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ANNUAL REPORT ON STRONG-MOTION EARTHQUAKE RECORDS
IN JAPANESE PORTS (1997)

港湾地域強震観測年報(1997)

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Abbreviations used above:

AR : Analog Records of Reproduced Accelerograms

IR : Integrated Velocities and Displacements

RS : Response Spectra

FS : Fourier Spectra

LO : Loci of Accelerations, Velocities and Displacements

港湾地域強震観測年報 (1997)

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要 旨

1962年より実施されている港湾地域強震観測網においては、1997年12月31日現在、5391個の強震記録が蓄積されるに至っている。このうち、1997年中には168個の強震記録が得られている。強震計の台数としては、1997年12月31日現在、95台の強震計が59港に設置されており、設置状況としては、65台が地盤上に、22台が地中に、8台が構造物上となっている。本強震観測網では、機械式アナログ記録方式のSMAC-B2型強震計、電気式アナログ記録方式のERS-B、-C、-D型強震計および電気式デジタル記録方式のERS-F、-G型強震計の6種類の強震計が使用されている。ただし、アナログ型のSMAC-B2型強震計およびERS-B、C、D型強震計については、最新型のERS-G型強震計に数年の内に更新される予定となっている。

本報告は、1997年に港湾地域強震観測網で得られた記録について報告するものである。本観測網で得られた記録は、地震毎に分類され、地震諸元、観測地点、記録番号、最大加速度等とともに、本報告に掲載されている強震観測表(Strong-Motion Earthquake Observation Results)にまとめられている。強震観測表の地震諸元は、気象庁地震津波監視課発行の「地震月報」および「地震火山概況」に基づいている。また、強震記録の記録番号は、各観測地点から記録が送られてきた順番に付けられており、記録の分類として、頭文字「S」で始まる記録はSMAC-B2型強震計で得られた記録、「M」はERS-B、-C、-D型強震計で得られた記録、「F」はERS-F、-G型強震計で得られた記録をそれぞれ示している。強震観測表にまとめられている記録の中で、最大加速度が20Galを越える記録については、観測結果として再生した加速度記録波形を示している。また、最大加速度が50Galを越える比較的大きな記録については、さらに、補正加速度記録波形、速度波形、変位波形、応答スペクトル、フーリエスペクトル、水平面内の加速度・速度・変位の軌跡も併せて示している。

1997年における港湾地域強震観測は、以下に示す諸機関の協力の下に実施された。

運輸省港湾局
東京都港湾局

運輸省港湾建設局
静岡県港湾課

北海道開発局港湾部
宮城県港湾課

沖縄開発庁沖縄総合事務局
大阪市港湾局

また、本年報の作成には、各観測地点での強震観測担当者の努力に負うところが非常に大きい。担当者各位に敬意と謝意を表すと同時に、各観測地点で実際に強震計の点検ならびに記録の取扱いに携わった方々の氏名を次頁以降に掲載する。

キーワード： 地震， 港湾強震観測， 数値化加速度記録， 応答スペクトル

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第一港湾建設局

秋田	港湾工事事務所	玉内 克一	末永 清和	沓沢 文之	
酒田	〃	川村 浩	小野寺 悌介	古玉 悟	
新潟	港湾空港工事事務所	橋本 正夫	松村 高司	佐々木 均	渡辺 義
伏木富山	港湾工事事務所	岡本 博	小西 努	内生蔵一樹	
金沢	港湾空港工事事務所	安野 浩正	森永 真朗		
敦賀	港湾工事事務所	高野 政広	高野 剛光	西田 一彦	

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		丸岡 純			
釜石	港湾工事事務所 宮古工場	黒沢 忠男	吉田 静夫	一戸 秀久	
釜石	〃	高橋 三吉	佐藤 和敏	山内 尚	後藤 健二
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小名浜	〃 相馬工場	佐々木英秋	佐々木昌治		
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鹿島	〃 常陸那珂建設支所	千葉 仁	高橋 三吉		
千葉	〃	笹森秀一郎	山中 一成	及川 修一	
京浜	〃	北川 俊治	有路 隆一	大野 勉	関 伸哉

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十勝	港湾建設事業所	折原 靖夫	菊地 隆一		
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留萌	港湾建設事務所	西村 善雄	藤田 雄二	渡辺 光弘	
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紋別	〃	小玉 茂義	高橋 哲美	平良木映光	

沖縄総合事務局

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那覇	〃 中城港湾出張所	大村 誠	知念 正尚		
平良	港湾工事事務所	新垣 英隆	仲村 進一		
石垣	〃	石嶺 隆二	新崎 栄作		

都道府県

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宮崎県北部港湾事務所	宮崎 義昭	永山 敏広			

ANNUAL REPORT ON STRONG-MOTION EARTHQUAKE RECORDS IN JAPANESE PORTS (1997)

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Synopsis

Since 1962, strong-motion earthquakes and earthquake responses of structures have been observed in the major ports in Japan. By the end of December 1997, 5391 accelerograms had been accumulated and analyzed at the Geotechnical Earthquake Engineering Laboratory of the Port and Harbour Research Institute.

The strong-motion earthquake observation network in port areas in Japan consists of 95 strong-motion accelerographs installed at 59 ports as of December 1997. 65 accelerographs out of 95 are installed at ground surface, 22 accelerographs are in ground by using bore-hole and the rest 8 are on structures such as quay walls. In the network, two types of accelerographs have been used; one is the SMAC-B2 accelerograph and the other is the ERS accelerograph. The SMAC-B2 accelerograph is of a mechanical type and the ERS accelerograph is of an electrical type equipped with either analogue or digital recorder.

This report presents results of observation and preliminary analysis of records obtained in 1997, which are listed in the tables of Strong-Motion Earthquake Observation Results with their maximum accelerations, being classified in accordance with earthquakes. For the records of ground motions with maximum accelerations exceeding 20 Gals (=cm/sec²), computer plots of reproduced acceleration are presented. For the records of ground motions with maximum acceleration exceeding 50 Gals, computer plots of corrected acceleration, integrated velocity and displacement, response spectra, Fourier spectra, and loci of accelerations, velocities and displacements in horizontal plane are presented.

Key Word: Earthquake, Port, Strong-Motion Earthquake Observation, Digitized Acceleration Records, Response Spectra

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1. Introduction

The observation of the strong-motion earthquake in major ports in Japan was started in 1962 by the Geotechnical Earthquake Engineering Laboratory of the Port and Harbour Research Institute. The observation network was expanded year by year and 95 accelerographs had been installed in 59 ports as of December 1997. 5391 accelerograms had been obtained in the network by the end of 1997. The number of accelerograms obtained in 1997 were 168. Two types of accelerographs have been used in the network, namely the SMAC-B2 accelerograph and the ERS accelerograph. As of December 1997, 2658 accelerograms out of 5391 had been obtained by the SMAC-B2 accelerograph and 2733 accelerograms by the ERS accelerograph.

The records had been published as annual reports after preliminary processing and analyses which will be explained later. The records from 1963 to 1975 had been published in the preceding annual reports which had similar format to the present one¹⁾⁻¹¹⁾. Because digitized data of vertical components of the records from 1963 to 1975 were not included in those reports, the data were reported separately¹²⁾. After the annual report for the records of 1976 and 1977, a new data processing procedure was introduced, and accelerations with instrument correction, integrated velocities and displacements, Fourier spectra and response spectra had been reported in the annual reports¹³⁾⁻²⁹⁾. When disastrous earthquakes occurred, special reports had been published for the earthquake records besides annual reports³⁰⁾⁻⁴¹⁾.

In 1968, there occurred an earthquake of JMA Magnitude 7.9 in south-east off Hokkaido island. This earthquake was named the 1968 Tokachi-Oki Earthquake, and large number of after shocks followed. Many damage took place to buildings, roads, port facilities and many other types of structures, and many accelerograms were obtained in the network. In particular, an accelerogram with the maximum acceleration of 259 Gals (=cm/sec²) was recorded at Hachinohe Port in northern part of Honshu island. Because of the large magnitude of the earthquake and the damage to structures, the records were of great interest and importance, and a special report was published for the records³⁰⁾. In 1978, Japan was hit by two great earthquakes which were the 1978 Izu-Oshima-Kinkai Earthquake of JMA Magnitude 7.0 in south-central off Honshu island and the 1978 Miyagi-Ken-Oki Earthquake of JMA Magnitude 7.4 in north-east off Honshu island. Records of these earthquakes were compiled into two special reports^{31),32)}. In 1982, port structures were damaged by the 1982 Urakawa-Oki Earthquake of JMA Magnitude 7.1 in south-east off Hokkaido island, and records of the earthquake were also compiled into a special report³³⁾. In 1983, serious damage was brought about in the Japan Sea side of north-west off Honshu island by the 1983 Nipponkai-Chubu Earthquake of JMA Magnitude 7.7, and records of the earthquake were compiled into a special report³⁴⁾. In 1984, an earthquake of JMA Magnitude 7.1 occurred off east coast of Kyushu island in Hyuga-nada, and brought slight damage to port facilities. Records of the earthquake were compiled into a special report³⁵⁾. In 1987, an earthquake of JMA Magnitude 6.7 hit the metropolitan area. The earthquake caused some damages to structures and reclaimed lands area also liquefied slightly by this earthquake. Records of the earthquake are compiled into a special report³⁶⁾. In 1993, two great earthquakes occurred in Hokkaido island, which were the 1993 Kushiro-Oki Earthquake of JMA Magnitude 7.8 in east off Hokkaido on January 15 and the 1993 Hokkaido-Nansei-Oki Earthquake of JMA Magnitude 7.8 in south-west off Hokkaido on July 12. Serious damage was brought about in Hokkaido and many accelerograms were recorded in the network. The records obtained by these two big earthquakes were compiled into special reports^{37),38)}. In 1994, two great earthquakes occurred, which were the 1994 Hokkaido-Toho-Oki Earthquake of JMA Magnitude 8.1 in east off Hokkaido island on October 4 and the 1994 Sanriku-Haruka-Oki Earthquake of JMA Magnitude 7.5 in east off Honshu island on December 28. Many accelerograms were recorded in the network. These records are also compiled into special reports^{39),40)}.

