OCEAN DRILLING PROGRAM

LEGS 125 AND 126 SCIENTIFIC PROSPECTUS

BONIN-MARIANA ARC-TRENCH SYSTEM

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ABSTRACT

The Bonin-Mariana region is made up of a complex series of arcs and basins formed since the start of westward subduction of Pacific lithosphere in the Eocene. ODP Legs 125 and 126 have been designed to study three important and poorly understood aspects of this system, namely:

1. The origin and evolution of the forearc terranes, to be investigated by drilling a series of holes through the sediments and into the basement of the Bonin forearc basin (proposed sites BON3 through BON6) and into three serpentinite seamounts from the Mariana outer-arc high (proposed sites MAR3A and MAR3B) and Bonin lower slope terrace (proposed site BON7).
2. The process and products of arc rifting, to be investigated by drilling two holes (proposed sites BON1 and BON2) into the center and eastern wall of the Sumiso rift within the active Bonin island arc.
3. Dewatering of the subducted lithosphere, to be investigated indirectly from the composition of the forearc basin and rifted arc volcanic rocks recovered from proposed sites BON1-BON6, and directly from the analyses of fluids, chemical precipitates, and metamorphic rocks from the serpentinite seamounts at proposed sites MAR3A, MAR3B, and BON7.

TECTONIC SETTING AND EVOLUTION OF THE BONIN-MARIANA REGION

The present-day tectonic configuration of the Bonin-Mariana region (Fig. 1) comprises, from east to west: the trench; the forearc terrane, made up of an inner trench wall that in the Bonin system has a 30-km-wide along-strike terrace or ridge, an outer-arc high, a forearc basin, and a frontal-arc high; the active Izu-Bonin and Mariana island arcs; the actively spreading Mariana backarc basin; the West Mariana Ridge, a remnant arc; the Parece Vela and Shikoku marginal basins; and the Palau-Kyushu Ridge, the westernmost remnant arc. Subduction of Pacific oceanic lithosphere is currently taking place at absolute velocities between 8 and 10 cm per year to the northwest; the subduction angle is about 12° at shallow depths, steepening in some places to nearly vertical below about 80 km.

The evolution of these arc and basin systems is thought to have begun in the early-middle Eocene when westward subduction of Pacific lithosphere began beneath the West Philippine plate (Karig, 1975). Development of the system continued through the early Oligocene, forming an intraoceanic volcanic arc on top of a 200-km-wide forearc composed of volcanic rocks primarily of tholeiitic to boninitic affinities (Natland and Tarney, 1981). In the Mariana area, this arc formed on or near the edge of the West Philippine Basin whereas in the Bonin area, it formed on the edge of the Amani-Oki Daito province, a series of island arcs and intervening basins of Santonian to Paleocene age. Middle Oligocene rifting split the arc, and late Oligocene to early Miocene backarc spreading in the Parece Vela and Shikoku basins isolated a remnant arc (the Palau-Kyushu Ridge) from an active Bonin-Mariana arc (Kobayashi and Nakada, 1979). The initiation of this backarc spreading event was not synchronous along the length of the Oligocene arc. Spreading began at about 31 Ma in what became the central Parece Vela Basin and propagated both north and south, giving the basin its bowed-out shape. A second spreading episode began by 25 Ma in what became the northernmost Shikoku Basin and propagated south (Kobayashi and Nakada, 1979). By 23 Ma the two systems had joined at what is now approximately 25°N, and both basins shared a common spreading axis until spreading ceased at 17-15 Ma.

A repetition of this cycle of events began in the late Miocene when the southern part of the arc split again. Subsequently, 6-8 m.y. of spreading in the Mariana backarc basin isolated the active Mariana arc from, and increased its curvature with respect to, a remnant arc, the West Mariana Ridge (Karig et al., 1978; Hussong and Uyeda, 1981). Spreading in the Mariana backarc basin may now be propagating to the north, "unzipping" the Mariana arc from the West Mariana Ridge (Stern et al., 1984). The Bonin arc is still in the early rifting stage of backarc formation, undergoing extension along most of its length (Honza and Tamaki, 1985). The major zone of rifting lies immediately west of the active volcanic chain, but some volcanoes near 29°N are surrounded by grabens (Taylor et al., 1985; in press). Volcanism is continuing along both the active and "remnant" arcs, and volcanic centers have also developed in the rift basins. The latter contain lavas with a bimodal basalt-rhyodacite composition. The basalts have major and trace element abundances that resemble the backarc basin basalts of the Mariana backarc basin rather than the island arc basalts of the adjacent active Bonin arc (Fryer et al., 1985a).

The backarc rifts are semicontinuous along strike, segmented by structural highs and chains of submarine volcanoes extending westward from the island arc volcanoes (Taylor et al., 1985; in press). Similar volcanic cross-chains are located west of the Mariana volcanoes, and older chains extend westward into the Parece Vela and Shikoku basins from the West Mariana Ridge and Bonin arc.

The differences in arc-basin evolution between the Mariana and Bonin systems have produced corresponding differences in their forearcs. These differences are further accentuated by the fact that seamount chains and aseismic ridges on the subducting plate have collided only with the Mariana forearc and southernmost Bonin arc. The Bonin forearc has experienced little deformation since subduction began (Honza and Tamaki, 1985); thus, it comprises a broad forearc basin filled with volcaniclastic and hemipelagic sediments that developed behind an outer-arc high (Fig. 2A). Biostratigraphic dating of the strata that lap onto this high, both at sea and on its subaerial expression on the Bonin islands (Hanzawa, 1947), suggests that this high has been a positive topographic feature since its uplift in the early Eocene. Several mature, dendritic submarine canyon systems have developed across the Bonin forearc basin and the outer-arc high by mass wasting and headward erosion. These canyons have incised as much as 1 km into the 1.5-4 km thick sedimentary section (Taylor and Smoot, 1984).

The Mariana forearc has a broadly similar structure but has undergone extensive vertical uplift and subsidence resulting from seamount collision, and tensional and rotational fracturing associated with adjustments to plate subduction and to changes in configuration of the arc. These fractures have provided easy egress for rising serpentinite from the underlying mantle wedge. A broad zone of serpentinite seamounts (up to 2500 m high and 30 km in diameter), 50 to 120 km from the trench axis, occurs along the trench-slope break (outer-arc high) of the Mariana system. These seamounts are formed by the diapiric rise and eruption of serpentinite bodies (Fryer et al., 1985b; Fryer and Fryer, 1987). In the Bonin forearc, chloritized basic and serpentinized ultrabasic rocks have been dredged from a chain of local highs located less than

50 km from the trench axis along a lower slope terrace. These serpentinite seamounts may represent the nonaccretionary intraoceanic forearc analogue of dewatering zones in accretionary sedimentary wedges. Only very minor, and probably ephemeral, accretionary complexes occur at the bases of the inner walls of the Bonin and Mariana trenches.

ARC/FOREARC DEVELOPMENT: Background to Sites BON3-BON6

With the exception of dredges from inner trench walls and large fault scarps (Bloomer and Hawkins, 1983; Bloomer and Fisher, 1987; Johnson and Fryer, 1988), our direct knowledge of intraoceanic forearc basement is based primarily on data from three island chains and two Deep Sea Drilling Project (DSDP) sites: the Mariana and Tonga frontal arc islands (Guam, Saipan, and 'Eua) and the Bonin islands, which expose Eocene island arc tholeiites and boninites (Reagan and Meijer, 1984; Ewart et al., 1977; Shiraki et al., 1980); and DSDP Leg 60 Sites 459 and 458, which sampled Eocene arc tholeiites and lower Oligocene boninites and arc tholeiites, respectively, from the Mariana outer-arc high. Basement beneath the thickly sedimented upper-slope basin between the frontal arc and outerarc high has never been sampled. Only in dredge hauls at one site in the Mariana forearc, close to Conical Seamount (MAR3A), has the deep forearc basement beneath the carapace of interbedded arc pillow lavas, flows, and sills been sampled (Johnson and Fryer, 1988).[1] From the available data, it appears that the present 150-220 km wide Bonin-Mariana forearc formed in large part by volcanism during the initial stages of arc development in the Eocene and early Oligocene. Similar volcanism has not occurred since and cannot to our knowledge be studied as an active phenomenon anywhere on Earth at present.

There are three main alternative hypotheses for the origin and evolution of this forearc terrane: (1) the frontal arc and outer-arc high could have originally been continuous and subsequently

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[1]This single sample locality provides the first concrete evidence of the existence of MORB lavas in a forearc environment but cannot constitute proof of widespread occurrence of ocean ridge volcanics along the Bonin-Mariana forearc terrane.

separated by forearc spreading; (2) the frontal arc and outer-arc high could have been built separately but nearly synchronously on former West Philippine plate crust; or (3) the terrane could form part of a continuous Eocene arc volcanic province, possibly with overprints of later forearc volcanism. Each scenario of forearc basement development implies a different crustal structure for the forearcs. The question remains: how do these different structures relate to ophiolite sheets? Many authors now ascribe a majority of ophiolites to subduction-related settings because of their chemistry and associated sediments. Pearce et al. (1984) propose that supra-subduction zone (SSZ) ophiolites (having the geochemical characteristics of island arcs, but the structure of oceanic crust) formed by seafloor spreading during the initial stages of subduction prior to the development of any volcanic arc. Boninites, whose type locality is the Bonin Islands, are a common occurrence in SSZ ophiolites. They appear to require variable degrees of hydrous partial melting of a refractory source to produce wet magmas. These magmas then rise to shallow depth while maintaining fairly high temperatures to avoid amphibole crystallization. These unusual conditions may occur only during initial subduction or arc rifting. However, the eruptive style and exact tectonic setting of the Eocene volcanism is unclear. Multichannel seismic (MCS) surveys of the Bonin forearc have revealed a complicated basement which is often seismically stratified and cut by dipping reflectors. These reflection characteristics are unlike those of normal oceanic crustal sections and suggest that the Eocene volcanism may have been accompanied by stretching tectonics and/or that it was superimposed on an older arc terrane such as the Amani Plateau (Taylor et al., in press). The Bonin forearc basin drill sites, BON3 through BON6 (Fig. 2; Fig. 3), will sample the hitherto unstudied forearc basement in order to constrain some of these models for forearc evolution.

The presence of arc igneous rocks near the trench, together with observations of normal faulting in the forearc and interpretations of outer-arc subsidence, have been cited as evidence for large-scale removal of Mariana forearc material by tectonic erosion since the late Eocene (Hussong and Uyeda, 1981). This analysis has subsequently been questioned by Karig and Ranken (1983) and Hussong himself (pers. comm., 1988) who infer that the Mariana forearc has not undergone significant tectonic subsidence or erosion.

Likewise, in the Bonin forearc, the presence of shallow water Eocene fossils on the Bonin Islands, and of a well-developed submarine canyon system and lower-slope terrace elsewhere in the forearc, suggest that fairly stable conditions have prevailed since the anomalous Eocene phase of arc-basin development. This hypothesis will be tested by determining the uplift-subsidence history across the forearc, using backstripping techniques on cored/logged holes and seismic stratigraphic analyses of interconnecting MCS profiles. Microstructures in the drill cores should also help determine the intensity of faulting in space and time across the forearc terrane. We also do not know whether the frontal arc and outer-arc high developed by igneous construction or by differential uplift, or whether the upper-slope basin between them is caused by forearc spreading or differential subsidence, or whether flexural loading either by arc volcanoes or by coupling with the subducting plate is an important process. Determining the forearc vertical displacement field should provide some of the information on forearc flexure and basin development necessary to evaluate these hypotheses.

The forearc stratigraphy should also record a history of the variations in intensity and chemistry of arc volcanism, and allow the correlation of these variations with such parameters as subduction rate and backarc spreading. Karig (1975) proposed that periods of arc volcanic maxima correlated with periods of marginal basin formation and high subduction rate. Scott and Kroenke (1981) suggested rather that initial periods of backarc spreading are coincident with minimal arc volcanism. Contrary to both, Hussong and Uyeda (1981) inferred that arc volcanism has probably been continuous since the Eocene, but that the initiation of backarc spreading by arc rifting produced drastic subsidence of the arc volcanoes resulting in deep-water eruptions with limited lateral transport of volcanic material. Studies of the tephrachronology, and the frequency and geochemistry of ash and pyroclastic flow deposits in the forearc basin drill cores, will enable these various models to be evaluated. Such studies will also test whether boninitic (Beccaluva et al., 1980), alkalic (Stern et al., 1984), and/or rhyodacitic (Gill et al., 1984; Fryer et al., 1985a) volcanism characterizes periods of arc rifting.

Paleomagnetic studies of the subaerial portions of the Bonin and Mariana forearcs have shown at least 20° of northward drift and 30°

to over 90° of clockwise rotation since the Eocene (see summary in Keating et al., 1983). How and when these motions occur, and the nature of their relationship to the overall structural evolution of the forearc, are enigmatic. One model would suggest that the islands acted as "ball-bearings" between the Pacific and Philippine plates. Karig and Moore (1975) suggested that they might be an exotic terrain introduced from the south by oblique motion. However, marine geophysical data indicate a structural continuity of the Bonin Islands with the outer-arc high (Honza and Tamaki, 1985) and support the model of Keating et al. (1981) that the Bonin Islands (and therefore the Philippine plate) were situated near the Equator in the Eocene, roughly perpendicular to their present trend. If true, this has major implications for reconstructions of the Philippine and surrounding plates, and the related issues of initial subduction and West Philippine Basin evolution; paleomagnetic studies of the drill cores will enable this model to be tested and further refined.

RIFTING OF THE BONIN ARC: Background to sites BON1 and BON2

The processes associated with the rifting and subsequent separation of continental lithosphere have been a major research focus and drilling objective for some time. In contrast, the rifting of arc lithosphere prior to backarc spreading has, until recently, received almost no attention, despite the fact that similar processes and questions are involved (e.g., the extent and nature of crustal stretching, the duration of rifting, and the interaction between vertical tectonics, rift sedimentation, and volcanism). These processes may best be observed in active rifts before the syn-rift sediments are buried by arc volcaniclastics. To date, no seaward-dipping seismic reflectors, interpreted to represent massive outpourings of volcanic material, have been recognized in backarc basins. However, SeaMARC II surveys in the Bonin region have revealed widespread syn-rift volcanism, not only on the active and "remnant" arcs but in the rift basins as well (Taylor et al., in press). Most dredged samples are basalts, but andesites, dacites, and rhyolites have also been recovered. The fact that the basalts are similar to Mariana Trough basalts means that mantle relatively unmodified by a subduction component is melted even during the initial stage of backarc opening.

The best studied area of Bonin arc rifting is the Sumisu Rift, located between the active arc volcanoes of Sumisu Jima and Tori Shima (Fig. 2B). It is a graben bounded by high-angle normal faults, in which the locus of maximum subsidence lies within an inner subgraben on its eastern side (Murakami, 1988). Faulting occurs along NNE/NNW doglegs, forming an orthorhombic fabric similar to that found in continental rifts (Brown and Taylor, 1988; Taylor et al., in press). The surface sediments in the rift basin include hemipelagic muds and volcaniclastic turbidites, with both ash and pumice layers (Nishimura and Murakami, 1988). Whether the basement of the graben is formed of stretched, subsided arc crust, recently intruded crust, or some combination of the two, is unknown, as is the duration of rifting. Drilling sites BON1 and BON2 (Fig. 3), on the center and eastern flanks of the graben, respectively, will help us to determine whether volcanism began at the same time as, or subsequent to, rifting in the Mariana backarc basin (~10 Ma), whether arc volcanism continued throughout its development, and when extrusion of backarc-type basalts began.

The locus of maximum uplift and backtilting of the horst blocks that bound the basin varies back and forth along strike between the eastern and western sides of the graben. To the north and south of Tori Shima this locus lies on the eastern side (Fig. 2), whereas adjacent to this volcano it lies to the west, perhaps because volcano loading supresses the uplift. There is also some evidence of half-graben tectonics, with a master normal fault marking the edge of the dominant horst block and smaller antithetic normal faults on the other side forming the graben. However, transfer zones linking the opposed master faults are not seen in the side-scan or seismic data, and MCS profiles have not been able to determine whether the faults are listric at depth. The uplifted horst blocks are isolated from recent submarine volcaniclastic flow deposits and therefore form a good site to drill (BON2), both to determine the differential vertical tectonics with respect to the graben and to penetrate into the older arc basement.

The tectonic setting and volcanic associations of the Bonin rifts are similar to those of the Kuroko district in Japan during its ore-forming period at about 13-14 Ma (Cathles et al., 1981; Fujioka, 1983). Iron hydroxide and barite deposits sampled with ALVIN from the rhyolite caps of the basalt ridges in the Sumisu Rift (Taylor et al., 1987) have similar trace metal abundances to the iron chert (*Tetsusekei*) overlying the Kuroko massive sulfide deposits (Urabe, pers. comm., 1988). The chemistry of the fluids responsible for precipitating these deposits, and presumably sulfide deposits at depth, is unknown. Heat flow measurements in the rift basin require hydrothermal circulation to explain the locally high but widely variable values ranging from 12 to 700 mW m^{-2} (Yamazaki, 1988; pers. comm., 1988). Drilling in the Sumisu rift will thus enable us to investigate the metallogenic implications of arc rifting.

SERPENTINITE SEAMOUNTS: background to sites MAR3A, MAR3B, and BON7

Drilling of Mariana and Bonin forearc sites in serpentinite materials will address the problems of the nature and origin of serpentinite in nonaccretionary, intraoceanic forearcs and provide information on the dewatering of the lithosphere during subduction, the composition of the mantle wedge, and the development of the outer forearc regions of intraoceanic island arcs.

Conical Seamount, the site for MAR3A (the summit site) and MAR3B (the flank site) (Fig. 4), is in the broad zone of forearc seamounts along the Mariana outer-arc high. It is a roughly circular seamount, rising 2000 m above the seafloor a distance of 100 km from the trench axis. Recent flows of unconsolidated sedimentary serpentinite mantle its surface, and there is evidence within the edifice for recent deformation of the forearc sedimentary and basement sequences. Fluids are seeping from chimneys and related structures on the summit of the seamount, precipitating carbonate and silicate compounds that are cementing the uppermost portion of the sedimentary serpentinite flows (Fryer et al., 1987). Hydration of the crust and upper mantle of the forearc wedge is clearly facilitated by the escape of fluids from the subducting Pacific plate (Fryer et al., 1985b; Fryer and Fryer, 1987) and thermal modeling suggests that large regions beneath the forearc lie within the chlorite, greenschist, and blueschist stability fields. The mantle and lower crust of the forearc wedge can thus readily accommodate large volumes of fluids through metamorphic processes (Fryer and Fryer, 1987). Under appropriate tectonic conditions, serpentinite diapirs could be emplaced in any nonaccretionary forearc. Forearc serpentinite deposits have indeed been identified in the circum-

Pacific, Mediterranean, and Caribbean areas. However, none of these areas is known to show development of serpentinite diapirism on the scale of that in the Mariana system. By comparison with modern forearcs, the Mariana forearc is more extensively deformed (Fryer and Fryer, 1987). Conical Seamount is one of only two Mariana forearc seamounts where active protrusion of sedimentary serpentinite is known to be occurring at present. Conical Seamount therefore provides an *in situ* locality for studying the formation of diapirically emplaced sedimentary serpentinite bodies and their associated mineral deposits.

Drilling at proposed site MAR3A will enable us to investigate (1) the mechanical properties of the diapiric neck and emplacement mechanism of the diapir, (2) the composition of the associated fluids and entrained metamorphosed xenoliths, and (3) the compositional and physical variability of the rising diapiric material in order to determine the potential for ore deposition within the diapir. At proposed site MAR3B we will investigate the history of uplift and metasomatism of the surrounding country rock near the diapiric neck. While these immediate objectives are site specific, they apply to the understanding of several larger questions. The most obvious of these are the relationship of diapirism to the history of development of the forearc region of an intraoceanic arc system, and the geochemical mass balance of the subduction process. The diapirs provide "windows" through which we can observe the alteration and metamorphism of the central forearc at depth by components derived from the subducting slab, and through which we can trace the changes in P-T regimes of the deep forearc.

The physical properties of the diapir and the mechanism of its emplacement will be studied in greatest detail at MAR3A. The rising serpentinite diapirs in the Mariana forearc entrain deep-seated fluids as they are rising and lose these fluids during protrusion of the serpentine flows onto the surface. There is strong evidence that settling of the flows occurs soon after they are erupted, perhaps owing to the escape of entrained fluids. Once the rising diapir has stopped erupting and/or stopped venting fluids, it is likely that the density of the serpentinite increases. It is possible that the physical properties of the diapir will change with depth as well as with age. Documenting such changes and the study of the physical properties of the diapiric material will allow us better to interpret sedimentary serpentinite deposits studied in subaerial exposures such as those of the basal Great Valley sequence in Napa County, California (Phipps, 1984). The rate of uplift of the seamounts as the diapirs rise beneath them will also be investigated. Drilling on the south flank of Conical Seamount (MAR3B) should provide sufficient stratigraphy to allow determination of the uplift rate of the seamount.

Studies of the composition of fluids actively seeping from chimney structures on Conical Seamount have revealed high pH (9.28 vs. 7.72 for ambient seawater), high alkalinity (5.53 vs. 2.41 meq/L) and enrichment in CH_4 (1,000 vs. 2.1 nM), SiO_2 (0.75 vs. 0.12 mM), SO_4 (30.4 vs. 28.6 mM), and H_2S (2.1 mM vs. not detected) (Tilbrook, pers. comm., 1988). The CH_4 and H_2S detected in the vent fluids are particularly interesting. Since the Mariana forearc has only a small volume of sedimentary substrate (Hussong and Uyeda, 1981) with organic carbon contents typically less than 0.3% (Schorno, 1981), the methane and sulfide in the Mariana vent fluids are unlikely to have formed by the biogenic processes associated with accretionary complexes (Kulm et al., 1986). Rather, they were probably generated during serpentinization reactions. Overall, the chemical analyses of these fluids imply that deep-seated serpentinization processes, juvenile mantle fluids, interaction of seawater with crustal rocks, and interactions of seawater with the surficial serpentinite may all contribute to the composition of the fluids.

