	16 July 27 July	11.1 (2.1)	
Transit J1d-1 to J3b-1			0.3
AR J3b-1 LV J3b-1	28 July 7 August	10.0 (3.2)	
Transit J3b-1 to J1e-1			1.4
AR J1e-1 LV J1e-1	8 August 20 August	11.6 (2.3)	
Transit J1e-1 to Niigata			1.0
AR Niigata	21 August		

[a]Time for downhole measurements/experiments is given in parentheses.

Table 2b. Proposed Site Occupation Schedule, Leg 128

	Date	Time on Station[a] (days)	Transit Time (days)
Leg 128 departs Niigata on August 26, 1989			
Transit Niigata to JS-2			1
AR JS-2	27 August	6.6 (1.4)	
LV JS-2	2 September		
Transit JS-2 to J2a-1			1
AR J2a-1	3 September	20.9 (3.0)	
LV J2a-1	24 September		
Transit J2a-1 to J1b-1			1
AR J1b-1	25 September	7.0 (6.0)	
LV J1b-1	2 October		
Transit J1b-1 to port[b]			2.5
Contingency time		3.0	
AR port[b]	7 October		

[a]Time for downhole measurements/experiments is given in parentheses.
[b]Arrival port has not yet been established.

Figure Captions

Figure 1. Location map of the Japan Sea showing the proposed sites for drilling during Legs 127 and 128 and DSDP Leg 31 Sites 299-302. First priority sites are marked with open star symbols (Leg 127: J1b-1, J1d-1, J3b-1, J1e-1. Leg 128: JS2, J2a-1). Alternate sites are shown by closed star symbols. DSDP sites are shown as closed circles.

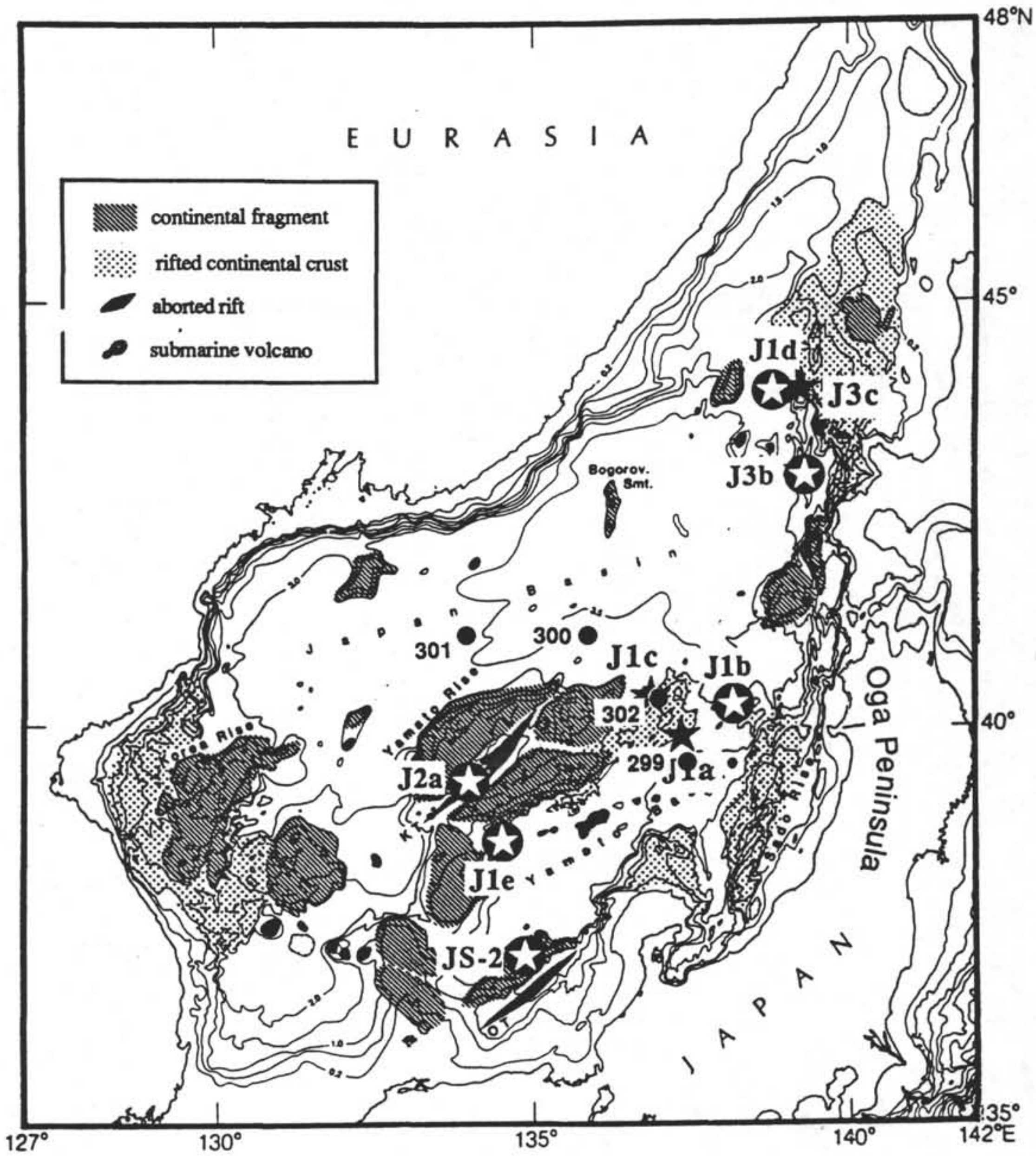
Figure 2. Schematic diagram showing the specific objectives for drilling at each site.

Figure 3. Summary of major lithospheric plates (A) and microplates (B) in the Japan Sea region. See text for references.

Figure 4. Seismic velocity structure across the Japan Sea (from Ludwig et al., 1975). The most recent seismic controlled source experiment in 1985 using MCS and 20 OBS's revealed a very detailed structure across the Yamato Basin (Hirata, 1989, pers. comm.), as shown by the shaded areas.

Figure 5. Cross-sectional sketch across the Japan Basin and Yamato Basin, showing the location of DSDP sites drilled during Leg 31 (see Fig. 1 for site locations). "Stratified" and "Transparent" intervals are seismic units.

Figure 6. Stratigraphy, age, paleobathymetry, paleoenvironments, and depositional history of Neogene deposits in the Oga Peninsula surface section, northwestern Honshu, Japan (see Figure 1 for site locations). Note that columns are plotted both in terms of maximum stratigraphic thickness and time. This sequence is typical for many of the now filled and deformed Neogene sub-basins along the eastern margin of the Sea of Japan. The Funakawa Formation of this diagram includes the upper Miocene Shinzen Diatomite of various authors (e.g., Tsuchi et al., 1981). Recent evidence suggests that the Pliocene/Pleistocene boundary is located in the lower portion of the Kitaura Formation rather than at the base of this unit (Tsuchi et al., 1981). The facies change from diatomaceous mudrocks of the middle Funakawa Formation to overlying Pliocene terrigenous sediments is likely correlative with a similar facies change apparent in seismic reflection profiles in the modern Sea of Japan and penetrated at DSDP Leg 31 sites (Fig. 5). Figure from Ingle (1981).



E U R A S I A
continental fragment
rifted continental crust
aborted rift
submarine volcano
J1d
J3c
J3b
Bogorov. Smt.
Japan Basin
301
300
J1c
J1b
302
299
J1a
J2a
Yamato Rise
Korea Rise
J1e
Yamato
JS-2
Sado Rise
Oga Peninsula
JAPAN
48°N
45°
40°
35°
127°
130°
135°
140°
142°E

Figure 1.

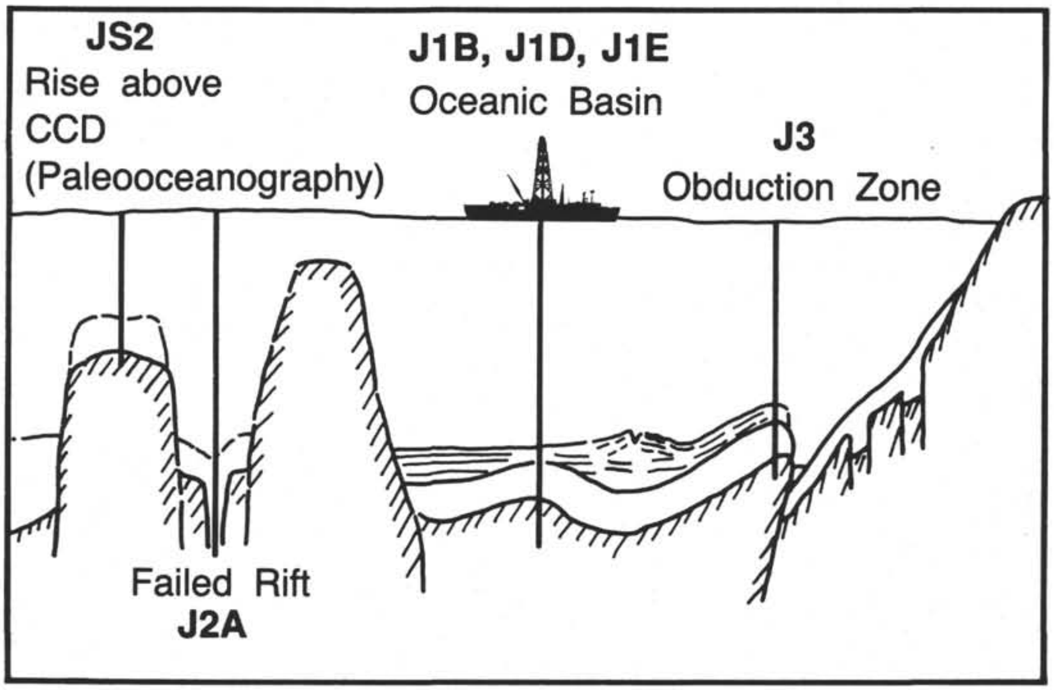

JS2
Rise above
CCD
(Paleooceanography)
J1B, J1D, J1E
Oceanic Basin
J3
Obduction Zone
Failed Rift
J2A

Figure 2.

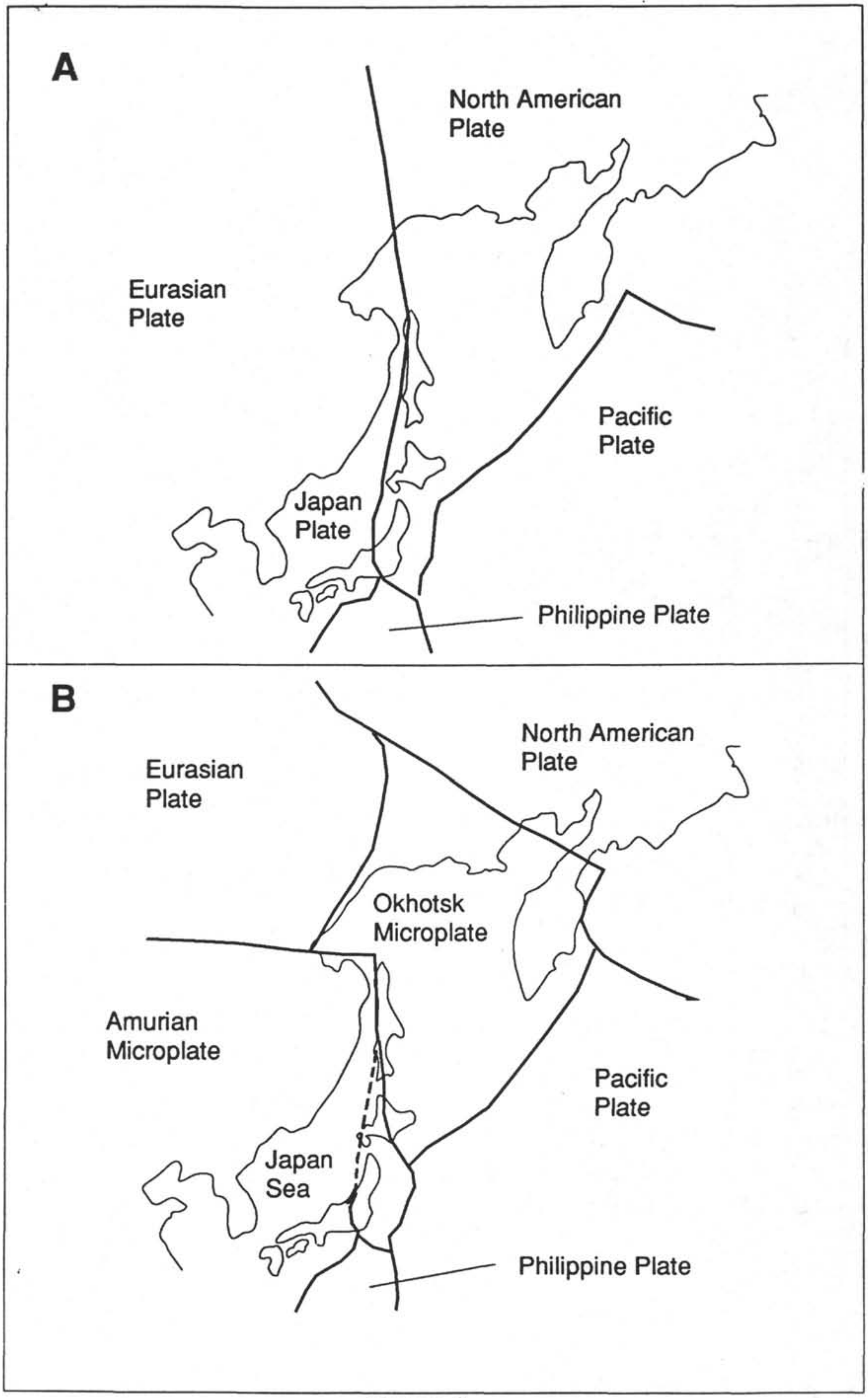

A
North American Plate
Eurasian Plate
Pacific Plate
Japan Plate
Philippine Plate
B
North American Plate
Eurasian Plate
Okhotsk Microplate
Amurian Microplate
Pacific Plate
Japan Sea
Philippine Plate

Figure 3.

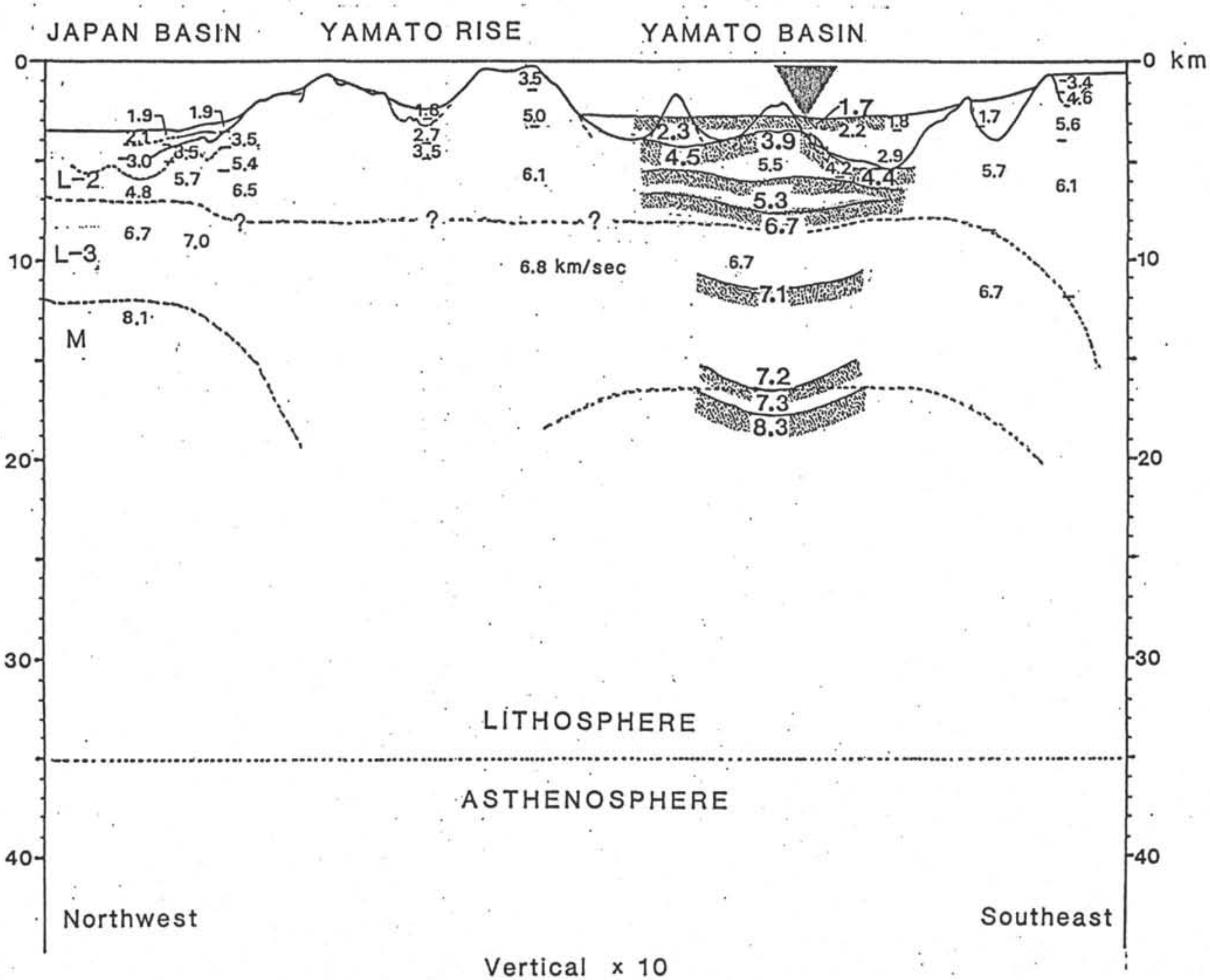

JAPAN BASIN
YAMATO RISE
YAMATO BASIN
0 km
L-2
L-3
M
6.8 km/sec
LITHOSPHERE
ASTHENOSPHERE
Northwest
Southeast
Vertical x 10

Figure 4.

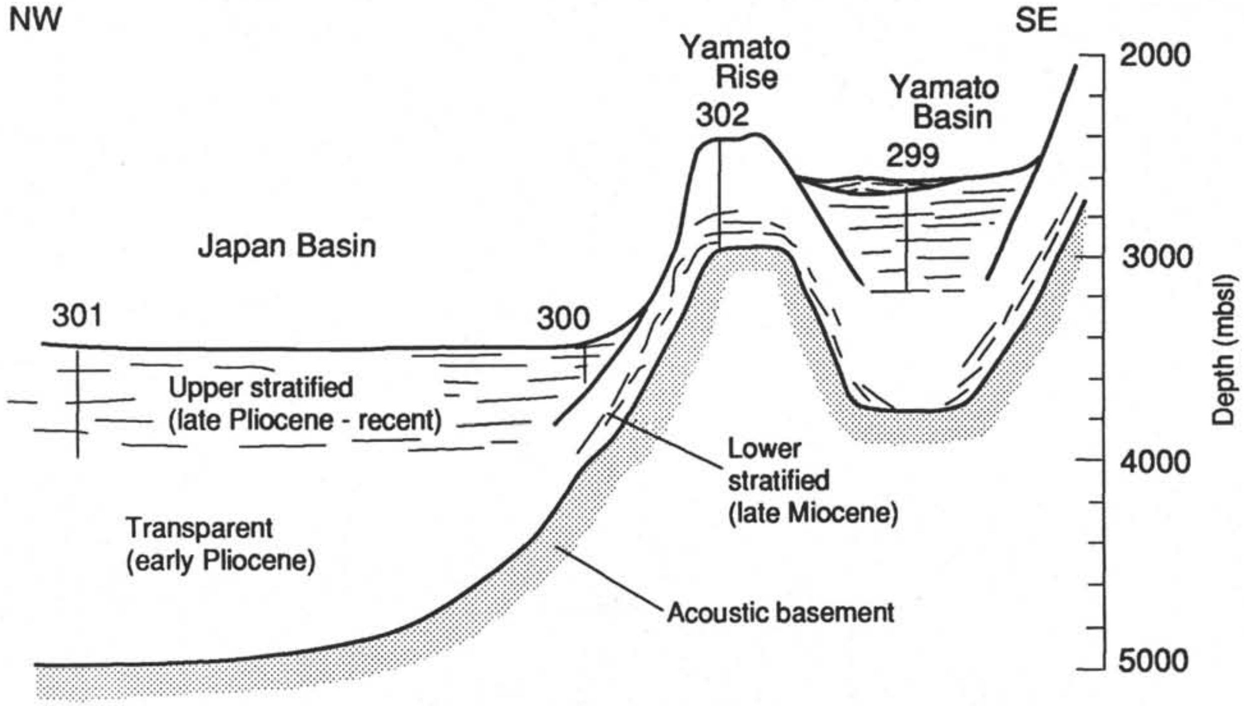

NW
SE
Yamato Rise
302
Yamato Basin
299
Japan Basin
301
300
Upper stratified (late Pliocene - recent)
Transparent (early Pliocene)
Lower stratified (late Miocene)
Acoustic basement
2000
3000
4000
5000
Depth (mbsl)

Figure 5.