In 1995, one of the most disastrous earthquake in the world hits Hanshin area of Japan. The earthquake named as 1995 Hyogo-ken nambu earthquake of JMA Magnitude 7.2. Most of structures in Kobe port were severely damaged by this earthquake. The records obtained during this earthquake and aftershocks are compiled into a special

report⁽⁴¹⁾.

This report presents the strong-motion earthquake records observed in 1997. The records obtained in the network in 1997 are listed in tables of Strong-Motion Earthquake Observation Results with their maximum accelerations, being classified by earthquakes. For the acceleration records obtained in ground or on ground with maximum accelerations exceeding 20 Gals, computer plots of reproduced accelerograms are prepared. For the records obtained in ground or on ground with maximum acceleration exceeding 50 Gals, computer plots of reproduced accelerograms, integrated velocities and displacements, response spectra, Fourier spectra and loci of accelerations, velocities and displacements in horizontal plane are prepared. Digitized data table of accelerograms and calculated data table of response spectra had been listed in the proceeded annual reports in old days, but those data are not included in this report because those printed digital data tables are not often used any more.

Following organizations cooperated with the Port and Harbour Research Institute in the strong-motion earthquake observation in port area;

- (a) The Bureau for Ports and Harbours of the Ministry of Transport
- (b) The Regional Bureaus for Port Construction of the Ministry of Transport
- (c) The Port and Harbour Division, Hokkaido Development Bureau of the Hokkaido Development Agency
- (d) The Okinawa General Office of the Okinawa Development Agency
- (e) The Harbour Bureau of Tokyo Metropolitan Government
- (f) The Harbour Bureau of Osaka Municipal Government
- (g) The Harbour Section of Shizuoka Prefectural Government
- (h) The Harbour Section of Miyazaki Prefectural Government

2. Network and Instruments

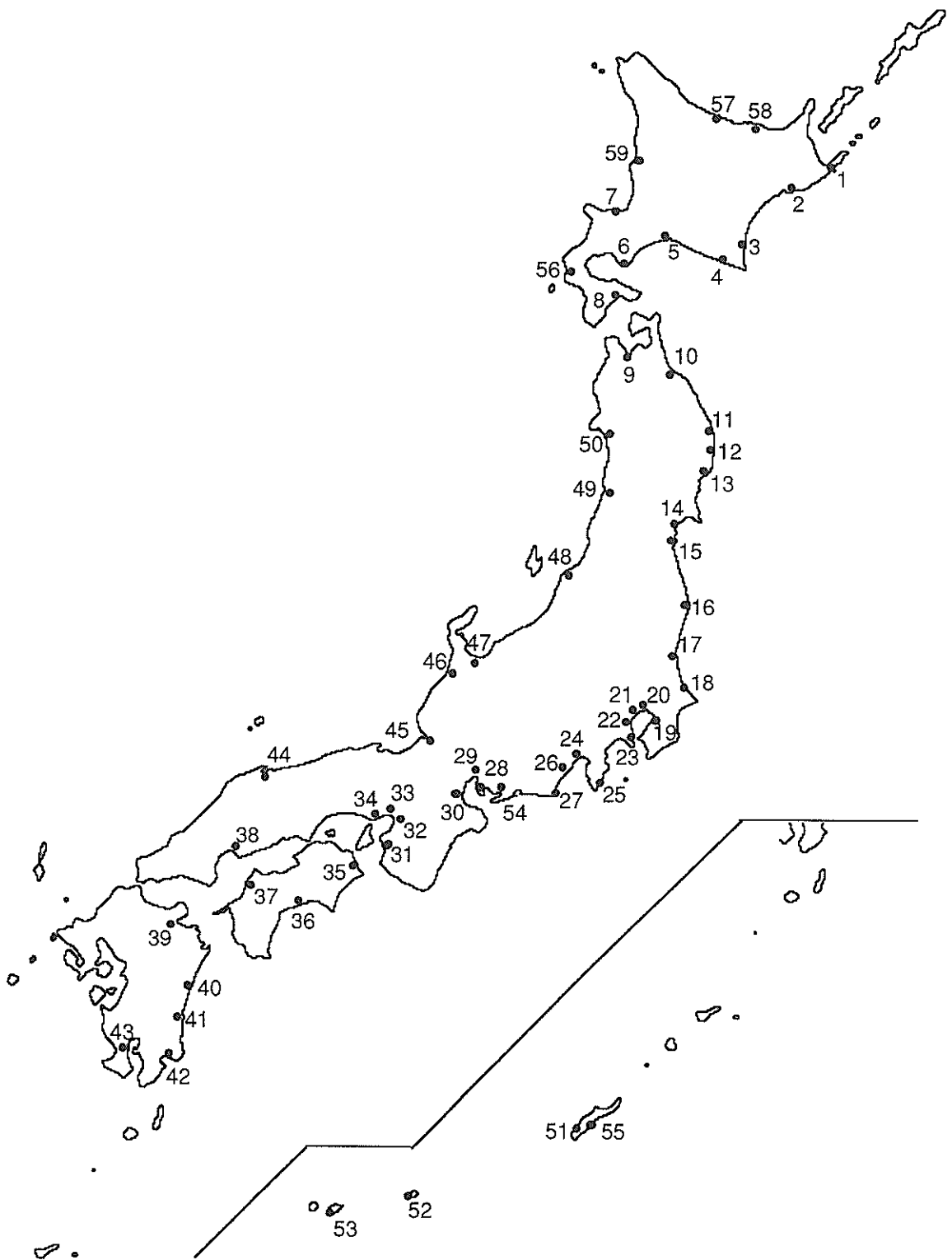
(1) Network

The network of the Port and Harbour Research Institute covered the whole coast line of Japan with 95 strong-motion accelerographs in 59 ports at the end of 1997. The locations of ports where accelerographs were installed as of December 1997 are shown in Figure 1. The numbers attached to the ports in Figure 1 correspond to the numbers of ports in Table 1.

The stations in the network are listed in Table 1 with the type of accelerograph and the installation condition, being classified by ports. The detailed information of the stations is described in the reports on the site characteristics⁽⁴²⁾⁻⁴⁶⁾. At the end of 1997, the accelerographs at 7 stations out of 95 stations were the SMAC-B2 accelerographs and the rest 88 were the ERS accelerographs.

(2) Servicing

Installation and servicing of the accelerographs have been made by the port construction offices of the previously described organizations under the guidance of the Geotechnical Earthquake Engineering Laboratory. It is directed that accelerographs should be checked at least once a month and after an earthquake larger than the JMA seismic intensity scale II shown in Table 2. JMA seismic intensity scale has slightly changed at February 1996 and new scale are summarized in Table 2. Immediately after the earthquake, the accelerograms are sent to the Laboratory by mail without any treatment or reading to avoid possible damage to the records.



Figuer1 Location of ports where accelerographs are installed as December 1997

Table 1 List of Strong-Motion Earthquake Stations of the Port and Harbour Research Institute

(December 1997)

No.of port*	Name of port	Name of station	Type of accelerograph	Installation condition	Ref. No.**
1	Hanasaki	1 Hanasaki-F	ERS-F	on ground	
2	Kushiro	2 Kushiro-G	ERS-G	on ground	34
		3 Kushiro-GB	ERS-G	in ground	
3	Tokachi	4 Tokachi-G	ERS-G	on ground	298
4	Urakawa	5 Urakawa-G	ERS-G	on ground	
5	Tomakomai	6 Tomakomai-G	ERS-G	on ground	107
6	Muroran	7 Muroran-G	ERS-G	on ground	34,107
7	Otaru	8 Otaru-G	ERS-G	on ground	107
8	Hakodate	9 Hakodate-G	ERS-G	on ground	298
		10 Hakodate-FB	ERS-F	in ground	
		11 Hakodate-F	ERS-F	on ground	
		12 Hakodate-FR	ERS-F	on structure	
9	Aomori	13 Aomori-G	ERS-G	on ground	107,298,156
10	Hachinohe	14 Hachinohe-G	ERS-G	on ground	34,107
		15 Hachinohe-GB	ERS-G	in ground	
11	Miyako	16 Miyako-G	ERS-G	on ground	34,107
12	Kamaishi	17 Kamaishi-M	ERS-C	on ground	351
		18 Kamaishi-MB	ERS-D	in ground	351
13	Ofunato	19 Ofunato-bochi-G	ERS-G	on ground	34,107
		20 Ofunato-bo-S	SMAC-B2	on structure	34,107
		21 Ofunato-mound-M	ERS-C	on structure	
14	Sendai	22 Sendai-M	ERS-C	on ground	351
		23 Sendai-MB	ERS-D	in ground	351
15	Soma	24 Soma-S	SMAC-B2	on ground	
16	Onahama	25 Onahama-ji-G	ERS-G	on ground	34,351
		26 Onahama-ji-GB	ERS-G	in ground	
17	Hitachinaka	27 Hitachinaka-F	ERS-F	on ground	
18	Kashima	28 Kashima-zokan-S	SMAC-B2	on ground	34,156,298
19	Chiba	29 Chiba-G	ERS-G	on ground	107
		30 Chiba-GB	ERS-G	in ground	
20	Tokyo	31 Shinagawa-G	ERS-G	on ground	
		32 Shinagawa-GB	ERS-G	in ground	
21	Kawasaki	33 Kawasaki-FB	ERS-F	in ground	
		34 Kawasaki-F	ERS-F	on ground	
		35 Kawasaki-FR	ERS-F	on structure	
22	Yokohama	36 Yamashita-FB	ERS-F	in ground	
		37 Yamashita-F	ERS-F	on ground	
		38 Yamashita-FR	ERS-F	on structure	
23	Yokosuka	39 Koken-G	ERS-G	on ground	
		40 Koken-S	SMAC-B2	on ground	34
24	Tagonoura	41 Tagonoura-S	SMAC-B2	on ground	107
25	Shimoda	42 Shimoda-F	ERS-F	on ground	
26	Shimizu	43 Shimizu-G	ERS-G	on ground	
		44 Shimizu-GB	ERS-G	in ground	
27	Omaezaki	45 Omaezaki-M	ERS-C	on ground	351
28	Kinuura	46 Kinuura-ji-S	SMAC-B2	on ground	107,298
29	Nagoya	47 Nagoya-sorami-G	ERS-G	on ground	
		48 Nagoya-sorami-GB	ERS-G	in ground	
		49 Nagoya-inae-G	ERS-G	on structure	34
30	Yokkaichi	50 Yokka-sekitan-M	ERS-B	on structure	34
		51 Yokkaichi-G	ERS-G	on ground	34
		52 Yokkaichi-GB	ERS-G	in ground	