Trace element and stable isotopic compositions of the carbonate chimney materials from Conical Seamount are also consistent with deposition from serpentinite related fluids that contained components either from the forearc mantle or from the subducted slab or both (Haggerty, 1987). Compared with fracture zone carbonates thought to have a dominantly seawater origin, for example, Mariana aragonite is depleted in Sr (Mariana samples = 7,000-9,400 ppm; fracture zone aragonite = 9,500-11,600 ppm), enriched in Mg (Mariana = 750-6,300 ppm, fracture zone < 300 ppm), and has a significantly lighter carbon isotopic signature (Mariana = -1.2 to -21.2 ‰, fracture zone = +0.03 to +1.12 ‰) and heavier oxygen isotopic signature (Mariana = +5.1 to +7.6 ‰, fracture zone = +3.16 to +4.87 ‰). These values are consistent with an origin involving seawater interactions with ultramafics, and are consistent with derivation from dewatering of subducted oceanic lithosphere and/or from the mantle underlying the forearc. By detailed sampling at depth within the serpentinite body and in the neighboring country rock, it should be possible to constrain either the nature of the shallow level reactions influencing the fluid composition or the possible sources of the fluids.

Several sedimentary serpentinite deposits on land have yielded ore-grade deposits of a variety of compounds, nickel/iron, mercury, chromium, and native gold. The nature of these deposits depends on the local oxidation-reduction conditions of the rising diapir. Drilling is the only way in which to secure samples that will allow us to constrain the small-scale variations in conditions of fluids within the serpentinite.

The process of serpentinization of forearc materials will be investigated not only at the Mariana sites, but also at proposed site BON7 on the outermost part of the Bonin forearc (Figs. 2 and 3). Serpentinites in the Bonin forearc are found along the lower slope terrace, 20-30 km wide, which runs along the inner wall of the Bonin Trench (Taylor and Smoot, 1984). Swath-mapping shows that this feature is not a simple linear structural ridge. It is composed of a series of seamounts spaced at intervals of 15 to 40 km, with summit depths between 4 and 7 km. Salients on some of the seamounts appear geomorphically similar to rift zones on volcanic seamounts. However, several dredges and one core from seamounts along this ridge have yielded serpentinized harzburgite, metamorphosed gabbro, dolerite, and basalt, and their sedimentary derivatives (serpentinite breccia, sandstone, and mudstone). SeaMARC II surveys of the three domes south of 32°N indicate sedimented slopes with some radial debris flows, and seismic reflection profiles along and across the domes reveal an acoustically chaotic basement with thin or no sediment cover (Fig. 3). Most of the inner trench wall, both above and below the terrace, has been stripped of sediment, presumably by slumping. However, sediments showing complex unconformities, both turbidite deposits and pelagic sequences, are ponded behind the domes, drape their lower flanks, and fill the lows between them. BON7 is situated on the flank of one of these domes. The major objectives in studying the serpentinite in these two forearc locations are (1) to compare and contrast the nature and genesis of greenschist facies metamorphism in the forearc regime and (2) to establish end members for investigations of geochemical mass balance and fluid flux in convergence zones.

DRILLING OBJECTIVES

The Bonin and Mariana regions are the best studied intraoceanic arc-trench systems. They are the type examples with which other older or less well-studied systems are compared. Yet fundamental questions about their evolution remain with regard to (1) arc rifting, (2) arc/forearc magmatism and structure, (3) arc/forearc stratigraphy and vertical tectonics, and (4) outer forearc serpentinite diapirism. To address these questions, Legs 125 and 126 have the following objectives:

Bonin sites BON1 and BON2 (Leg 126) seek to determine:

1. the differential uplift/subsidence history of the rift basin and adjacent arc,
2. the nature of volcanism and sedimentation in the rift and on the arc,
3. the duration of rifting and the nature of the rift basement, and
4. the chemistry of hydrothermal fluids circulating in the rift basin.

Bonin sites BON3-BON5 (Leg 126) and BON6 (Leg 125) seek to determine:

1. the uplift/subsidence history across the forearc to provide information on forearc flexure and basin development as well as the extent of tectonic erosion,
2. the stratigraphy of the forearc with its record of: (a) sedimentation, depositional environment and paleoceanography; and (b) the variations in intensity and chemistry of arc volcanism over time;
3. the nature of igneous basement forming the frontal arc, outer-arc high and beneath the intervening basin, to answer questions concerning the initial stages of subduction-related volcanism, the origin of boninites, and the formation of the 200 km wide arc-type forearc crust, and
4. the micro-structural deformation and the large scale rotation and translation of the forearc.

Mariana sites MAR3A and MAR3B and Bonin site BON7 (Leg 125) seek to determine:

1. the timing and mechanism of emplacement of the serpentinite seamounts, including their internal fabric, fracture patterns and flow structures,

2. the chemistry and hence source of the associated fluids, and

3. the conditions at depth in the outer forearc from the igneous and metamorphic petrology of the lower crust/upper mantle rocks.

OPERATIONS PLAN

Nine primary and five alternate sites have been identified to meet the cruise objectives of Legs 125 and 126. Leg 125 is scheduled to drill proposed sites MAR3A, MAR3B, BON6A, BON6B, and BON7; alternate sites for drilling on that cruise are BON6C and BON6 (Table 1a). Leg 126 is scheduled to drill proposed sites BON1A, BON2, BON5B, and BON4 in that order; alternate sites are BON1, BON3, and BON5A (Table 1b).

Leg 125

Leg 125 is scheduled to leave Guam on 20 February 1989 and arrive in Tokyo on 18 April 1989, after 57 operational days at sea (Table 2a). The cruise will first occupy the serpentinite diapir sites in the Mariana region (MAR3A and MAR3B). Both sites will be APC/XCB-cored to refusal, followed by RCB coring to the total depth of 700 m (or deeper if time permits) at each site. The holes will be logged with the standard Schlumberger suite. In addition, wireline packer measurements will be made and the borehole televiewer run at MAR3B.

Leg 125 will then transit to the Bonin region and drill sites BON6A and BON6B. Both sites will be APC/XCB-cored to basement. RCB coring 150 m into basement will be accomplished in a second hole at each site. Standard Schlumberger logs, borehole televiewer, magnetic/susceptibility, and packer runs will be made at both sites. As time permits, a reentry cone will be set at BON6A.

Finally, Leg 125 will core site BON7, with the APC/XCB in a first hole to refusal followed with the RCB to a total depth of ~500 m in a second hole. Standard Schlumberger data will be collected.

Leg 126

Leg 126 is scheduled to leave Tokyo on 23 April 1989 and return to Tokyo on 19 June 1989, after 57 operational days (Table 2b). A standard reentry cone will be set at Site BON2; mini-cones may be used at the other sites if drilling conditions so dictate.

Standard Schlumberger logging and formation microscanner (FMS) data will be collected at all sites. The wireline packer and vertical seismic profiler (VSP) will be run at sites BON1A and BON2. A magnetic/susceptibility log will also be run at site BON2. If time allows, Leg 126 will also re-occupy the reentry hole established during Leg 125 at site BON6A and run the FMS and VSP tools in that hole.

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Table 1a: Leg 125 proposed drill sites

Site #	Latitude/ Longitude	Water Depth (m)	Penetration (m) (sed)	(bsmt)	Time Estimates (days) Drill[1]	Log[2]	Total
MAR-3A	19°32.5'N 146°39.6'E	3112	700	-	8.0	1.6	9.6
MAR-3B	19°27.0'N 146°39.0'E	3450	700	-	8.0	2.0	10.0
BON-6A	30°50.5'N 140°55.0'E	2625	600	150	12.8	2.3 (reentry site)	15.1
BON-6B	30°53.5'N 141°18.0'E	2970	400	150	7.0	2.1	9.1
BON-7	30°58.0'N 141°48.0'E	4600	150	350	7.3	1.5	8.8
					TOTAL		52.6
ALTERNATE SITES							
BON-6C	31°52.5'N 141°14.0'E	3100	150	50	3.4	0	3.4
BON-6	31°54.0'N 141°06.0'E	2850	950	150	21.1	2.8 (reentry site)	23.9

[1]Drilling Plan:
MAR-3A/MAR-3B/BON-7: APC/XCB to refusal; RCB to T.D.
BON-6A: APC/XCB to basement; reentry RCB to T. D.
BON-6B: RCB to T. D.

[2]Logging Plan:
Two Schlumberger runs at each site (FMS not available).
Wireline packer at MAR-3A/MAR-3B/BON-7.
Packer and magnetometer/susceptibility at BON-6A and BON-6B.
Borehole televiewer at MAR-3B/BON-6A/BON-6B.

Table 1b: Leg 126 proposed drill sites

Site #	Latitude/ Longitude	Water Depth (m)	Penetration (m) (sed)	Penetration (m) (bsmt)	Time Estimates (days) Drill[1]	Log[2]	Total
BON-1A	30°55.0'N 139°51.5'E	2270	1050	-	10.1	3.5	13.6
BON-2	30°55.0'N 140°00.0'E	1100	1200	-	11.6	3.6 (reentry site)	15.2
BON-5B	32°23.0'N 140°48.0'E	3400	800	100	11.0	1.6	12.6
BON-4	32°24.0'N 140°23.0'E	1800	850	50	8.4	1.4	9.8
BON-6A	30°50.5'N 140°55.0'E	2625	-	-	1.0	1.5	2.5
					TOTAL		53.7
ALTERNATE SITES							
BON-1	30°55.0'N 139°52.5'E	2270	1050	-	10.1	2.3	12.4
BON-3	31°32.0'N 140°17.4'E	1430	860	40	6.8	1.4	8.2
BON-5A	32°26.0'N 140°47.0'E	2700	925	-	8.5	1.5	10.0

[1]Drilling Plan:

BON-1A: Hole A: APC/XCB to 300 m
Hole B: RCB to T.D. with free-fall funnel

BON-2: Hole A: Exploratory APC/XCB hole to 500 m
Hole B: RCB reentry hole to T.D.

BON-4 and BON-5B: RCB to T.D. with free-fall funnel

[2]Logging Plan:

Formation microscanner and 2 Schlumberger runs at each site. Wireline packer at BON-1A and BON-2. Magnetometer/susceptibility at BON-2. Induced polarization at BON-1A. Vertical seismic profile at BON-1A and BON-2. Return to BON-6A (drilled on Leg 125) for FMS and VSP.

Table 2a: Leg 125 tentative drilling schedule

	Date	Time on Site (days)	Transit time* (days)
Leg 125 departs Guam on 20 February 1989			
Transit from Guam to MAR-3A			1.0
AR MAR-3A	21 Feb	9.6	
LV MAR-3A	3 March		
AR MAR-3B	3 March	10.0	
LV MAR-3B	12 March		
Transit MAR-3B to BON-6A			1.0
AR BON-6A	13 March	15.1	
LV BON-6A	28 March		
AR BON-6B	28 March	9.1	
LV BON-6B	6 April		
AR BON-7	6 April	8.8	
LV BON-7	15 April		
Transit to Tokyo			1.0
Contingency = 2 days			
AR Tokyo	18 April		

*Transit time assumes average speed of 10 kt.

Table 2b: Leg 126 tentative drilling schedule

	Date	Time on Site (days)	Transit time* (days)
Leg 126 departs Tokyo on 23 April 1989			
Transit from Tokyo to BON-1A			1.0
AR BON-1A	24 April	13.6	
LV BON-1A	8 May		
AR BON-2	8 May	15.2	
LV BON-2	24 May		
AR BON-5B	24 May	12.6	
LV BON-5B	5 June		
AR BON-4	5 June	9.8	
LV BON-4	15 June		
AR BON-6A	15 June	2.5	
LV BON-6A	18 June		
Transit to Tokyo			1.0
AR Tokyo	19 June 1989		

*Transit time assumes average speed of 10 kt.

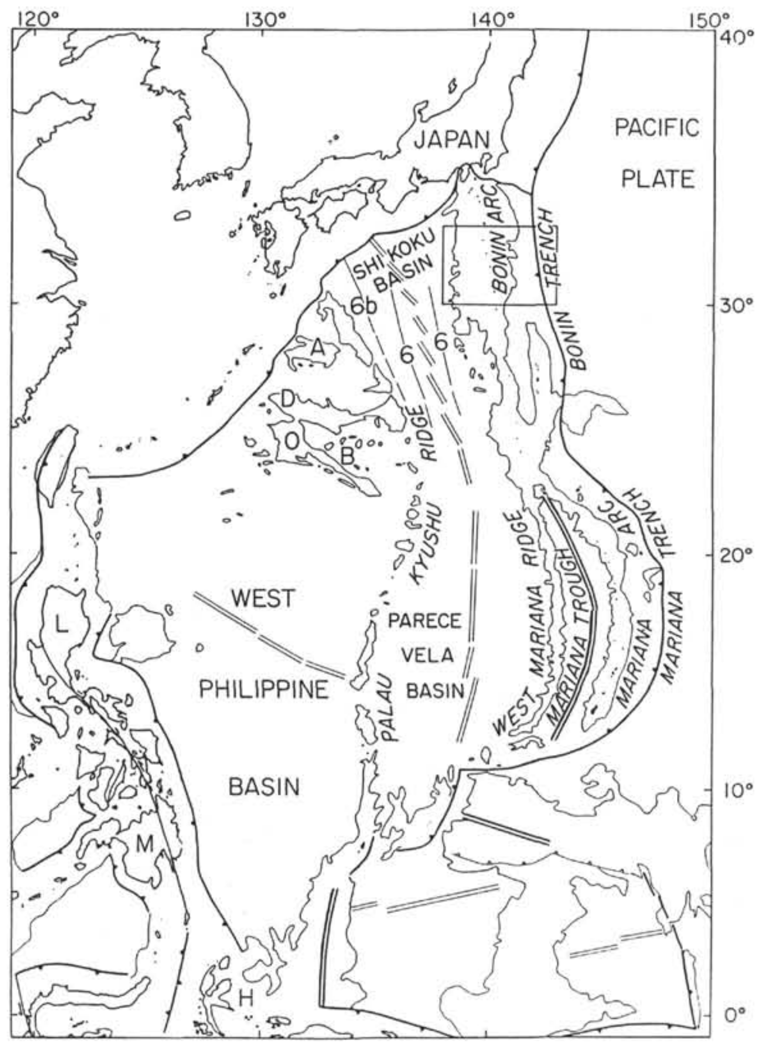


Figure 1: Active plate boundaries and relict spreading centers in the Philippine Sea region. Barbed lines locate subduction zones, medium double lines locate active spreading centers, and thin double lines locate relict spreading centers. Basins and ridges are outlined by the 4-km bathymetric contour, except for the Bonin, West Mariana and Mariana arcs which are outlined by the 3-km contour. Magnetic anomalies 6 and 6B are shown by single thin lines in the Shikoku Basin.
A: Amami Plateau. B: Daito Basin. D: Daito Ridge. H. Halmahera.
L: Luzon. M: Mindanao. O: Oki-Daito Ridge. Box shows location of Figure 2.

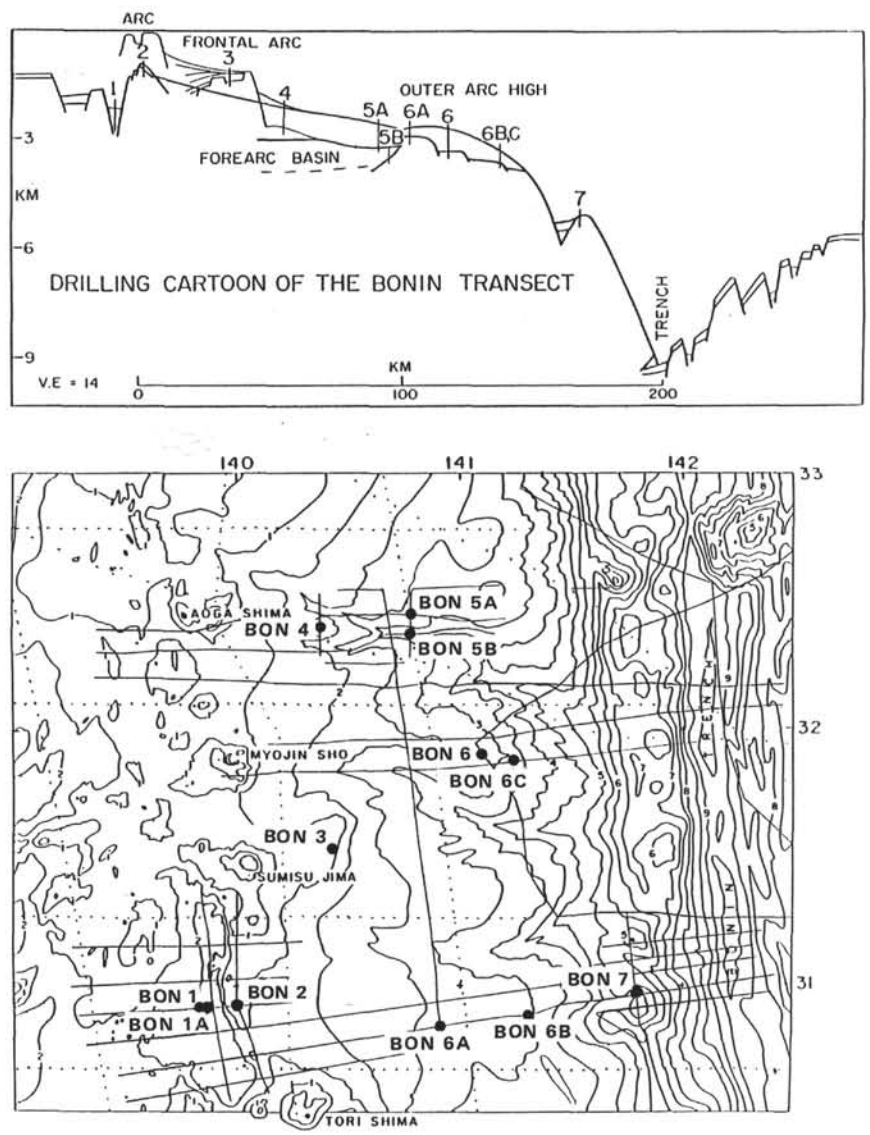


Figure 2: Location of multichannel seismic profiles and proposed ODP drill sites in the Bonin region.

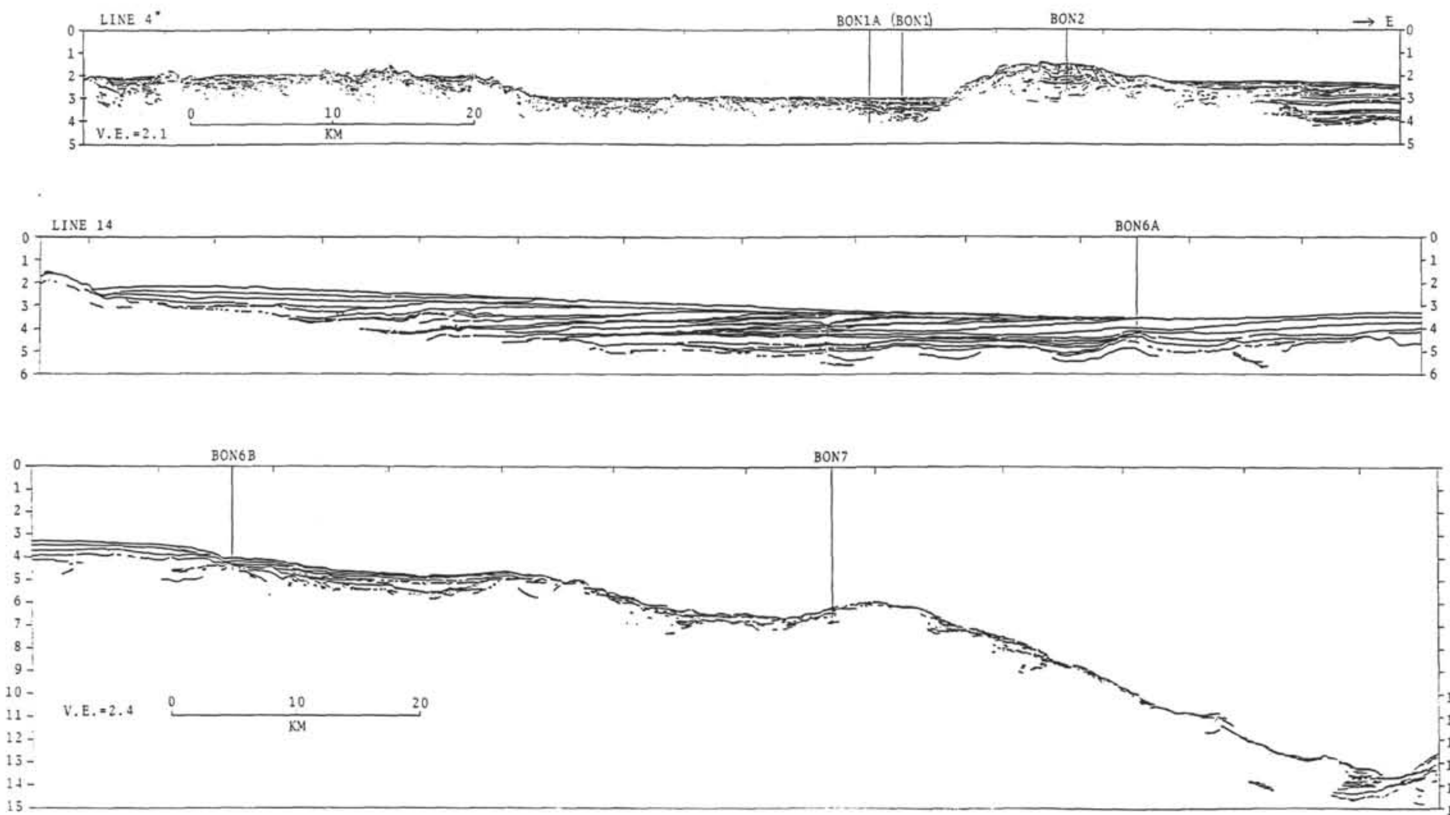


Figure 3: Line drawing of MCS profiles across the Bonin arc-trench system at 31°N showing the location of proposed ODP drill sites.

