VI. CONTINUOUS SEISMIC REFLECTION PROFILING SURVEY

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Continuous seismic reflection measurements were carried out along the ship's tracks (Fig. I-1). Methods and equipment used for these measurements are summarized in Table VI-1. Physiographic provinces in the survey area are shown on Fig. II-1.

Six interpreted profiles have been selected and are presented in Figs. VI-1(L31), VI-2 (L35), VI-3(L40), VI-4(N8), VI-5(J18), and VI-6(J10). In the text sediment thickness is indirectly expressed in terms of two-way acoustic travel time.

Only preliminary observations are given here; more detailed interpretation of the data will be reported at a later date.

(1) Continental shelf

The continental shelf is generally narrow in the survey area except around the Noto Peninsula and off Niigata.

Acoustic basements, folded sedimentary layers, and undeformed sedimentary covers are recognized on the continental shelf. The whole coast of the surveyed area lies within the Green Tuff Region—a complex mixture of Neogene sediments and volcanic rocks. The acoustic basement and the folded sedimentary layers on the continental shelf can be correlated with onshore Neogene volcanics and Neogene sediments, respectively, while the undeformed sedimentary cover is assumed to correspond to Quaternary deposits. These undeformed sediments are well developed to the west of the Noto Peninsula while the wide continental shelf off the Noto Peninsula is characterized by extensive Neogene

Table VI-1 Equipments and conditions of seismic reflection survey.

1) Equipment		
	Air Gun	Bolt Par Air Gun 1900B × 2
	Compressor	Norwalk APS–120 (120 S.C.F.M.)
	Receiver	Hydrostreamer GSJ-4II-78 (with 78 elements of Geo Space MP18-200)
	Amplifier	Geo Space 111 Amplifier
	Recorder	Raytheon UGR-196B
2) Condition		
	Total volume of air gun	270 to 300 in^3 (4425 to 4916 cm^3)
	Pressure	1500 p.s.i. (105 kg/cm^2)
	Shot interval	10 sec.
	AGC of amplifier	Off
	Filter range	16 to 98 Hz
	Record range	4 sec.
	Ship speed	10 knots
	Hydrostreamer	towed 150 m behind the ship

volcanic rocks (Fig. VI-3).

(2) Continental slope

The continental slope to the north of the Noto Peninsula has a complex topography with NNE (south of the Oga Peninsula) to NS trending (north of the Oga Peninsula) ridges and troughs. Notable features among these are the Sado Ridge, the Mogami Trough, the Okushiri Ridge, and the Okushiri Basin (Figs. VI-4 and VI-6).

Some ridges are covered by sedimentary layers while others are free of sediment. The sediments at the Mogami Trough and the Okushiri Basin exceed 1.5 seconds; the basement could not be detected by the seismic profiler records. A prominent uplifted feature of the basement is observed in the Mogami Trough (Fig. VI-4).

It should be noted, that the ridge and trough region is observed only on the eastern margin of the Japan Sea and that the northern, NS trending region, is independent of the trend of the Quaternary Tohoku (Northeastern Japan) and Kuril Arcs. The origin and nature of the tectonic process responsible for the ridge and trough region is still under investigation. However it is clear from preliminary observations that the movements which produced these features represent a major event in the tectonic development of the Japan Sea.

To the west of the Noto Peninsula, the topography is rather simple and quite different from that in the north. Gently folded, densely stratified, sedimentary layers of thicknesses less than 1.5 seconds, overlie a rugged acoustic basement which, on the upper continental slope, exhibit markedly folded sedimentary layers (Figs. VI-1 and VI-2). A distinct unconformity occurs between the upper, gently folded, sedimentary layer and the lower, markedly folded, layer (Fig. VI-2). The Oki Trough, at the foot of the continental slope, is filled by sediments of undeformed layer with a thickness exceeding 2.0 seconds; the upper part of this layer is acoustically stratified while the lower part is transparent (Fig. VI-2).

The difference in these features on the northern and southern continental slopes may be of particular importance in studying the tectonic history of the Japan Sea.

(3) Deep sea basins

Four major, deep sea basins (the Tartary Trough, the Japan Basin, the Yamato Basin, and Tsushima Basin) are recognized in the Japan Sea. The Japan Basin and the Yamato Basin occur in the survey area. While the Yamato Basin is fully surveyed with numerous complete traverses, only the eastern margin of the Japan Basin was surveyed (Fig. I-1).