(to be continued)

(Table 1 Continued)

No. of port*	Name of port	Name of station	Type of accelerograph	Installation condition	Ref. No.**
31	Wakayama	53 Wakayama-G	ERS-G	on ground	34,298
32	Osaka	54 Osaka-ji-G	ERS-G	on ground	34
		55 Osaka-minami-G	ERS-G	on ground	34
33	Amagasaki	56 Amagasaki-G	ERS-G	on ground	156
34	Kobe	57 Kobe-ji-S	SMAC-B2	on ground	34
		58 Kobe-ji-GB80	ERS-G	in ground	
		59 Kobe-ji-GB40	ERS-G	in ground	
		60 Kobe-ji-G	ERS-G	on ground	
		61 Kobe-dai8-G	ERS-G	on structure	34
		62 Kobe-maya-G	ERS-G	on ground	298
		63 Rokko-GB80	ERS-G	in ground	
		64 Rokko-GB40	ERS-G	in ground	
		65 Rokko-G	ERS-G	on ground	
35	Komatsujima	66 Komatsujima-G	ERS-G	on ground	107
36	Kochi	67 Kochi-G	ERS-G	on ground	34,298
37	Matsuyama	68 Matsuyama-G	ERS-G	on ground	156
38	Hiroshima	69 Hiroshima-G	ERS-G	on ground	34
39	Oita	70 Oita-G	ERS-G	on ground	156
40	Hososhima	71 Hososhima-F	ERS-F	on ground	34,298
41	Miyazaki	72 Miyazaki-G	ERS-G	on ground	298
		73 Miyazaki-GB	ERS-G	in ground	
42	Shibushi	74 Shibushi-G	ERS-G	on ground	
43	Kagoshima	75 Kagoshima-G	ERS-G	on ground	34,298
44	Sakaiminato	76 Sakaiminato-G	ERS-G	on ground	34,298
45	Tsuruga	77 Tsuruga-G	ERS-G	on ground	34
46	Kanazawa	78 Kanazawa-G	ERS-G	on ground	107
47	Toyama	79 Toyama-G	ERS-G	on ground	34
		80 Toyama-GB	ERS-G	in ground	
48	Niigata	81 Niigata-G	ERS-G	on ground	34,298
49	Sakata	82 Sakata-G	ERS-G	on ground	34
50	Akita	83 Akita-G	ERS-G	on ground	34,351
		84 Akita-GB	ERS-G	in ground	
51	Naha	85 Naha-G	ERS-G	on ground	298
		86 Naha-GB	ERS-G	in ground	
52	Hirara	87 Hirara-G	ERS-G	on ground	298
53	Ishigaki	88 Ishigaki-G	ERS-G	on ground	298
54	Mikawa	89 Mikawa-G	ERS-G	on ground	
		90 Mikawa-GB	ERS-G	in ground	
55	Nakagusuku	91 Nakagusuku-G	ERS-G	on ground	
56	Setana	92 Setana-G	ERS-G	on ground	
57	Monbetsu	93 Monbetsu-G	ERS-G	on ground	
58	Abashiri	94 Abashiri-G	ERS-G	on ground	
59	Rumoi	95 Rumoi-G	ERS-G	on ground	

*The numbers correspond to those in Figure 1.

**The numbers correspond to those of the Technical Note of the Port and Harbour Research Institute, in which site characteristics of the stations are given. These references include the site where initially SMAC-B2 accelerograph and it was already replaced with ERS type.

Table 2 JMA Seismic Intensity Scale (December 1997)

0 : NO FEELING	Imperceptible to people.
I : SLIGHT	Felt by only some people in the building.
II : WEAK	Felt by most people in the building. Some people awake. Hanging objects such as lamps swing slightly.
III : RATHER STRONG	Felt by most people in the building. Dishes in a cupboard rattle occasionally. Electric wires swing slightly.
IV : STRONG	Many people are frightened. Most sleeping people awake. Hanging objects swing considerably and dishes in a cupboard rattle. Unstable ornaments fall occasionally. Electric wires swing considerably.
V(Lower) : VERY STRONG(Lower)	Some people find it difficult to move. Hanging objects swing violently. Most unstable ornaments fall. People notice electric-light poles swing. Occasionally, less earthquake-resistant houses suffer damage to walls and pillars.
V(Upper) : VERY STRONG(Upper)	Many people are considerably frightened and find it difficult to move. Most dishes in a cupboard and most books on a bookshelf fall. In many cases, unreinforced concrete-block walls collapse and tombstones overturn. Many automobiles stop because it becomes difficult to drive. Occasionally, less earthquake-resistant houses suffer heavy damage to walls and pillars and lean.
VI(Lower) : DISASTROUS(Lower)	Difficult to keep standing, A lot of heavy and unfixed furniture moves and falls. In some buildings, wall tiles and windowpanes are damaged and fall. Occasionally, less earthquake-resistant houses collapse.
VI(Upper) : DISASTROUS(Upper)	Impossible to keep standing and to move without crawling. Most heavy and unfixed furniture moves and falls. In many buildings, wall tiles and windowpanes are damaged and fall. Most unreinforced concrete-block walls collapse. Many, less earthquake-resistant houses collapse.
VII : VERY DISASTROUS	Thrown by the shaking and impossible to move at will. Most furniture moves to a large extent and some jumps up. In most buildings, wall tiles and windowpanes are damaged and fall. Occasionally, even highly earthquake-resistant buildings are severely damaged and lean.

(3) Station

There are three kinds of stations in the network. The first is to record accelerations at ground surface, the second is in ground by using bore-hole and the third is to record earthquake response of structures. The station which records earthquake response of structures is always accompanied with another station which records ground acceleration in its vicinity.

In the stations which record the ground acceleration, one of the horizontal components of the accelerograph is directed to the due north except a few accelerographs. Some of the accelerographs are installed in parallel with the structures because most of port facilities such as quay walls or piers have two-dimensional-structure and it is desir-

able to record the components of the ground acceleration parallel and perpendicular to the principal axes of the structure. In the stations which record structural response and the accompanying stations which record the ground acceleration in its vicinity, accelerographs are installed parallel to the structure in which earthquake response is needed.

Two horizontal components of the accelerograph are usually corresponding to North-South (NS) and East-West (EW) direction, respectively. However, if the direction of the component of the accelerograph is different from the geometric direction, the deviation angle in degree is used to represent components direction. For example, N10E component means that the direction deviates 10 degrees eastward from the due north.

Each station in the network has its own abbreviated name listed in Table 1. The name consists of the location, the type of the accelerograph and the installation condition. For instance, the stations in Kushiro port in Hokkaido island are named Kushiro-G and Kushiro-GB, respectively. 'Kushiro' means the location of the station. In some sites where the accelerograph installed at the port construction office, the suffix 'ji' is attached as 'Kobe-ji'. The suffix 'G' represents type of acceleration and means that the ERS-G type accelerograph is installed at Kushiro port. If the SMAC-B2 accelerograph is installed, this suffix becomes 'S', if the ERS-B, -C and -D type accelerograph, 'M', and if the ERS-F type accelerograph, 'F'. The suffix 'B' after 'G' in Kushiro-GB represents installation condition and means that the accelerograph is installed in ground using bore-hole. If there is no suffix representing installation condition such as Kushiro-G, that means the accelerograph is being installed at ground surface. If the suffix representing installation condition becomes 'R', that means the accelerograph is being installed on the structure. In the Kobe-ji site and Rokko site, two accelerograph are installed at different depth of in ground. The suffix of number like '40' after 'B' represents the depth of in ground accelerograph.

(4) Accelerograph

(a) SMAC-B2 accelerograph

The SMAC-B2 accelerograph was developed by the Committee for the Standard Strong Motion Accelerograph.