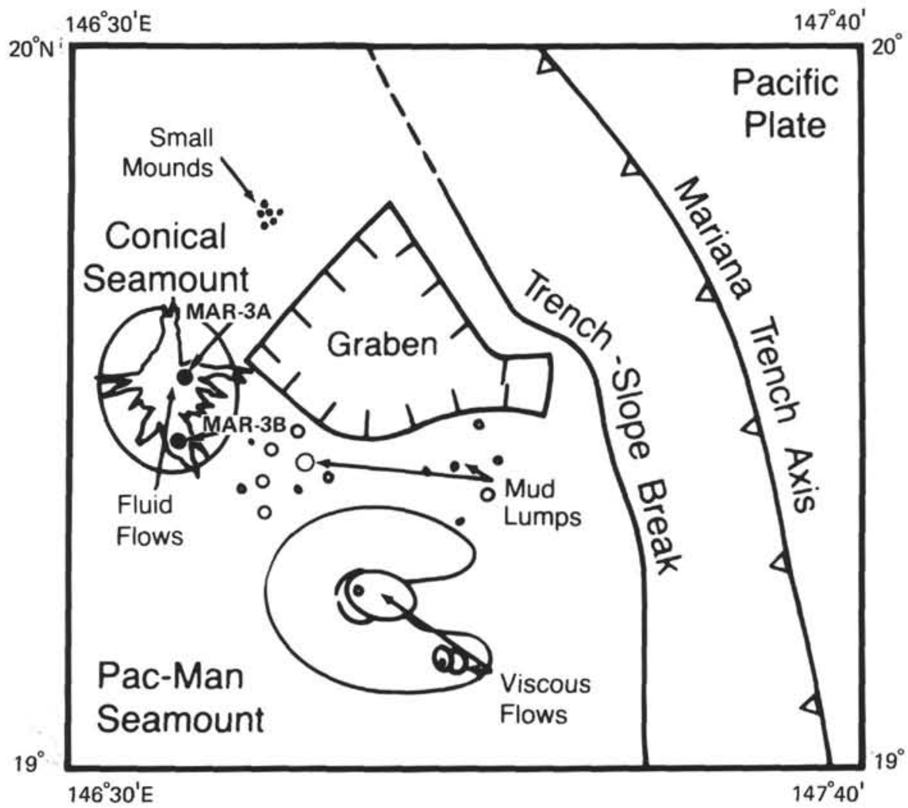


Figure 4: Mariana forearc geologic sketch.

SITE: MAR3A PRIORITY: 1

POSITION: 19°32.5'N
146°39.6'W

WATER DEPTH: 3112 m SEDIMENT THICKNESS: 700+ m

PROPOSED DRILLING PROGRAM: APC/XCB to refusal; RCB if required.

SEISMIC RECORD: Fred Moore October 1987: line DS-3, shot 798; line DS-1, shot 1027.

HEAT FLOW: Yes WATER SAMPLER: Yes

LOGGING: Standard Schlumberger logging
Wireline packer

OBJECTIVES: To penetrate the neck of a rising serpentinite diapir.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Unconsolidated sedimentary serpentinite (clays + carbonate).

SITE: MAR3B

PRIORITY: 1

POSITION: 19°27'N
146°39'E

WATER DEPTH: 3450 m

SEDIMENT THICKNESS: 105 m sedimentary serpentinite,
360 m consolidated serpentinite,
810 m silicified vitric siltstone/sandstone

PROPOSED DRILLING PROGRAM: APC/XCB to refusal, RCB into basement.

SEISMIC RECORD: Fred Moore, October 1987: line DS-3, shot 860

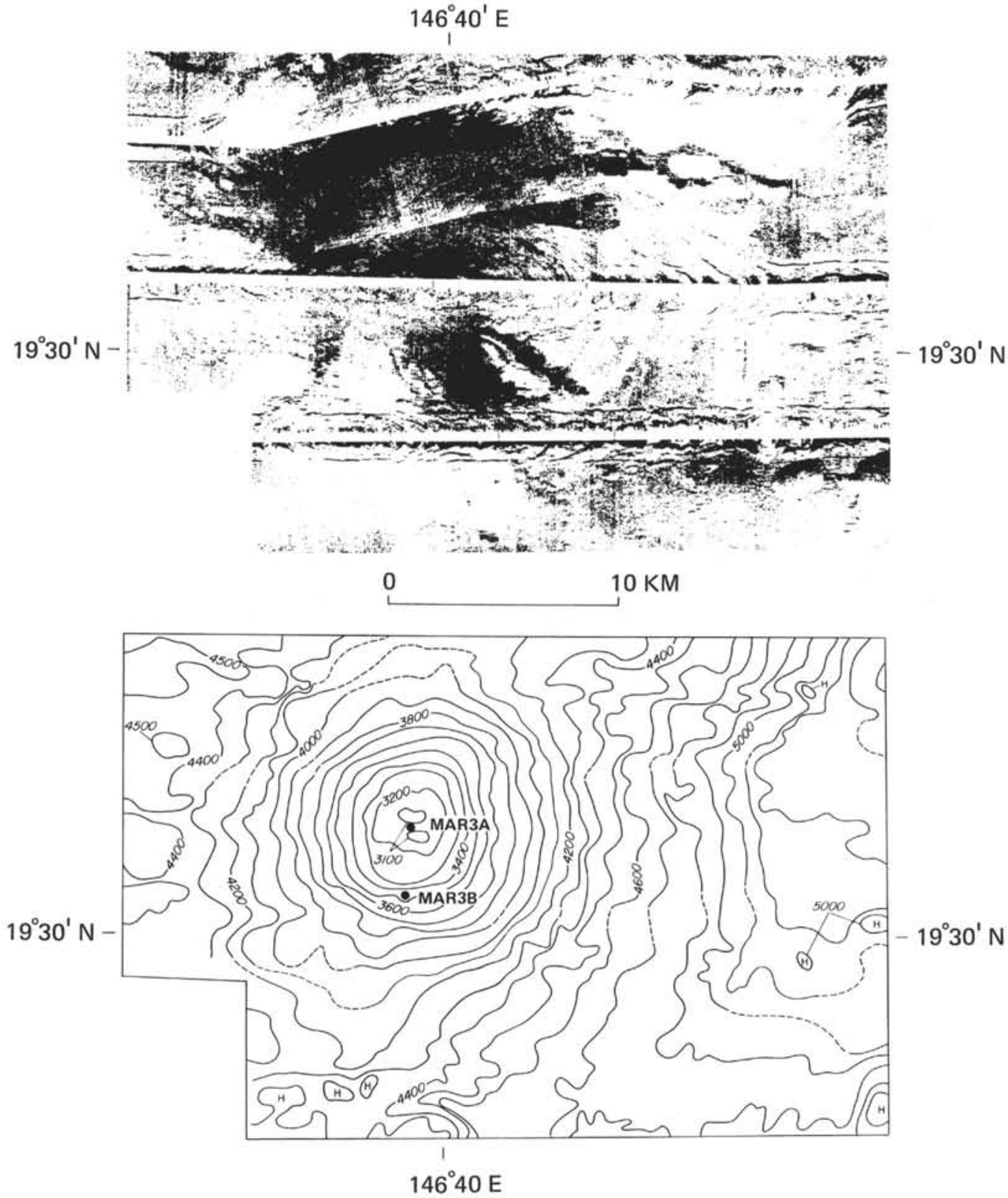
HEAT FLOW: Yes

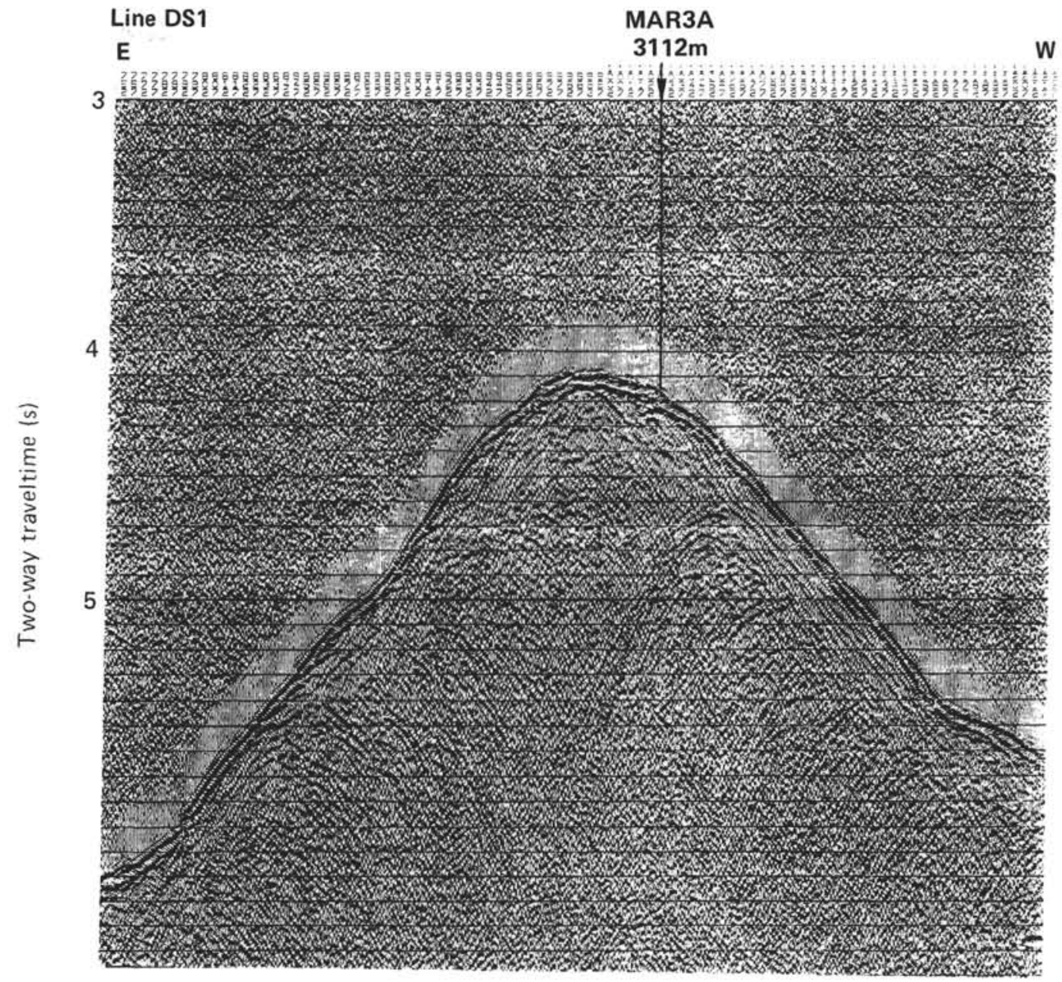
WATER SAMPLER: Yes

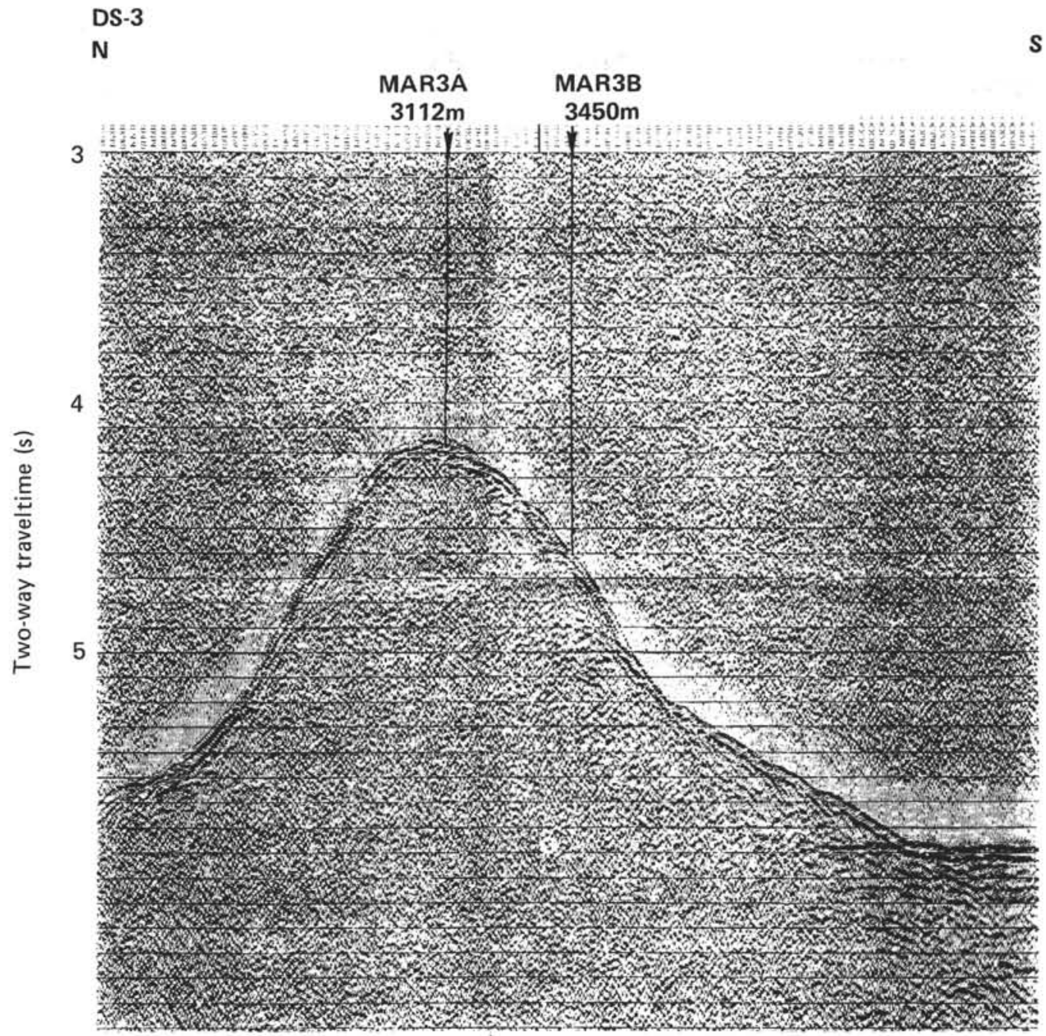
LOGGING: Standard Schlumberger logging
Borehole televiewer
Wireline packer

OBJECTIVES: To penetrate through flank flows of sedimentary serpentinite into underlying sediments (and crystalline basement if possible).

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Sedimentary serpentinite flows, vitric clay/silt, silicified siltstone/sandstone.


146°40' E
19°30' N
19°30' N
0
10 KM
4500
4500
4400
4000
3800
3200
MAR3A
3100
3400
3600
MAR3B
4200
4400
4200
4600
4400
5000
5000
H
19°30' N
19°30' N
4400
146°40 E


Line DS1
E
MAR3A
3112m
W
3
4
5
Two-way traveltime (s)


DS-3
N
S
MAR3A
3112m
MAR3B
3450m
3
4
5
Two-way traveltime (s)

SITE: BON-1

PRIORITY: 2 (Alternative to BON-1A)

POSITION: 30°55'N
139°52.5'E

WATER DEPTH: 2270 m

SEDIMENT THICKNESS: ≥1000 m

PROPOSED DRILLING PROGRAM:

Hole A: APC/XCB to 400 m
Hole B: RCB to 1050 m with free-fall funnel

SEISMIC RECORD: Fred Moore 3507 at intersection of lines 4 (2005Z) and 8 (0025Z)

HEAT FLOW: Yes

WATER SAMPLER: Yes

LOGGING: Standard Schlumberger logging
Formation microscanner
Induced polarization
Vertical seismic profiling
Wireline packer

OBJECTIVES: (1) Nature and age of syn-rift sedimentation and volcanism, (2) Nature and age of pre-rift sedimentation and volcanism, (3) History of vertical motion, (4) Nature of fluids and mineralization.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Syn-rift: volcaniclastic and hemipelagic sediments with pumice and ash layers; pre-rift: as above, with intercalated arc lavas.

SITE: BON-1A

PRIORITY: 1

POSITION: 30°55'N
139°51.5'E

WATER DEPTH: 2270 m

SEDIMENT THICKNESS: ≥1030 m

PROPOSED DRILLING PROGRAM: Hole A: APC/XCB to 300 m
Hole B: RCB to 1050 m with free-fall funnel

SEISMIC RECORD: Fred Moore 3507, line 4 (1950Z)

HEAT FLOW: Yes

WATER SAMPLER: Yes

LOGGING: Standard Schlumberger logging
Formation microscanner
Induced polarization
Vertical seismic profiling
Wireline packer

OBJECTIVES: (1) Nature and age of syn-rift sedimentation and volcanism, (2) Nature and age of pre-rift sedimentation and volcanism, (3) History of vertical motion, (4) Nature of fluids and mineralization.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Syn-rift: volcaniclastic and hemipelagic sediments with pumice and ash layers; pre-rift: as above, with intercalated arc lavas.

SITE: BON-2 PRIORITY: 1

POSITION: 30°55'N
140°00'E

WATER DEPTH: 1100 m SEDIMENT THICKNESS: >2 km, interbedded with lavas.

PROPOSED DRILLING PROGRAM: RCB to 1200 m with reentry cone.

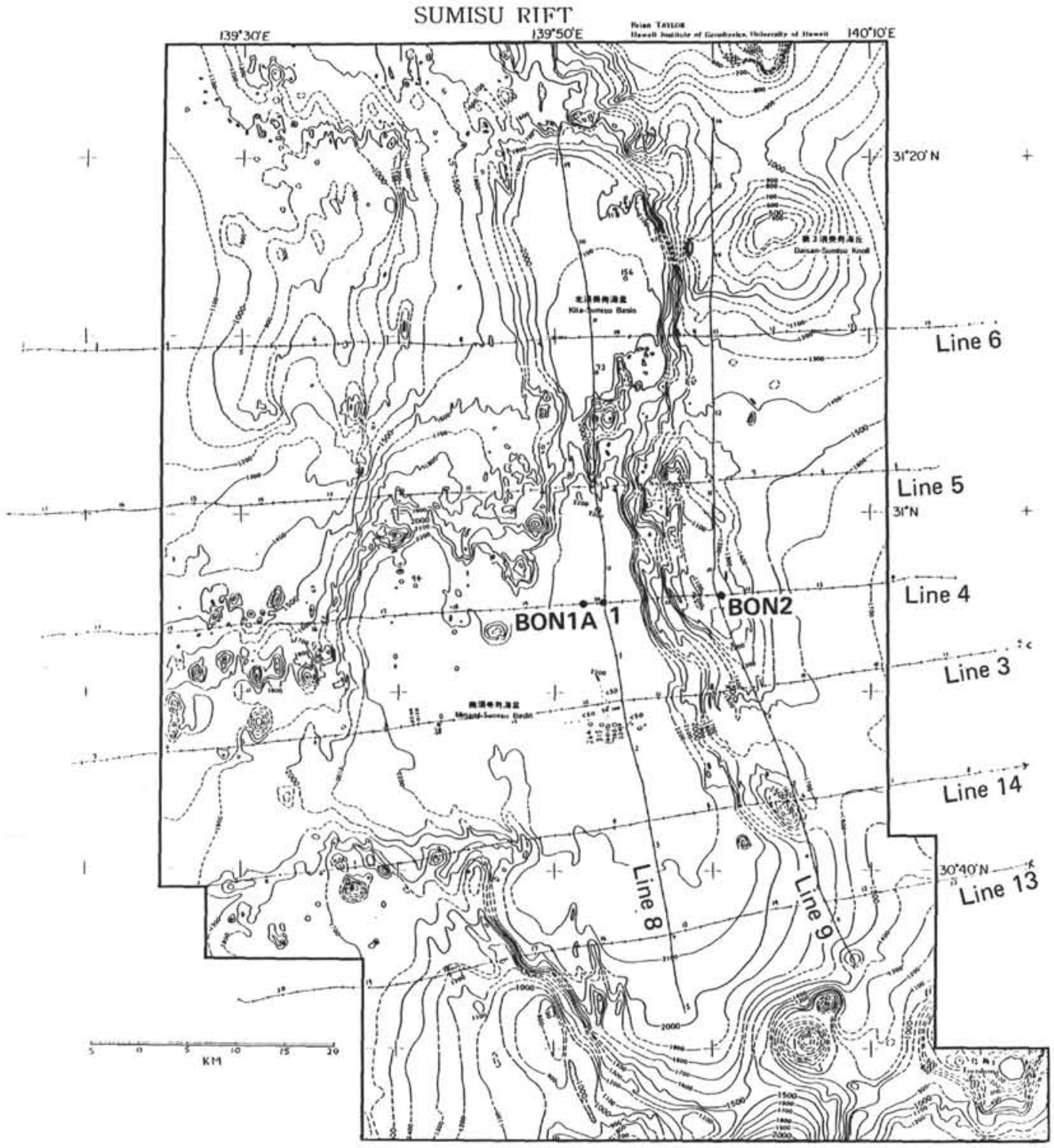
SEISMIC RECORD: Fred Moore 3507 at intersection of lines 4 (2140Z) and 9 (0943Z).