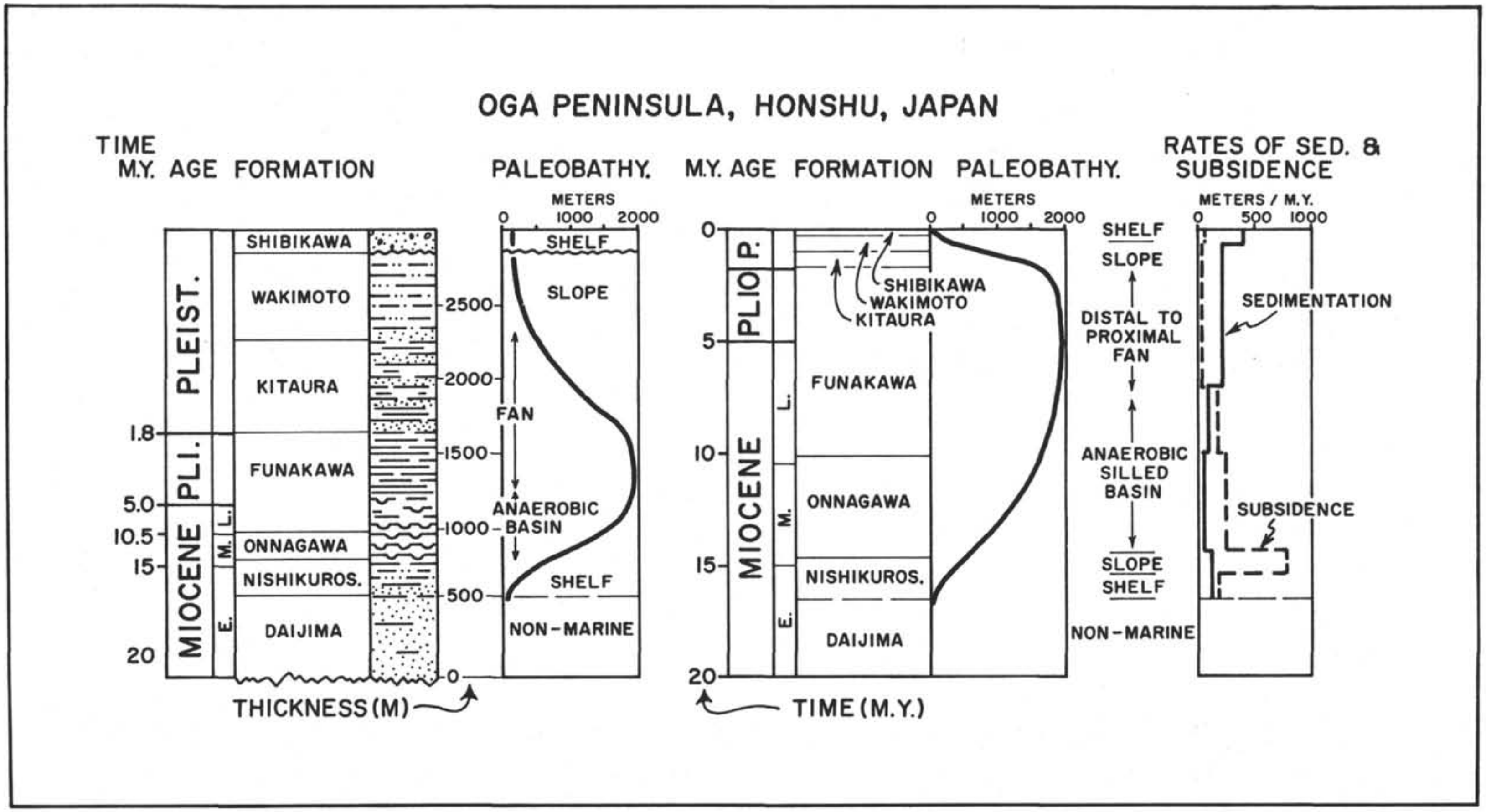

OGA PENINSULA, HONSHU, JAPAN
TIME M.Y.
AGE
FORMATION
PALEOBATHY.
METERS
0
1000
2000
SHIBIKAWA
WAKIMOTO
KITAURA
FUNAKAWA
ONNAGAWA
NISHIKUROS.
DAIJIMA
PLEIST.
PLI.
MIOCENE
L.
M.
E.
1.8
5.0
10.5
15
20
2500
2000
1500
1000
500
0
SHELF
SLOPE
FAN
ANAEROBIC BASIN
SHELF
NON-MARINE
THICKNESS (M)
M.Y.
AGE
FORMATION
PALEOBATHY.
METERS
0
1000
2000
0
5
10
15
20
PLIO P.
MIOCENE
L.
M.
E.
SHIBIKAWA
WAKIMOTO
KITAURA
FUNAKAWA
ONNAGAWA
NISHIKUROS.
DAIJIMA
TIME (M.Y.)
SHELF
SLOPE
DISTAL TO PROXIMAL FAN
ANAEROBIC SILLED BASIN
SLOPE
SHELF
NON-MARINE
RATES OF SED. & SUBSIDENCE
METERS / M.Y.
0
500
1000
SEDIMENTATION
SUBSIDENCE

Figure 6.

SITE: J1b-1 PRIORITY: 1

POSITION: 40°11'N
138°15'E

WATER DEPTH: 2825 m SEDIMENT THICKNESS: 620 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 300 m; Hole B, RCB to basement; Hole C, RCB 100 m into basement, set reentry cone and casing through sediment section; Hole D: Drill with RCB to bit destruction in basement for electrical conductivity experiment.

SEISMIC RECORD: Tansei-maru (KT-88-9) 1988: line 108, shot 1262;
nearby record Wakashio-maru (DELP85) 1985: line E, shot 3851

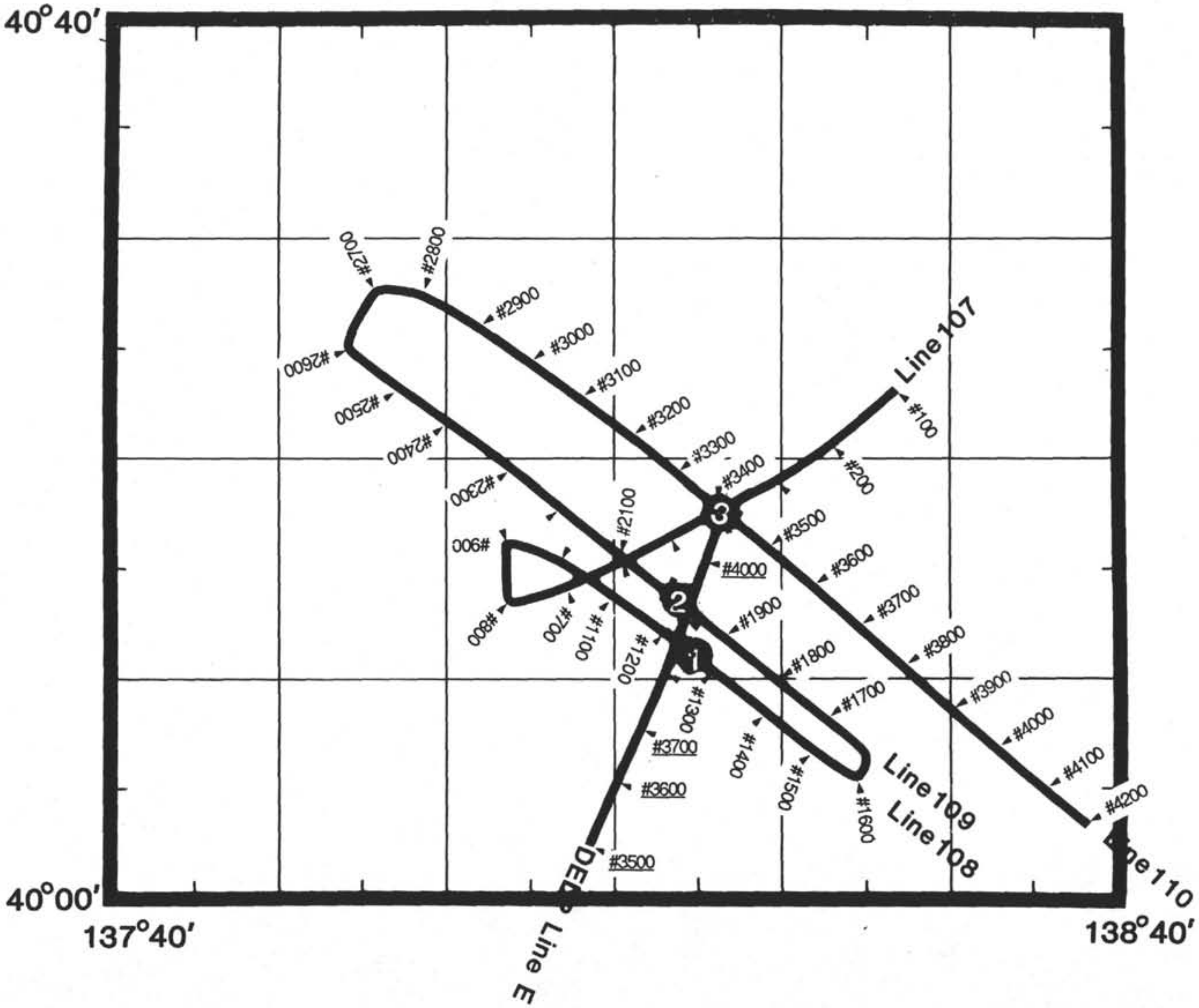
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Magnetometer/Susceptibility
Packer/Hydrofracture
VSP

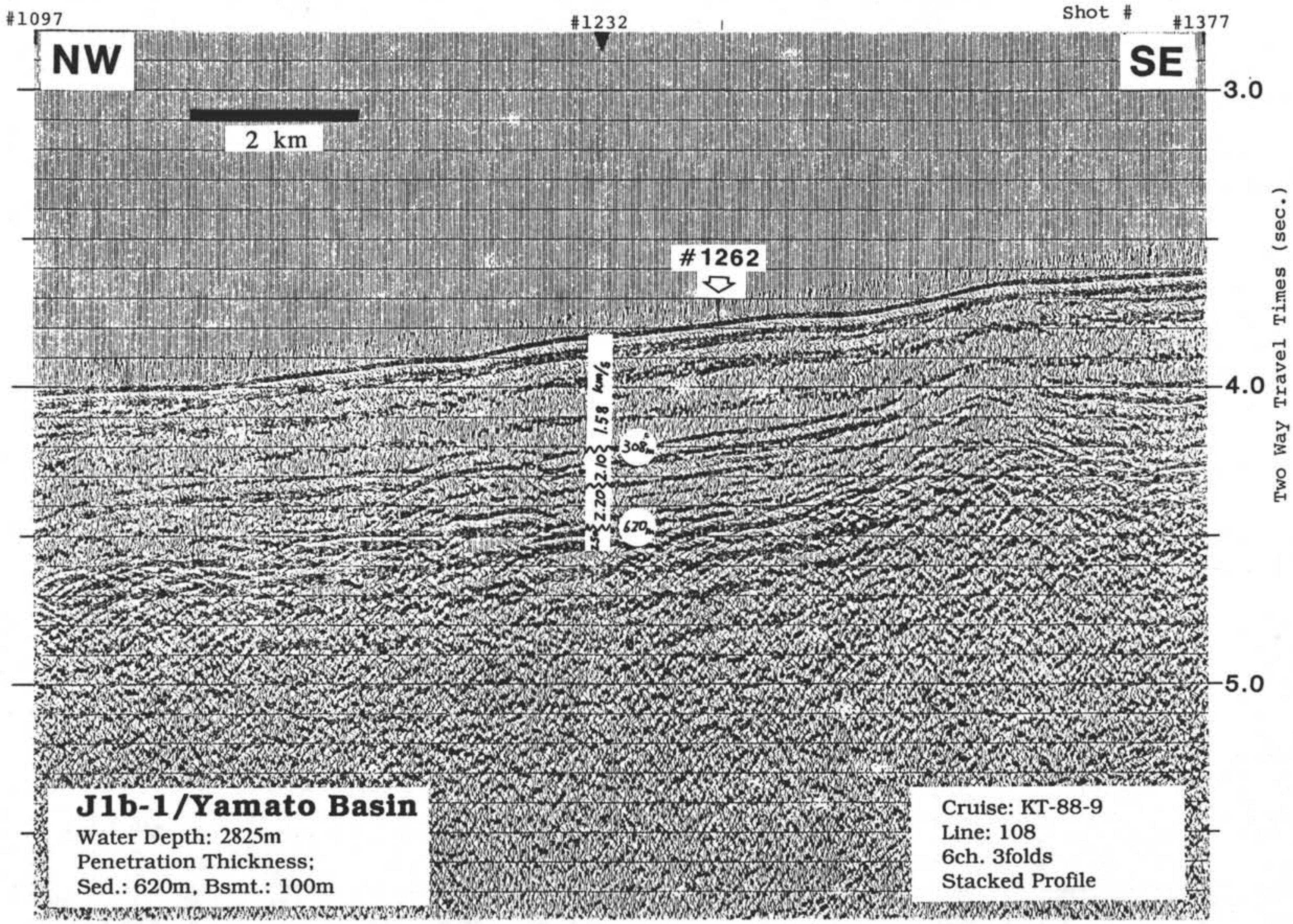
OBJECTIVES: Nature and age of the basement rocks; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1b-1, 2 & 3



40°40′
40°00′
137°40′
138°40′
Line 107
Line 109
Line 108
Line 110
DEEP Line E
#100
#200
#700
#800
#900
#1100
#1200
#1300
#1400
#1500
#1600
#1700
#1800
#1900
#2100
#2300
#2400
#2500
#2600
#2700
#2800
#2900
#3000
#3100
#3200
#3300
#3400
#3500
#3600
#3700
#3800
#3900
#4000
#4100
#4200
#4000
#3700
#3600
#3500
1
2
3


#1097
#1232
Shot #
#1377
NW
SE
2 km
#1262
3.0
4.0
5.0
Two Way Travel Times (sec.)
1.58 km/s
2.10
2.20
308m
670m
J1b-1/Yamato Basin
Water Depth: 2825m
Penetration Thickness;
Sed.: 620m, Bsmt.: 100m
Cruise: KT-88-9
Line: 108
6ch. 3folds
Stacked Profile

SITE J1b-1

Sub-bottom depth(m)	Key reflectors, unconformities, faults, etc.	Age	Assumed velocity (km/sec)	Lithology	Paleo-environment	Average rate of sediment accumulation (m/m.y.)	Comments
			1.50	(Water)			
0	Sea floor						
0–200		Pliocene to Recent	1.58	Interbedded sand, silt and clay	Distal turbidites in basinal setting	60	Upper stratified seismic interval
	???	Pliocene to late Miocene	2.10	Diatomaceous clay	Hemipelagic basinal setting	100	Basal stratified seismic interval??
400	???	Miocene ?	2.20	Clay and diatomaceous clay		100 ?	Upper transparent seismic interval?
600	AB*	Miocene ?	2.50	Basalt and volcanoclastics	Back-arc/ marginal sea		Acoustic basement

AB* = Acoustic Basement

SITE: J1d-1

PRIORITY: 1

POSITION: 44°00'N
138°52.7'E

WATER DEPTH: 3374 m

SEDIMENT THICKNESS: 630 m

PROPOSED DRILLING PROGRAM: APC/XCB to 630 m; RCB 50 m into basement

SEISMIC RECORD: Tansei-maru (KT-87-6)1987: line MC1, shot 543; Tansei-maru (Kt-88-9)1988: line 102, shot 1357.

HEAT FLOW: YES

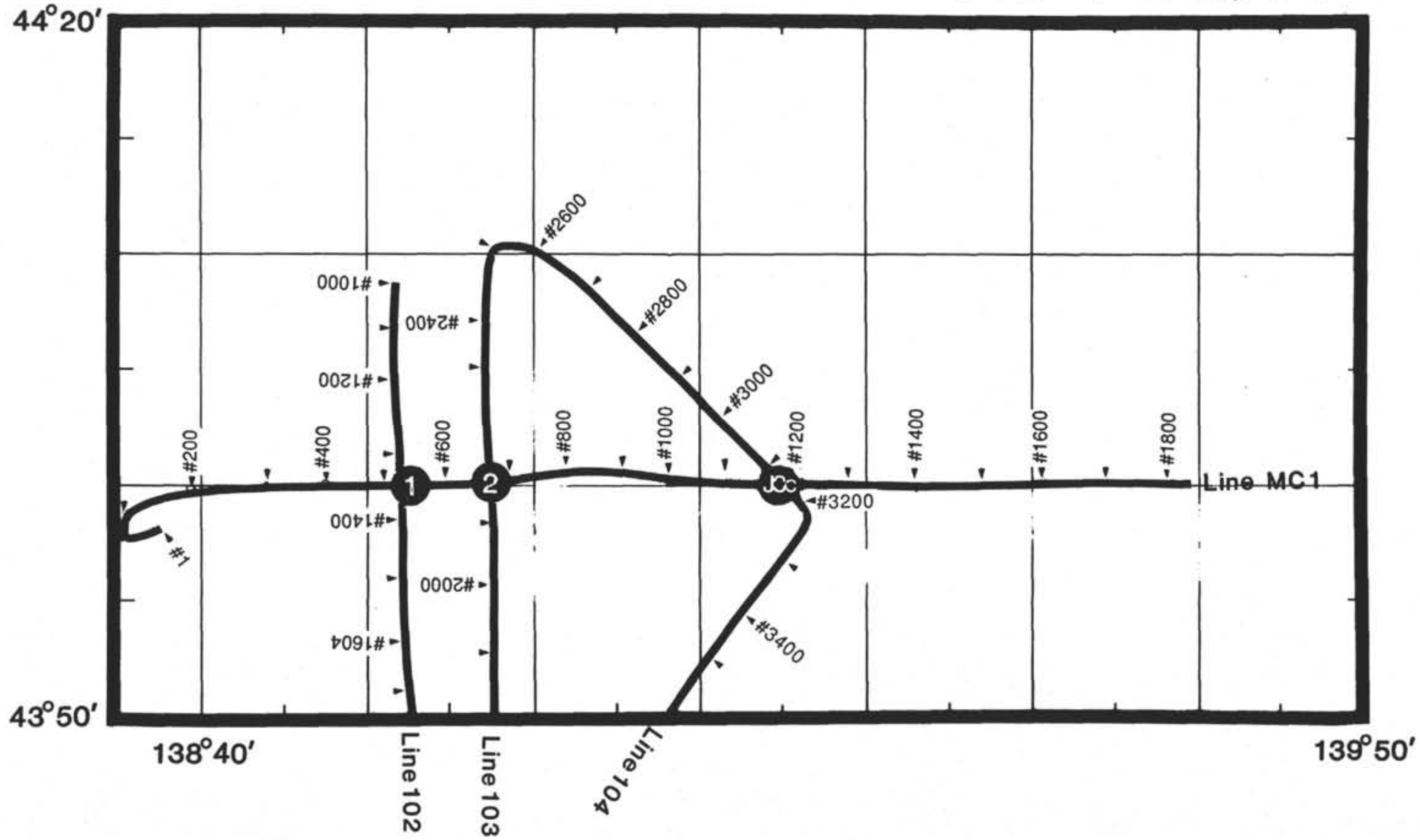
WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Magnetometer/Susceptibility
Borehole Televiewer

OBJECTIVES: Penetrate remnant spreading ridge; Nature and age of the basement rocks; Style of multiple rifting; Style and evolution of sedimentation at Japan Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1d-1 & 2, J3c