Table 3 Specifications of the SMAC-B2 accelerograph

Component	2 horizontal and 1 vertical
Natural period	0.14 sec.
Sensitivity	12.5 Gal/mm
Damping	Critical
Damping mechanism	Air piston
Maximum recording acceleration	500 Gal
Recording speed	10 mm/sec.
Recording medium	Waxed paper
Driving mechanism for recorder	Hand-wound spring motor
Recording duration	3 min.
Recording capacity	5 earthquakes/roll
Starter	Electric contact made by vertical motion
Period of starter pendulum	0.3 sec.
Starter threshold	5 Gal
Auxiliary starter	Mechanical, works at 100 gal
Time marking	1 sec.
Power supply	4 dry cells
Size	54 × 54 × 37 in cm
Net weight	100 kg

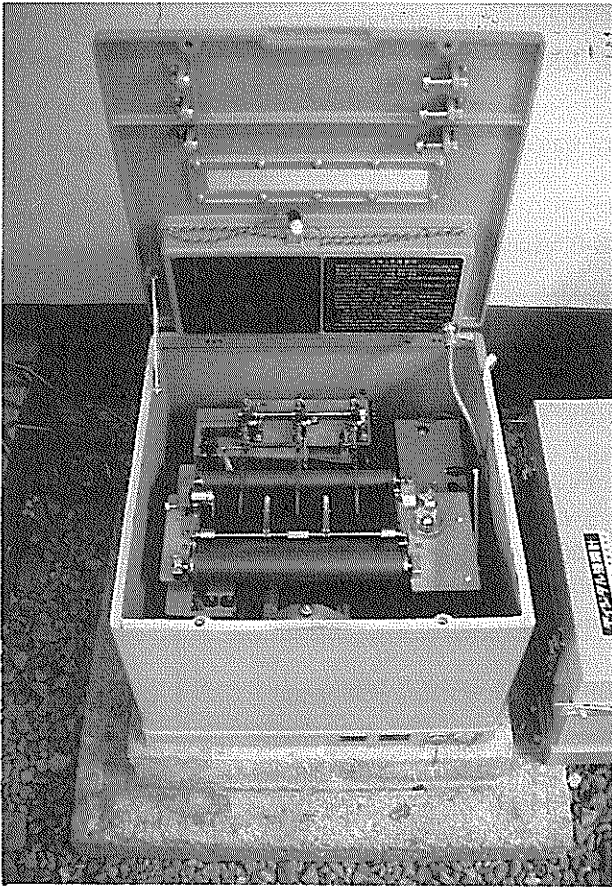
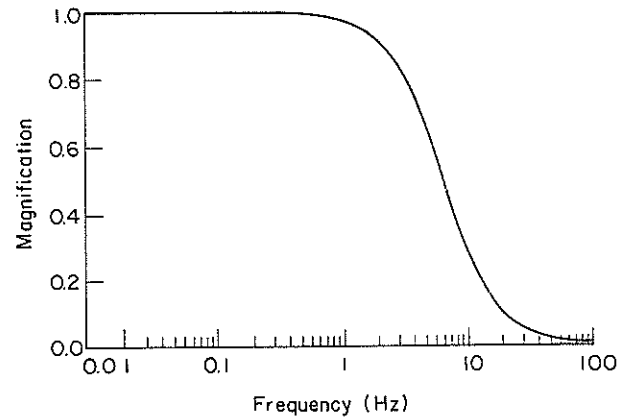
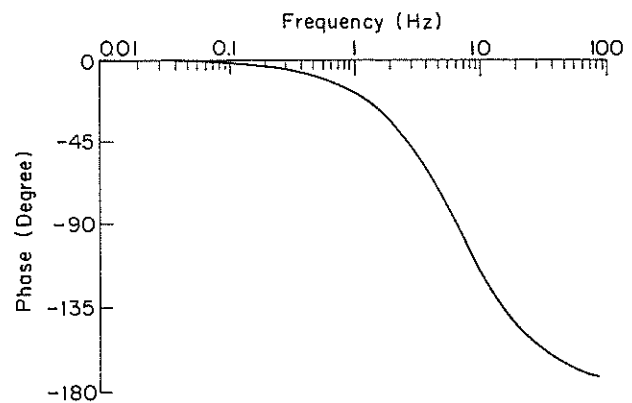


Figure2 Inside view of the SMAC-B2 accelerograph



(a) amplitude



(b) phase

Figure3 Frequency characteristics of the SMACB-2 accelerograph

It is a three component mechanical type accelerograph which scratches records on a rolled waxed paper. The specifications of the SMAC-B2 accelerograph are shown in Table 3. Inside view and theoretical frequency characteristics are also shown in Figure 2 and Figure 3, respectively.

The SMAC-B2 accelerograph has been one of the standard accelerographs in the network of the Port and Harbour Research Institute. At the earlier stage of the strong-motion observation, the SMAC-B2 accelerograph was one of the standard models and suitable for the observation condition in port areas. After the SMAC-B2 accelerograph, several types of accelerograph were developed by the Committee. In the network, however, the SMAC-B2 accelerograph has only been used as a mechanical type accelerograph because it was inconvenient to use many types of accelerographs from the view point of instrument correction procedure and maintenance. As of December 1997, total number of SMAC-B2 accelerograph being used is 7.

5 Gals ($=\text{cm}/\text{sec}^2$) is adopted as a triggering level of the accelerograph in places where ground noise is small, and 8 Gals in places where ground noise is relatively large because of heavy motor trucks for construction work or cargo transportation. A few number of the accelerographs located beside roads carrying very heavy traffic are triggered at 11 Gals.

At present, an action program is going on to replace the SMAC-B2 accelerographs with digital type accelerographs.

(b) ERS accelerograph

The SMAC-B2 accelerograph has been very widely used in the network. However, there exist some places where the SMAC-B2 accelerograph can not be installed, such as on structures or in ground. For that reason, the ERS accelerograph was developed by the Geotechnical Earthquake Engineering Laboratory to observe earthquake motions in a specific condition. Transducers and a recorder of the ERS accelerograph are separately installed for the observation.

First, the accelerograph with magnetic tape data recorders was developed. This accelerograph was called the

Table 4 Specifications of the ERS-B accelerograph

Transducer	
Type	Moving coil type
Component	2 horizontal
Natural period	0.5 sec.
Damping factor	17
Damping mechanism	Electro-magnetic
Capacity	250 Gal
Coil impedance	320 ohm
Sensitivity	about 2mv/Gal(circuit open)
Water tightness	over 200 kg/cm ²
Recorder	
Type	Electro magnetic oscillograph
Natural frequency of galvanometer	100 Hz
Sensitivity	166 mm/mA
Recording paper	92 mm(width)×30 m(length) (visible without processing)
Paper speed	2 cm/sec.
Time mark	0.1 sec.
Power supply ...	Rechargeable battery, Charged automatically when it is necessary.

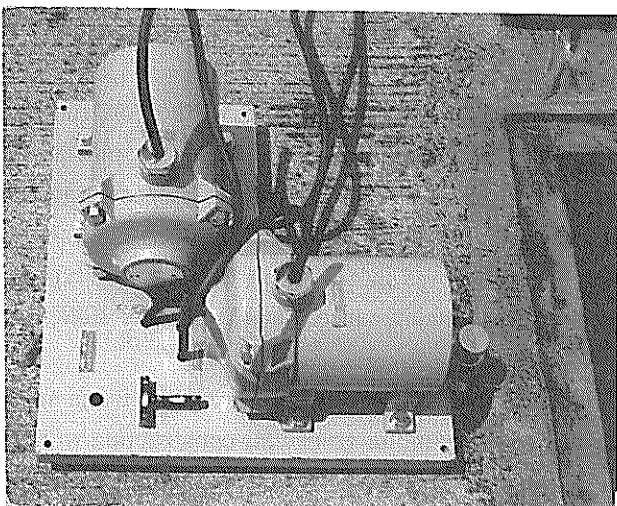


Figure4 Transducers of the ERS-A and -B accelerograph

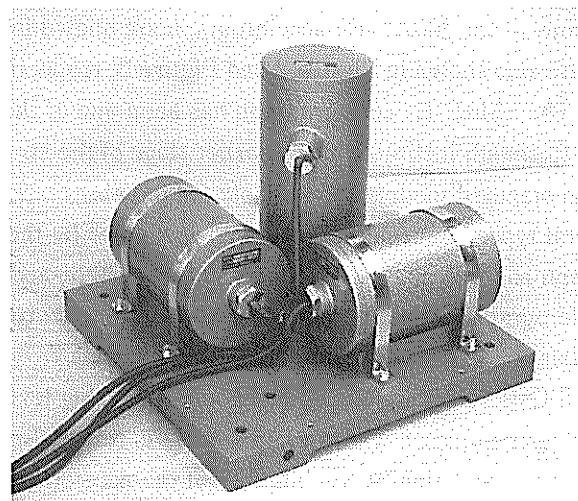


Figure5 Transducers of the ERS-C accelerograph

Table 5 Specifications of the ERS-C(D) accelerograph

Transducer	
Type	Moving coil type
Component	2 horizontal and 1 vertical
Natural frequency	3 Hz(5 Hz)
Damping factor	17(10)
Damping mechanism	Electro-magnetic
Capacity	500 Gal
Water tightness	over 20 kg/cm ²
Recorder	
Type	Electro magnetic oscillograph
Natural frequency of galvanometer	270 Hz
Recording paper	198 mm(width)×30m(length) (visible without processing)
Paper speed	4 cm/sec.
Time mark	0.1 sec.
Sensitivity (overall)	2 Gal/mm, or 10 Gal/mm
Power supply ... Rechargeable battery, Charged automatically when it is necessary.	