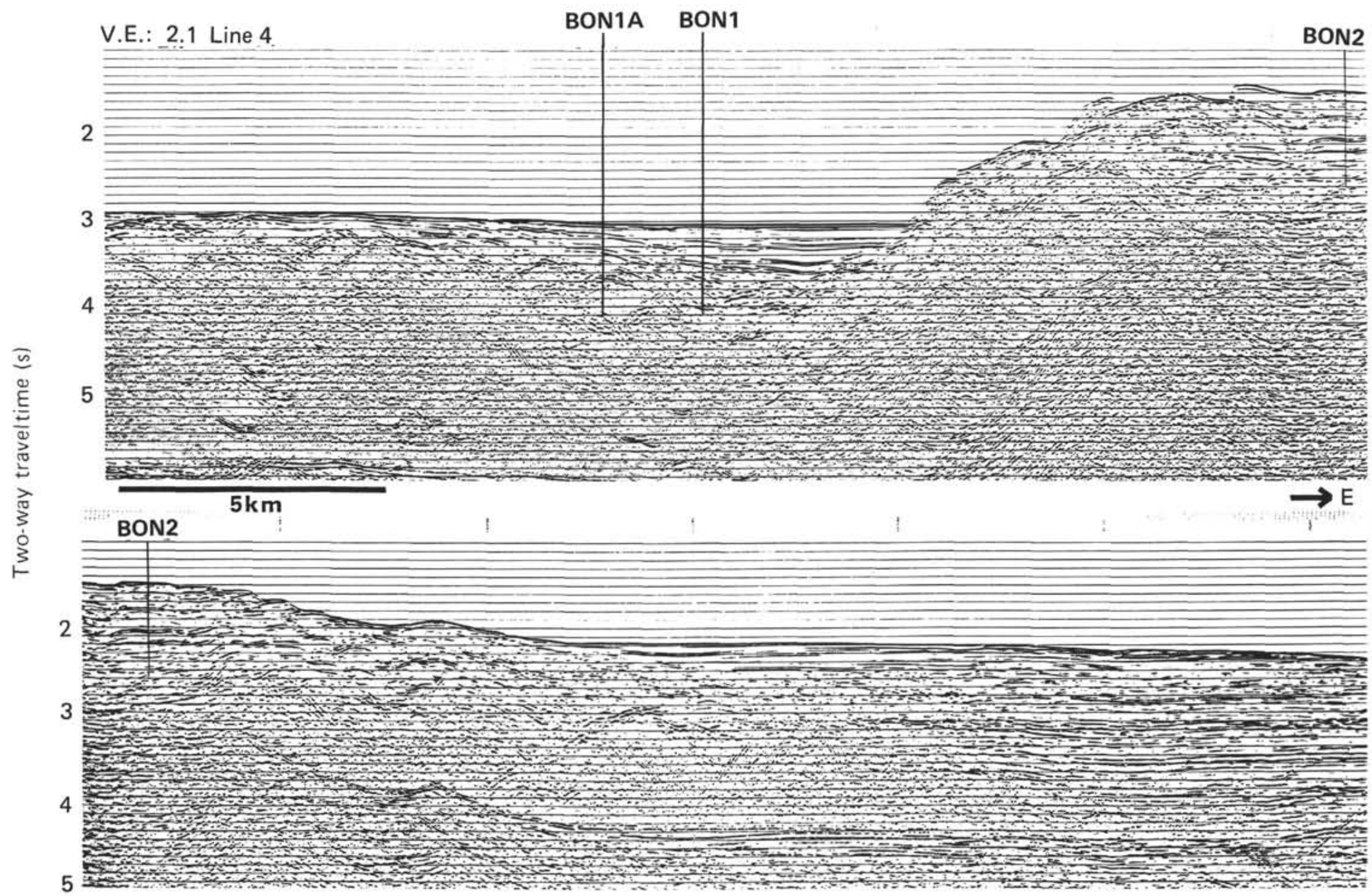
HEAT FLOW: Yes

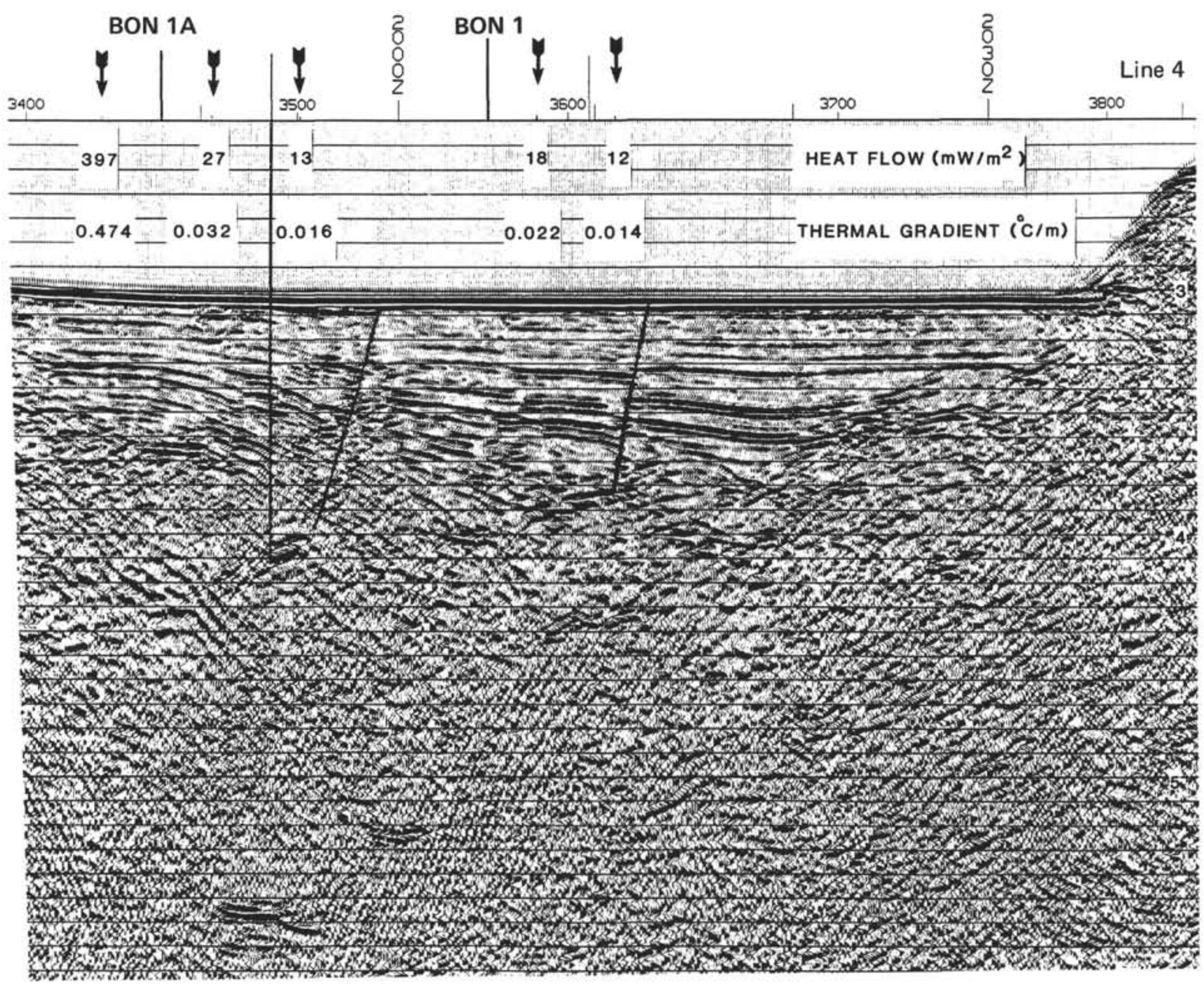
LOGGING: Standard Schlumberger logging
Formation microscanner
Magnetometer/Susceptibility
Vertical seismic profiling
Wireline packer

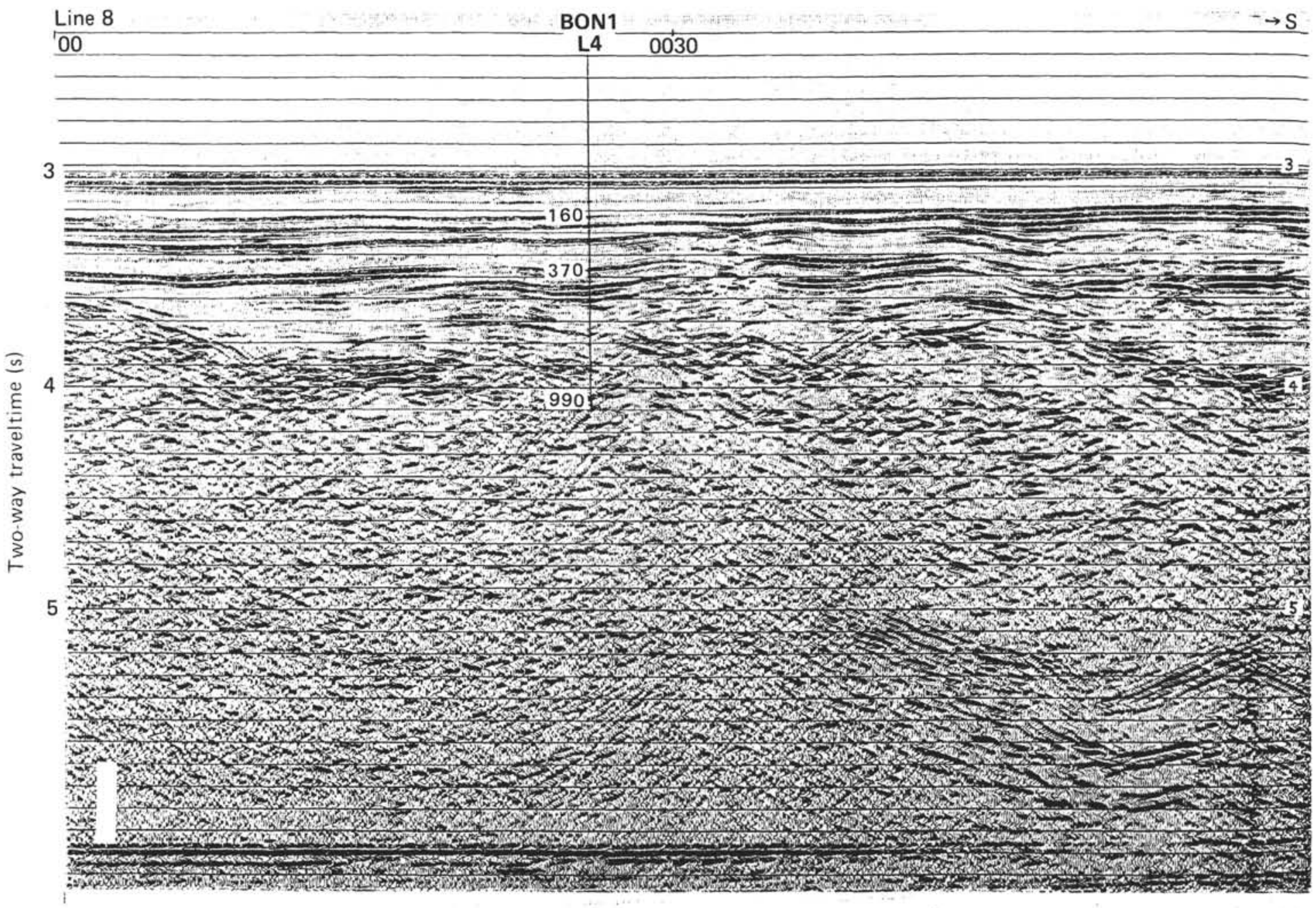
OBJECTIVES: (1) Nature of arc volcanism and sedimentation, (2) History of vertical motion.

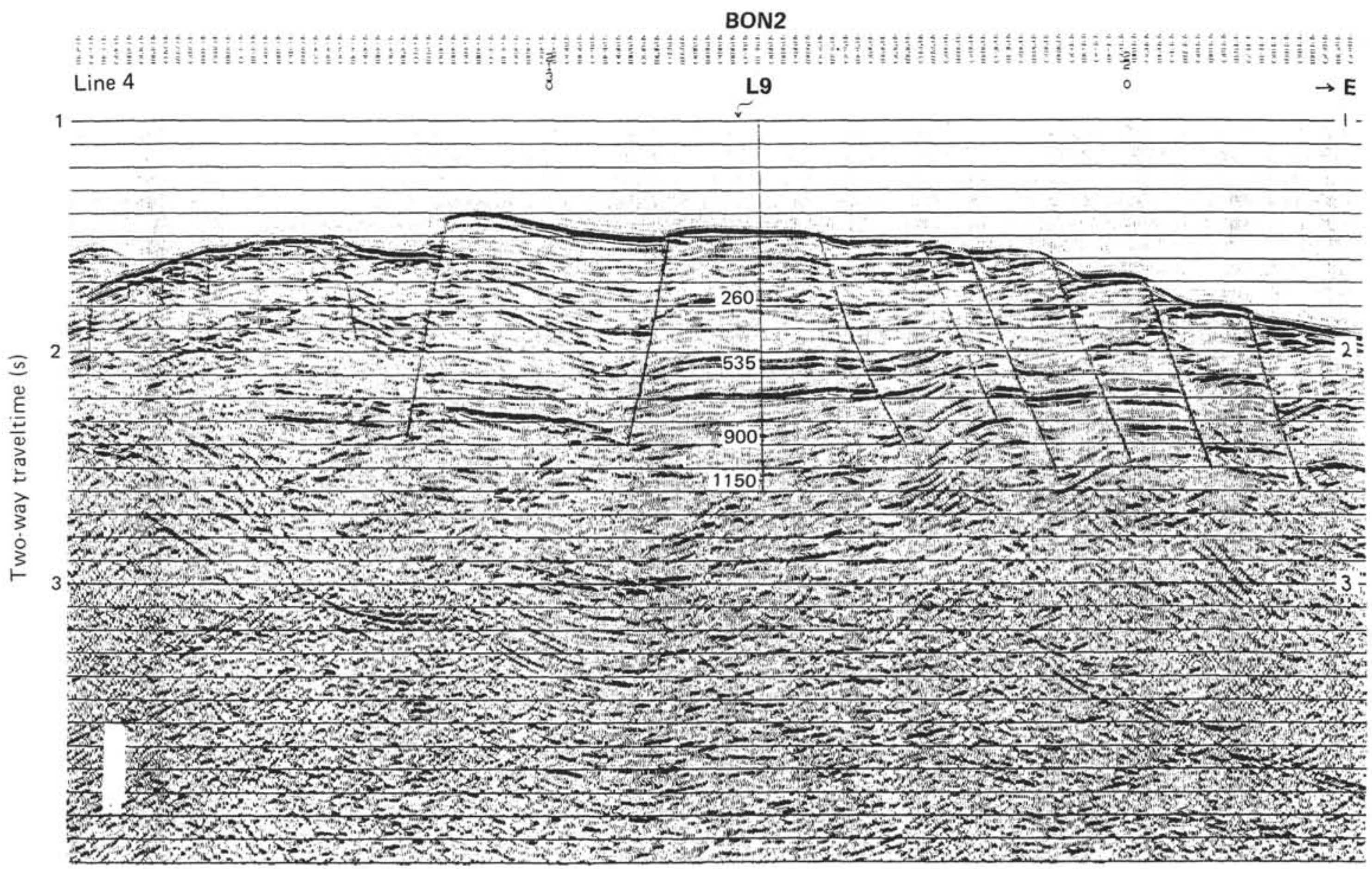
NATURE OF SEDIMENT/ROCKS ANTICIPATED: intercalated arc lavas (and sills), volcaniclastic sediments and pumice.

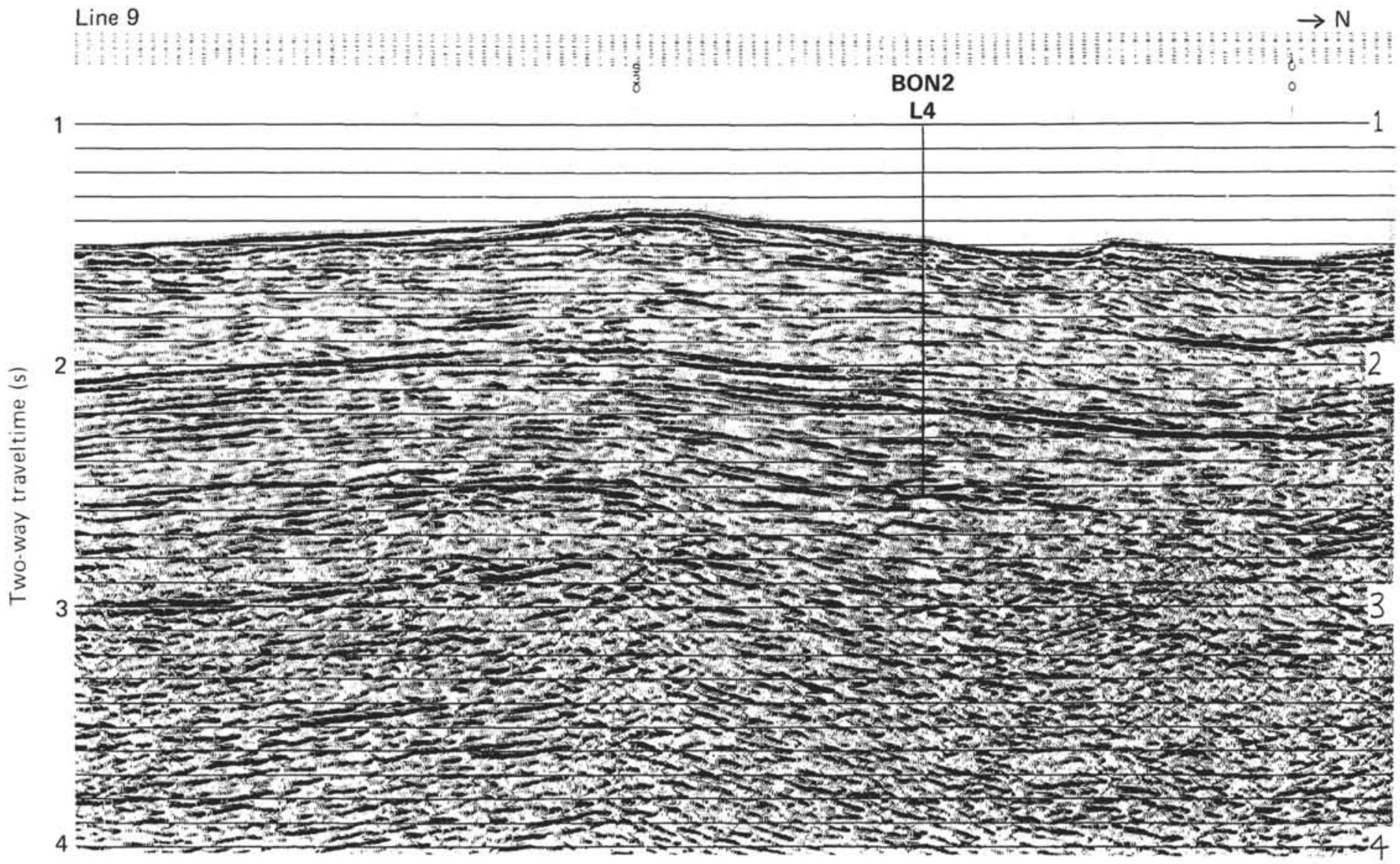

SUMISU RIFT
Brian TAYLOR
139°30'E
139°50'E
140°10'E
31°20'N
31°N
30°40'N
Daisan-Sumisu Knoll
Kita-Sumisu Basin
Line 6
Line 5
Line 4
BON1A
1
BON2
Line 3
Line 14
Line 13
Line 8
Line 9
KM


V.E.: 2.1 Line 4
BON1A
BON1
BON2
2
3
4
5
Two-way traveltime (s)
5km
E
BON2
2
3
4
5


BON 1A
BON 1
Line 4
3400
3500
3600
3700
3800
HEAT FLOW (mW/m²)
397
27
13
18
12
THERMAL GRADIENT (°C/m)
0.474
0.032
0.016
0.022
0.014
3
4
5


Line 8
BON1
L4
00
0030
→ S
3
160
370
4
990
5
Two-way traveltime (s)


BON2
Line 4
L9
→ E
1
2
3
260
535
900
1150
Two-way traveltime (s)



Line 9
→ N
BON2
L4
Two-way traveltime (s)
1
2
3
4

SITE: BON-3 PRIORITY: 2

POSITION: 31°32'N
140°17.4'E

WATER DEPTH: 1430 m SEDIMENT THICKNESS: 860 m

PROPOSED DRILLING PROGRAM: RCB to 900 m

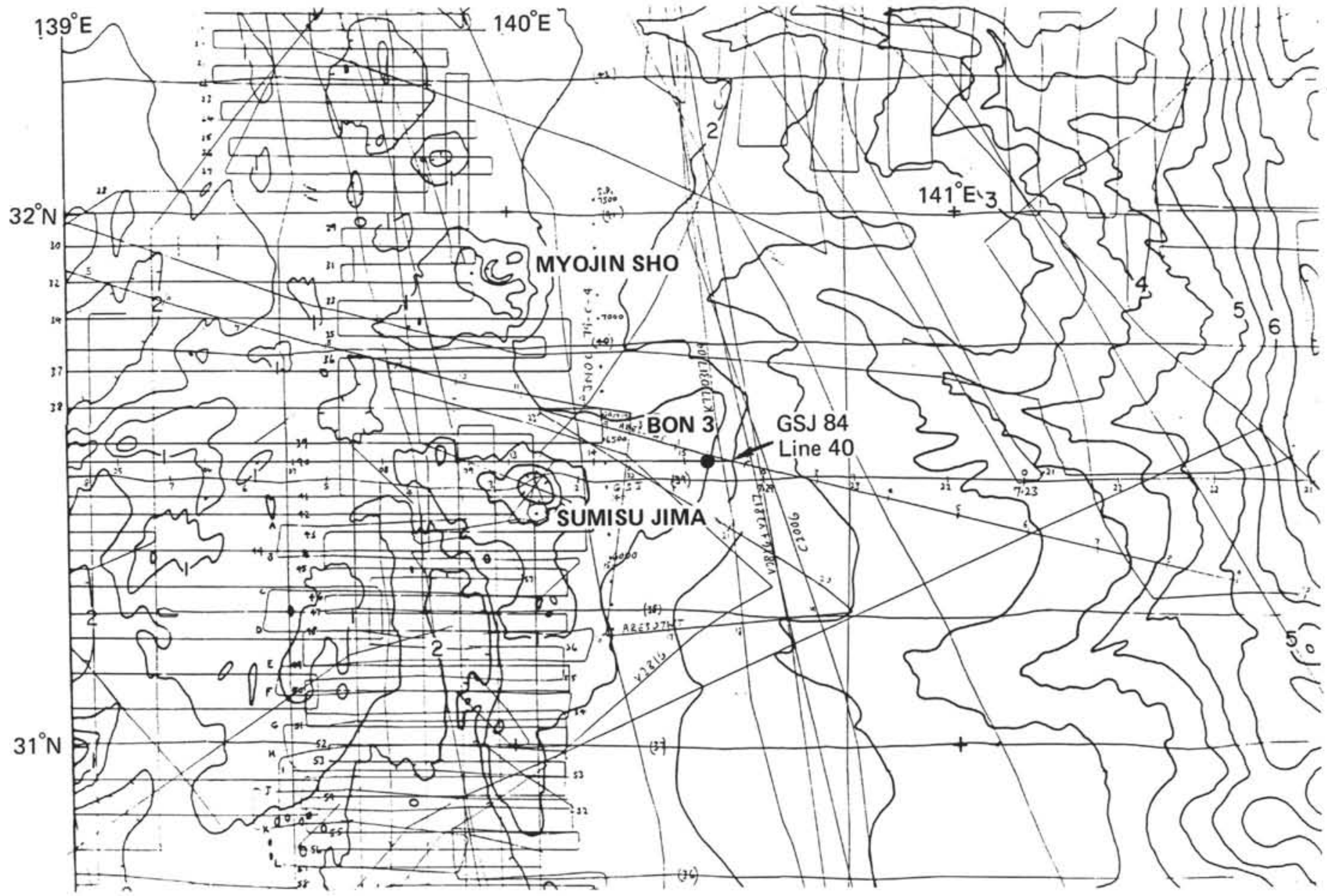
SEISMIC RECORD: Hakurei Maru 1984, line 40 (1515 hr)