44°20′
43°50′
138°40′
139°50′
Line MC1
Line 102
Line 103
Line 104
1
2
J3c
#1
#200
#400
#600
#800
#1000
#1200
#1400
#1600
#1800
#1000
#1200
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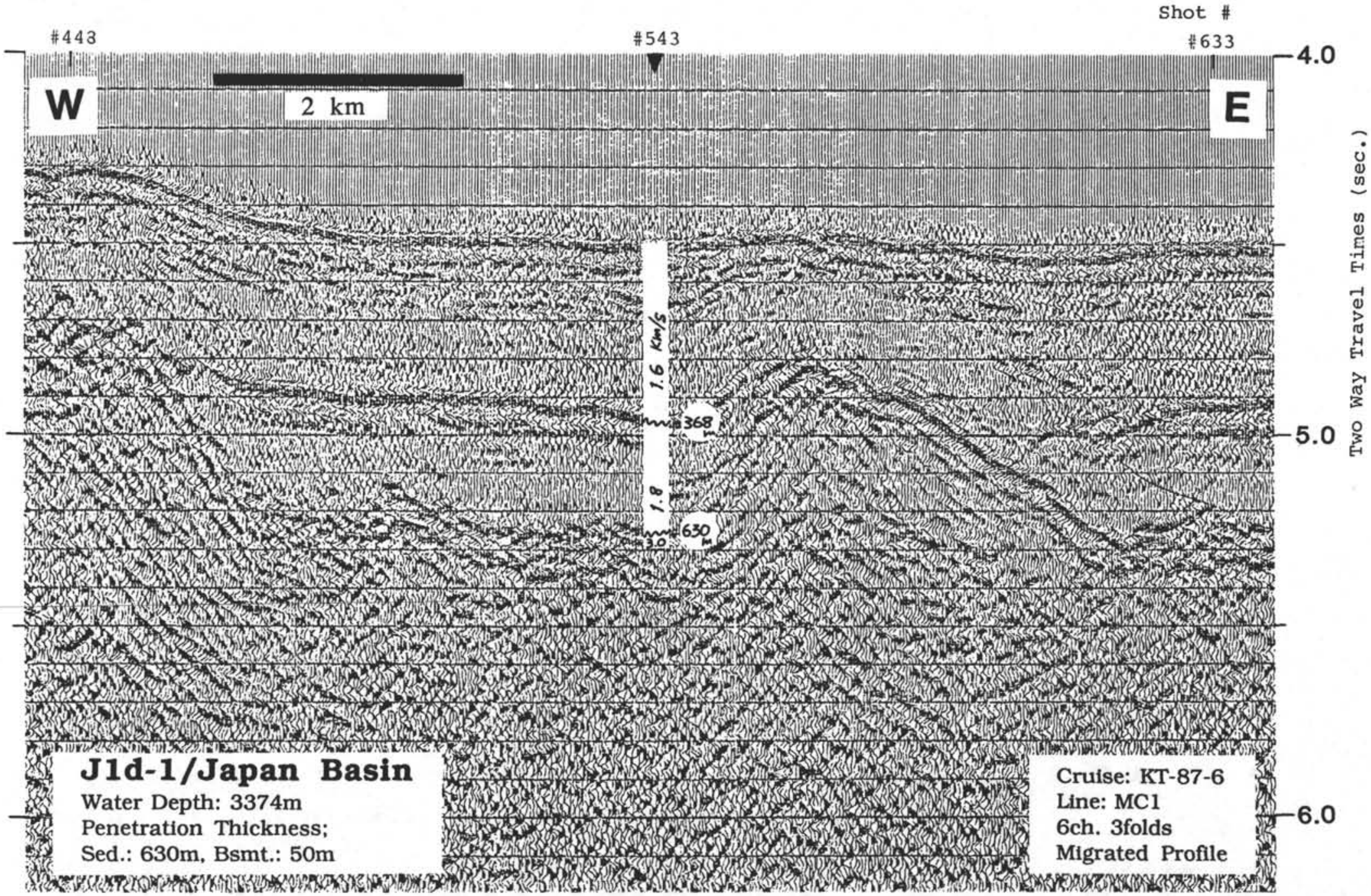
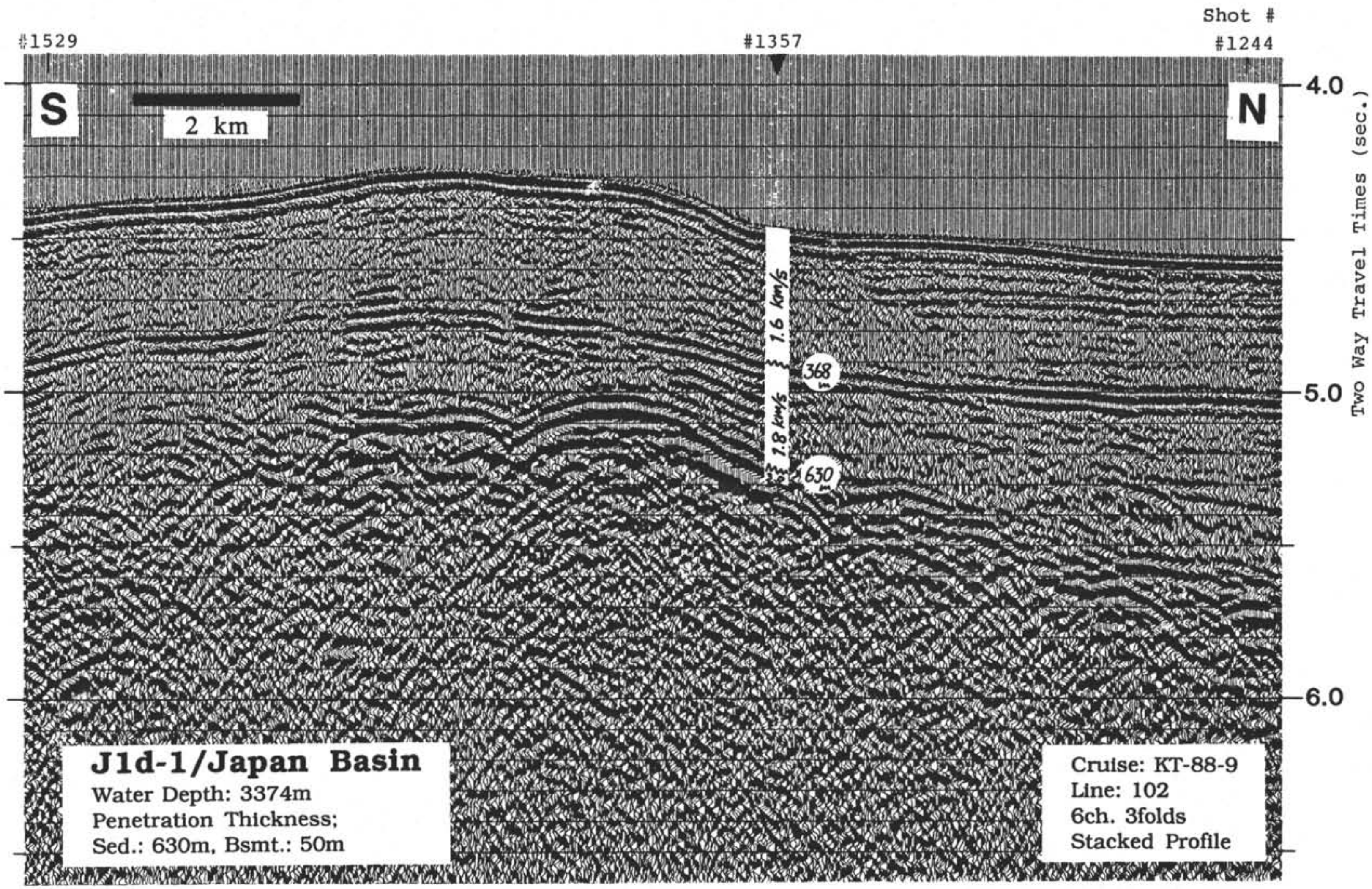
#3000
#3200
#3400


Shot #
#443
#543
#633
W
E
2 km
4.0
5.0
6.0
Two Way Travel Times (sec.)
1.6 Km/s
368
1.8
630
3.0
J1d-1/Japan Basin
Water Depth: 3374m
Penetration Thickness;
Sed.: 630m, Bsmt.: 50m
Cruise: KT-87-6
Line: MC1
6ch. 3folds
Migrated Profile


Shot #
#1529
#1357
#1244
S
N
2 km
4.0
5.0
6.0
Two Way Travel Times (sec.)
1.6 km/s
1.8 km/s
368
630
J1d-1/Japan Basin
Water Depth: 3374m
Penetration Thickness;
Sed.: 630m, Bsmt.: 50m
Cruise: KT-88-9
Line: 102
6ch. 3folds
Stacked Profile

SITE J1d-1

Sub-bottom depth(m)	Key reflectors, unconformities, faults, etc.	Age	Assumed velocity (km/sec)	Lithology	Paleo-environment	Average rate of sediment accumulation (m/m.y.)	Comments
			1.50	(Water)			
0	Sea floor						
0–200		Pliocene to Recent	1.60	Interbedded sand, silt and clay	Turbidites in proximal basin setting	90	Upper stratified seismic interval?
	???						
400		Late Miocene ???	1.80	Silt, clay and diatomaceous clay	Hemipelagic basinal setting	100 ?	Basal upper stratified to upper transparent seismic interval
600	AB*						
		Miocene ??	3.00	Basalt and volcanoclastics			Acoustic basement

SITE: J3b-1 PRIORITY: 1

POSITION: 42°50'N
139°25'E

WATER DEPTH: 2323 m SEDIMENT THICKNESS: 560 m

PROPOSED DRILLING PROGRAM: APC/XCB to 560 m; RCB 50 m into basement

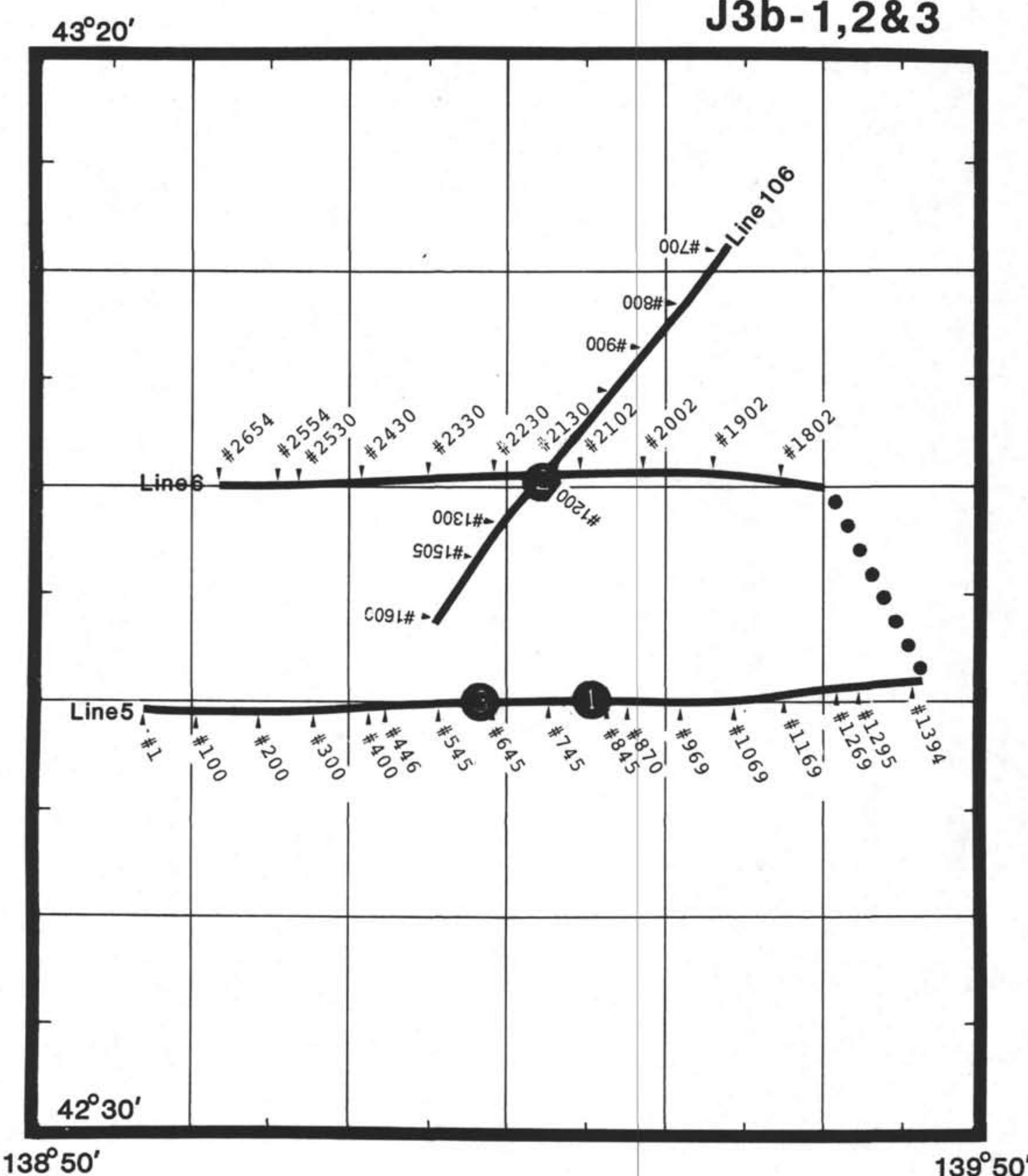
SEISMIC RECORD: Hakuho-maru (KH-86-2) 1986: line 5, shot 821

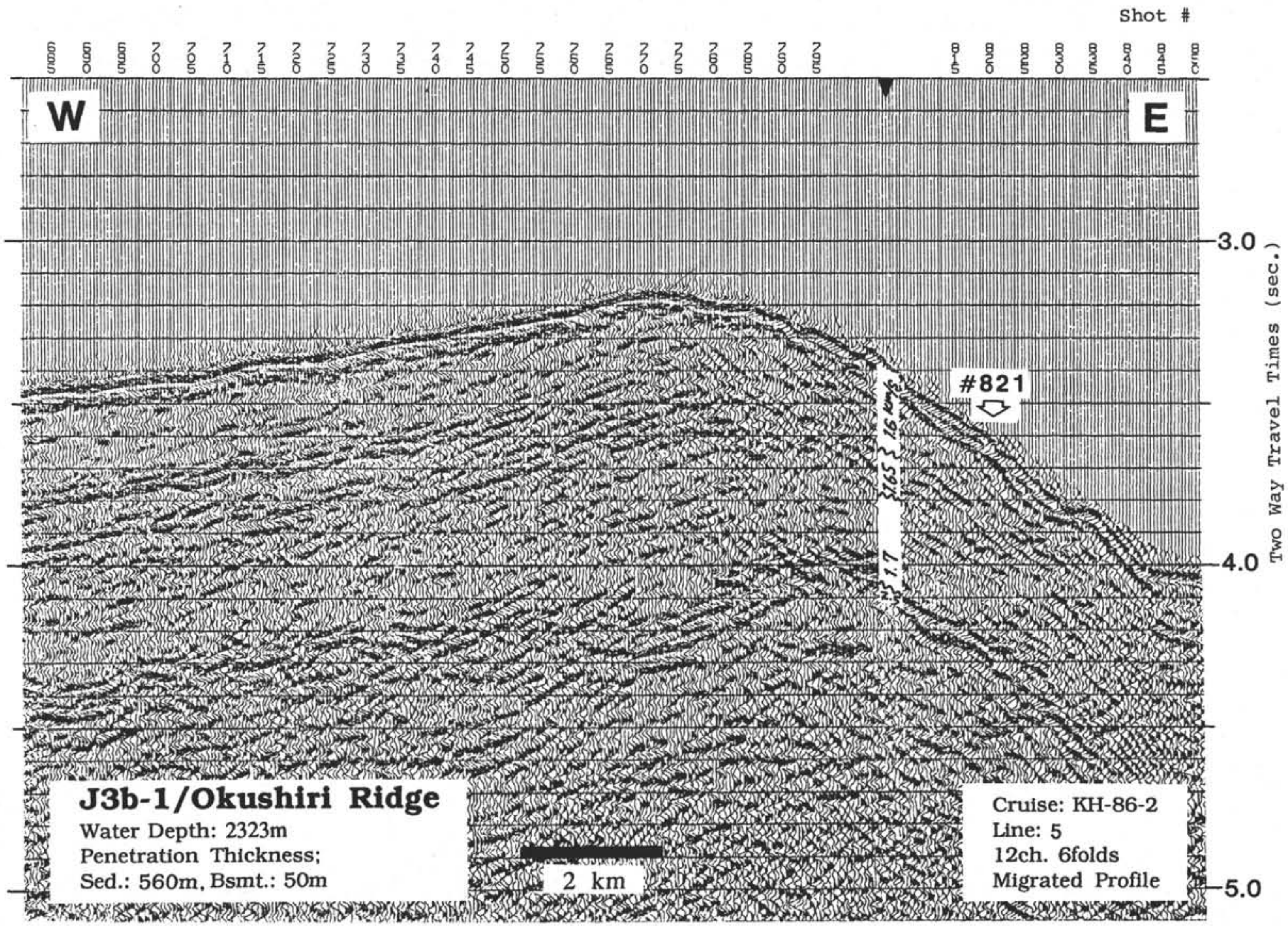
HEAT FLOW: NO WATER SAMPLER: NO

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Packer/Hydrofracture

OBJECTIVES: Penetrate Okushiri Ridge; Timing of uplift and compressional tectonics; Nature and age of the uplifted basement; Paleoceanography

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics


J3b-1,2&3
43°20'
42°30'
138°50'
139°50'
Line106
Line6
Line5
#700
#800
#900
#1200
#1300
#1505
#1600
#2654
#2554
#2530
#2430
#2330
#2230
#2130
#2102
#2002
#1902
#1802
#1
#100
#200
#300
#400
#446
#545
#645
#745
#845
#870
#969
#1069
#1169
#1269
#1295
#1394


Shot #
W
E
#821
3.0
4.0
5.0
Two Way Travel Times (sec.)
J3b-1/Okushiri Ridge
Water Depth: 2323m
Penetration Thickness;
Sed.: 560m, Bsmt.: 50m
2 km
Cruise: KH-86-2
Line: 5
12ch. 6folds
Migrated Profile

SITE J3b-1

Sub-bottom depth(m)	Key reflectors, unconformities, faults, etc.	Age	Assumed velocity (km/sec)	Lithology	Paleo-environment	Average rate of sediment accumulation (m/m.y.)	Comments
			1.50	(Water)			
0	Sea floor						
		Pliocene to Recent	1.60	Interbedded sand, silt and clay	Proximal turbidites in basin margin setting	50	Upper stratified seismic interval? Possible disruption by faulting
200	???						
		Late Miocene	1.65	Diatomaceous clay	Hemipelagic basinal setting	100	Basal upper stratified interval
	???						
400		Miocene ??	1.70	Clay and diatomaceous clay	Hemipelagic basinal setting	100 ?	Upper transparent seismic interval Possible disruption by faulting
	AB*						
600			2.50	Miocene older sediments? Cont. crust? Basalt?			Acoustic basement

SITE: J1e-1 PRIORITY: 1

POSITION: 38°36.7'N
134°32.6'E

WATER DEPTH: 2945 m SEDIMENT THICKNESS: 670 m

PROPOSED DRILLING PROGRAM: APC/XCB to 670 m; RCB 50 m into basement

SEISMIC RECORD: Geol. Survey Japan 1988: line J1e, shot 08:53;

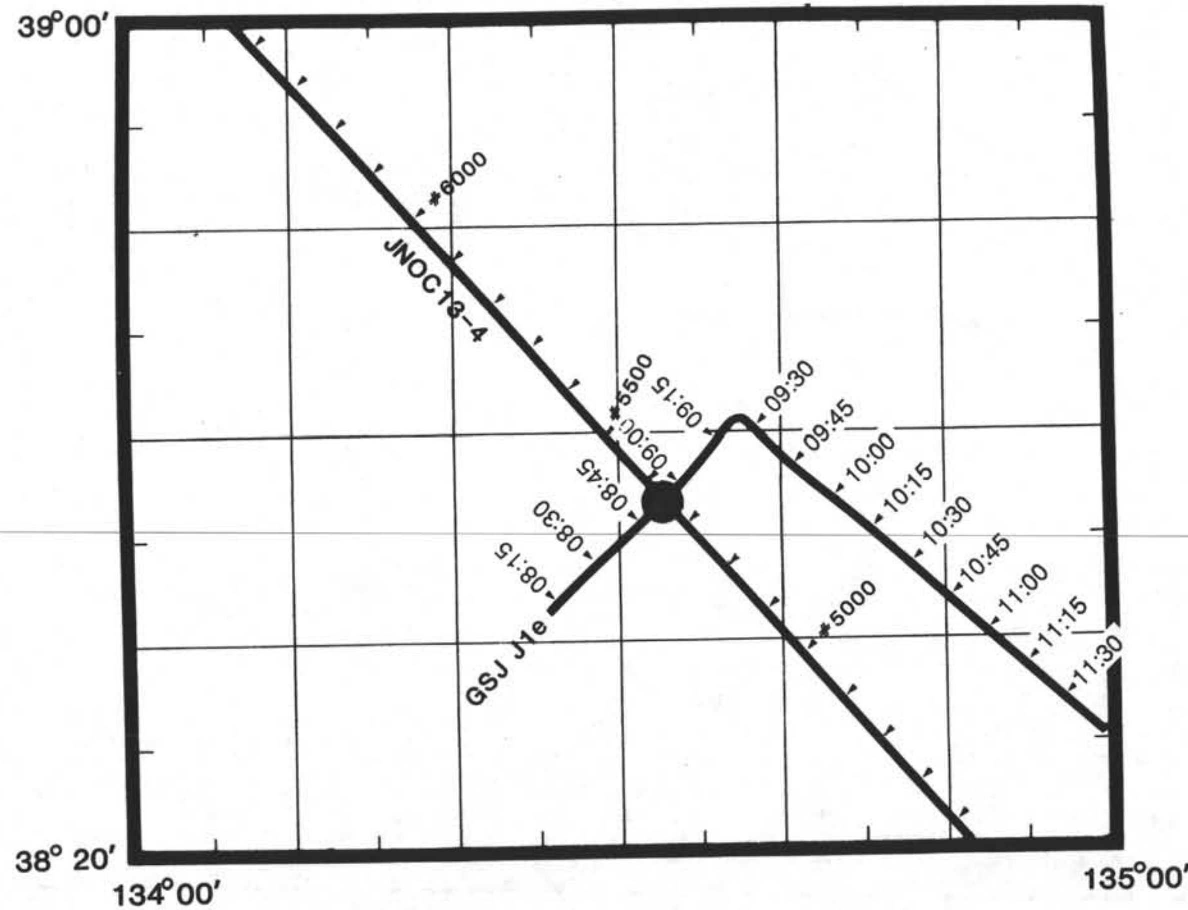
HEAT FLOW: YES WATER SAMPLER: YES

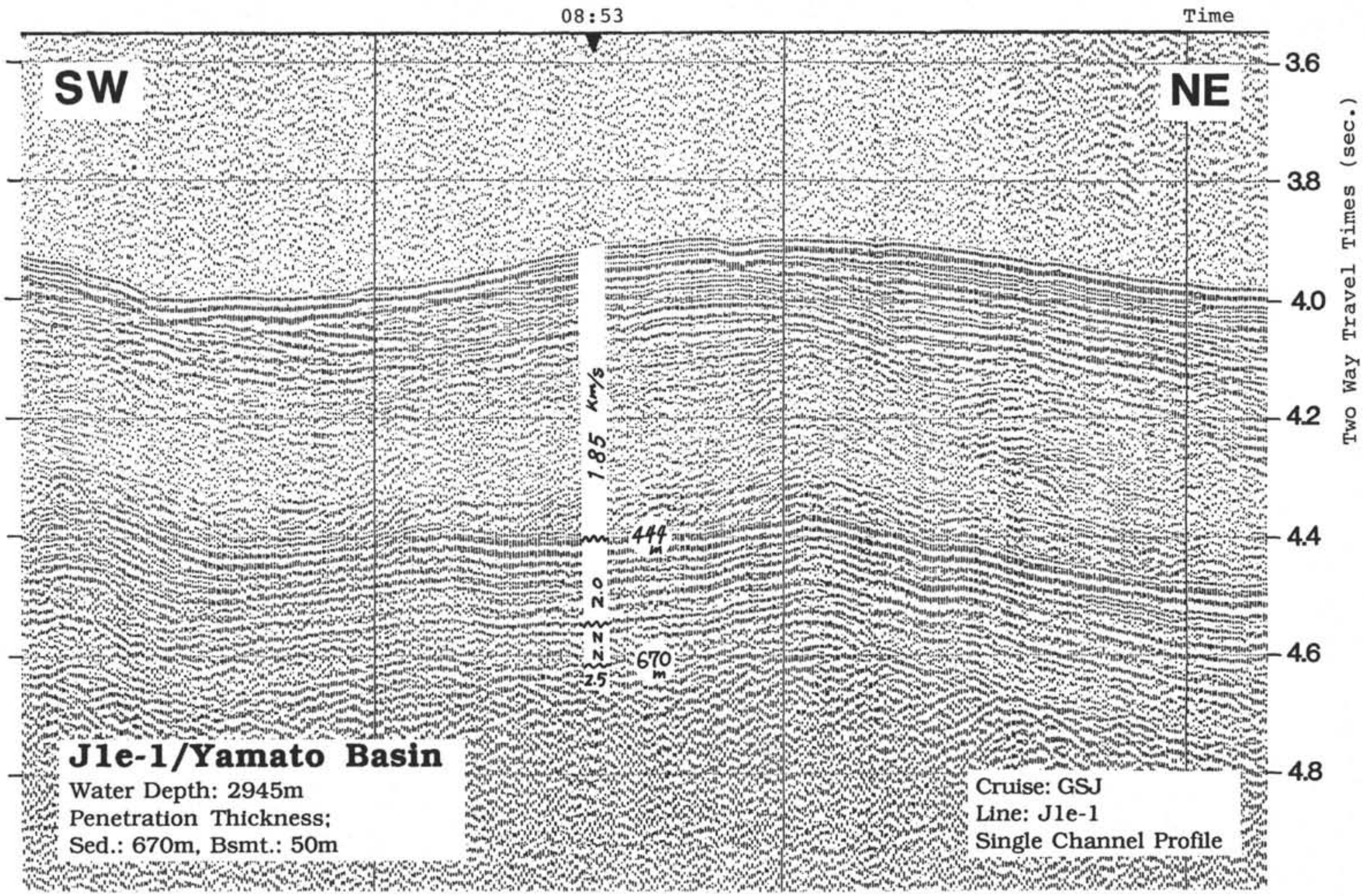
LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Magnetometer/Susceptibility