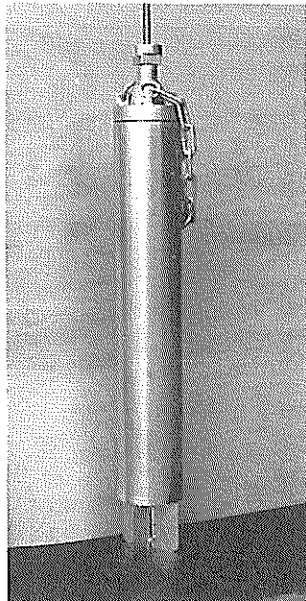
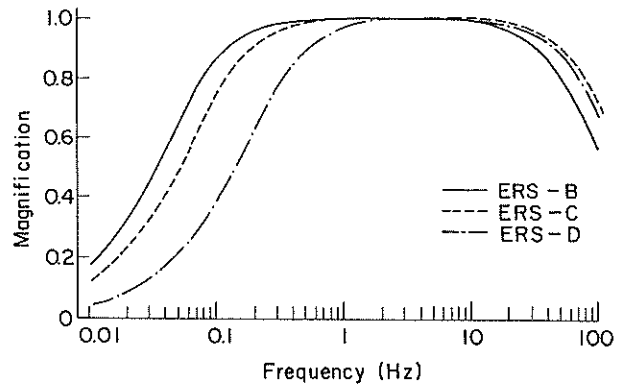
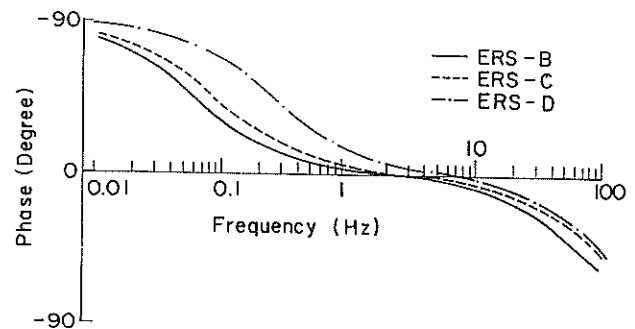


Figure6 Transducers of the ERS-D accelerograph



(a) amplitude



(b) phase

Figure7 Frequency characteristics of the ERS-B, -C and -D accelerograph

ERS-A accelerograph. After some period of operation, the magnetic tape data recorders were replaced by an oscillograph. The model with an oscillograph was named as the ERS-B accelerograph. The ERS-A and -B accelerograph records only two horizontal components of acceleration. The specifications of the ERS-B accelerograph are shown in Table 4 and the transducer of the ERS-A and -B are shown in Figure 4. The ERS-B accelerographs are used at only 1 stations at present as shown in Table 1.

After that, the ERS-C accelerograph was developed and installed. While the ERS-B accelerograph records accelerations in two horizontal components, the ERS-C accelerograph records acceleration of vertical component as well as two horizontal ones. The transducer of the ERS-C accelerograph is shown in Figure 5. The ERS-C accelerographs are working at 4 stations at present as shown in Table 1.

The ERS-D accelerograph was also developed for recording acceleration in ground. Accelerographs of this type had been installed at 2 stations in the network as shown in Table 1. The transducers of the ERS-D accelerograph are installed in bore-hole and they have the same specifications as those of the ERS-C accelerograph. The specifications of the ERS-C and -D accelerographs are shown in Table 5. The transducers of the ERS-D accelerograph are shown in Figure 6.

In the ERS-B, -C and -D accelerographs, the transducers are almost directly connected with galvanometers in the oscillograph. There exist only resistor circuits to adjust sensitivity and impedance matching between them. No electronic amplifier is used to attain

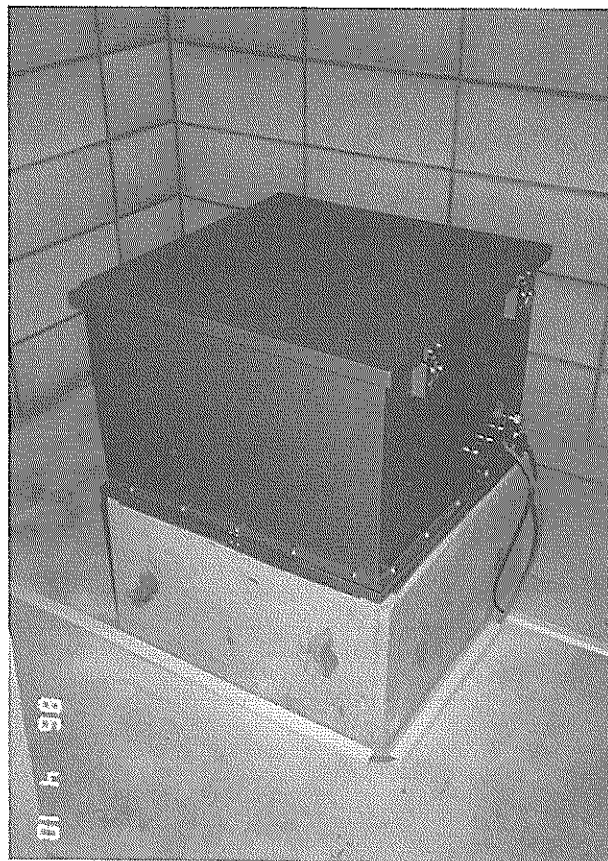


Figure9 Standard type of the ERS-F accelerograph

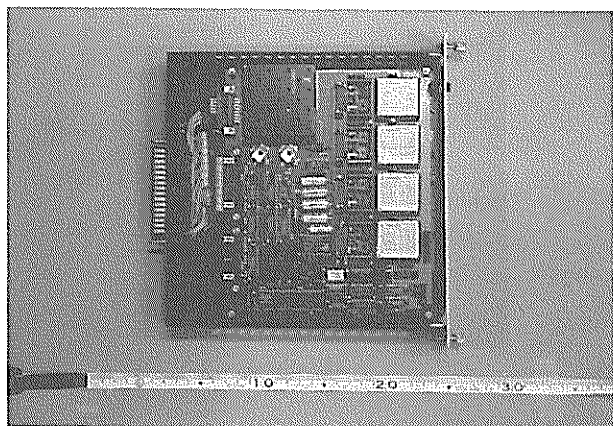


Figure8 Inside view of the memory of the ERS-F accelerograph



Figure10 Transducers of the ERS-F and -G accelerograph installed in ground

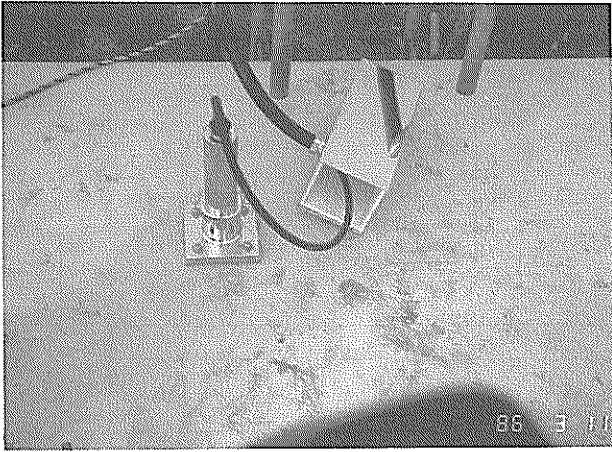


Figure 11 Transducers of the ERS-F and -G accelerograph attached to structures

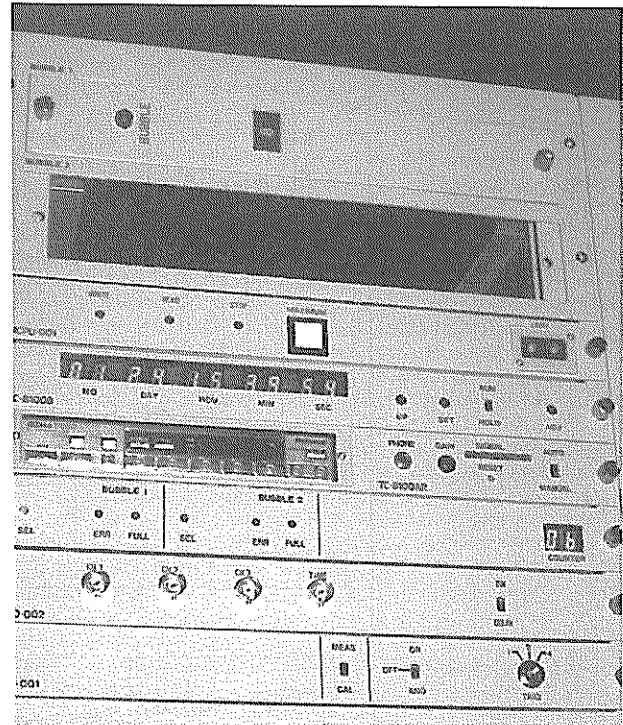


Figure 12 Front view of the recording system of the ERS-F accelerograph

reliability of the instrument. The overall sensitivity is more than 10 mm per Gals (=cm/sec²) and it is easily adjusted by changing resistors of the circuit. Therefore, the ERS-B, -C and -D accelerograph have advantage to start the observation in its maximum sensitivity and to readjust the sensitivity into the appropriate one for the strong-motion after obtaining some records. The frequency characteristics of these accelerographs are shown in Figure 7. The triggering levels of these ERS accelerographs are similar to those of the SMAC-B2 accelerographs. If the ERS-B, -C and -D accelerographs are installed at the station, the suffix which represents type of accelerograph becomes 'M' in the name of the station. For instance, the name of the station at Omaezaki port becomes Omaezaki-M because the ERS-C accelerograph is installed.

(c) ERS-F accelerograph

The ERS-F accelerograph is a digital type strong-motion accelerograph equipped with non-volatile, solid state magnetic bubble memories. The main unit of the recording system, shown in Figure 8, consists of four non-volatile, solid-state magnetic bubble memories of the total memory size of 1 Mbytes and the controlling parts, of which dimensions are 240×240×35 mm, weighing about 1 kg. Double units can be installed in a recording system, but single unit is installed for the recording system at Hakodate Port and Hitachinaka Port. Time signal is recorded by using one channel in this system and the recording time of three components of acceleration and one time signal is about 40 minutes in double bubble memories.

There are several types of the ERS-F accelerographs. The standard type shown in Figure 9 is a self-contained box type which contains transducers and a recorder with magnetic bubble memories all in one. The other is a separated type in which transducers and a recorder are separated with each other. Figure 10 shows the transducers which is to be installed in ground by using bore-hole and to observe earthquake motions at base or in ground. The transducers shown in Figure 11 is to be attached to structures. The front view of the recording system of the ERS-F accelerograph including the magnetic bubble memories is shown in Figure 12. Total number of the ERS-F accelerograph is 13 at present as shown in Table 1.