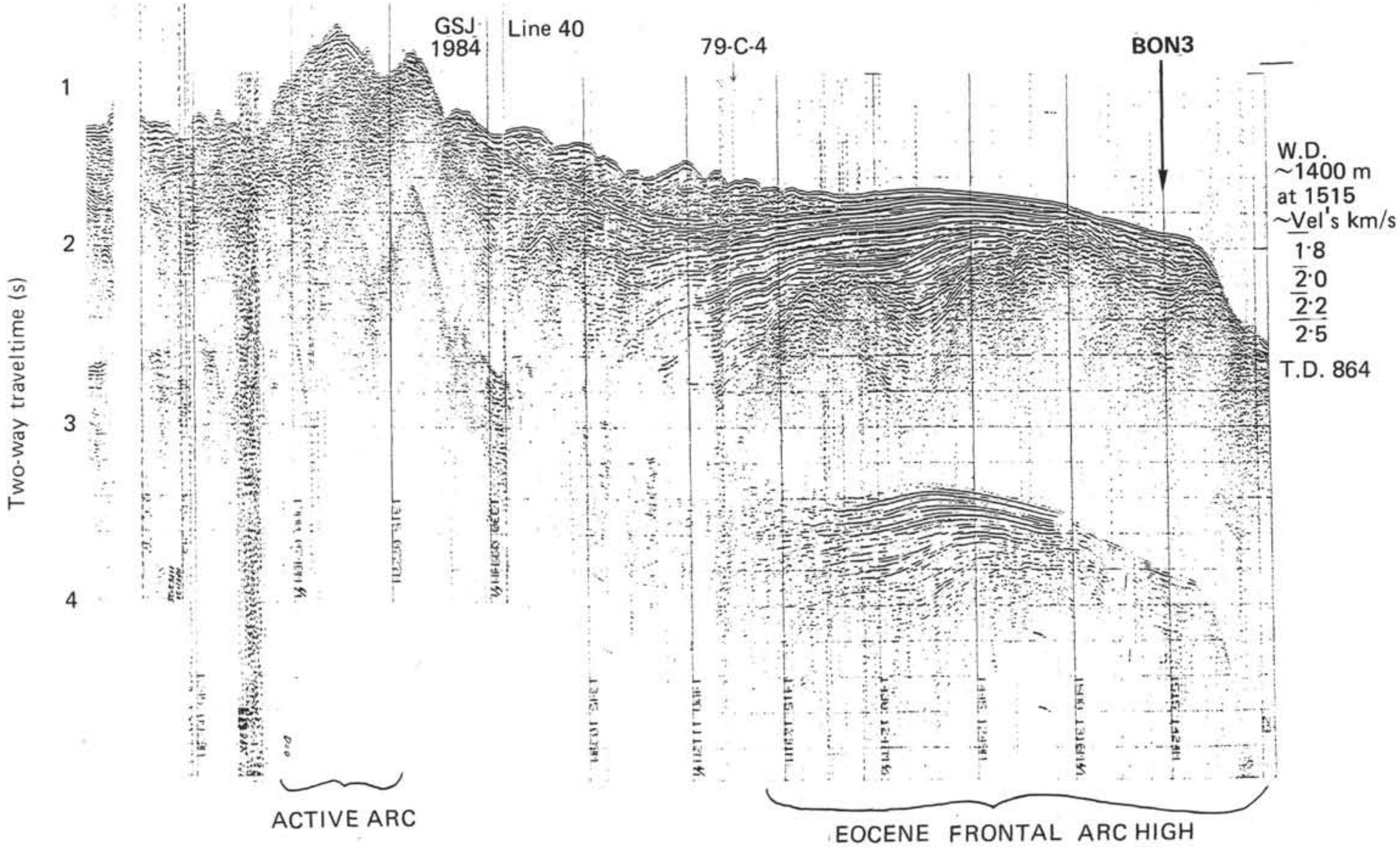
HEAT FLOW: Yes

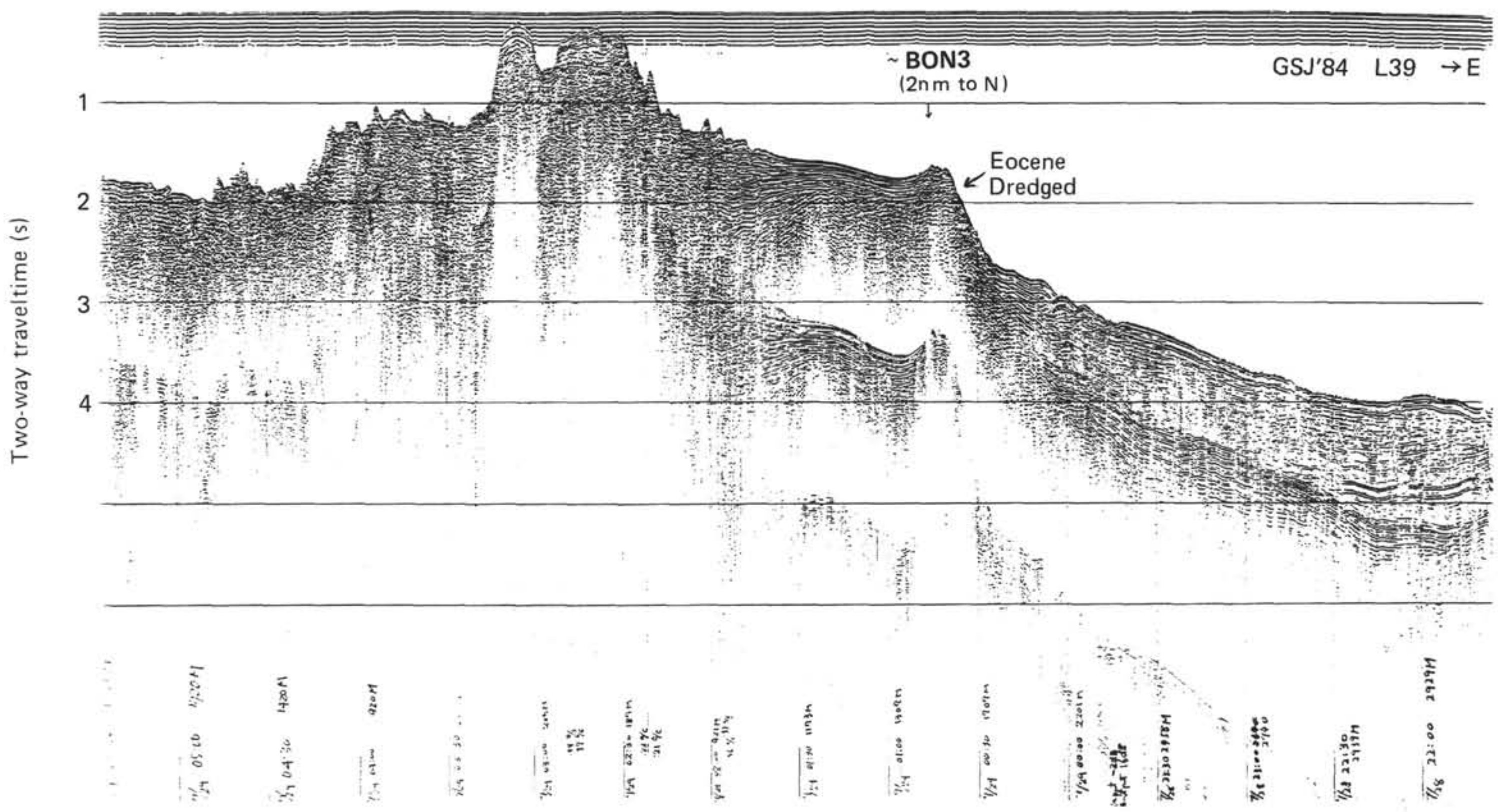
LOGGING: Standard Schlumberger logging
Formation microscanner

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, (c) variations in intensity and chemistry of arc volcanism, and (d) the paleo-Kuroshio current. (2) Nature of (Eocene) frontal arc basement high. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above (Eocene) arc lavas (and sediments).


139°E
140°E
141°E
32°N
31°N
MYOJIN SHO
BON 3
GSJ 84
Line 40
SUMISU JIMA


GSJ 1984
Line 40
79-C-4
BON3
W.D.
~1400 m
at 1515
~Vel's km/s
1·8
2·0
2·2
2·5
T.D. 864
1
2
3
4
Two-way traveltime (s)
ACTIVE ARC
EOCENE FRONTAL ARC HIGH


Two-way traveltime (s)
1
2
3
4
~BON3
(2nm to N)
GSJ'84 L39 →E
Eocene
Dredged

SITE: BON-4 PRIORITY: 1

POSITION: 32°24'N
140°23'E

WATER DEPTH: 1800 m SEDIMENT THICKNESS: 850 m

PROPOSED DRILLING PROGRAM: RCB to 900 m with free-fall funnel

SEISMIC RECORD: Fred Moore 3505 line 10 (0134:30Z)

HEAT FLOW: Yes

LOGGING: Standard Schlumberger logging
Formation microscanner

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement and overlying unconformity. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

SITE: BON-5A PRIORITY: 2

POSITION: 32°26'N
140°47'E

WATER DEPTH: 2700 m SEDIMENT THICKNESS: 1450 m

PROPOSED DRILLING PROGRAM: Hole A: APC to 200 m
Hole B: RCB to 925 m

SEISMIC RECORD: Fred Moore 3505 at intersection of lines 1 (2015Z) and 8 (1735Z)

HEAT FLOW: Yes WATER SAMPLER: Yes

LOGGING: Standard Schlumberger logging
Formation microscanner

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments.

SITE: BON-5B PRIORITY: 1

POSITION: 32°23'N
140°48'E

WATER DEPTH: 3400 m SEDIMENT THICKNESS: 800 m

PROPOSED DRILLING PROGRAM: RCB to 900 m with free-fall funnel

SEISMIC RECORD: Fred Moore 3505 at intersection of lines 2 (0634:30Z) and 8 (1835Z).

HEAT FLOW: Yes

LOGGING: Standard Schlumberger logging
Formation microscanner

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

SITE: BON-6

PRIORITY: 2 (Alternate to sites BON-6A and BON-6B)

POSITION: 31°54'N
141°06'E

WATER DEPTH: 2850 m

SEDIMENT THICKNESS: 950 m

PROPOSED DRILLING PROGRAM: Hole A: APC/XCB exploratory hole to 500 m
Hole B: Reentry hole to 1100 m (150 m sub-basement)

SEISMIC RECORD: Robert Conrad 2005, line 38 (1052 hr)

HEAT FLOW: Yes

WATER SAMPLER: Yes

LOGGING: Standard Schlumberger logging
Magnetometer/Susceptibility
Borehole televiewer
Wireline packer

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

SITE: BON-6A PRIORITY: 1

POSITION: 30°50.5'N
140°55'E

WATER DEPTH: 2625 m SEDIMENT THICKNESS: 600 m

PROPOSED DRILLING PROGRAM: RCB to 750 m (150 m into basement) with reentry cone

SEISMIC RECORD: Fred Moore 3505 at intersection of lines 12 (0412Z) and 14 (1530Z).

HEAT FLOW: Yes

LOGGING: Standard Schlumberger logging
Magnetometer/Susceptibility
Borehole televiewer
Wireline packer
Formation microscanner

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

SITE: BON-6B PRIORITY: 1

POSITION: 30°53.5'N
141°18'N

WATER DEPTH: 2970 m SEDIMENT THICKNESS: 400 m

PROPOSED DRILLING PROGRAM: RCB to 550 m (150 m into basement) with free-fall funnel

SEISMIC RECORD: Fred Moore 3505, line 14 (1940Z)

HEAT FLOW: Yes

LOGGING: Standard Schlumberger logging
Magnetometer/Susceptibility
Borehole televiewer
Wireline packer

OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

SITE: BON-6C

PRIORITY: 2 (Additional to site BON-6B if time available at end of primary sites)

POSITION: 31°52.5'N
141°14'E

WATER DEPTH: 3100 m

SEDIMENT THICKNESS: 150 m

PROPOSED DRILLING PROGRAM: RCB to 200 m (50 m into basement)

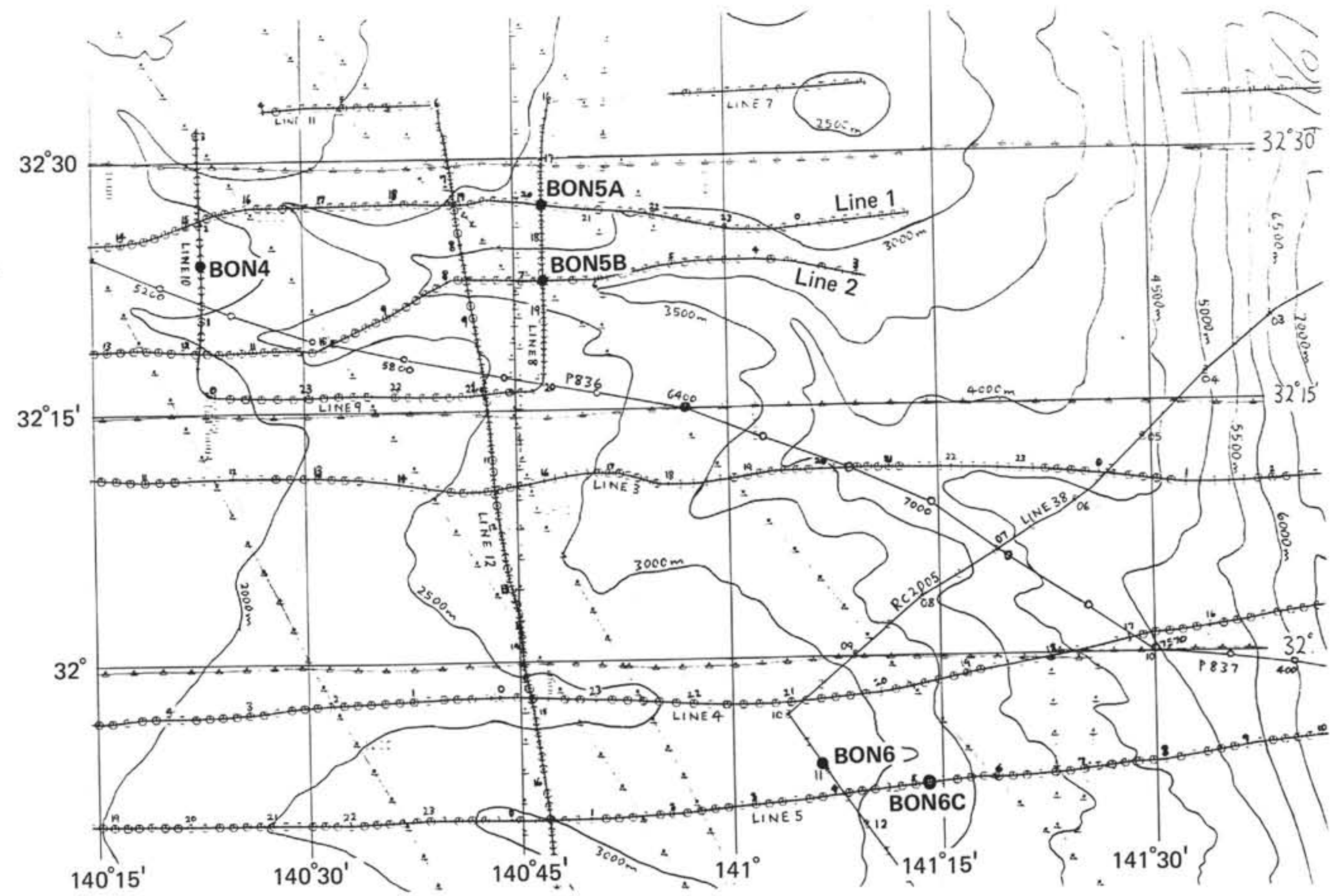
SEISMIC RECORD: Fred Moore 3505, line 5 (0510Z)

HEAT FLOW: No

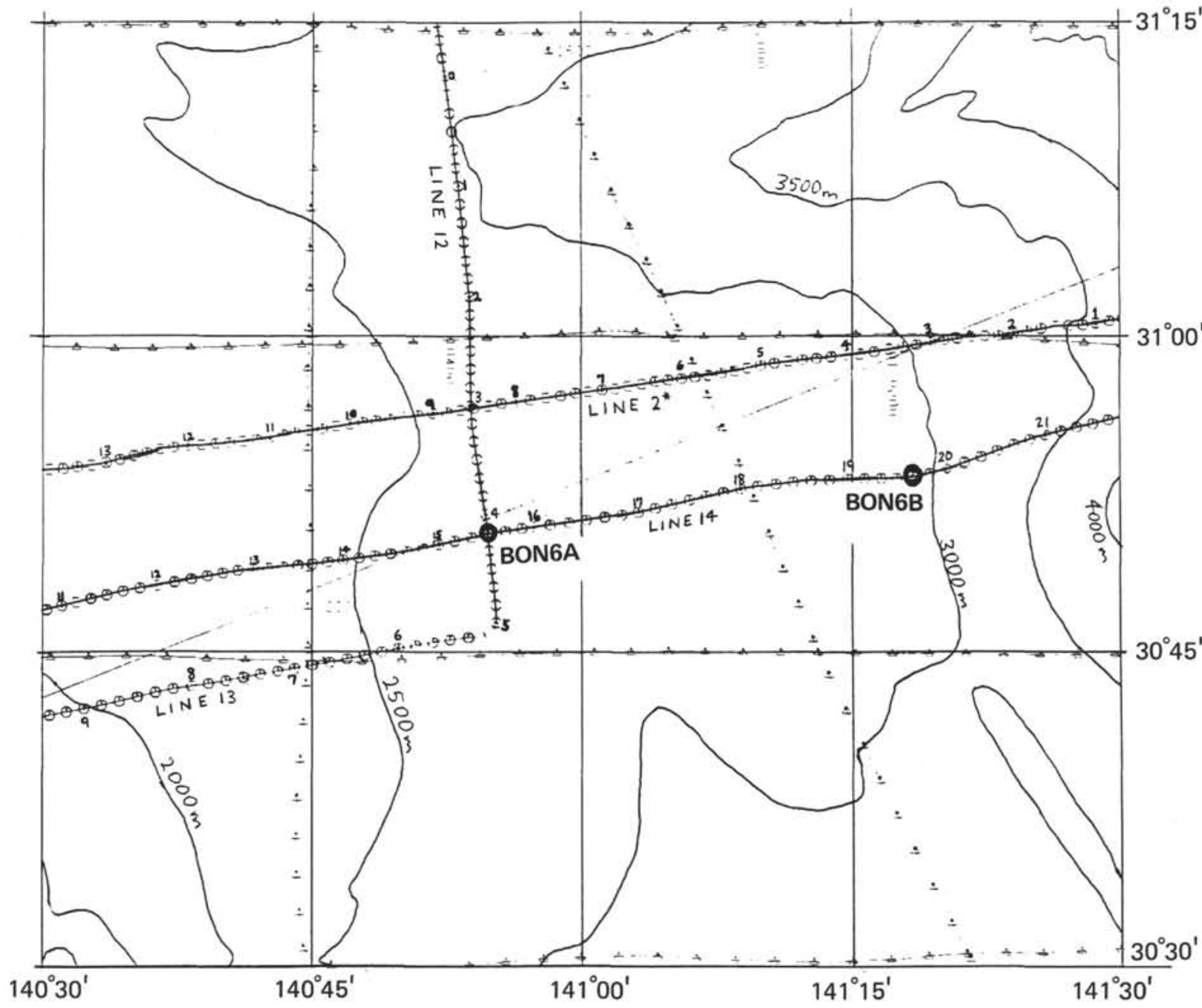
LOGGING: Standard Schlumberger logging only if time available

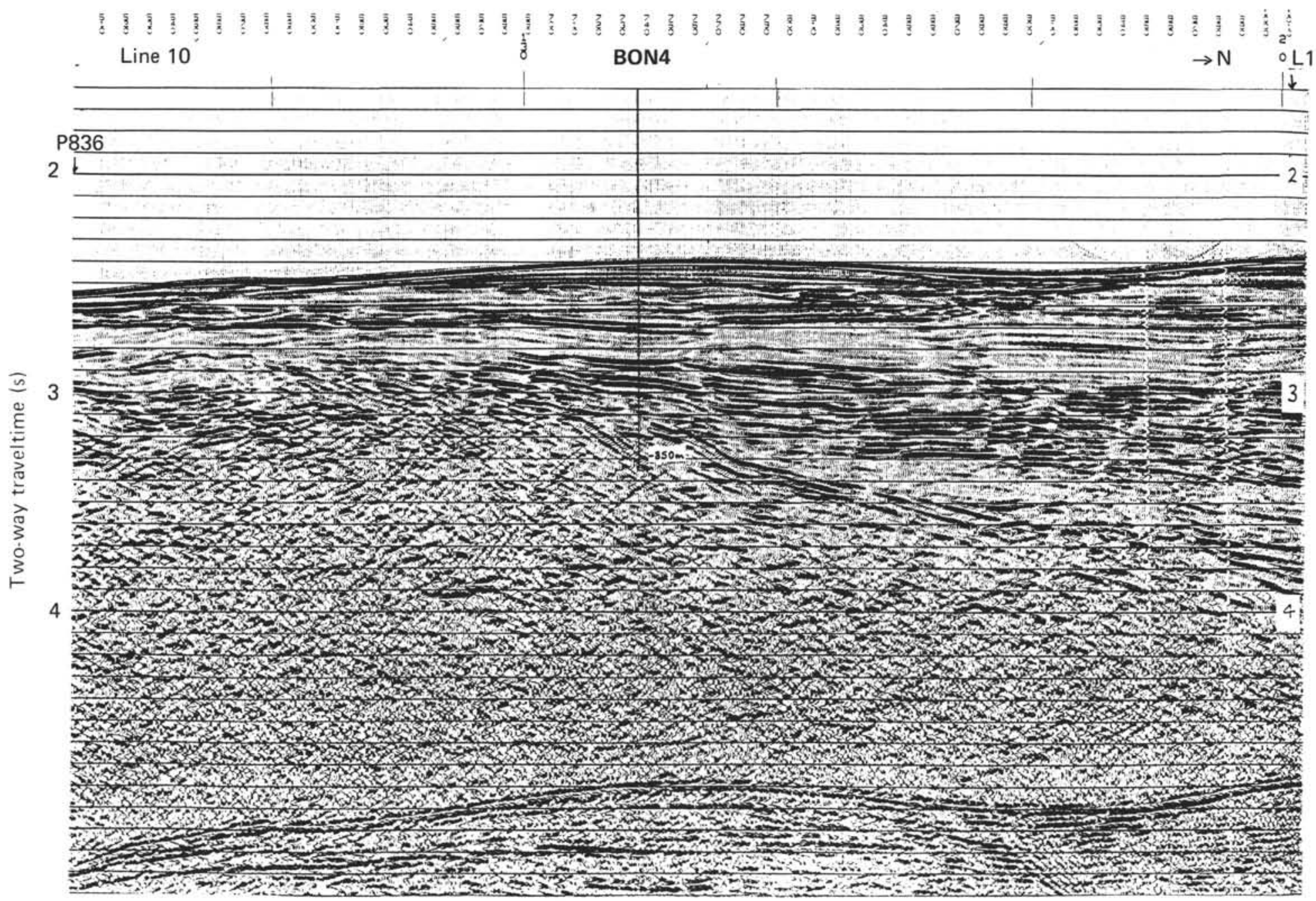
OBJECTIVES: (1) To determine the history of (a) vertical motion, (b) sedimentation, and (c) variations in intensity and chemistry of arc volcanism. (2) Nature and age of forearc basin basement. (3) Style of microstructural deformation and amount of large-scale forearc rotation/translation.