OBJECTIVES: Nature and age of the basement rocks; Style of multiple rifting; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1e-1


39°00′
38° 20′
134°00′
135°00′
JNOC13-4
GSJ J1e
#6000
#5500
#5000
08:15
08:30
08:45
09:00
09:15
09:30
09:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30


08:53
Time
SW
NE
3.6
3.8
4.0
4.2
4.4
4.6
4.8
Two Way Travel Times (sec.)
1.85 Km/s
444 m
2.0
2.2
670 m
2.5
J1e-1/Yamato Basin
Water Depth: 2945m
Penetration Thickness;
Sed.: 670m, Bsmt.: 50m
Cruise: GSJ
Line: J1e-1
Single Channel Profile

SITE J1e-1

Sub-bottom depth(m)	Key reflectors, uncomformities, faults, etc.	Age	Assumed velocity (km/sec)	Lithology	Paleo-environment	Average rate of sediment accumulation (m/m.y.)	Comments
			1.50	(Water)			
0 / 200 / 400	Sea floor	Pliocene to Recent	1.85	Interbedded sand, silt and clay	Distal turbidites in basinal setting	100	Upper stratified seismic interval?
	???	Late Miocene ??	2.00	Diatomaceous clay	Diatomaceous clay	100	Basal stratified seismic interval
600	???	Miocene	2.20	Clay and diatomaceous clay	Clay and diatomaceous clay		Upper transparent seismic interval
	AB*	Miocene ??	2.50	Basalt and volcanoclastics			Acoustic basement

SITE: J1b-2 PRIORITY: 2 (Alternative to J1b-1)

POSITION: 40°13'N
138°14'E

WATER DEPTH: 2800 m SEDIMENT THICKNESS: 610 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 300 m; Hole B, RCB 100 m into basement; Hole C, RCB 100 m into basement, set reentry cone and casing through sediment section; Hole D: Drill with RCB to bit destruction in basement for electrical conductivity experiment

SEISMIC RECORD: Tansei-maru (KT-88-9) 1988: line 109, shot 1965; nearby record Wakashio-maru (DELP85) 1985: line E, shot 3932

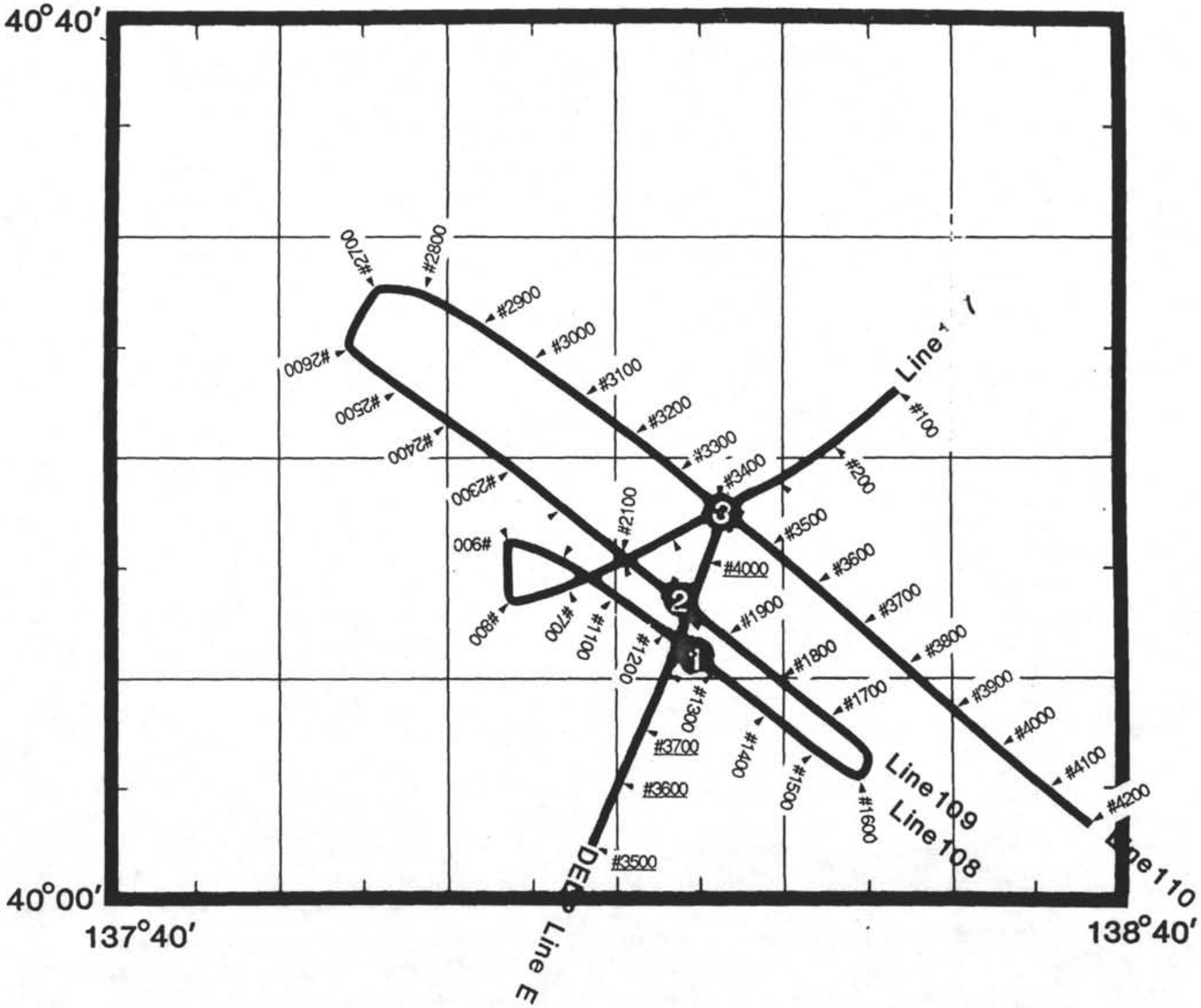
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Magnetometer/Susceptibility
Packer/Hydrofracture
VSP

OBJECTIVES: Nature and age of the basement rocks; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1b-1, 2 & 3



40°40′
40°00′
137°40′
138°40′
Line 109
Line 108
Line 110
DEEP Line E
#100
#200
#700
#800
#900
#1100
#1200
#1300
#1400
#1500
#1600
#1700
#1800
#1900
#2100
#2300
#2400
#2500
#2600
#2700
#2800
#2900
#3000
#3100
#3200
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#3500
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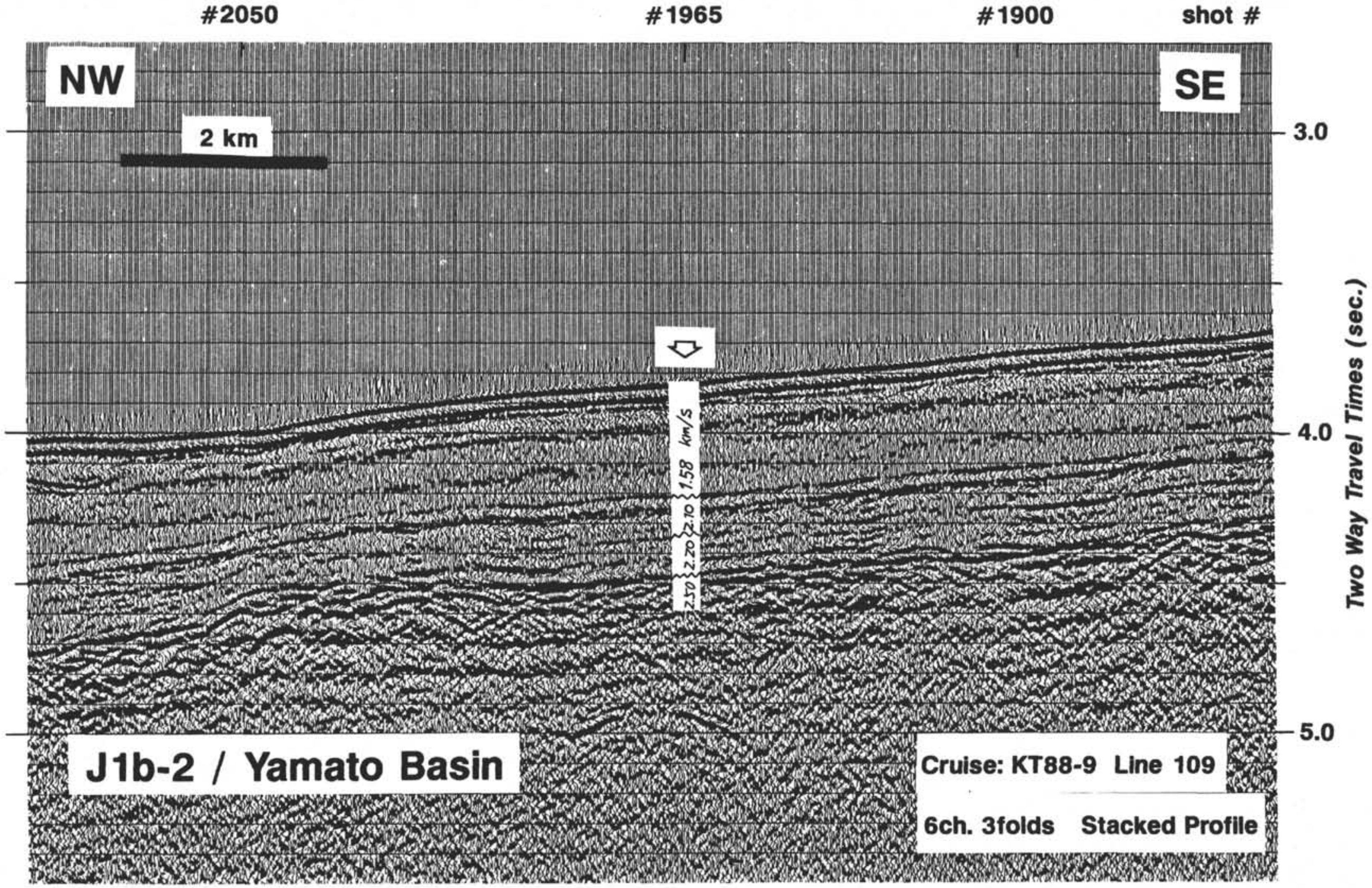
#4000
1
2
3


#2050
#1965
#1900
shot #
NW
SE
2 km
3.0
4.0
5.0
Two Way Travel Times (sec.)
1.58 km/s
2.10
2.20
2.50
J1b-2 / Yamato Basin
Cruise: KT88-9 Line 109
6ch. 3folds Stacked Profile

SITE: J1b-3

PRIORITY: 2 (Alternative to J1b-1)

POSITION: 40°17.6'N
138°16.0'E

WATER DEPTH: 2892 m

SEDIMENT THICKNESS: 490 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 300 m; Hole B, RCB 100 m into basement; Hole C, RCB 100 m into basement, set reentry cone and casing through sediment section; Hole D: Drill with RCB to bit destruction in basement for electrical conductivity experiment

SEISMIC RECORD: Wakashio-maru (DELP85) 1985: line E, shot 4096;
Tansei-maru (KT-88-9) 1988: line 107, shot 413;
Tansei-maru (KT-88-9) 1988: line 110, shot 3400

HEAT FLOW: YES

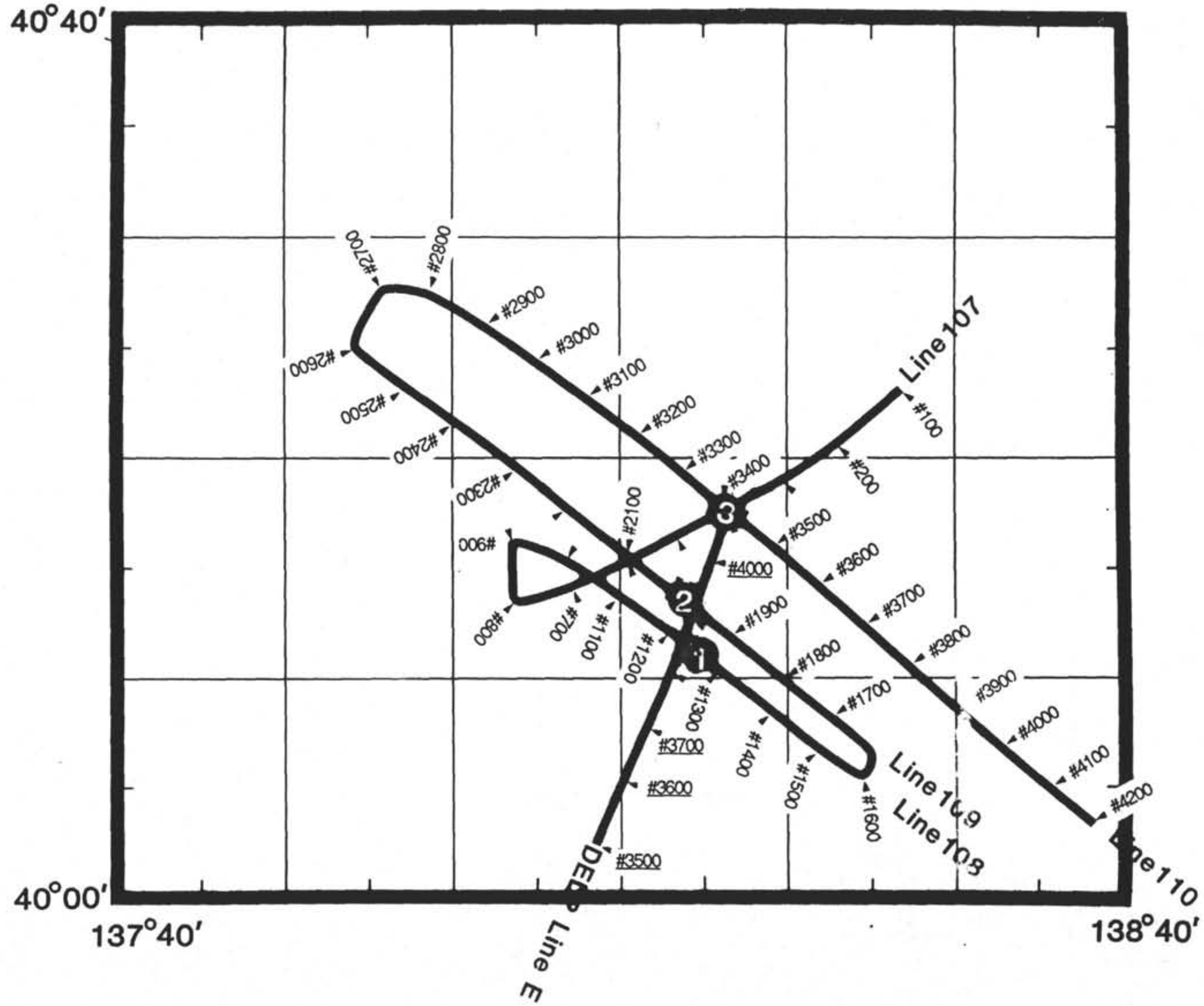
WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Magnetometer/Susceptibility
Packer/Hydrofracture
VSP

OBJECTIVES: Nature and age of the basement rocks; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1b-1, 2 & 3



40°40'
40°00'
137°40'
138°40'
Line 107
Line 109
Line 108
Line 110
Line E
#100
#200
#700
#800
#900
#1100
#1200
#1300
#1400
#1500
#1600
#1700
#1800
#1900
#2100
#2300
#2400
#2500
#2600
#2700
#2800
#2900
#3000
#3100
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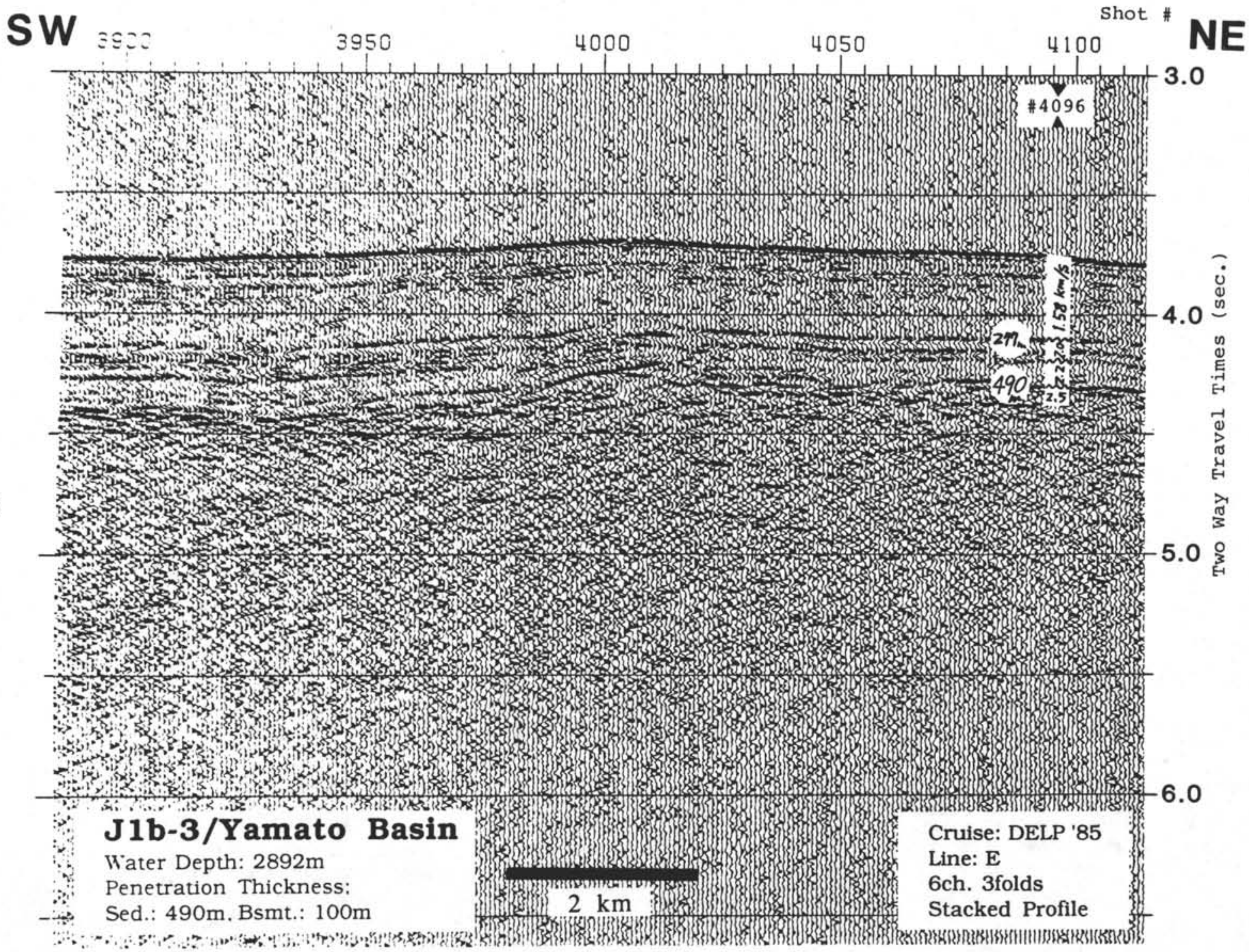
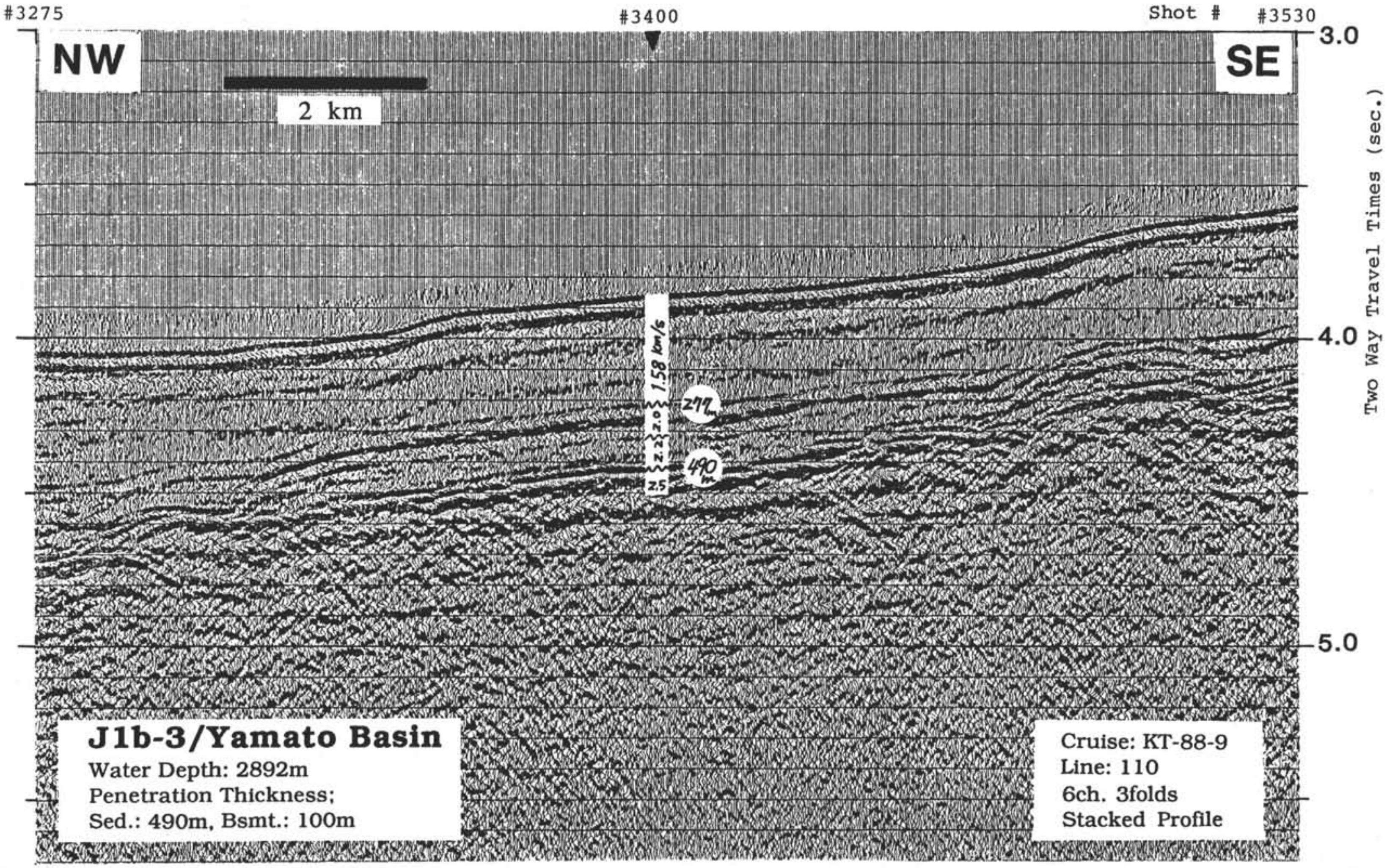
#4200
1
2
3