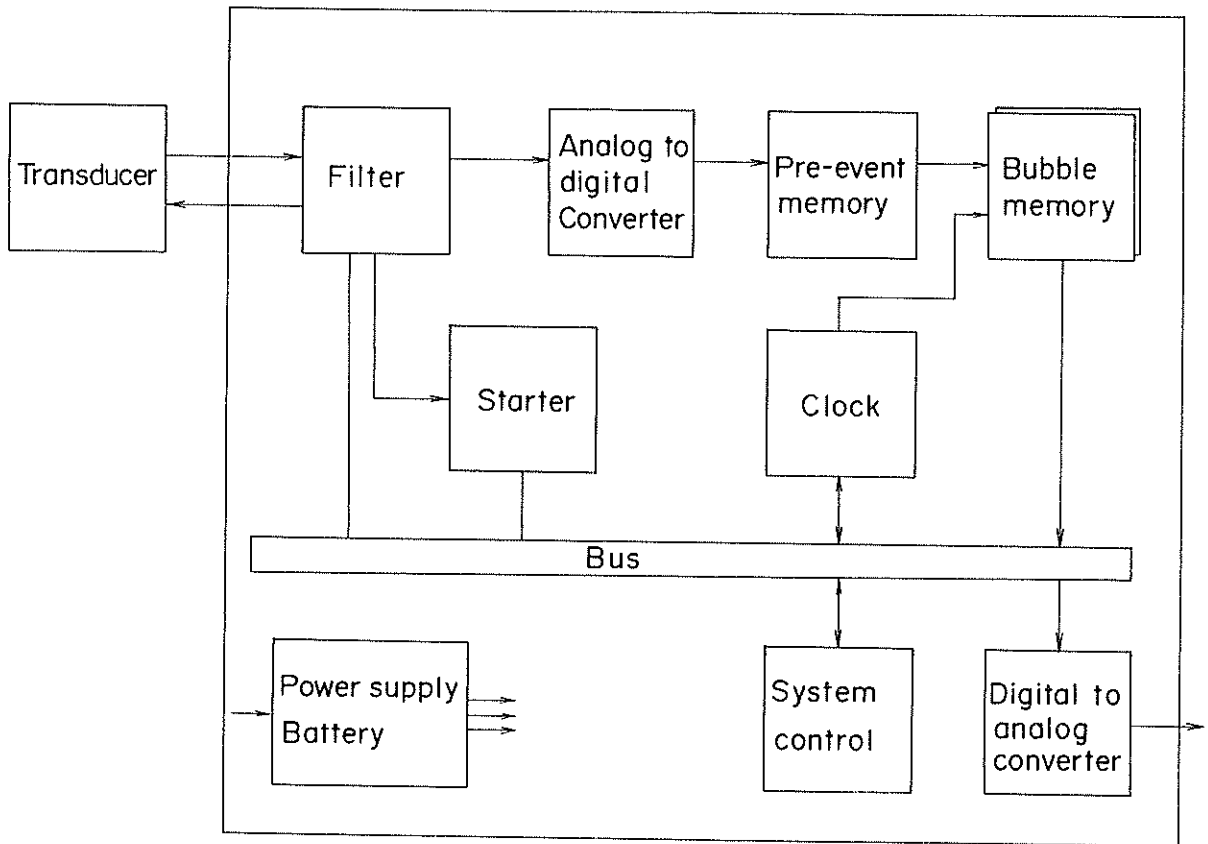
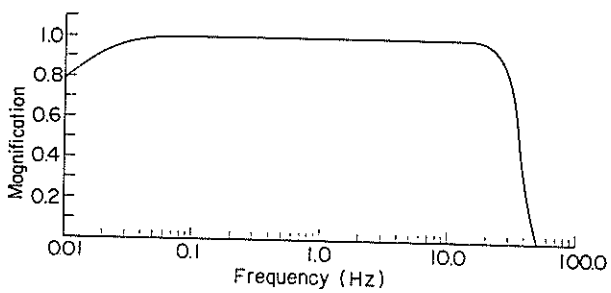
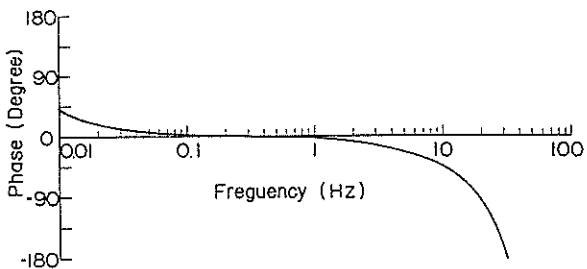


Figure13 Block-diagram of the ERS-F accelerograph



(a) amplitude



(b) phase

Figure14 Frequency characteristics of the ERS-F and -G accelerograph

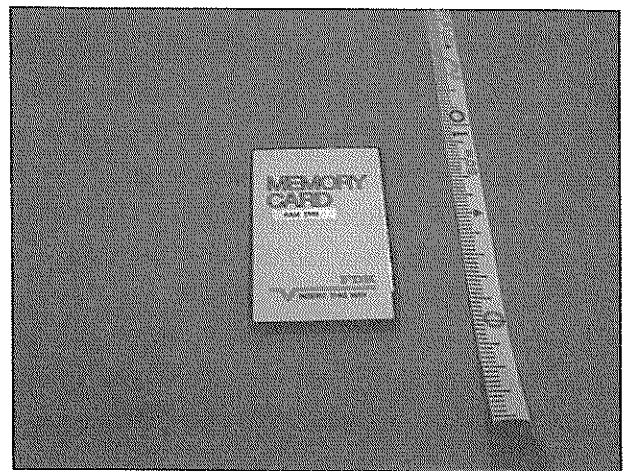


Figure15 Memory (IC-CARD) of the ERS-G accelerograph

Table 6 Specifications of the ERS-F and -G accelerograph

Overall Capabilities	Maximum acceleration capacity	(-F) 2G (-G) 0.008G~2G, variable
	Frequency characteristics	0.01Hz~35Hz
	Dynamic range	86 dB over
Transducer	Accelerometer	
	Component	2 horizontal, 1 vertical
	Maximum capacity	(-F) 2G (-G) 0.008G~2G, variable
	Sensitivity	10^{-5}
	Type	Force-balance servo or Velocity-balance servo
Filter	High pass	0.007 Hz -6 dB/octave
	Low pass	35 Hz -18 dB/octave
A/D conversion	Resolution	16 bits
	Conversion rate	100 Hz
Pre-Event Memory	10 seconds.	
Clock	Accuracy of internal clock 1/100 seconds corrected every an hour by NHK time signal	
Starter	Trigger levels : 0.5, 1, 2% of maximum acceleration	
Recorder	No. of channel	(-F) 4~10 channel (1 time signal) (-G) 3~12 channel
	Memory size	(-F) Bubble Memory : 1 Mbytes × 2 (-G) IC-CARD Memory: 2 Mbytes
	Record length	1 ~ 10 minutes/record
	Maximum Recording Length	(-F) 40 minutes/4ch. (-G) 52 minutes/3ch.
		Record of greatest maximum acceleration secured
Related Informations	Observation station,	Number of records,
	Start time of each data,	
	Maximum accelerations of each component	
Calibration	Overall calibration are possible	
Backup Power Supply	2 hour after power storage	
Container	Aluminum box, Water-Proof,	
	Size	(-F) : 54(L),54(W),38(H)cm (-G) : 54(L),54(W),33(H)cm

The ERS-F accelerograph has a system shown by a block-diagram in Figure 13, and satisfies the specification shown in Table 6. The frequency characteristics of the transducers are shown in Figure 14. Recording duration of an earthquake motions is one minute at minimum, and the duration can be extended up to 10 minute at a step of one minute by monitoring the level of the acceleration. The recording duration is extended if the level of the monitored acceleration after each 40 seconds from the trigger or extension is higher than the trigger level of the acceleration. The main unit of the recording system can record ten earthquake motions by 60 seconds of three components at the maximum. If earthquakes occur successively and the earthquake motion data should over flow the recording system, records of the greatest maximum accelerations are retained. As exception to this, however, records of 180 seconds are stored in the first-come first-serve basis.

(d) ERS-G accelerograph

The ERS-G accelerograph is an improved version over the ERS-F accelerograph. Transducers of the accele-

rographs are almost the same to those of the ERS-F accelerograph. In the ERS-G accelerograph, IC-CARD memory as shown in **Figure 15** is used for the recording system and some improvements are done for the controlling system. The memory size of the IC-CARD is 2 Mbytes. The recording time of three components of acceleration is about 52 minutes in one card. The triggering level of acceleration can be set at several steps. The capacity of accelerograph is 2G, and the level of maximum acceleration (sensitivity) can be set at appropriate value from 0.008G to 2G. Total number of the ERS-G accelerograph is 68 at the end of December 1997.

The specification of the ERS-G acceleration is shown in **Table 6** with the specifications of the ERS-F accelerograph and frequency characteristics of the transducers which are the same as the transducers of ERS-F accelerograph are shown in **Figure 14**. Standard type of the ERS-G accelerograph is shown in **Figure 16** in which transducers and recording system with IC-CARD are contained all in one. The type of the transducer of the ERS-F and -G accelerograph installed at ground surface is usually force-balance type. However, the velocity-balance type is recently adopted for the transducers installed in ground because of the safety against lightning.