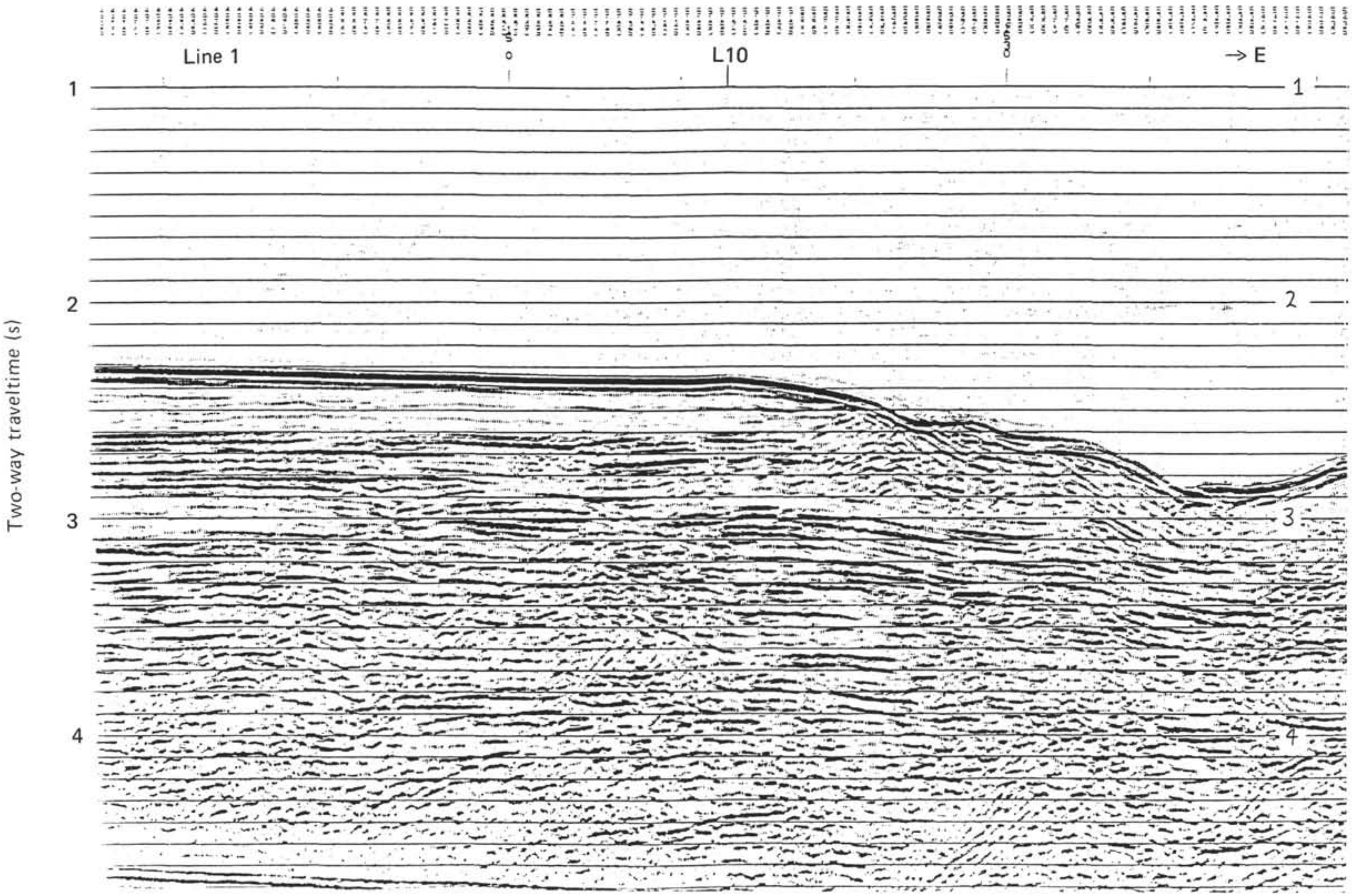
NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above arc lavas (and sediments).

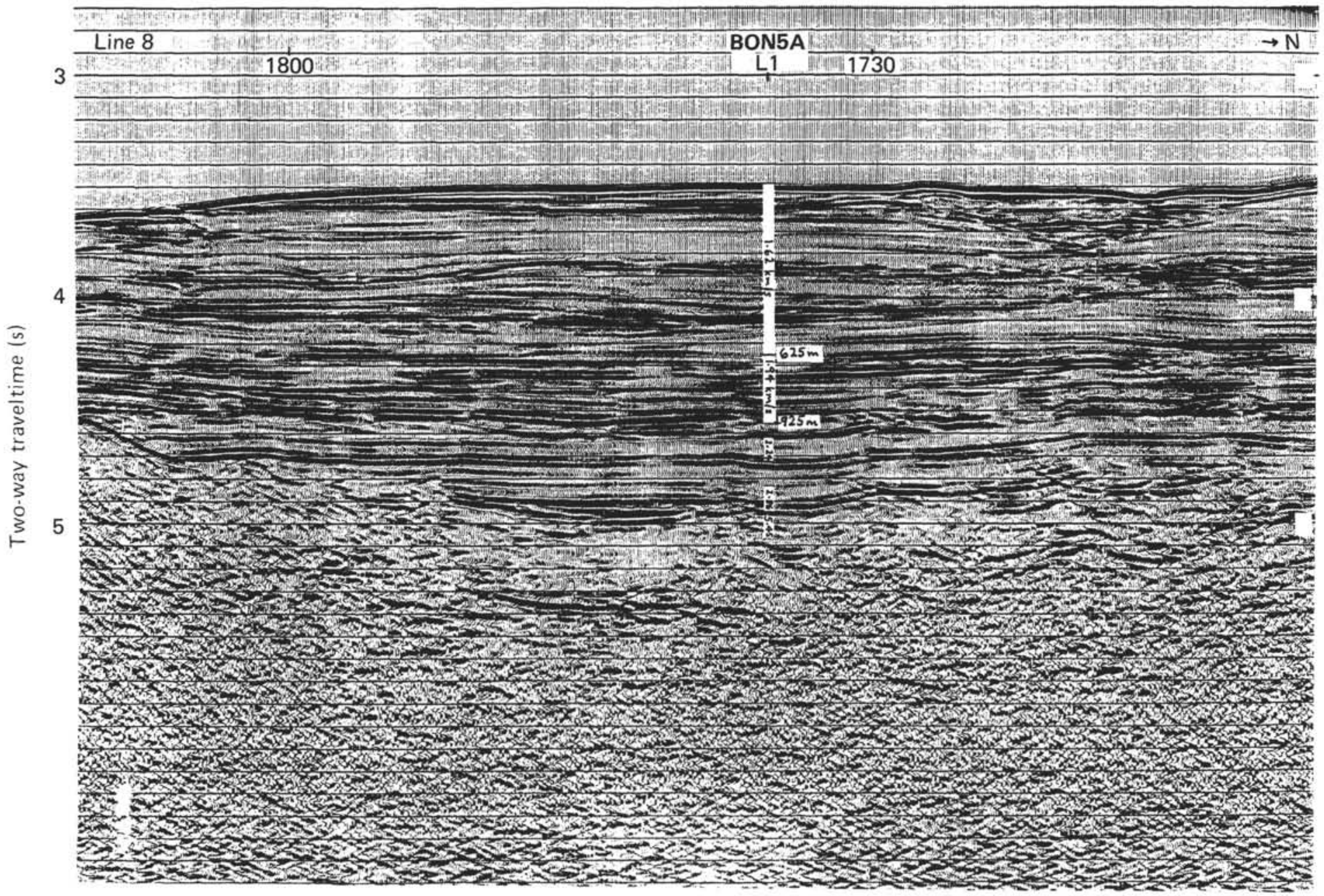


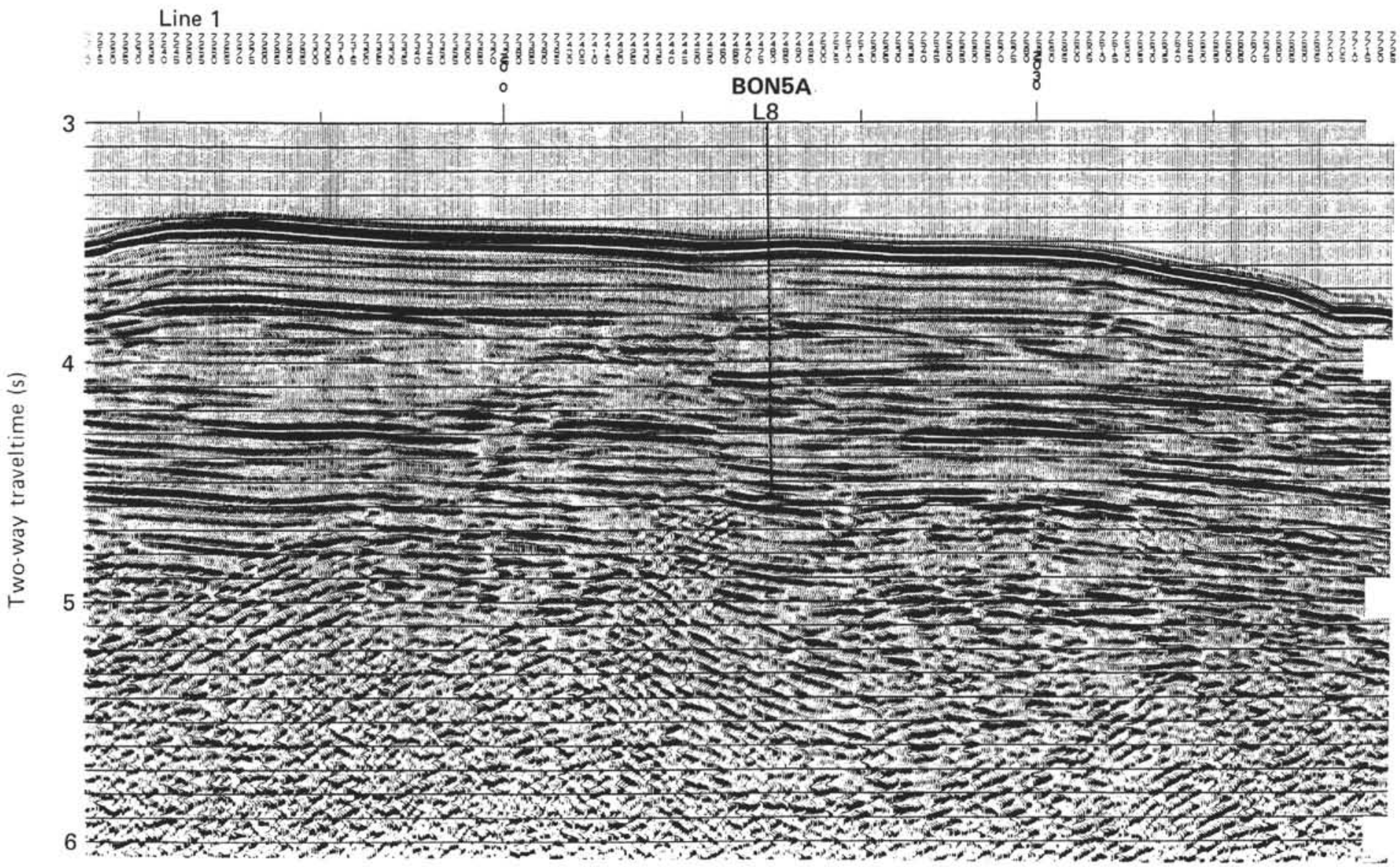
32°30
32°15'
32°
32°30'
32°15'
32°
140°15'
140°30'
140°45'
141°
141°15'
141°30'
BON5A
BON5B
BON4
BON6
BON6C
Line 1
Line 2
LINE 3
LINE 4
LINE 5
LINE 7
LINE 8
LINE 9
LINE 10
LINE 11
LINE 12
LINE 38
P836
P837
RC2005
2000m
2500m
3000m
3500m
4000m
4500m
5000m
5500m
6000m
6500m
7000m

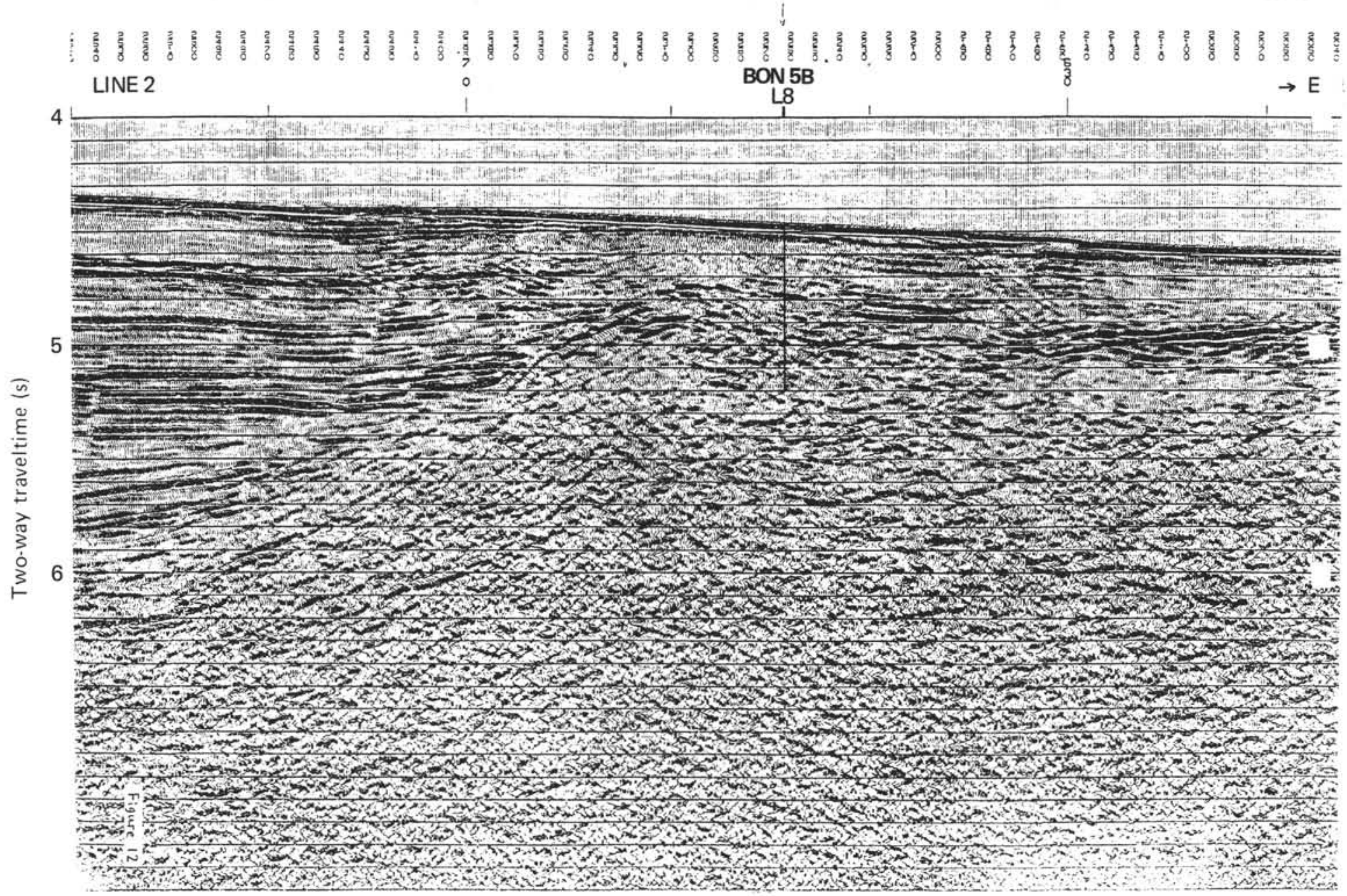

31°15'
31°00'
30°45'
30°30'
140°30'
140°45'
141°00'
141°15'
141°30'
LINE 12
LINE 2*
LINE 14
LINE 13
BON6A
BON6B
3500m
3000m
4000m
2500m
2000m