SW
NE
Shot #
3900
3950
4000
4050
4100
#4096
3.0
4.0
5.0
6.0
Two Way Travel Times (sec.)
1.58 km/s
2.2
2.5
490
J1b-3/Yamato Basin
Water Depth: 2892m
Penetration Thickness:
Sed.: 490m, Bsmt.: 100m
2 km
Cruise: DELP '85
Line: E
6ch. 3folds
Stacked Profile


#3275
#3400
Shot #
#3530
NW
SE
2 km
3.0
4.0
5.0
Two Way Travel Times (sec.)
490
J1b-3/Yamato Basin
Water Depth: 2892m
Penetration Thickness;
Sed.: 490m, Bsmt.: 100m
Cruise: KT-88-9
Line: 110
6ch. 3folds
Stacked Profile

SITE: J3b-2 PRIORITY: 2 (Alternate to J3b-1)

POSITION: 43°00'N
139°22.2'E

WATER DEPTH: 2312 m SEDIMENT THICKNESS: 920 m

PROPOSED DRILLING PROGRAM: APC/XCB to 920 m; RCB 50 m into basement

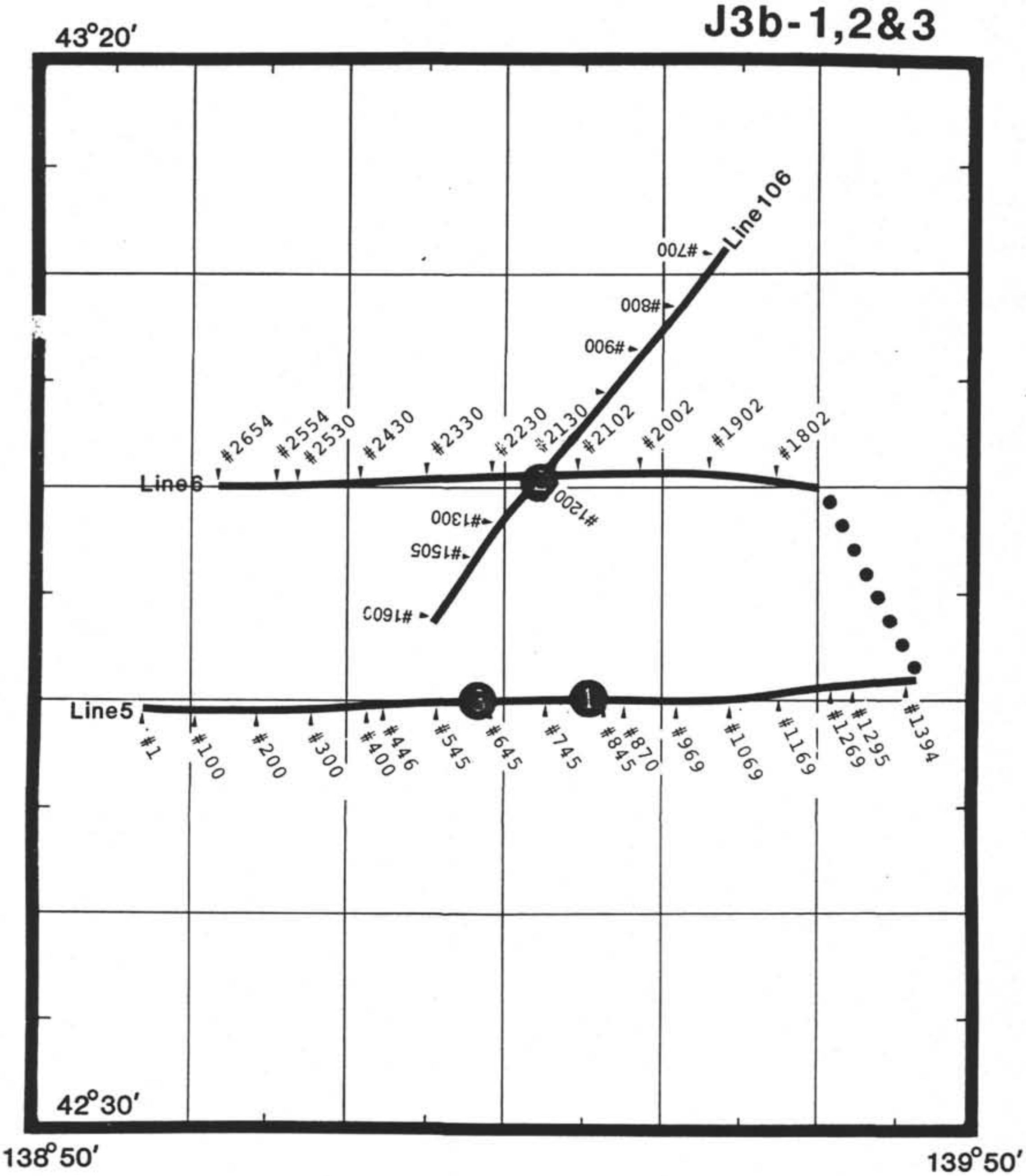
SEISMIC RECORD: Hakuho-maru (KH-86-2) 1986: line 6, shot 2190

HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Packer/Hydrofracture

OBJECTIVES: Penetrate Okushiri Ridge; Timing of uplift and compressional tectonics; Nature and age of the uplifted basement; Paleooceanography

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics


J3b-1,2&3
43°20'
42°30'
138°50'
139°50'
Line106
Line6
Line5
#700
#800
#900
#1200
#1300
#1505
#1603
#2654
#2554
#2530
#2430
#2330
#2230
#2130
#2102
#2002
#1902
#1802
#1
#100
#200
#300
#400
#446
#545
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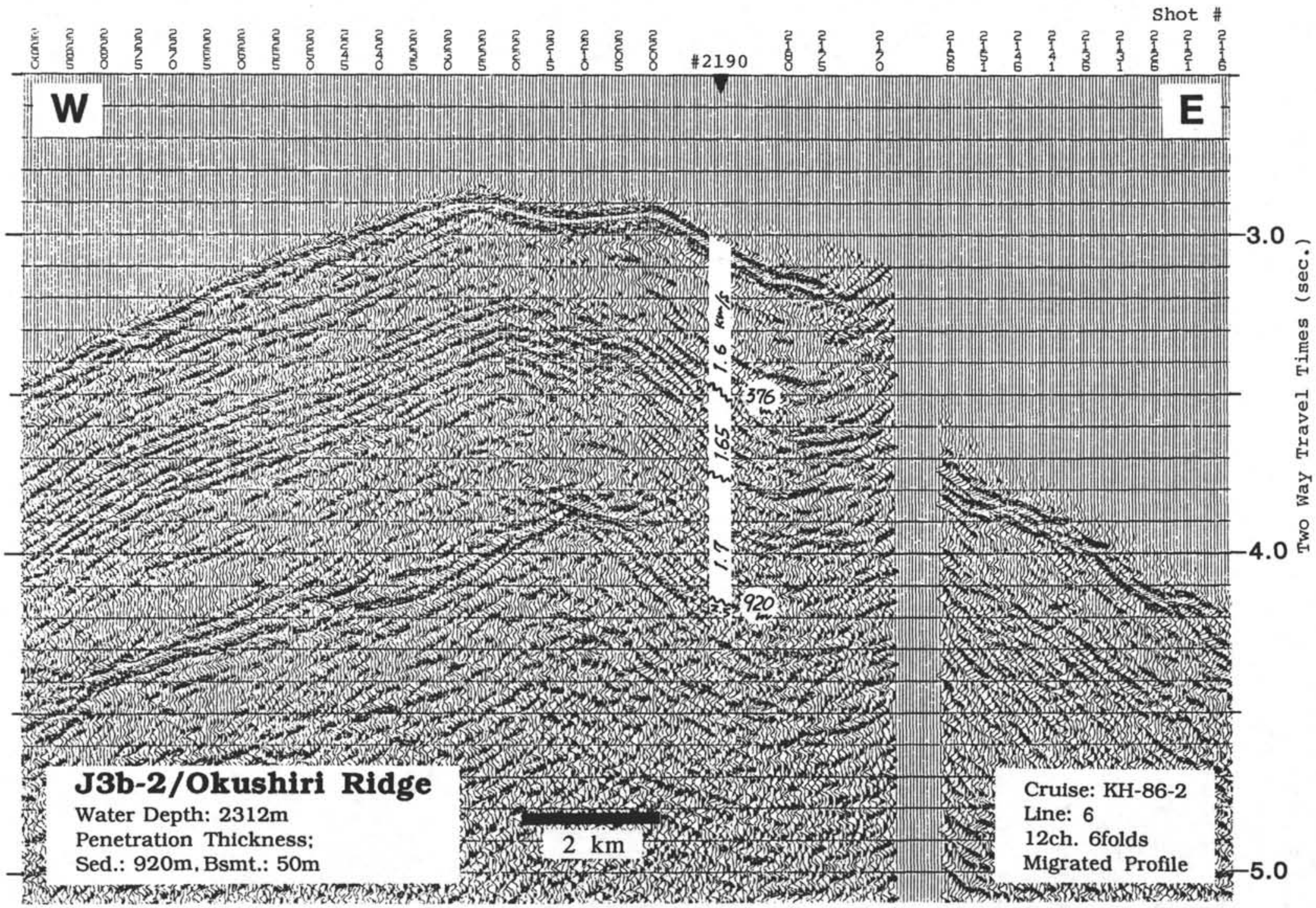
#1269
#1295
#1394


Shot #
#2190
W
E
3.0
4.0
5.0
Two Way Travel Times (sec.)
1.6 km/s
376 m
1.65
1.7
920 m
J3b-2/Okushiri Ridge
Water Depth: 2312m
Penetration Thickness;
Sed.: 920m, Bsmt.: 50m
2 km
Cruise: KH-86-2
Line: 6
12ch. 6folds
Migrated Profile

SITE: J3b-3 PRIORITY: 2 (Alternate to J3b-1)

POSITION: 42°50'N
139°18'E

WATER DEPTH: 2700 m SEDIMENT THICKNESS: 820 m

PROPOSED DRILLING PROGRAM: APC/XCB to 250 m

SEISMIC RECORD: Hakuho-maru (KH-86-2) 1986: line 5, shot 630

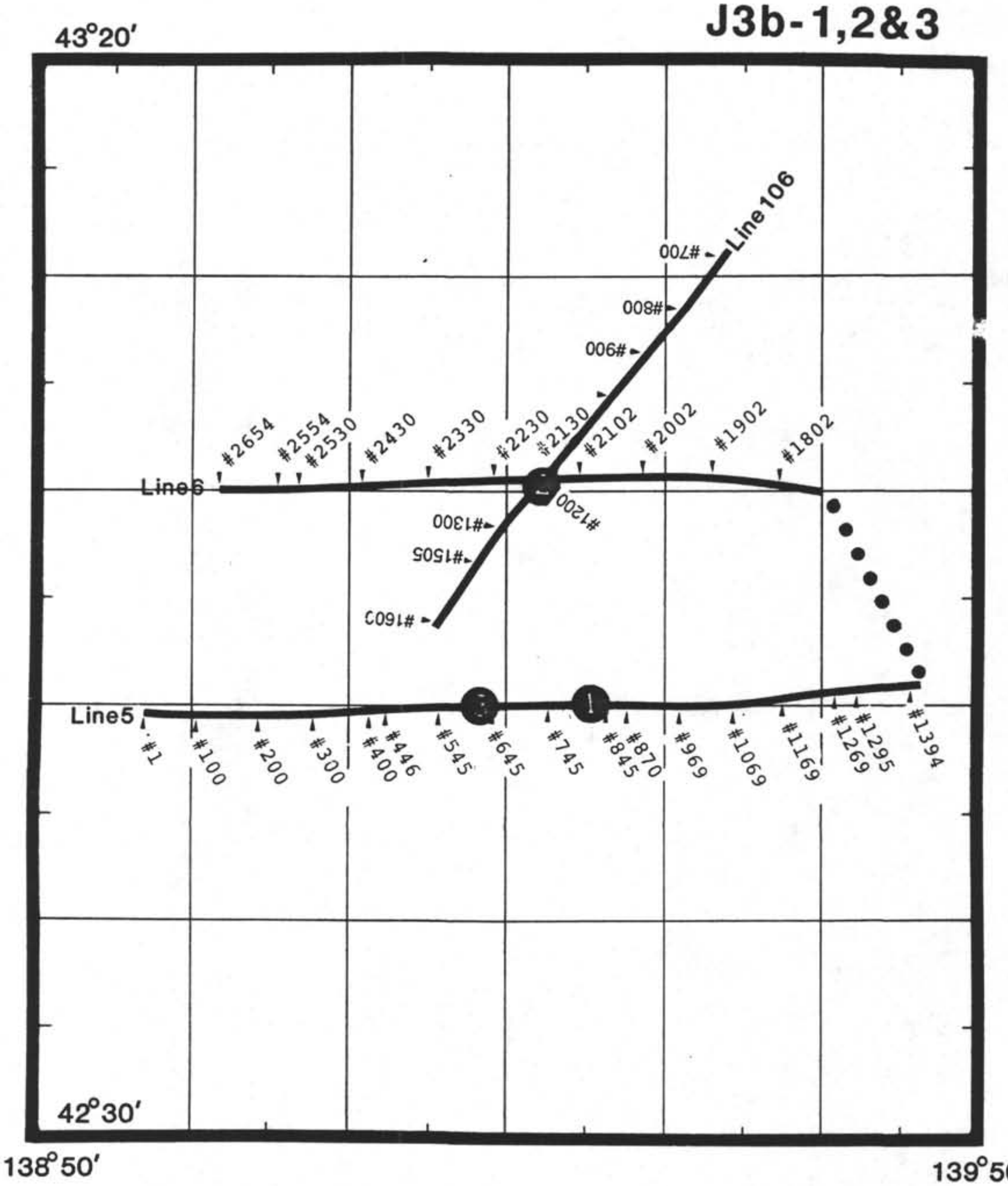
HEAT FLOW: NO WATER SAMPLER: NO

LOGGING: NO

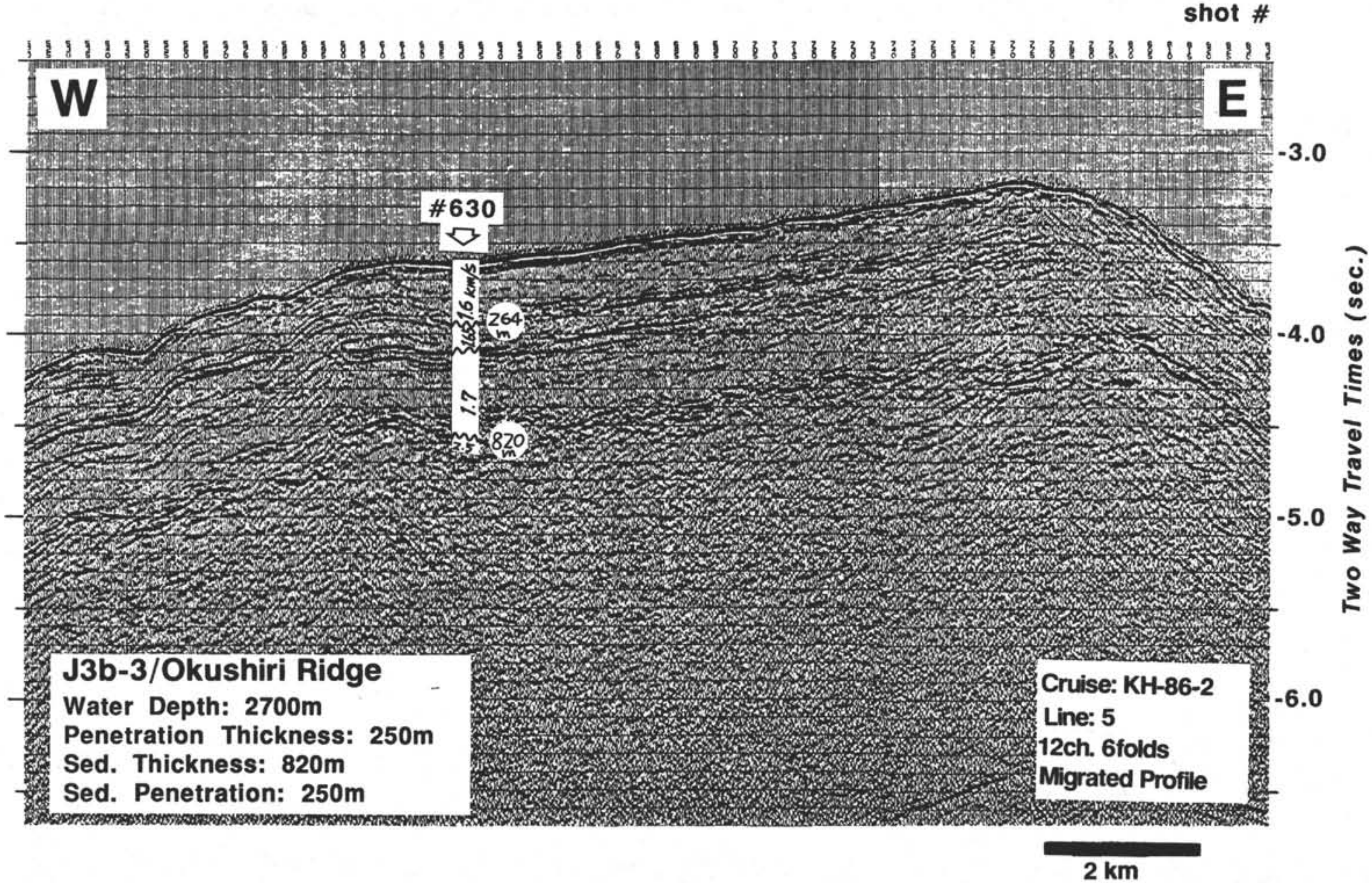
OBJECTIVES: Paleoceanography

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J3b-1,2&3



43°20′
42°30′
138°50′
139°50′
Line106
Line6
Line5
#700
#800
#900
#1200
#1300
#1505
#1603
#2654
#2554
#2530
#2430
#2330
#2230
#2130
#2102
#2002
#1902
#1802
#1
#100
#200
#300
#400
#446
#545
#645
#745
#845
#870
#969
#1069
#1169
#1269
#1295
#1394


shot #
W
E
#630
1.6 km/s
264 m
1.7
820 m
-3.0
-4.0
-5.0
-6.0
Two Way Travel Times (sec.)
J3b-3/Okushiri Ridge
Water Depth: 2700m
Penetration Thickness: 250m
Sed. Thickness: 820m
Sed. Penetration: 250m
Cruise: KH-86-2
Line: 5
12ch. 6folds
Migrated Profile
2 km