The Japan and Yamato Basin have several similarities and several interesting, differences. One of the most striking differences occurs in the depth-to acoustic basement which exceed 7.0 seconds below the sea surface in the Japan Basin but is not greater than 5.5 seconds in the Yamato Basin (Figs. VI-3 and VI-5). Another notable difference is in sediment thicknesses; maximum thicknesses in the Japan Basin exceed 2.0 seconds (Fig. VI-5) whereas in the Yamato Basin only 1.6 seconds are observed (Figs.VI-3 and VI-4).

The acoustic pattern of the sediments in both basins is similar. In general the sediments can be devided acoustically, into two units; an upper stratified layer and a lower transparent layer. The difference in total sediment thickness of the two basins is produced by variations in the thickness of the lower unit.

Water depth represents a further difference. Water depth in the Japan Sea is generally exceed 3,500 m, approximately 500 m deeper than the Yamato Basin. However, water depth difference are due to the greater basement depth in the Japan Basin rather than to differences in sediment thickness.

The deeper basement and the thicker, lower (older) sedimentary unit in the Japan Basin may imply that the basement in the Japan Basin is older than that of the Yamato Basin, from which it may be inferred that the formation of the Japan Sea consists of at least two stages of different ages (see Chapters XI and XII).

The marginal features of both basins also are different from one other; the sediments of the Japan Basin mostly abut, to the east, against the foot of the continental slope (Figs. VI-5 and VI-6), whereas the sediments of the Yamato Basin overlap the basement highs at the margins (Figs. VI-3 and VI-4). The lower transparent layer crops out at the foot of banks and seamounts at the Yamato Basin. These outcrops give us rare opportunities to recover the lower sedimentary unit without deep sea drillings, and several rock core samplings were carried out at these localities (see Chapter VIII).

A marked v-shaped, Toyama Deep Sea Channel, occurs across the NE and of the Yamato Basin (Fig. VI-4). The channel cuts into the upper part of the upper stratified layer but no buried channels are observed. This fact may suggest that the Toyama Channel was initiated after the deposition of the lower part of the upper sedimentary unit and upto the present time has maintained a fairly constant course. The initiation of the Toyama Channel should be recorded as a feature of the Quaternary history of the Japan Sea.

(4) Banks, ridges, and plateau

The many topographic highs which characterize the Japan Sea emphasize its complexity compared to other western Pacific back-arc basins. Seven prominent topographic highs are observed in the survey area. These are: the Oshima Plateau, the Takuyo Bank, the Kita-Yamato Bank, the Yamato Bank, the Kita-Oki Bank, and the Oki Ridge (Fig. II-1). The Yamato Bank is generally free of sediments but the others are overlain by a sedimentary cover not exceeding 1.0 second.

The Kita-Yamato and Oki Banks resemble each other in terms of their basement morphology and the acoustic pattern of their sedimentary covers (Figs. VI-1 and VI-3): the acoustic basements of both banks form plateau-like features with rugged summit terraces, with overlying, densely stratified, sedimentary covers. In places, the boundary between the two units is difficult to recognize because of acoustically opaque sediments.

The Kita-Oki and Takuyo Banks show a variation in the character of basement highs and depressions (Figs. VI-2 and VI-4). The basement highs are mostly free of sediments while the basement depressions are filled by over 1.0 second of acoustically stratified sediments which are less opaque than the sediments of the Kita-Yamato and Oki Banks. Unconformities are observed in the sediments at the Takuyo Bank.

The Yamato Bank forms an ENE trending, ridge-like feature with a flat summit, on which basement is mostly exposed, in minor cliffs. This flatish summit is interpreted as a wave cut platform formed when the upper parts of the Bank were at sea level. The western Oki Ridge also has a flat summit with minor cliffs but is free of sediment. In contrast, the eastern Oki Ridge shows a prominent central depression filled by sediments upto a maximum thickness of 0.8 second (Fig. VI-2).

The Oshima Plateau is different from the banks and ridge mentioned above (Fig. VI-6); the plateau has a slightly rugged summit but with a very thin sedimentary cover.

The different character of these topographic highs appears to be related to basement lithologies and their subsidence histories. A geological synthesis of these topographic highs may provide many important clues to the tectonic development of the Japan Sea.