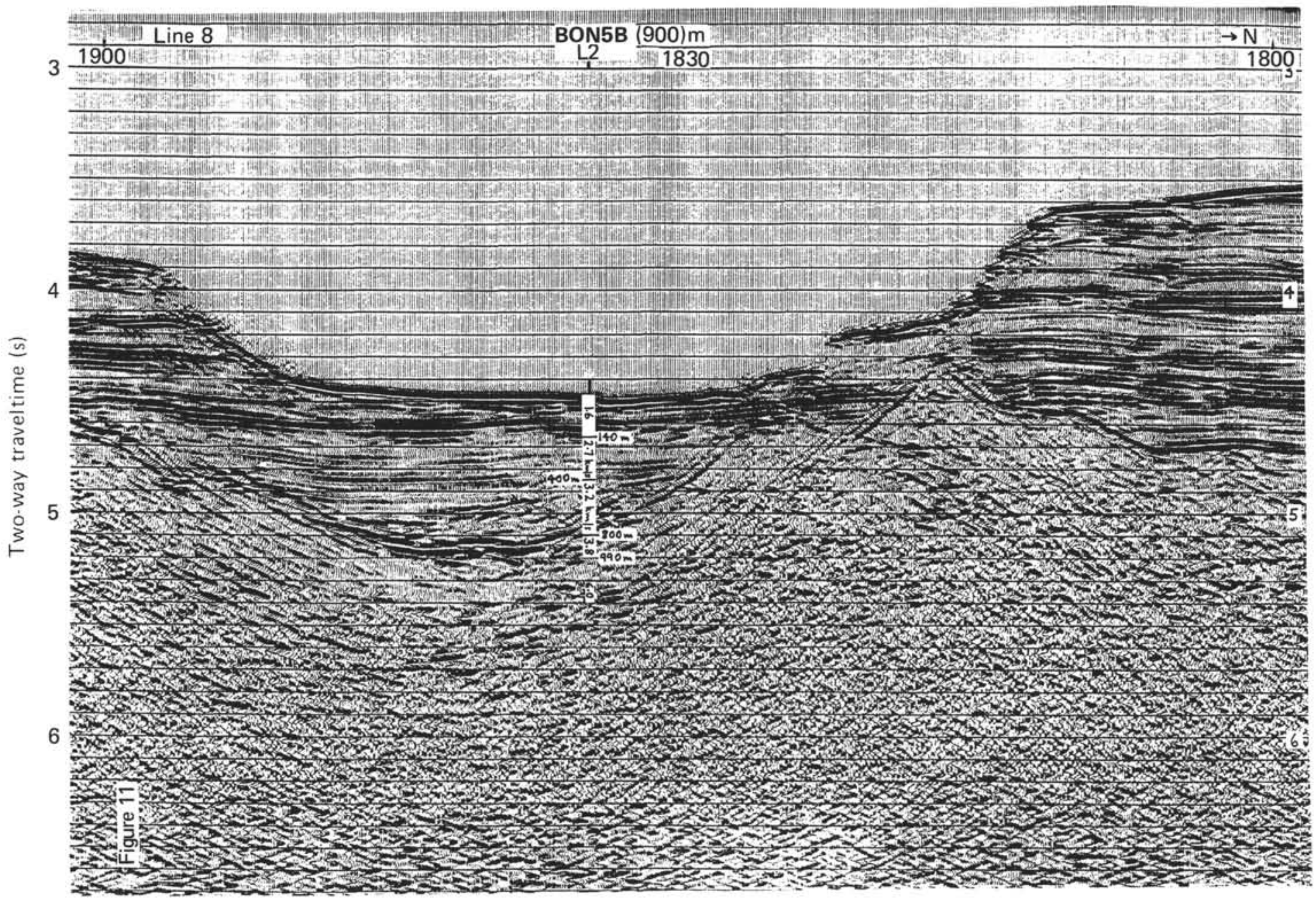

Line 10
BON4
→N
L1
P836
2
3
4
Two-way traveltime (s)
350m

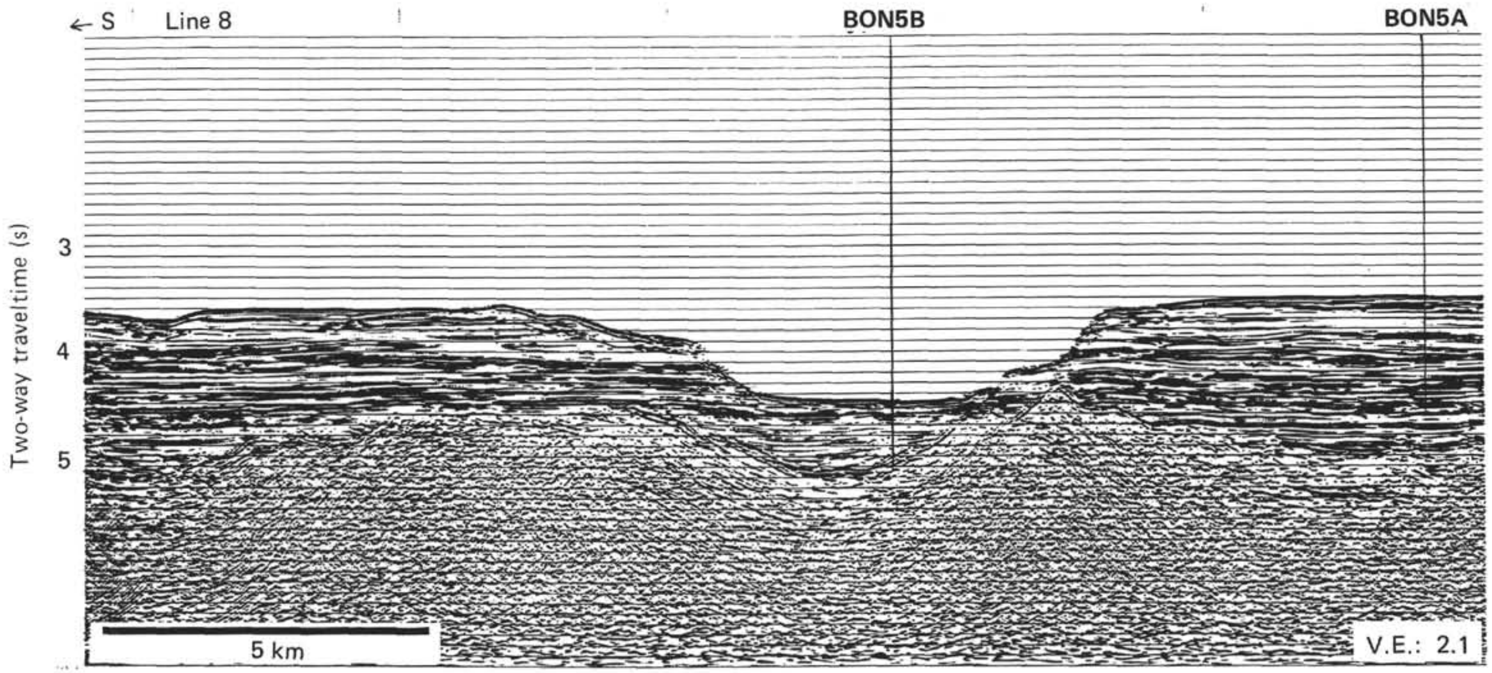

Line 1
L10
→ E
Two-way traveltime (s)
1
2
3
4

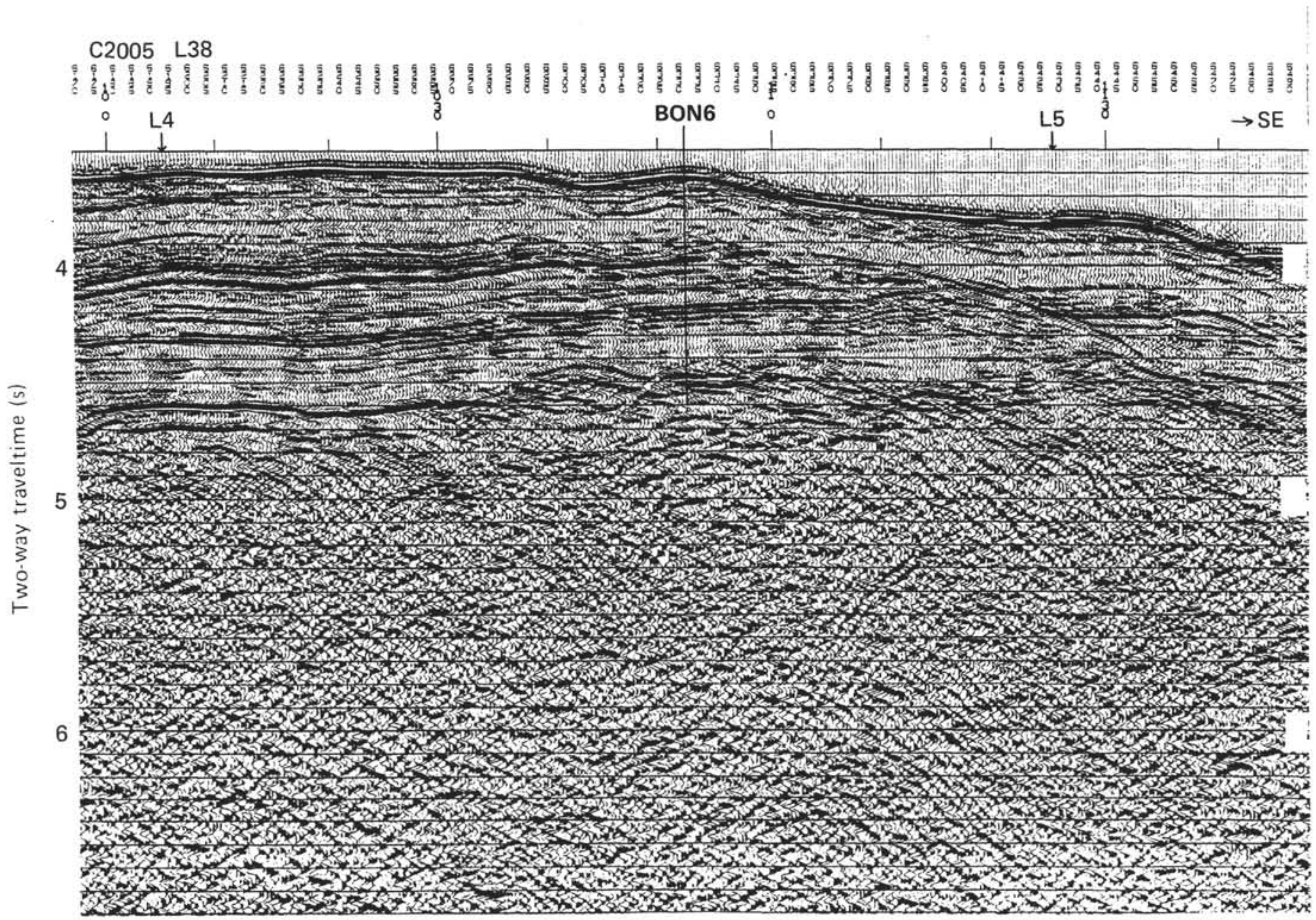

Line 8
BON5A
L1
1800
1730
→ N
3
4
5
Two-way traveltime (s)
625m
925m

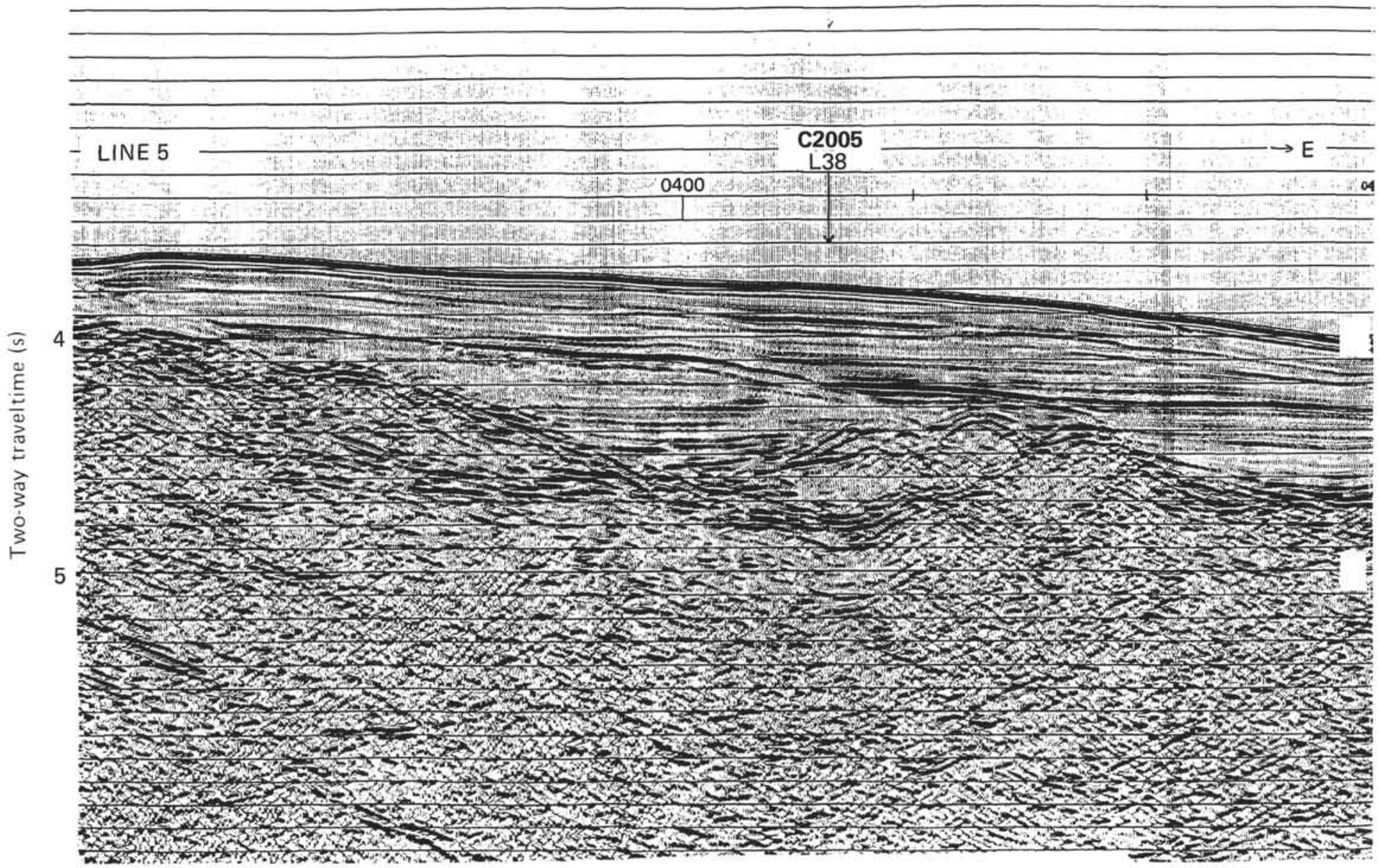

Line 1
BON5A
L8
3
4
5
6
Two-way traveltime (s)

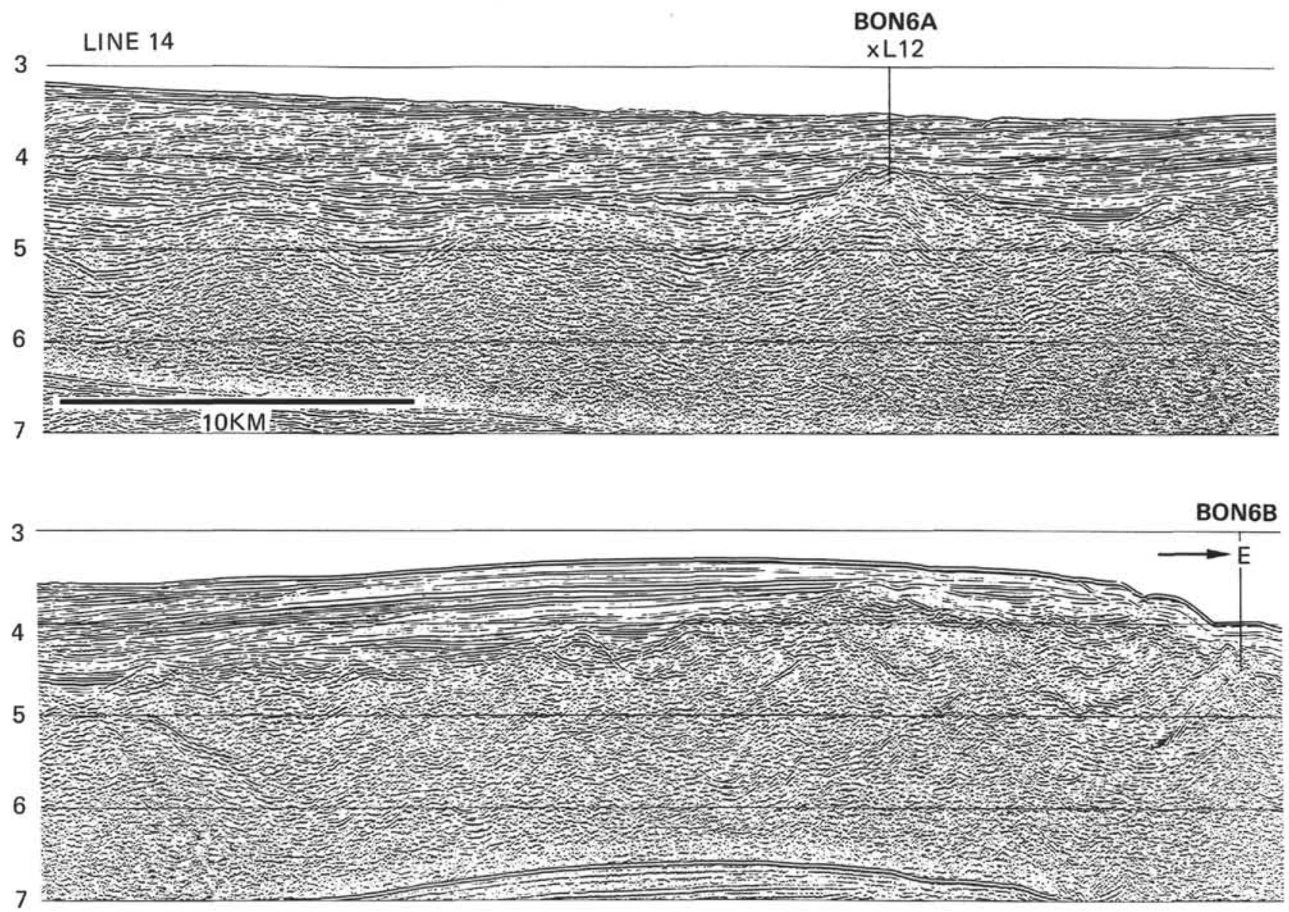

LINE 2
BON 5B
L8
→ E
4
5
6
Two-way traveltime (s)
Figure 12

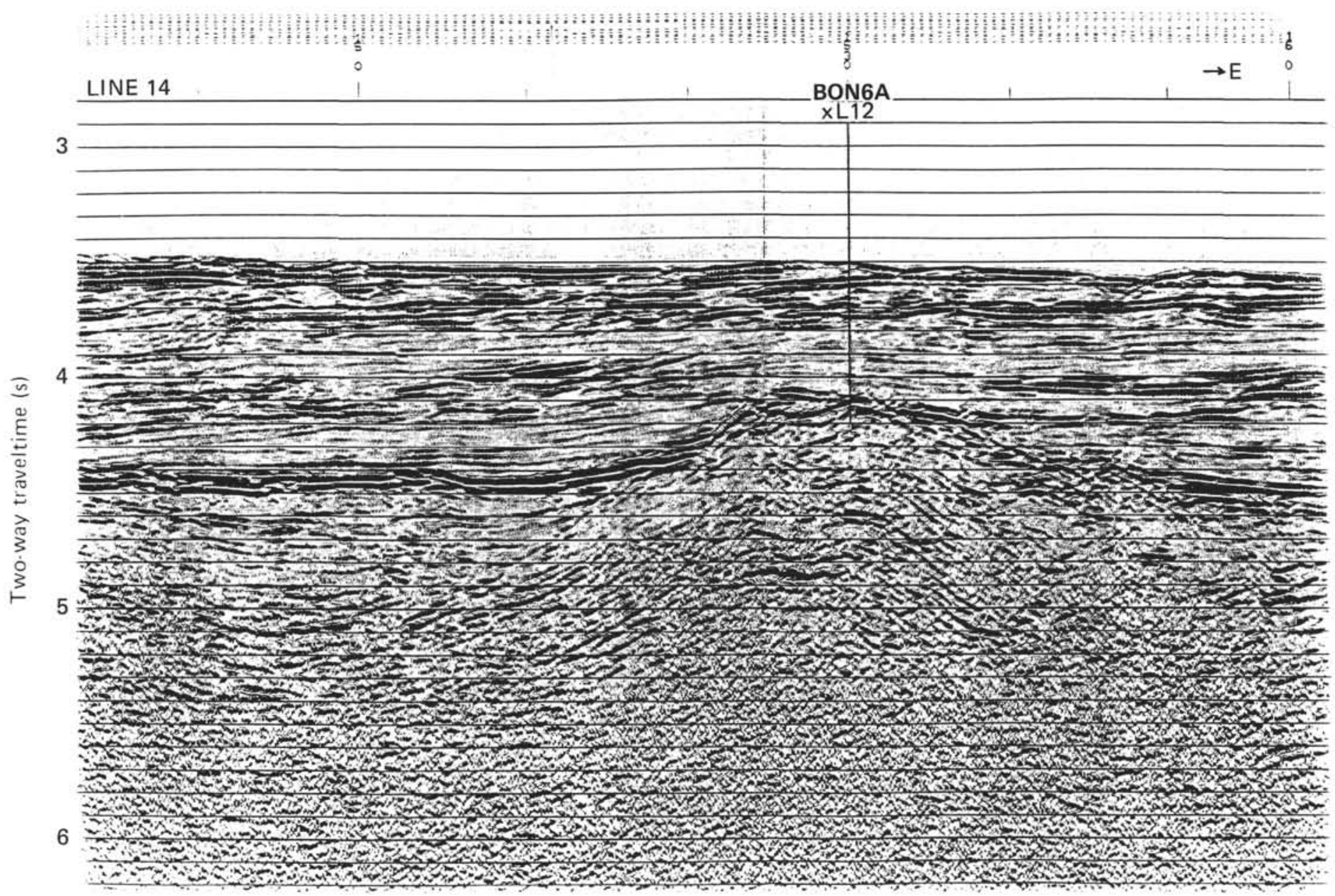

Line 8
BON5B (900)m
L2
→ N
1900
1830
1800
3
4
5
6
Two-way traveltime (s)
Figure 11