SITE: J3c

PRIORITY: 2 (Alternate to J3b-1)

POSITION: 44°00'N
139°15'E

WATER DEPTH: 1168 m

SEDIMENT THICKNESS: 246 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 246 m; Hole B, RCB 100 m into basement

SEISMIC RECORD: Tansei-maru (KT-87-6) 1987: line MC1, shot 1198

HEAT FLOW: YES

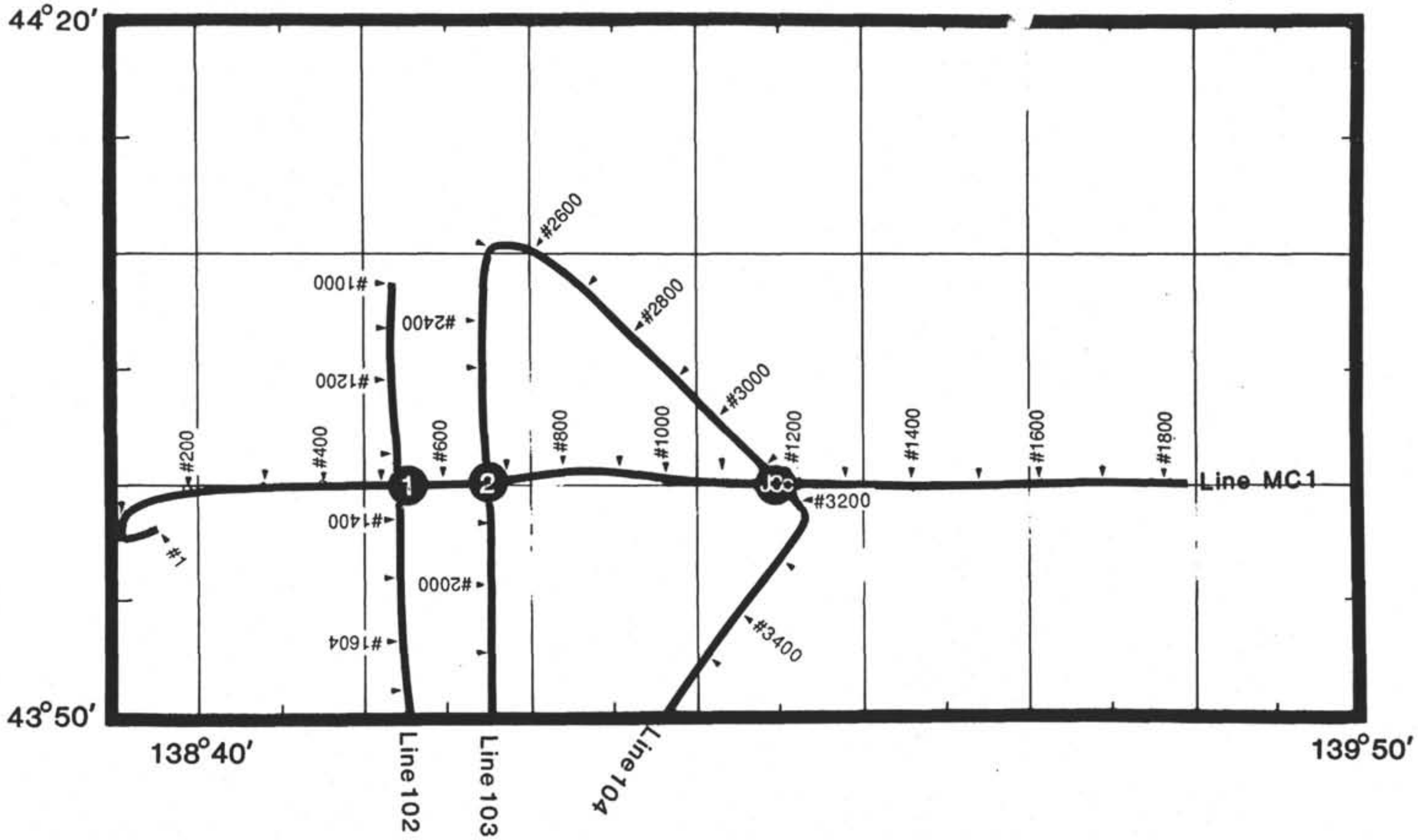
WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Packer/Hydrofracture

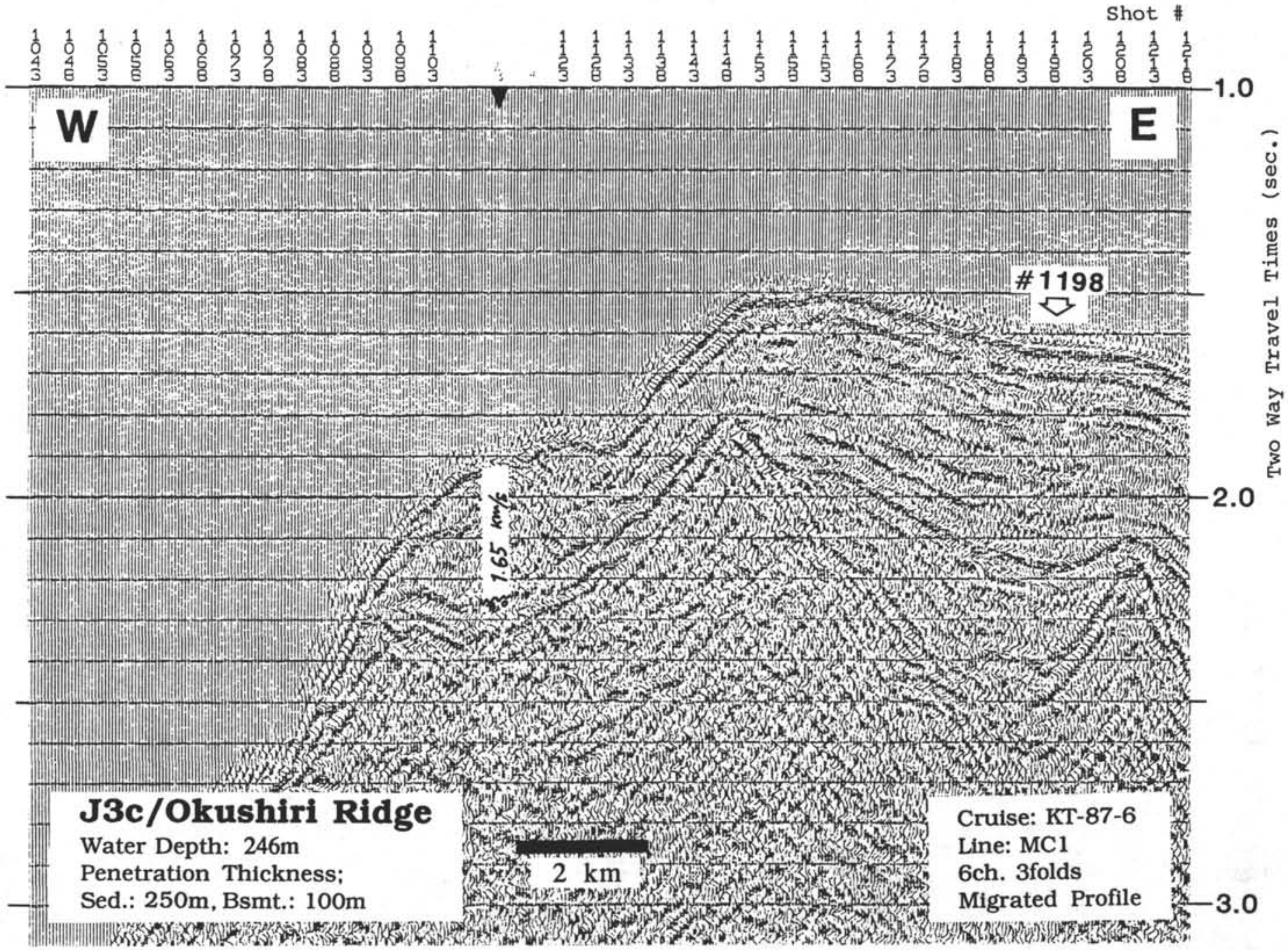
OBJECTIVES: Penetrate Okushiri Ridge; Timing of uplift and compressional tectonics; Nature and age of the uplifted basement

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Silt + Diatomaceous clay; Basalt+volcanoclastics

J1 1-1 & 2, J3c



44°20′
43°50′
138°40′
139°50′
Line MC1
Line 102
Line 103
Line 104
J3c
#1
#200
#400
#600
#800
#1000
#1200
#1400
#1600
#1800
#2000
#2400
#2600
#2800
#3000
#3200
#3400
#1604



Shot #
1043 1048 1053 1058 1063 1068 1073 1078 1083 1088 1093 1098 1103
1123 1128 1133 1138 1143 1148 1153 1158 1163 1168 1173 1178 1183 1188 1193 1198 1203 1208 1213 1218
W
E
1.0
2.0
3.0
Two Way Travel Times (sec.)
#1198
1.65 km/s
J3c/Okushiri Ridge
Water Depth: 246m
Penetration Thickness;
Sed.: 250m, Bsmt.: 100m
2 km
Cruise: KT-87-6
Line: MC1
6ch. 3folds
Migrated Profile

SITE: J1d-2 PRIORITY: 2 (Alternative to J1d-1)

POSITION: 44°00'N
138°57.5'E

WATER DEPTH: 3406m SEDIMENT THICKNESS: 760 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 760 m; Hole B, RCB 50 m into basement

SEISMIC RECORD: Tansei-maru (KT-87-6)1987: line MC1, shot 674; Tansei-maru (KT-88-9)1988: line 103, shot 2096.

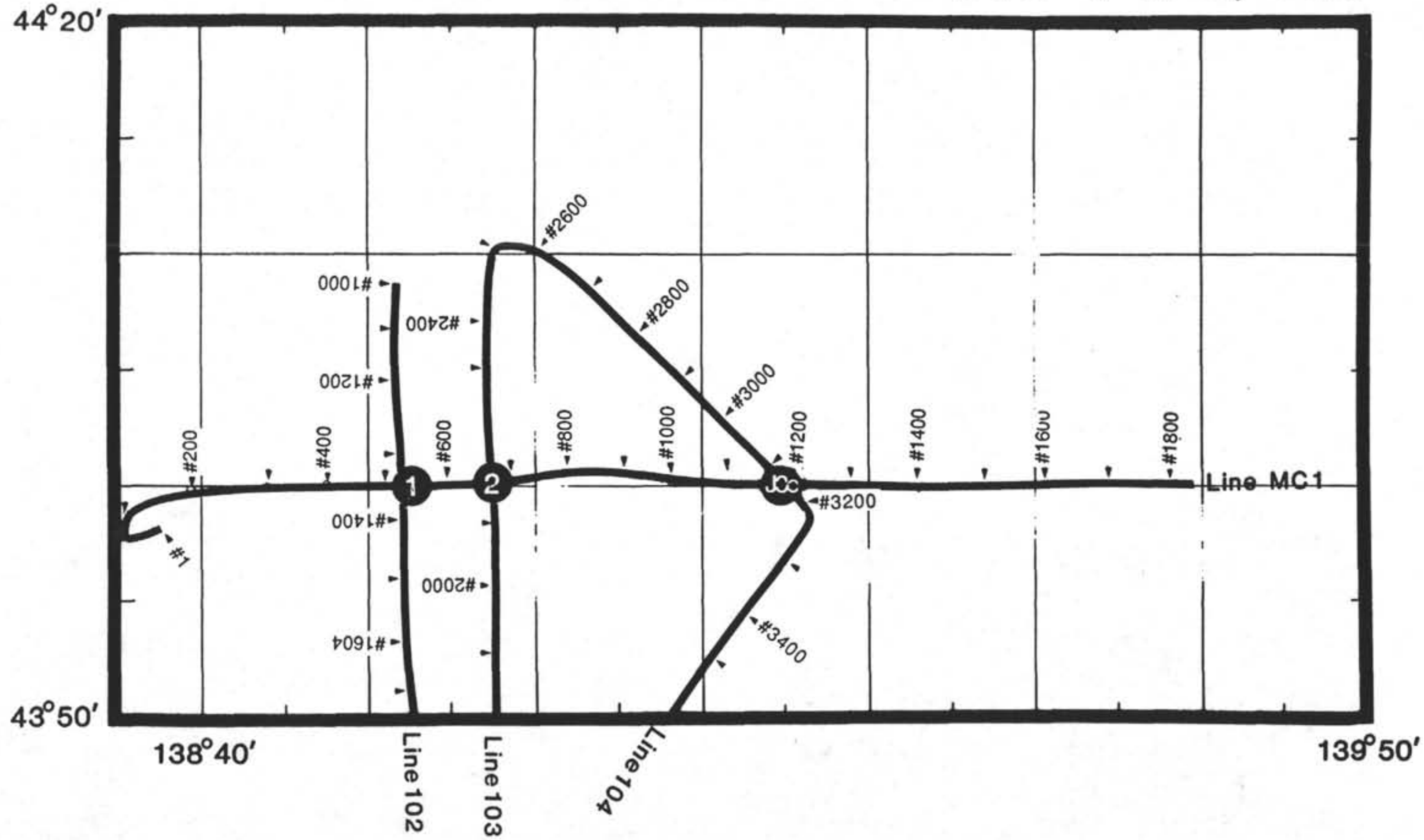
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
Magnetometer/Susceptibility
Borehole Televiewer

OBJECTIVES: Penetrate remnant spreading ridge; Nature and age of the basement rocks; Style of multiple rifting; Style and evolution of sedimentation at Japan Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1d-1 & 2, J3c



44°20′
43°50′
138°40′
139°50′
Line 102
Line 103
Line 104
Line MC1
1
2
J3c
#1
#200
#400
#600
#800
#1000
#1200
#1400
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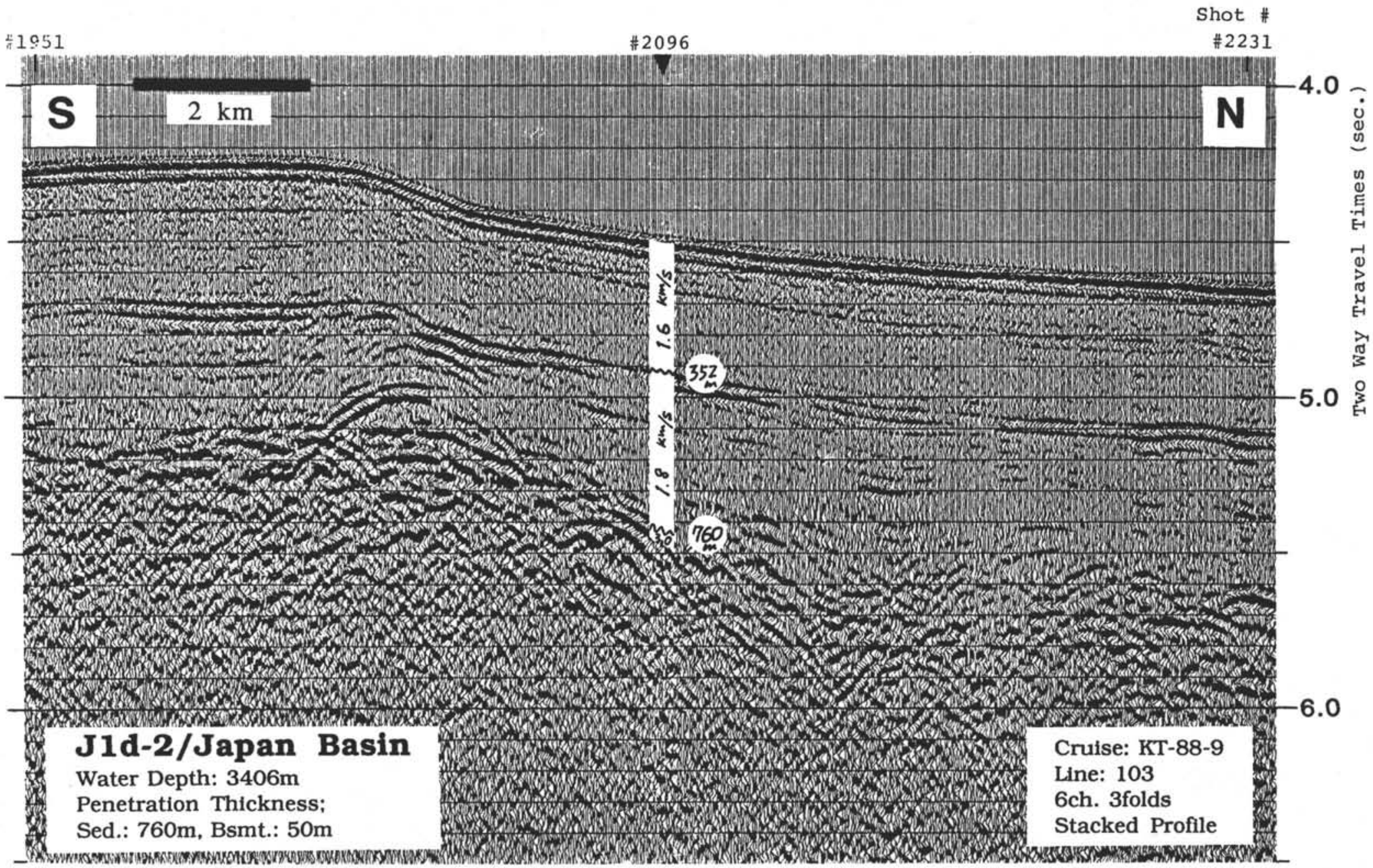
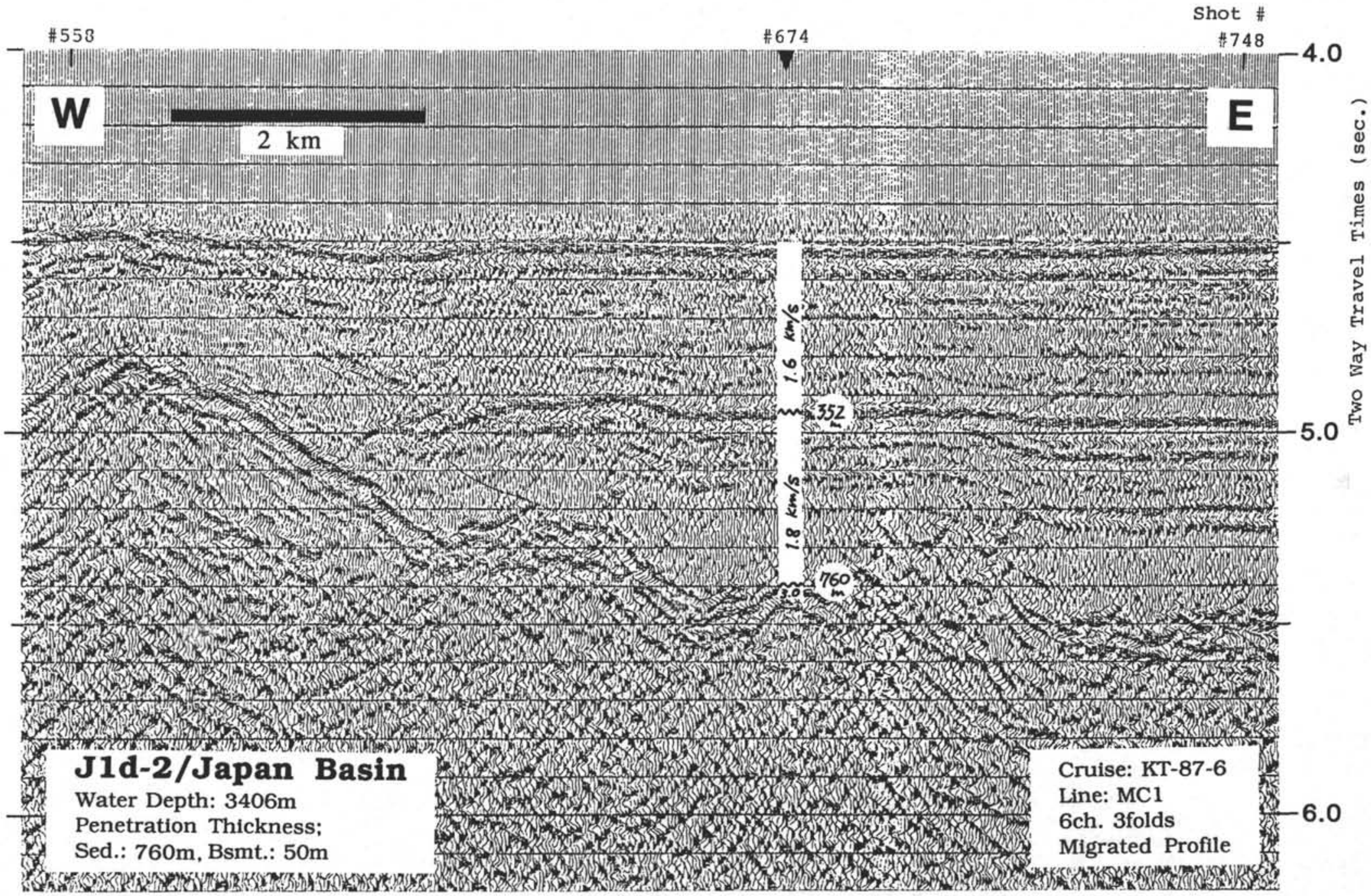
#2800
#3000
#3200
#3400


Shot #
#1951
#2096
#2231
S
N
2 km
4.0
5.0
6.0
Two Way Travel Times (sec.)
1.6 km/s
1.8 km/s
352 m
760 m
J1d-2/Japan Basin
Water Depth: 3406m
Penetration Thickness;
Sed.: 760m, Bsmt.: 50m
Cruise: KT-88-9
Line: 103
6ch. 3folds
Stacked Profile


Shot #
#558
#674
#748
W
E
2 km
4.0
5.0
6.0
Two Way Travel Times (sec.)
1.6 km/s
352 m
1.8 km/s
760 m
3.0
J1d-2/Japan Basin
Water Depth: 3406m
Penetration Thickness;
Sed.: 760m, Bsmt.: 50m
Cruise: KT-87-6
Line: MC1
6ch. 3folds
Migrated Profile

SITE: J1a

PRIORITY: 2 (Alternative to J1b-1)

POSITION: 39°50'N
137°25'E

WATER DEPTH: 2530 m

SEDIMENT THICKNESS: 580 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 300 m; Hole B, RCB to basement; Hole C, RCB 100 m into basement, set reentry cone and casing through sediment section; Hole D: Drill with RCB to bit destruction in basement for electrical conductivity experiment.