After recording earthquakes, the main unit (memory) of the recording system is pulled out from the recording system of the ERS-F and -G accelerograph and by another memory ready for recording the coming earthquakes. The pulled out unit, bubble memory with a static eliminator on the connector to the unit of the ERS-F accelerograph and IC-CARD of the ERS-G accelerograph, is packed in a case and sent to the Laboratory. The unit is set on the reproducer which is connected to a computer and digital time histories of earthquake motions are reproduced in the Laboratory. Absolute time at the trigger of the record is also obtained from the record of the internal clock of the accelerograph. As shown in **Table 6**, these recording system have digital delay memory for 10 seconds. If the recording started before the first motion of the earthquake, some of the portion of the record preceding the first motion is omitted.

(5) Foundation and House

As most of the harbour structures have shallow foundations and do not rest on bed rock, spread foundations for the accelerographs are being used. All the SMAC-B2 accelerographs in the network are installed on simple spread foundations which are made of reinforced concrete shown in **Figure 17**. The hollow space under the foundation is allocated to make the bulk density of the foundation equal to that of the soil, so that the disturbance to the records due to the foundation can be minimized. The foundations are also used for the ERS-F and -G accelerographs which were installed after the SMAC-B2 accelerograph for replacement.

The standard foundation for the ERS-B and -C accelerograph has not been established. Shape and size of a foundation for transducers of the ERS-C accelerograph are illustrated in **Figure 18**.

Usually, no pile is used to support the accelerograph and its foundation, but in the stations on very soft soil or very loose sand, concrete piles or wooden piles are used. For example, the foundation at the

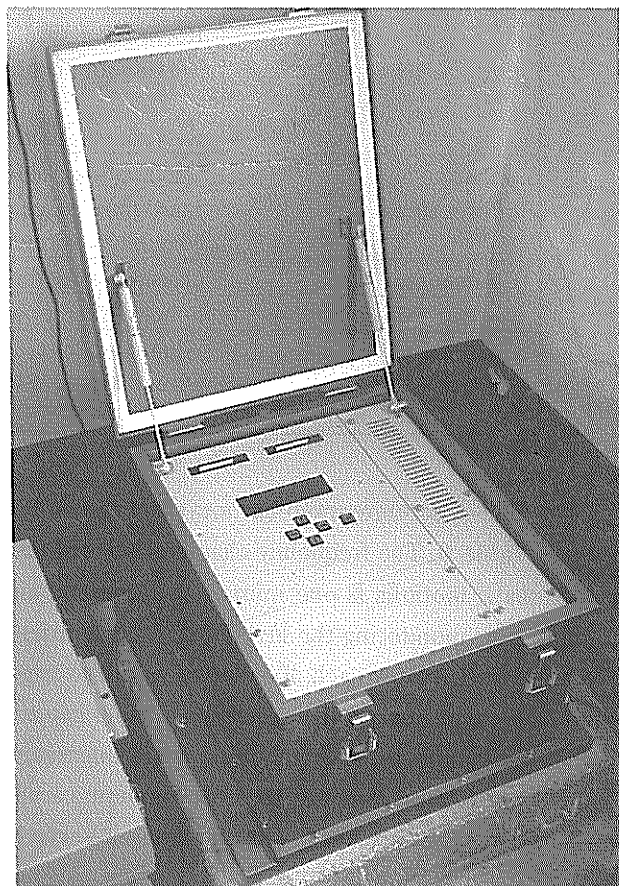


Figure16 Inside view of the ERS-G accelerograph

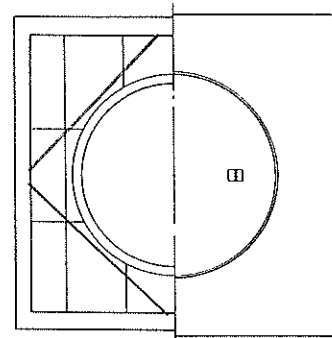
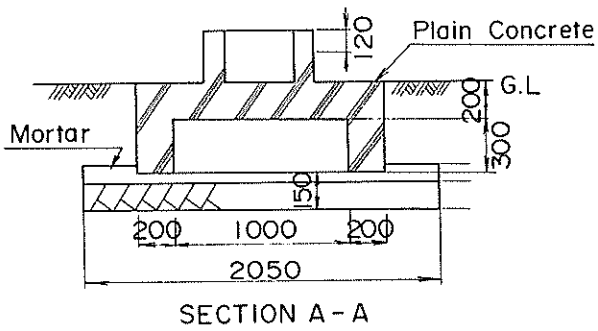
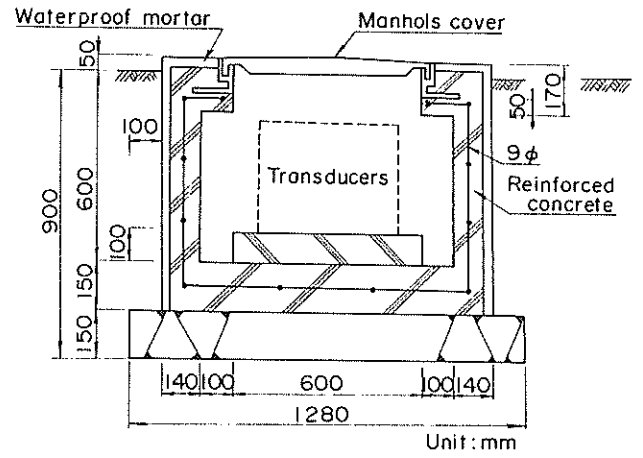
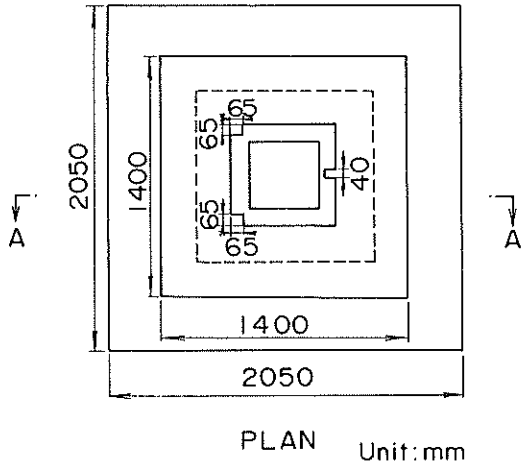


Figure17 Foundation for the SMAC-B2 accelerograph

Figure18 Foundation for the ERS-C accelerograph

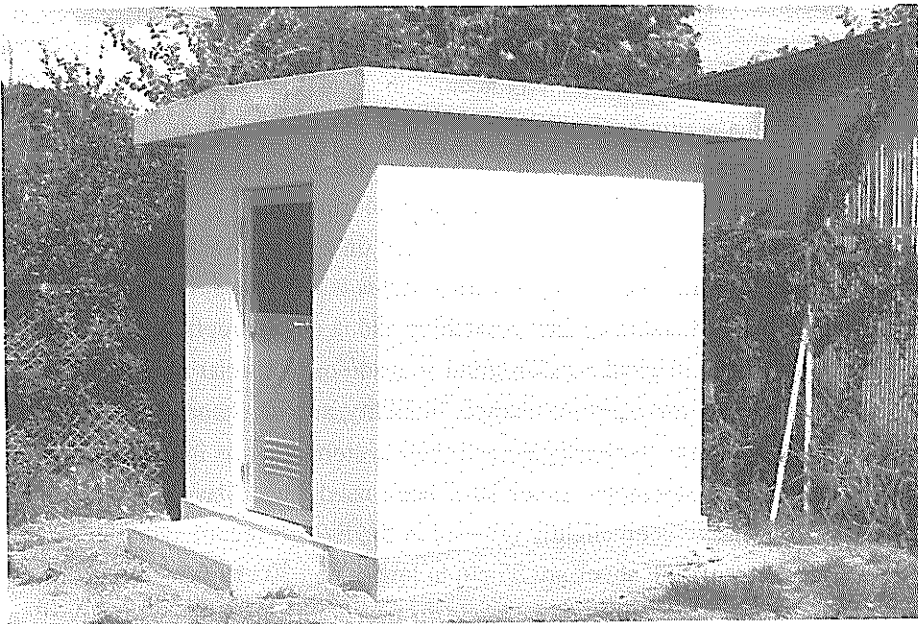


Figure19 House of the Station (Onahama-ji-G, GB Station)

Niigata-G station is supported by piles. All the foundations are isolated from houses covering the accelerographs.

Most of the accelerographs are covered with houses which were built for the accelerographs. Some of the accelerographs are installed in houses which were built for other purposes. The houses built for covering accelerographs are made of reinforced concrete or concrete blocks, and some are prefabricated houses. The house of the Onahama-ji-G,GB station is shown in **Figure 19** as an example.

3. Preliminary Processing

All the accelerograms collected at the Geotechnical Earthquake Engineering Laboratory of the Port and Harbour Research Institute are listed in the tables on Strong-Motion Earthquake Observation Results, which are classified by earthquakes and listed in the later part of this report. They undergo the following preliminary processing.

At first, each accelerogram is given a record number according to the order of its arrival at the Laboratory. The record number for the accelerogram by the SMAC-B2 accelerograph begins with the capital letter 'S', that by the ERS-B, -C and -D accelerograph, with the capital letter 'M' and that by the ERS-F and ERS-G, with the capital letter 'F'.

Then, an earthquake which corresponds to each accelerogram is confirmed or determined. There is no time information in the accelerograms obtained by the SMAC-B2 accelerograph and the ERS-B, -C and -D accelerograph because those accelerographs are not equipped with an internal clock. Therefore, most of the accelerograms are sent to the Laboratory with the earthquake information from the stations. However, there are a few of the accelerograms without such information because the accelerograms were found in the regular servicing and it was difficult to find the corresponding earthquake at the station. For such accelerograms without time information, the earthquake is determined by considering both the possible period of the recording and the earthquake occurred in that area at that period.