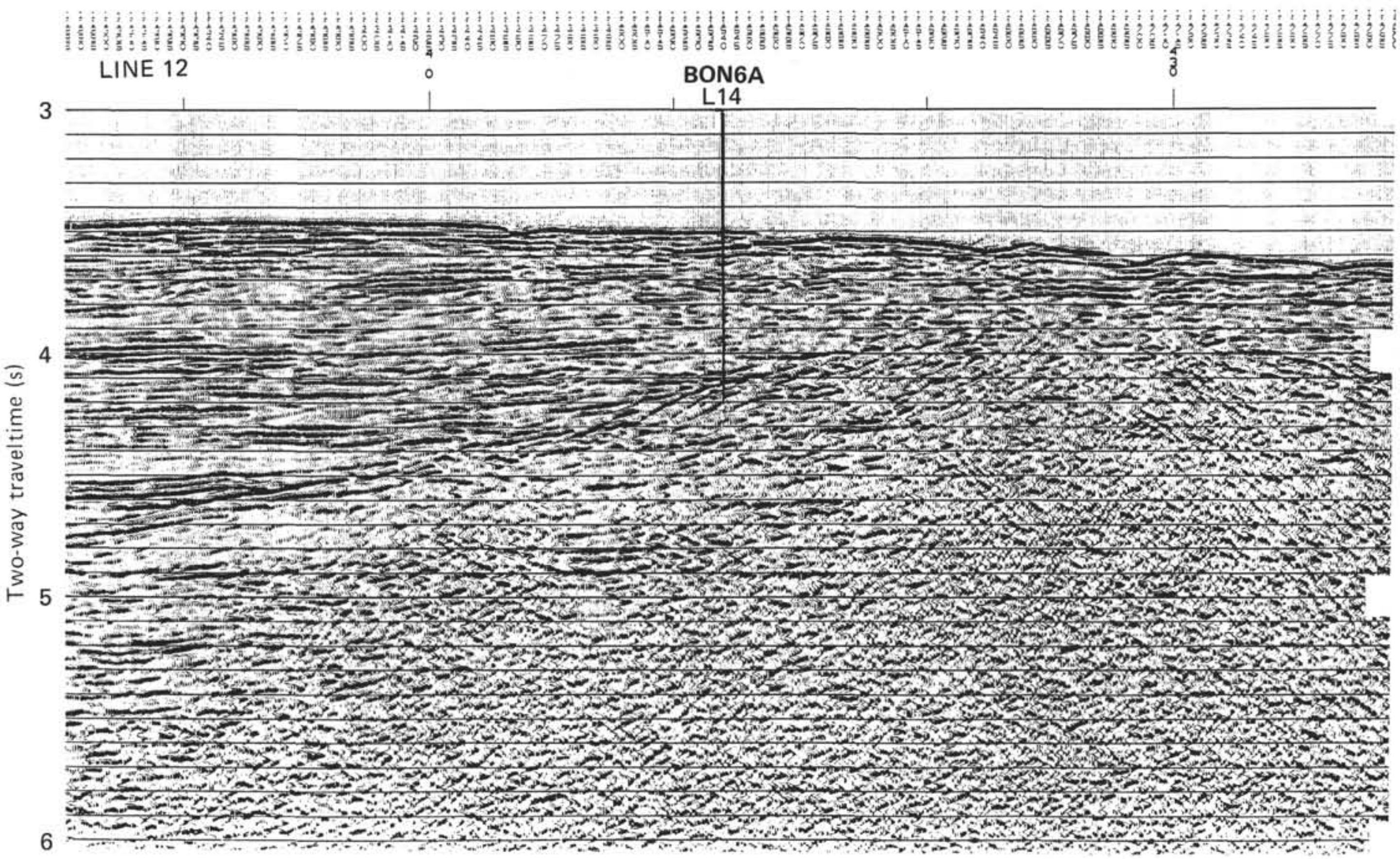

← S
Line 8
BON5B
BON5A
Two-way traveltime (s)
3
4
5
5 km
V.E.: 2.1

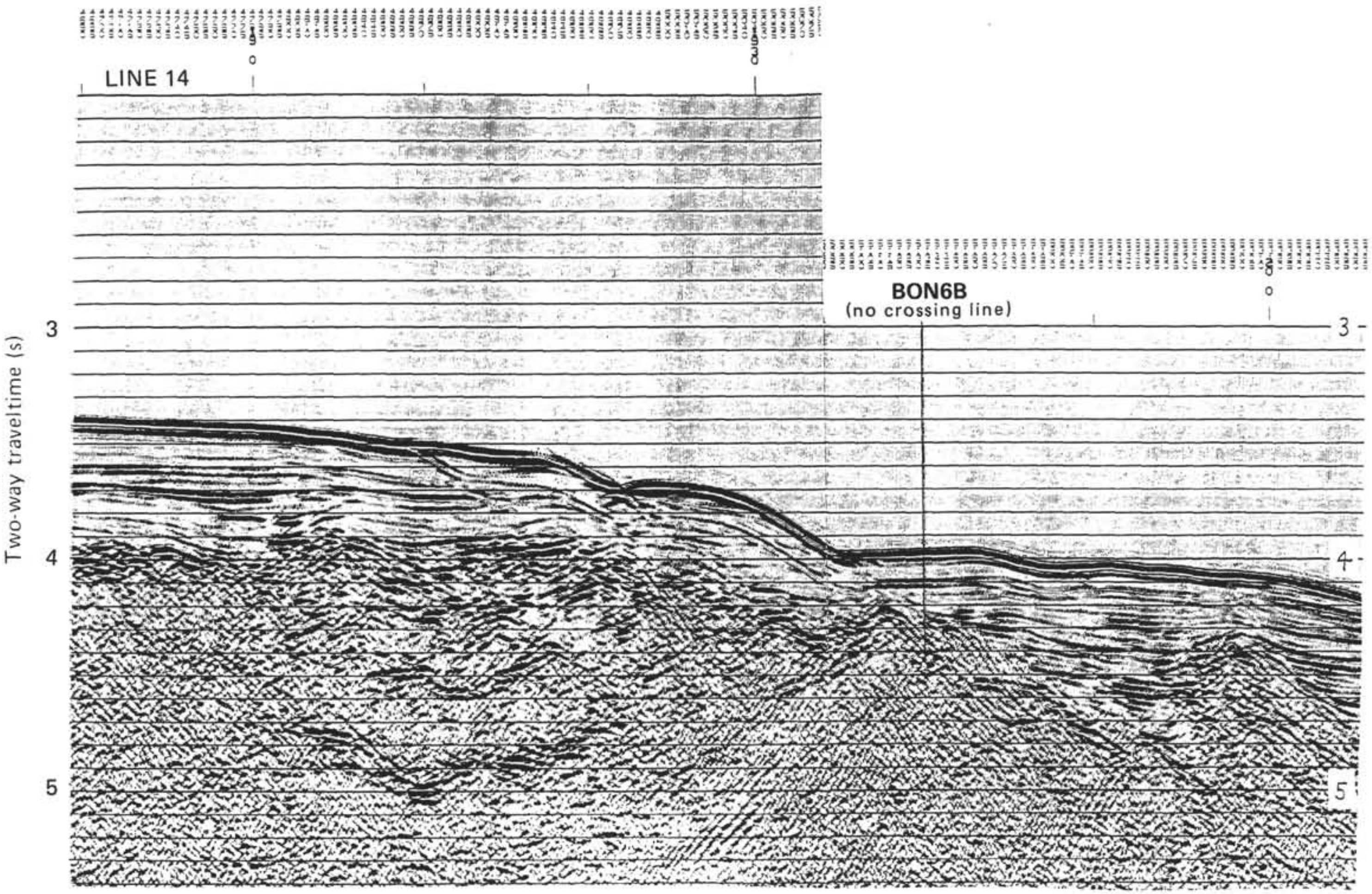

C2005 L38
L4
BON6
L5
→SE
4
5
6
Two-way traveltime (s)

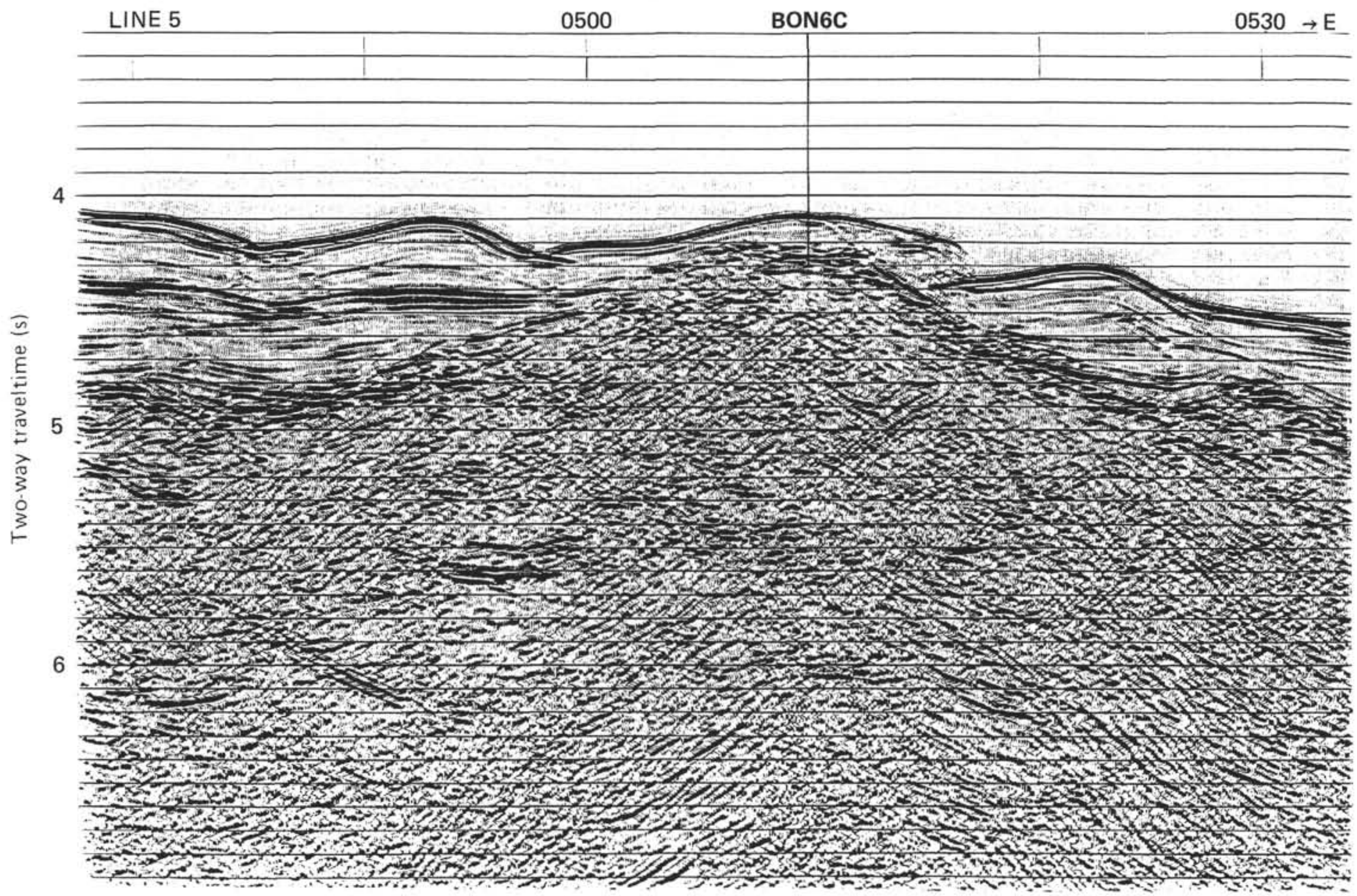

LINE 5
C2005
L38
0400
→ E
Two-way traveltime (s)
4
5


LINE 14
BON6A
xL12
3
4
5
6
7
10KM
BON6B
E
3
4
5
6
7


LINE 14
→E
BON6A
xL12
3
4
5
6
Two-way traveltime (s)


LINE 12
BON6A
L14
3
4
5
6
Two-way traveltime (s)


LINE 14
BON6B
(no crossing line)
Two-way traveltime (s)
3
4
5
3
4
5


LINE 5
0500
BON6C
0530 → E
4
5
6
Two-way traveltime (s)

SITE: BON-7 PRIORITY: 1

POSITION: 30°58'N
141°48'E

WATER DEPTH: 4600 m SEDIMENT THICKNESS: 150 m

PROPOSED DRILLING PROGRAM: Hole A: APC to refusal
Hole B: RCB to 500 m

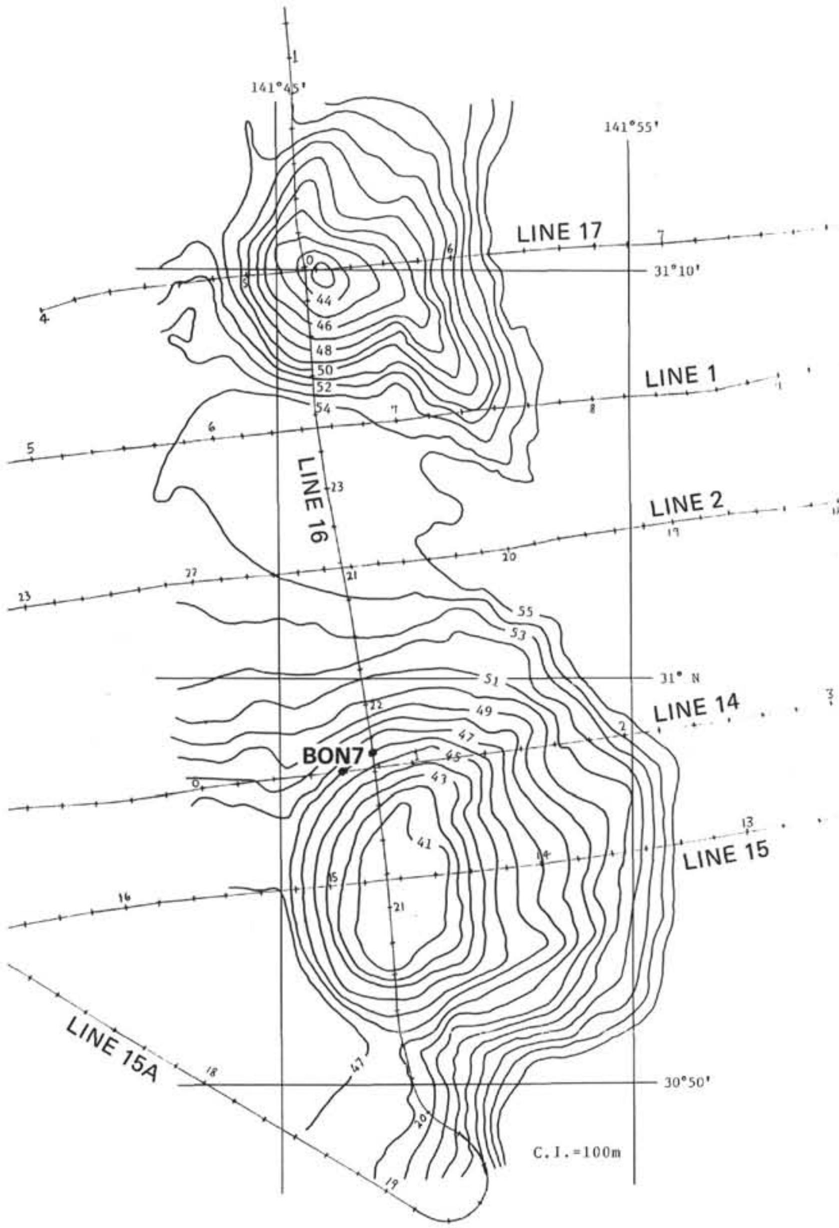
SEISMIC RECORD: Fred Moore 3505 at intersection of lines 14 (0339Z) and 16 (2145:30Z)

HEAT FLOW: Yes WATER SAMPLER: Yes

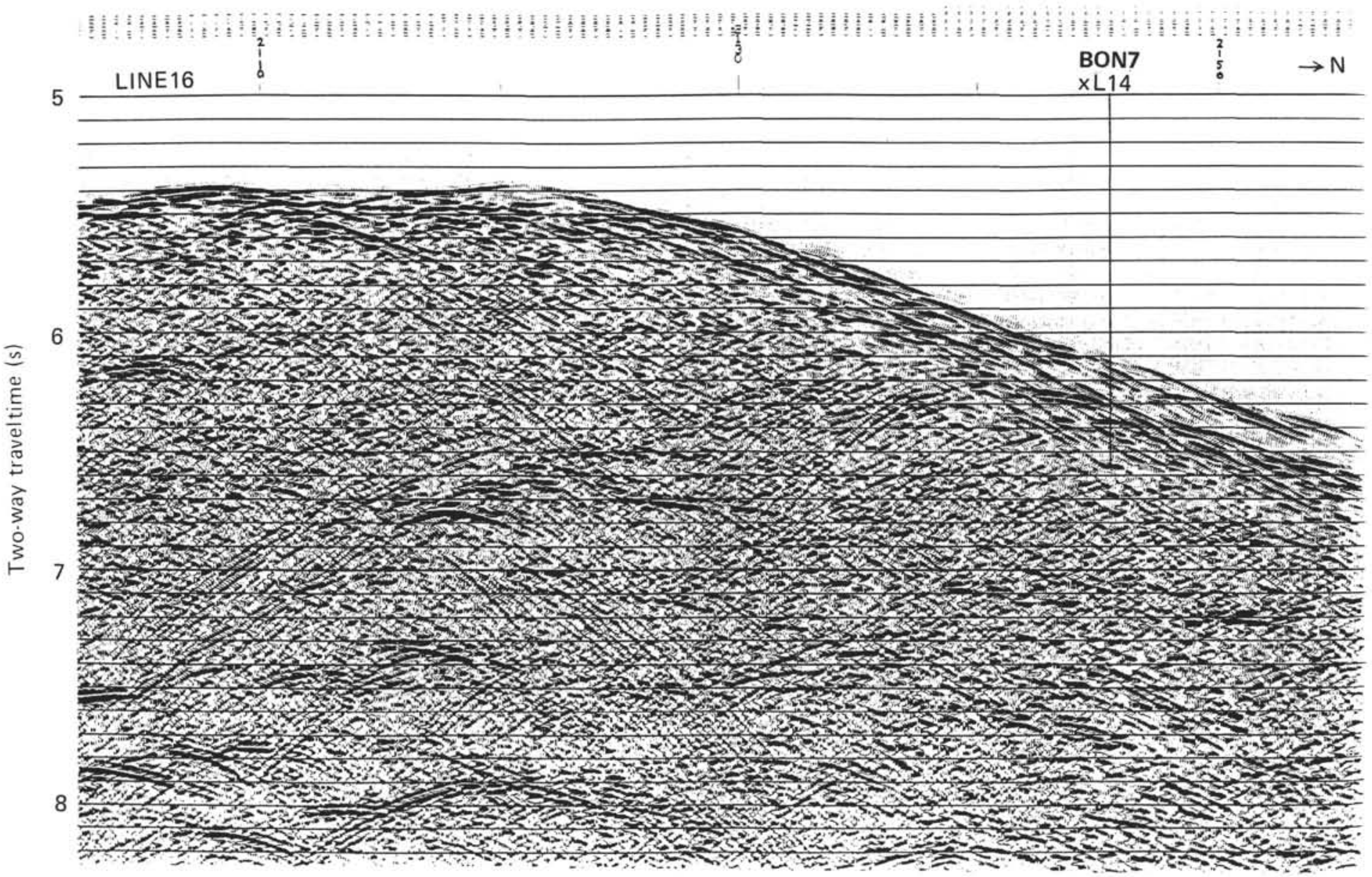
LOGGING: Standard Schlumberger logging
Wireline packer

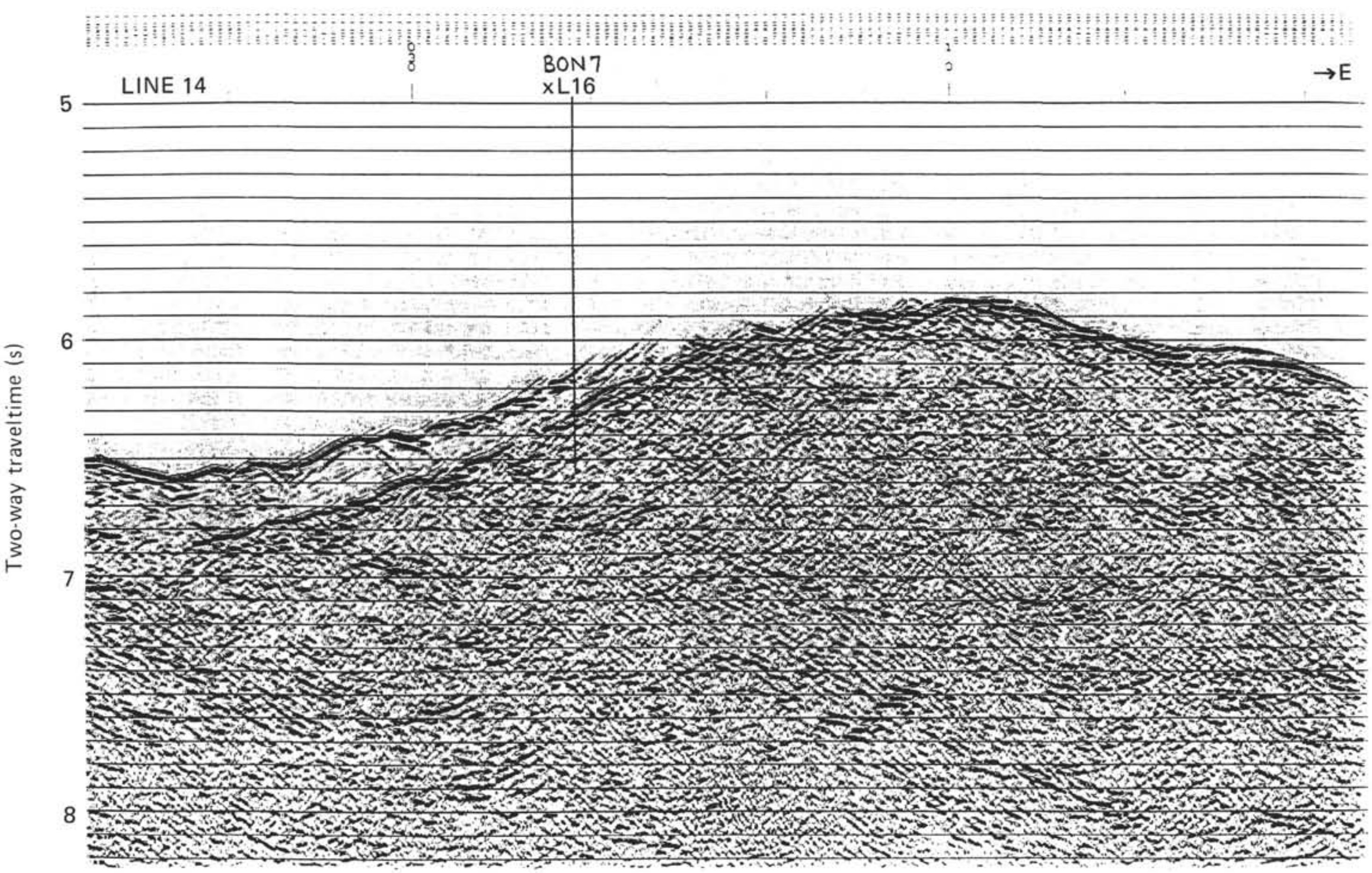
OBJECTIVES: (1) Age and mechanism of serpentinite emplacement, (2) Nature of fluids, (3) Nature of lower crustal rocks emplaced with the serpentinite

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Volcaniclastic and pelagic sediments above chloritized/serpentinized mafics/ultramafics (with talc-clay matrix?)



The seismic tie of MCS lines 14 and 16 at BON7 indicate a navigation mistie of ~1 nmi.


LINE16
BON7
×L14
→N
5
6
7
8
Two-way traveltime (s)


LINE 14
BON7
xL16
→E
5
6
7
8
Two-way traveltime (s)

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Sedimentologist:	TO BE NAMED
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OCEAN DRILLING PROGRAM LEG 126

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Paleontologist: (Radiolarians)	TO BE NAMED
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