SEISMIC RECORD: JNOC line 10-1, shot point 1977

HEAT FLOW: YES

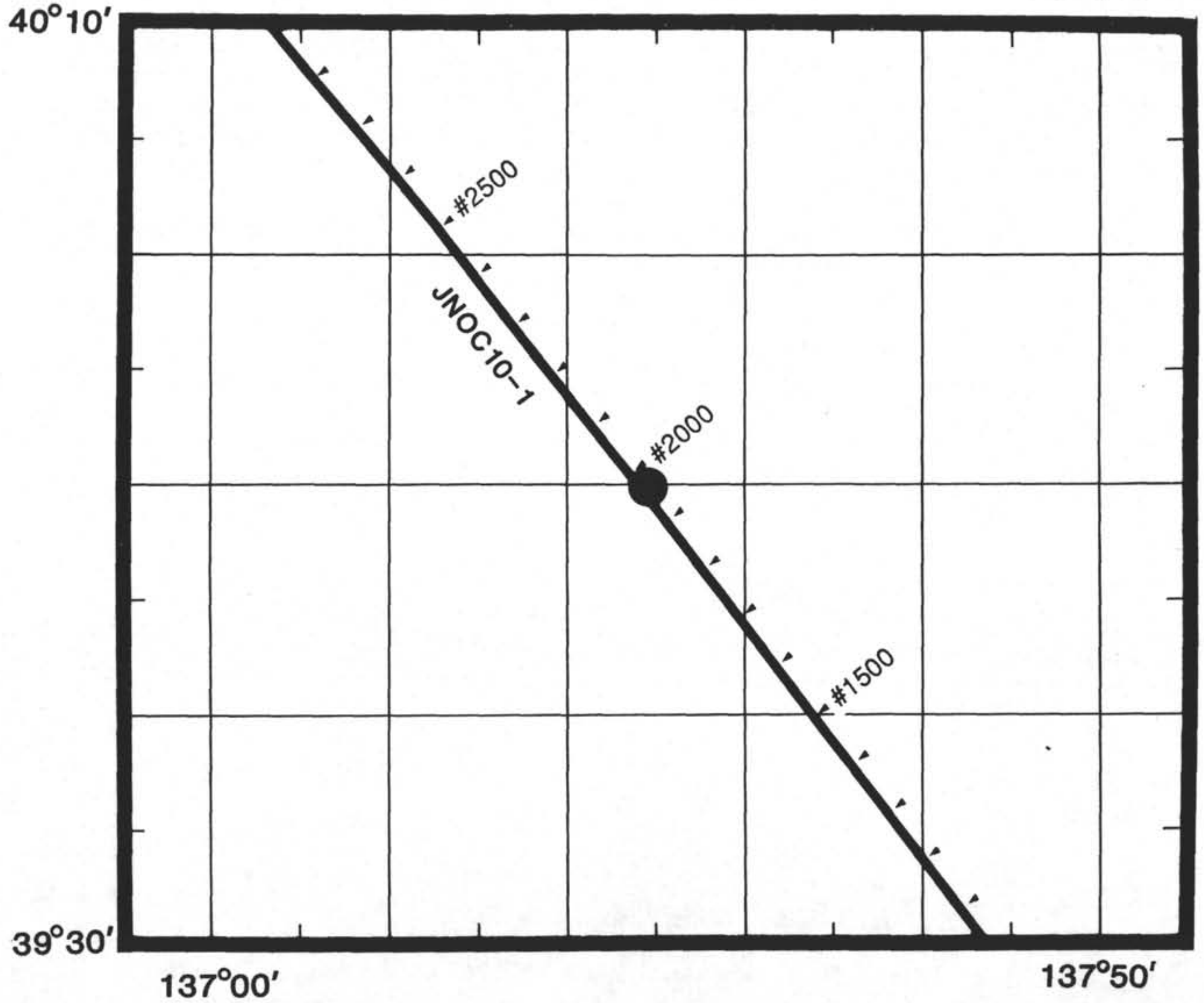
WATER SAMPLER: YES

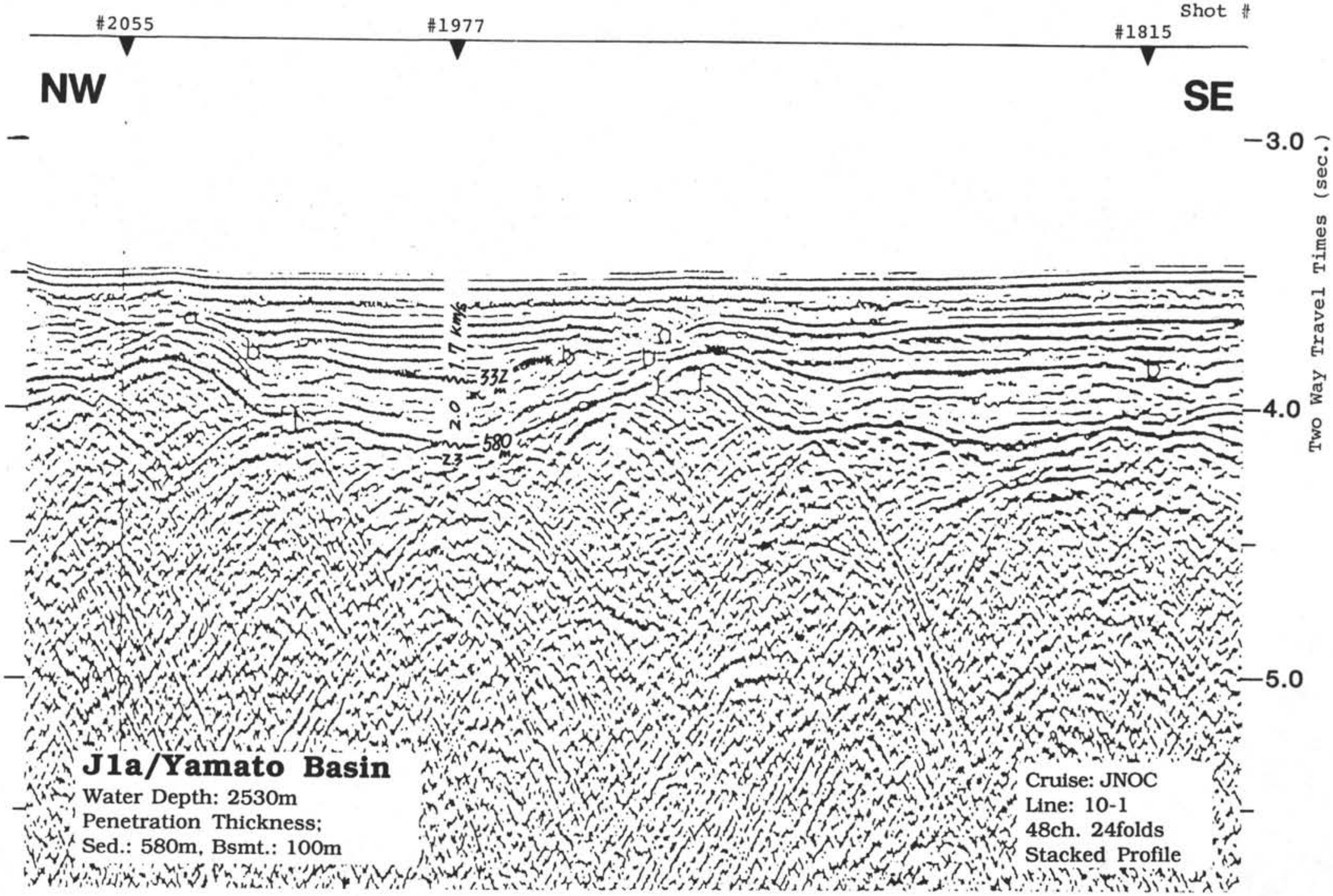
LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer
Magnetometer/Susceptibility
Packer/Hydrofracture
VSP

OBJECTIVES: Nature and age of the basement rocks; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics

J1a




Shot #
#2055
#1977
#1815
NW
SE
3.0
4.0
5.0
Two Way Travel Times (sec.)
1.7 km/s
332 m
2.0
580 m
2.3
J1a/Yamato Basin
Water Depth: 2530m
Penetration Thickness;
Sed.: 580m, Bsmt.: 100m
Cruise: JNOC
Line: 10-1
48ch. 24folds
Stacked Profile

SITE: J1c PRIORITY: 2

POSITION: 40°19'N
136°54'E

WATER DEPTH: 2400 m SEDIMENT THICKNESS: 720 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 300 m; Hole B, RCB to basement; Hole C, RCB 100 m into basement, set reentry cone and casing through sediment section; Hole D: Drill with RCB to bit destruction in basement for electrical conductivity experiment.

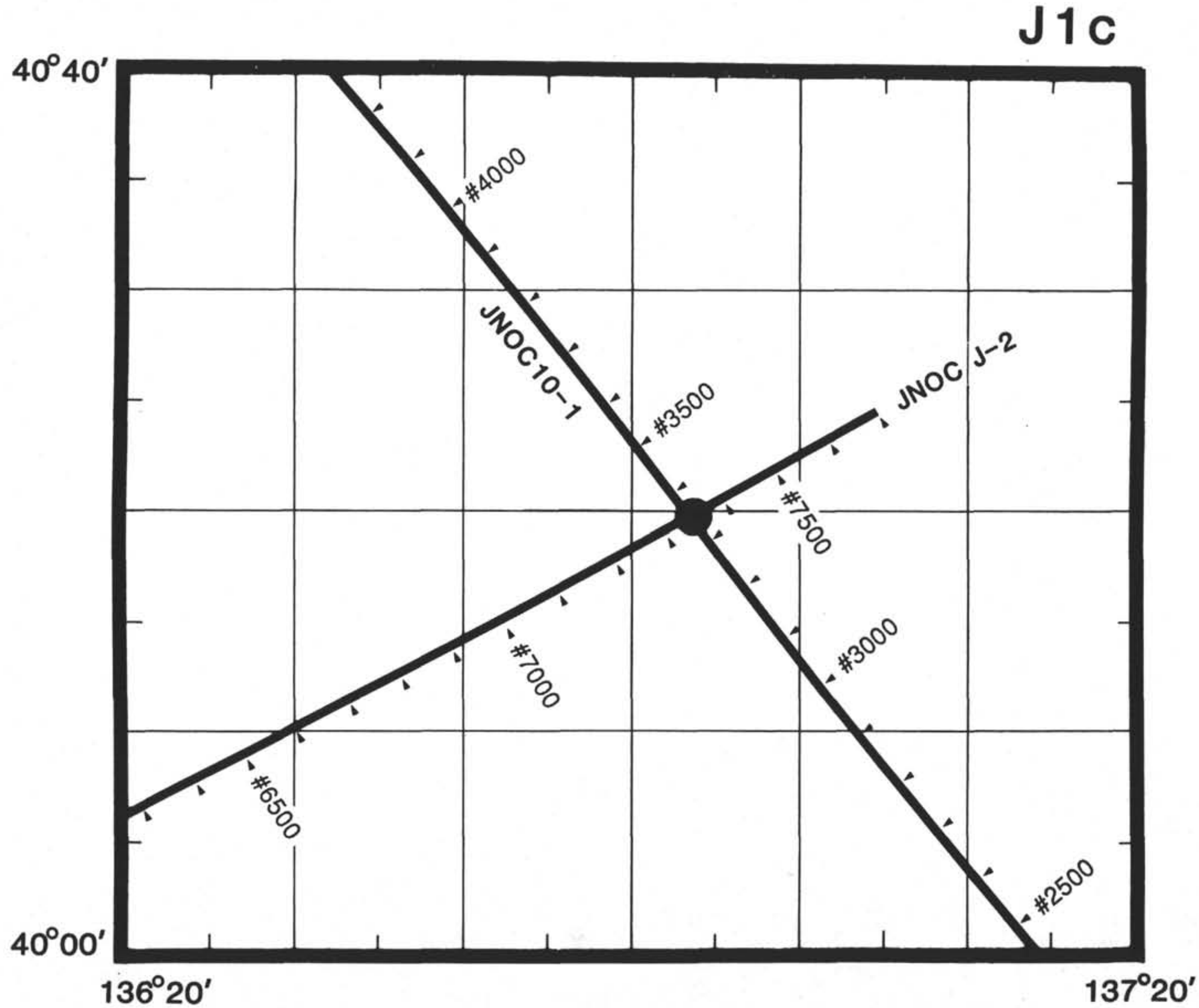
SEISMIC RECORD: JNOC: line 10-1, shot 3340

HEAT FLOW: YES WATER SAMPLER: YES

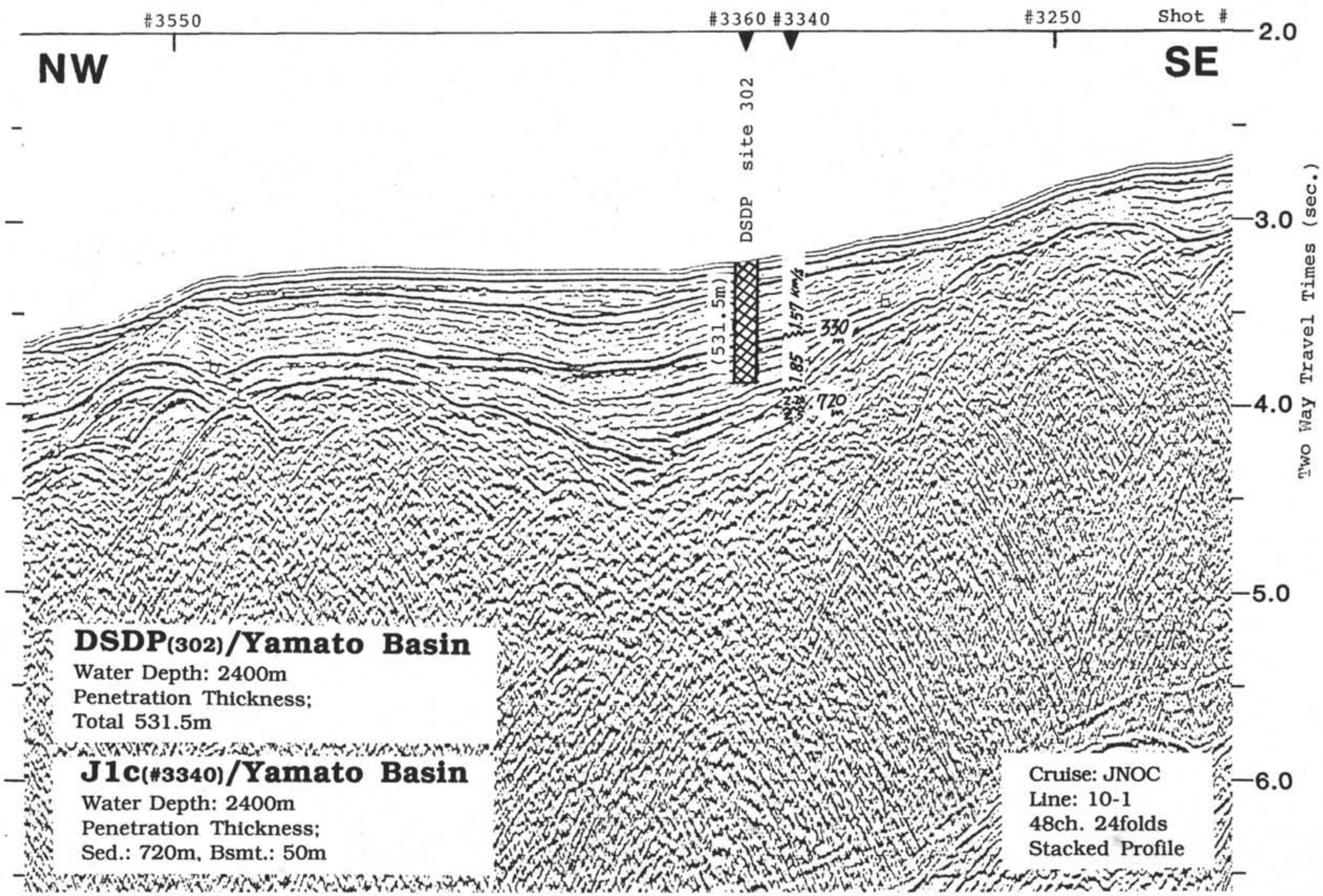
LOGGING: Standard Schlumberger logging
Formation Microscanner
Borehole Televiewer

OBJECTIVES: Nature and age of the basement rocks; Style and evolution of sedimentation at Yamato Basin

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics



J1c
40°40′
40°00′
136°20′
137°20′
JNOC10–1
JNOC J–2
#4000
#3500
#3000
#2500
#6500
#7000
#7500



#3550
#3360 #3340
#3250
Shot #
NW
SE
DSDP site 302
(531.5m)
330
720
2.0
3.0
4.0
5.0
6.0
Two Way Travel Times (sec.)
DSDP(302)/Yamato Basin
Water Depth: 2400m
Penetration Thickness;
Total 531.5m
J1c(#3340)/Yamato Basin
Water Depth: 2400m
Penetration Thickness;
Sed.: 720m, Bsmt.: 50m
Cruise: JNOC
Line: 10-1
48ch. 24folds
Stacked Profile

SITE: JS2 PRIORITY: 1

POSITION: 37°02.2'N
134°48.6'E

WATER DEPTH: 880 m SEDIMENT THICKNESS: 710 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to refusal; Hole B, APC to 120 m; Hole C, APC to 80 m

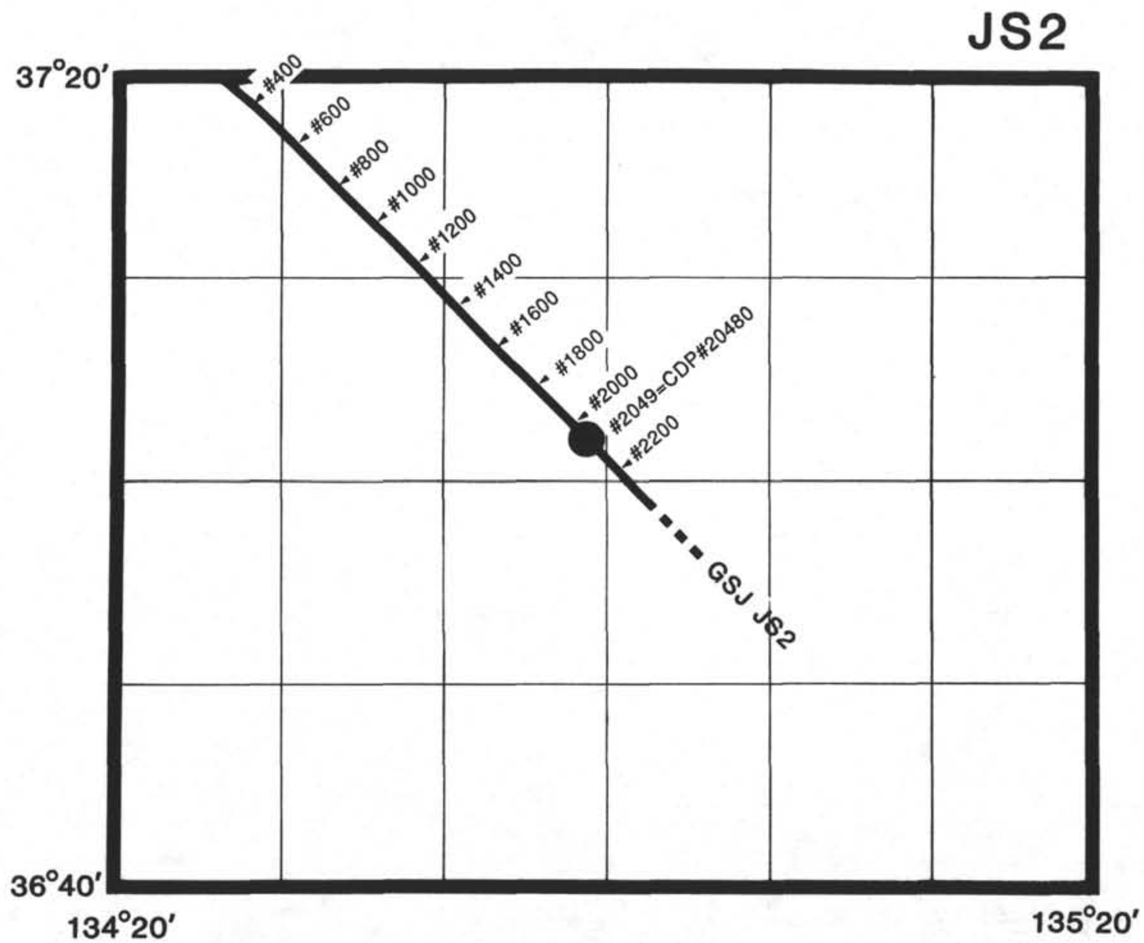
SEISMIC RECORD: Geol. Survey Japan: line JS2, shot 20480

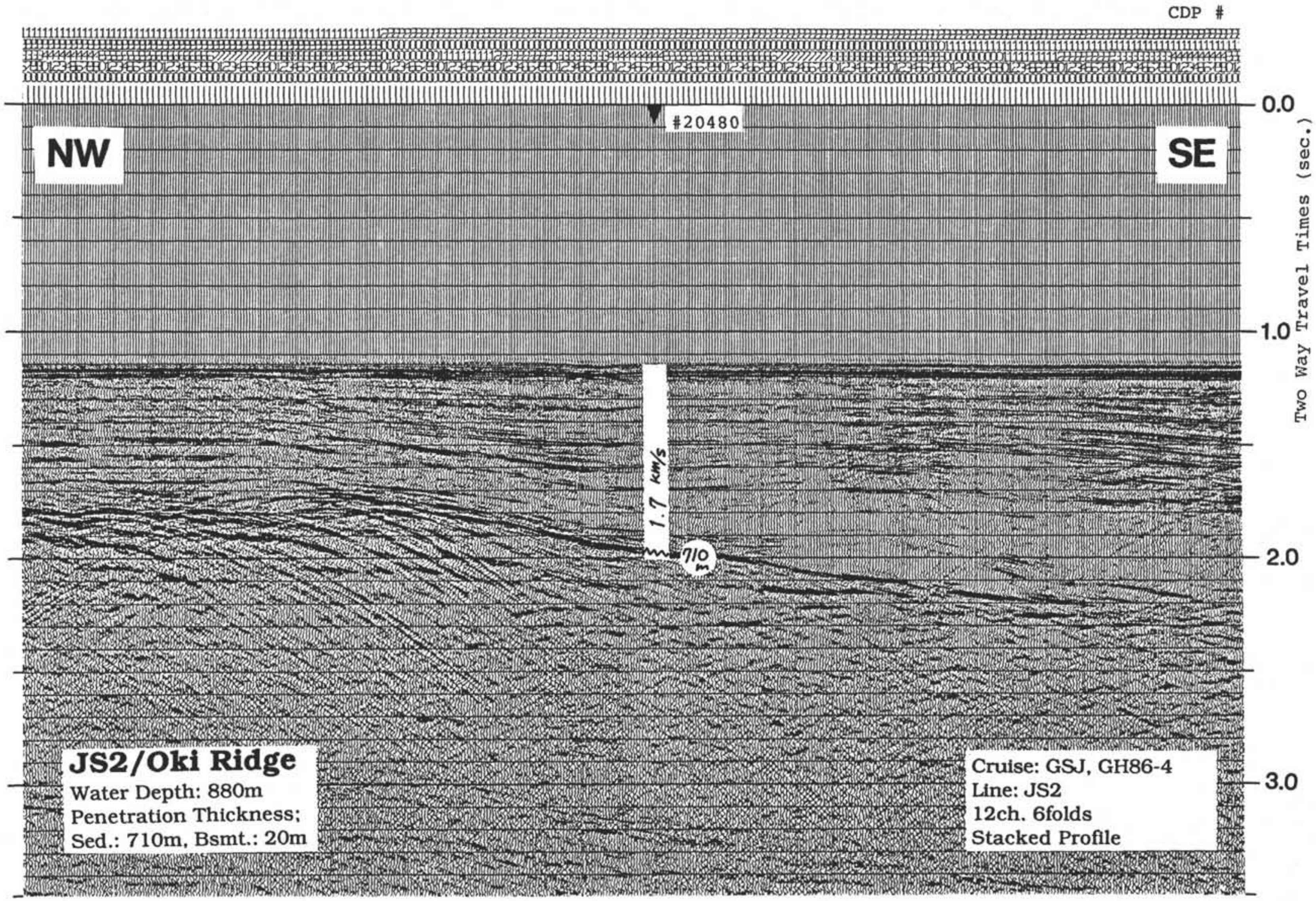
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner

OBJECTIVES: Penetrate Oki Ridge; Neogene paleoceanographic history; bacterial activity

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics


JS2
37°20′
36°40′
134°20′
135°20′
#400
#600
#800
#1000
#1200
#1400
#1600
#1800
#2000
#2049=CDP#20480
#2200
GSJ JS2


CDP #
#20480
NW
SE
0.0
1.0
2.0
3.0
Two Way Travel Times (sec.)
1.7 km/s
710 m
JS2/Oki Ridge
Water Depth: 880m
Penetration Thickness;
Sed.: 710m, Bsmt.: 20m
Cruise: GSJ, GH86-4
Line: JS2
12ch. 6folds
Stacked Profile

SITE: J2a-1 PRIORITY: 1

POSITION: 39°13'N
133°52'E

WATER DEPTH: 2085 m SEDIMENT THICKNESS: 1379 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 600 m; Hole B, RCB 50 m into basement

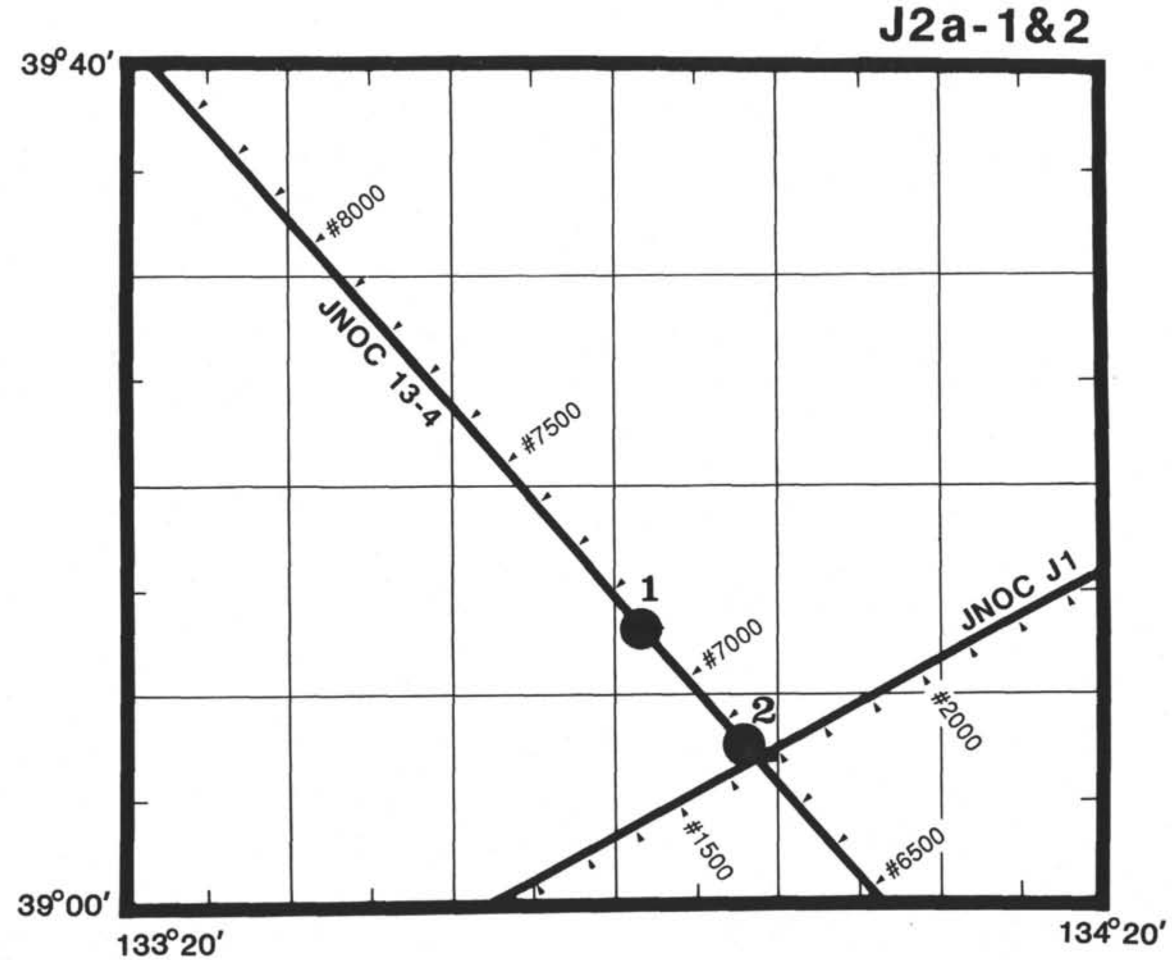
SEISMIC RECORD: JNOC: line 13-4, shot 7120

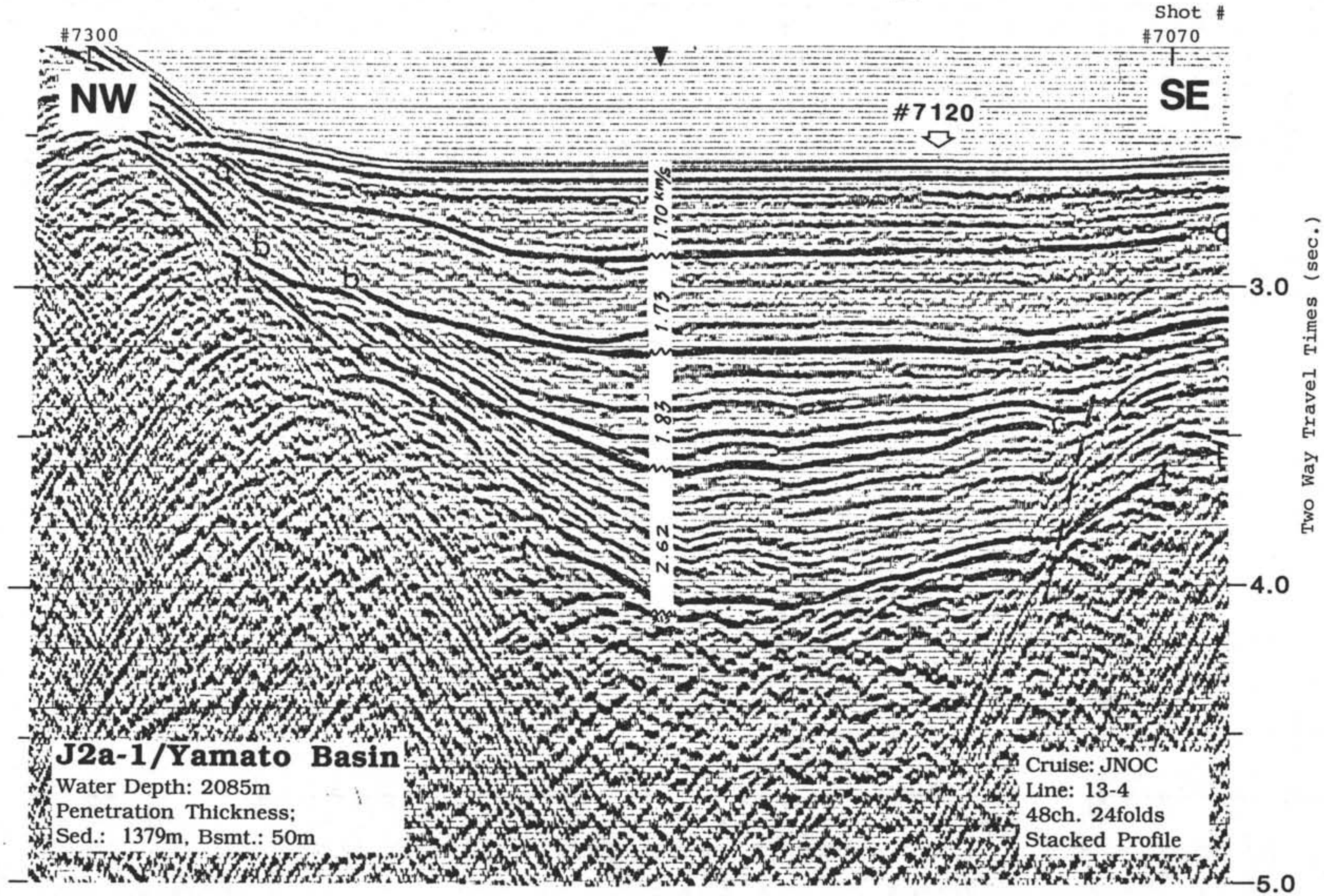
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
VSP

OBJECTIVES: Penetrate Kita-Yamato Trough; Metallogeny; Style and nature of sedimentation in failed rift; paleoceanographic history

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics


J2a-1&2
39°40'
39°00'
133°20'
134°20'
JNOC 13-4
JNOC J1
#8000
#7500
#7000
#6500
#1500
#2000
1
2



Shot #
#7300
#7070
NW
SE
#7120
1.70 km/s
1.73
1.83
2.62
a
b
b
c
a
3.0
4.0
5.0
Two Way Travel Times (sec.)
J2a-1/Yamato Basin
Water Depth: 2085m
Penetration Thickness;
Sed.: 1379m, Bsmt.: 50m
Cruise: JNOC
Line: 13-4
48ch. 24folds
Stacked Profile

SITE J2a-1

Sub-bottom depth(m)	Key reflectors, unconformities, faults, etc.	Age	Assumed velocity (km/sec)	Lithology	Paleo-environment	Average rate of sediment accumulation (m/m.y.)	Comments
			1.50	(Water)			
0	Sea floor						
0 – 264		Plio - Recent ?	1.70		Rift fill	100 ?	
264 – 548 (400)		Plio - late Miocene ?	1.73		Rift fill	100 ?	
548 – 914 (800)		Late Miocene ?	1.83		Rift fill	100 ?	
914 – 1560 (1200)		Miocene ?	2.62		Rift fill	100 ?	

SITE: J2a-2 PRIORITY: 2 (Alternate to J2a-1)

POSITION: 39°07.6'N
133°58.6'E

WATER DEPTH: 1860 m SEDIMENT THICKNESS: 880 m

PROPOSED DRILLING PROGRAM: Hole A, APC/XCB to 600 m; Hole B, RCB 100 m into basement

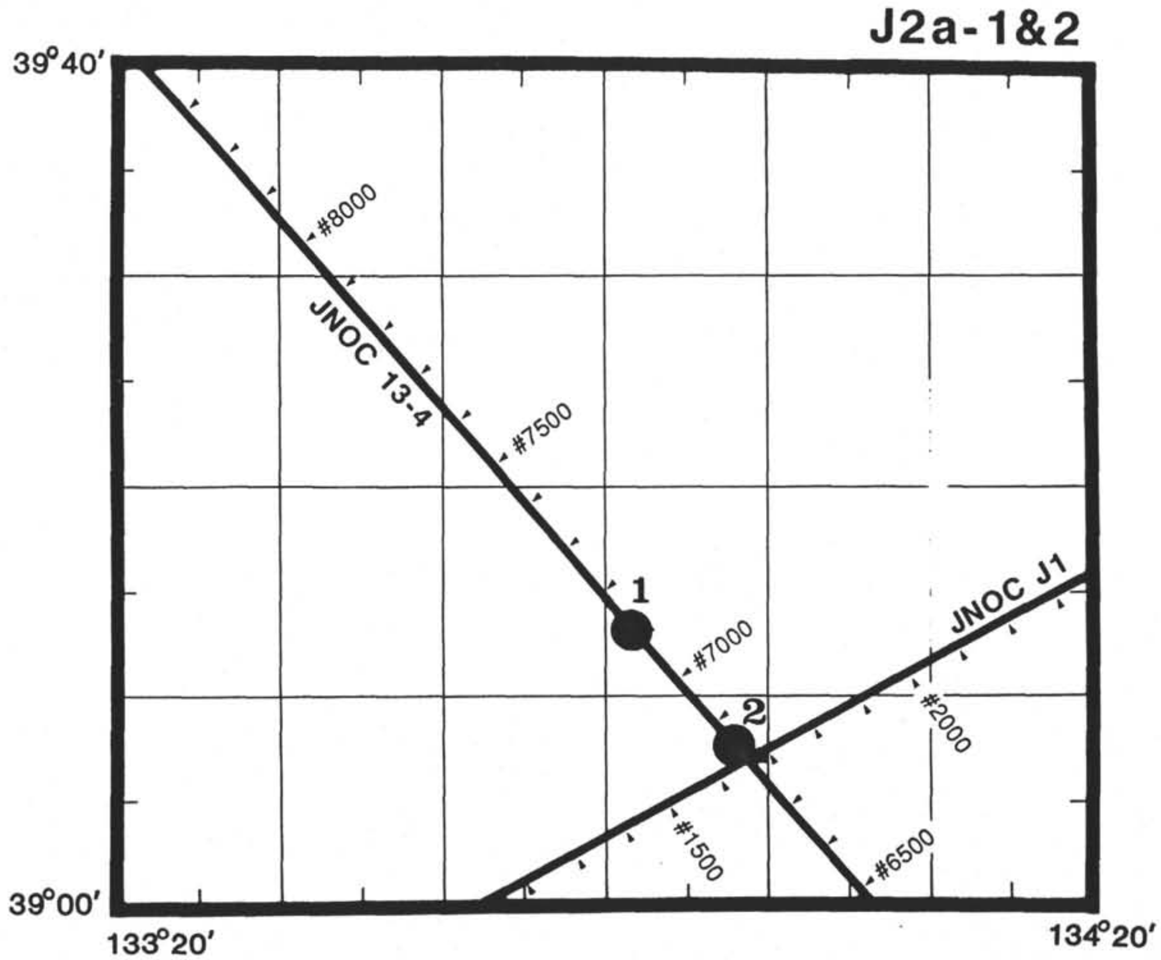
SEISMIC RECORD: JNOC: line 13-4, shot 6859

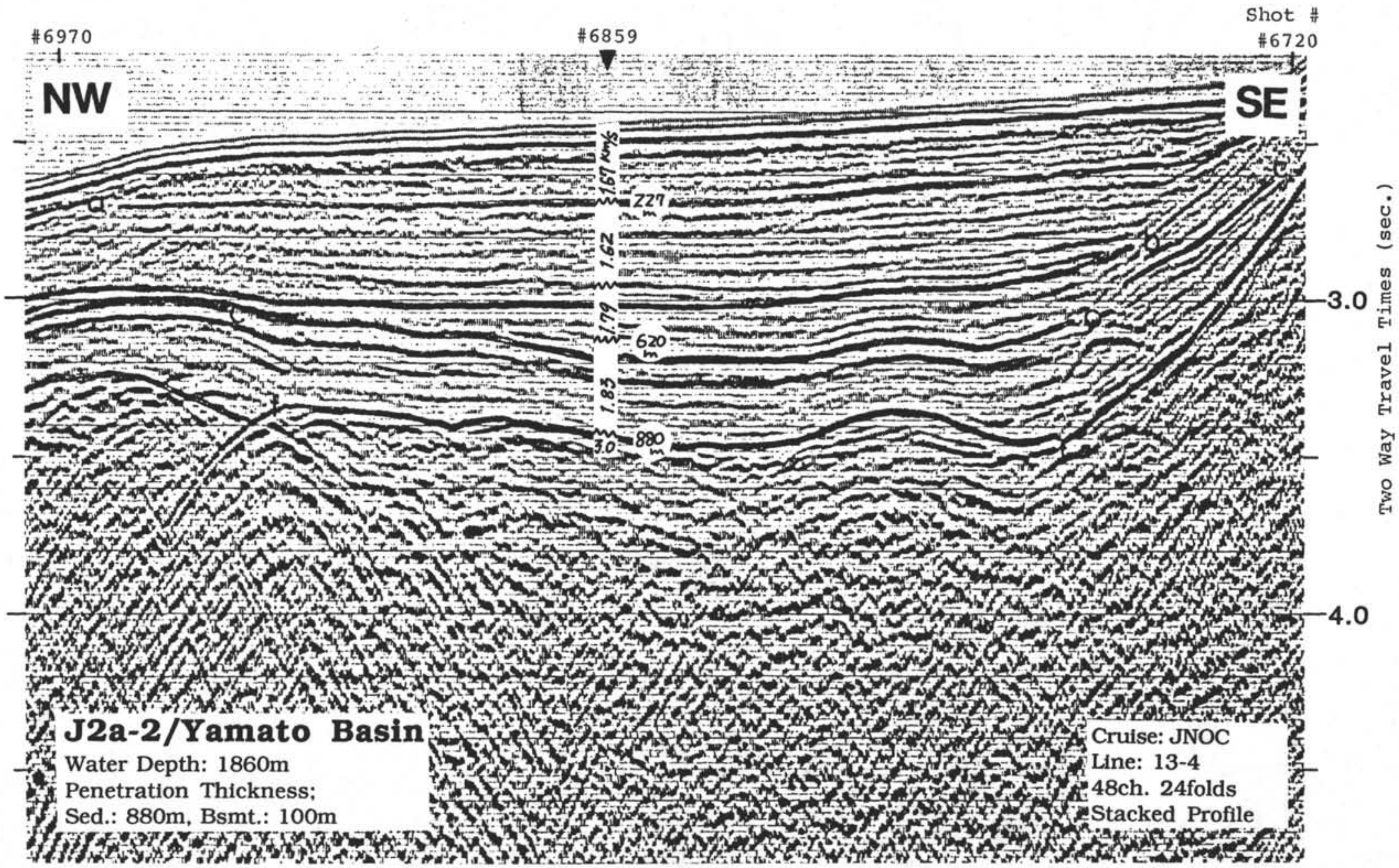
HEAT FLOW: YES WATER SAMPLER: YES

LOGGING: Standard Schlumberger logging
Formation Microscanner
VSP

OBJECTIVES: Penetrate Kita-Yamato Trough; Metallogeny; Style and nature of sedimentation; paleoceanography

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sand, silt and clay; Diatomaceous clay; Basalt+volcanoclastics


J2a-1&2
39°40′
39°00′
133°20′
134°20′
JNOC 13-4
JNOC J1
#8000
#7500
#7000
#6500
#2000
#1500
1
2


Shot #
#6970
#6859
#6720
NW
SE
1.67 km/s
227 m
1.62
1.79
620 m
1.83
3.0
880 m
3.0
4.0
Two Way Travel Times (sec.)
J2a-2/Yamato Basin
Water Depth: 1860m
Penetration Thickness;
Sed.: 880m, Bsmt.: 100m
Cruise: JNOC
Line: 13-4
48ch. 24folds
Stacked Profile

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