The determination or the confirmation of the corresponding earthquake is based on the Seismological Bulletin by the Japan Meteorological Agency (JMA)⁴⁷⁾. If the Seismological Bulletins on the earthquakes are not available because of time lag of the publication after earthquakes, the preliminary reports on earthquakes by the JMA are used to determine the earthquakes⁴⁸⁾. Some of the accelerograms, however, remain without matching earthquakes. In this case, those earthquakes are treated as earthquake unknown. The accelerogram whose earthquake is unknown is not listed in the tables if both of its maximum horizontal accelerations are smaller than 20 Gals. It will be noted that the reliability of the earthquake determination based on such procedure for accelerograms with small acceleration is limited in the case that accelerograms do not have accurate time information.

Accelerograms by the SMAC-B2 accelerograph are recorded on a rolled waxed paper which has dark red background. The recording by scratching the waxed paper with a stylus leaves the semi-translucent trace on the waxed paper. Because the waxed paper is not stable against scratching and is not appropriate to be used for the digitization, the photographic contact print of the original accelerogram is made on a special photographic sheet. This sheet is made of mylar film and stable against temperature change, humidity, and mechanical distortion. Because the photographing company which was used in the network changed their system and it is impossible to get the special photographic sheet any more, a normal photographic paper have been used since May, 1997. Therefore, the accuracy of reproducing the observed records have been slightly reduced in the S-2668 record and following records obtained by SMAC-B2 accelerograph. The sizes of the sheet are 55 cm in length and 30 cm in width. If the significant portion of the record is longer than 30 to 45 cm, the copy will be made on two sheets or more and the portion of about 10 cm at the end of each sheet is overlapped with each other for confirming data continuity in the successive sheets. After this processing, the record becomes black traces and semi-translucent background in the copy sheet and they are in good contrast for the digitization. The record by the ERS-B, -C and -D accelerograph is only chemically stabilized by sensitization before being used for digitization.

From the photographic copy or the stabilized original record, the maximum acceleration of each component is read by using a magnifying glass. In this reading, the base-line setting is not so accurate as that made in digitizing the accelerogram and these maximum accelerations are not so accurate and different from those processed through digitization, standard data processing and preliminary analyses which will be explained later. The maximum accelerations, which are listed in the tables of Strong-Motion Earthquake Observation Results and are not processed through preliminary analyses, are those determined by this preliminary processing. For the records by the ERS-F and -G accelerograph, acceleration data are directly read by a computer and the time information is included in the record. Therefore, the maximum acceleration and the time of triggering are obtained accurately, and the corresponding earthquakes of records are easily determined.

In the tables of Strong-Motion Earthquake Observation Results, the time in the earthquake data refers to the Japan Standard Time which is earlier than GMT by 9 hours, the magnitude is the JMA Magnitude which is determined by the JMA and the seismic intensity of the shock is estimated by the JMA according to the scale shown in Table 2.

4. Digitization

(1) Digitizer

Two types of digitizers are used in the Laboratory. One is for digitization of records by the SMAC-B2 accelerograph and the other is for digitization of records by the ERS-B, -C and -D accelerograph.

The digitizer for the accelerograms obtained by the SMAC-B2 accelerograph is a semi-automatic instrument. The view and the specifications of the digitizer are shown in Figure 20 and Table 7, respectively. The digitizer works in the following way.

On the digitizer table, there is a magnifying glass which can be moved along the transverse (vertical) axis by rotating a small wheel near the glass. A magnescale is connected to the wheel, and the electric digital output corresponding to the position of the magnifying glass is produced from the magnescale. The magnifying glass has a cross-hair and a lamp to illuminate the accelerogram within its range. The operator places the cross-hair on the trace of an acceleration record and pushes a button, then the digital output from the magnescale is displayed on the panel and is stored in the memories of the computer. After this step, the magnifying glass is automatically shifted along the longitudinal (horizontal) axis by 0.1 mm.

The records obtained by the ERS-B, -C and -D accelerographs are processed with an on-line oscillogram digitizer connected to a computer which is shown in Figure 21. A record is placed on the digitizer table and an operator traces earthquake wave forms with a cursor of the digitizer. The travels of the cursor along horizontal and vertical axis are digitally counted and the coordinates of the cursor are transferred into memories of the computer at a step of 0.1 mm along the horizontal axis.

After the necessary portions of the record are digitized, digitized values in the memories are processed by computer programs. According to the directions given to the computer through the keyboard, printed list, magnetic tape and analog reproduction etc. are obtained as outputs of the digitized records in the memories.

(2) Digitization

The digitization procedure, which is shown in Figure 22 and described here, has been applied for records obtained since 1976.

(a) SMAC-B2 accelerograph

The records by the SMAC-B2 accelerograph consist of acceleration records, fixed traces, timing marks, arc traces and free vibration traces for calibration of the characteristic periods and damping factors of the accelerograph.



Figure20 Digitizer for records by the SMAC-B2 accelerograph

Table 7 Specifications of digitizer for records by the SMAC-B2 accelerograph

Digitizer Table	
Size of table	750 mm(X)×660 mm(Y)
Effective area	430 mm(X)×300 mm(Y)
Magnifying glass	5x, with a cross hair and illumination
Translation of magnifying glass	
Y-axis (vertical)	manual by rotating a wheel
X-axis (horizontal)	automatic, at intervals of 0.1 mm
Analog to Digital Converter and Control	
Resolution(overall)	1000 counts per a millimeter
Indication	
Y-axis (vertical)	sign and 4 digits
X-axis (horizontal)	4 digits

Among them, traces to be digitized are the recorded accelerations, the fixed traces and the arc traces. Digitized fixed traces and digitized arc traces are used for the standard data processing described later.

The fixed traces are recorded by the pens fixed to the accelerograph frame. The arc traces are recorded manually with the recording pens supported by pivots while the paper drive mechanism is stopped. The arc traces show offset of the pens from the normal position where the pens are parallel to the direction of paper driving. The timing marks are pulses at intervals of one second. The timing marks are used only to obtain the average recording speed because fluctuation of the timing marks are estimated as small as the digital unit of the digitizer (0.1 mm) according to the results of the tests of the SMAC-B2 accelerographs⁴⁹⁾. The average error in the time marking is expected to be less than 1 % and the fluctuation is less than 0.5 % according to the results of the tests of the SMAC-B2 accelerographs. In order to obtain the average paper speed, intervals of 30 pulses is measured by the digitizer for a record by the ERS-B, -C and -D accelerographs.

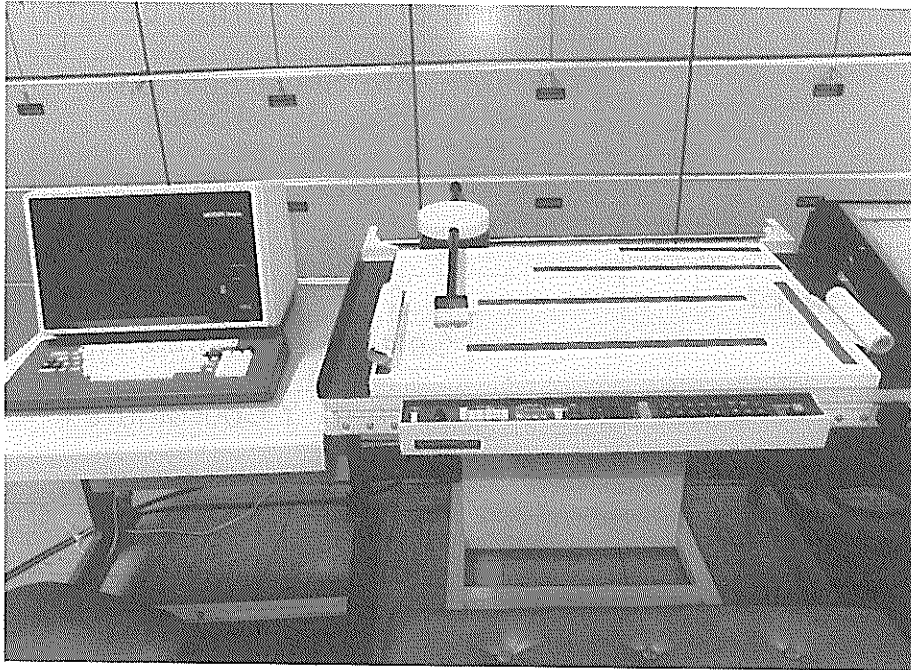


Figure21 Digitizer for records by the ERS-B, -C and -D accelerograph

A record is digitized from the starting point of recording. Portion of the record to be digitized is determined so as to include discernible acceleration on the paper. This determination is done by observation of a record to be digitized. The portion of the record to be digitized is divided into some sections because of the limitation of the digitizer table. Length of each section is about 30 to 45 cm which is almost equivalent to 30 to 45 seconds. Digitization unit in the amplitude is 0.008 mm which is equivalent to 0.1 Gal. Contact prints are made for each section as described previously. Digitization procedure is summarized as follows;

- Setting of the copy

A photographic copy of a record to be digitized is fixed on the table of the digitizer with tape. The table is rotated by an adjusting screw so that the fixed trace on the copy is parallel to horizontal axis of the digitizer. Two points on the fixed trace located on both ends of section are used for this adjustment and vertical coordinate value of the two points are made to coincide with each other.

- Initialization of transverse coordinate

The origin of vertical coordinate of each sheet is tentatively set in the digitization procedure because Sectional Base-Line Location described later is to be applied in the standard data processing. Transverse coordinate of a first point to be digitized is usually set to zero.

- Tracing

The traces are digitized by an operator in the way described in the preceding section. Three components of accelerations, two fixed traces, and three arc traces are digitized at the intervals of 0.1 mm along horizontal axis. The intervals are almost equivalent to 0.001 second. Because accelerations are recorded in a cylindrical coordinate system, the digitized amplitude values do not correspond to equal time intervals.

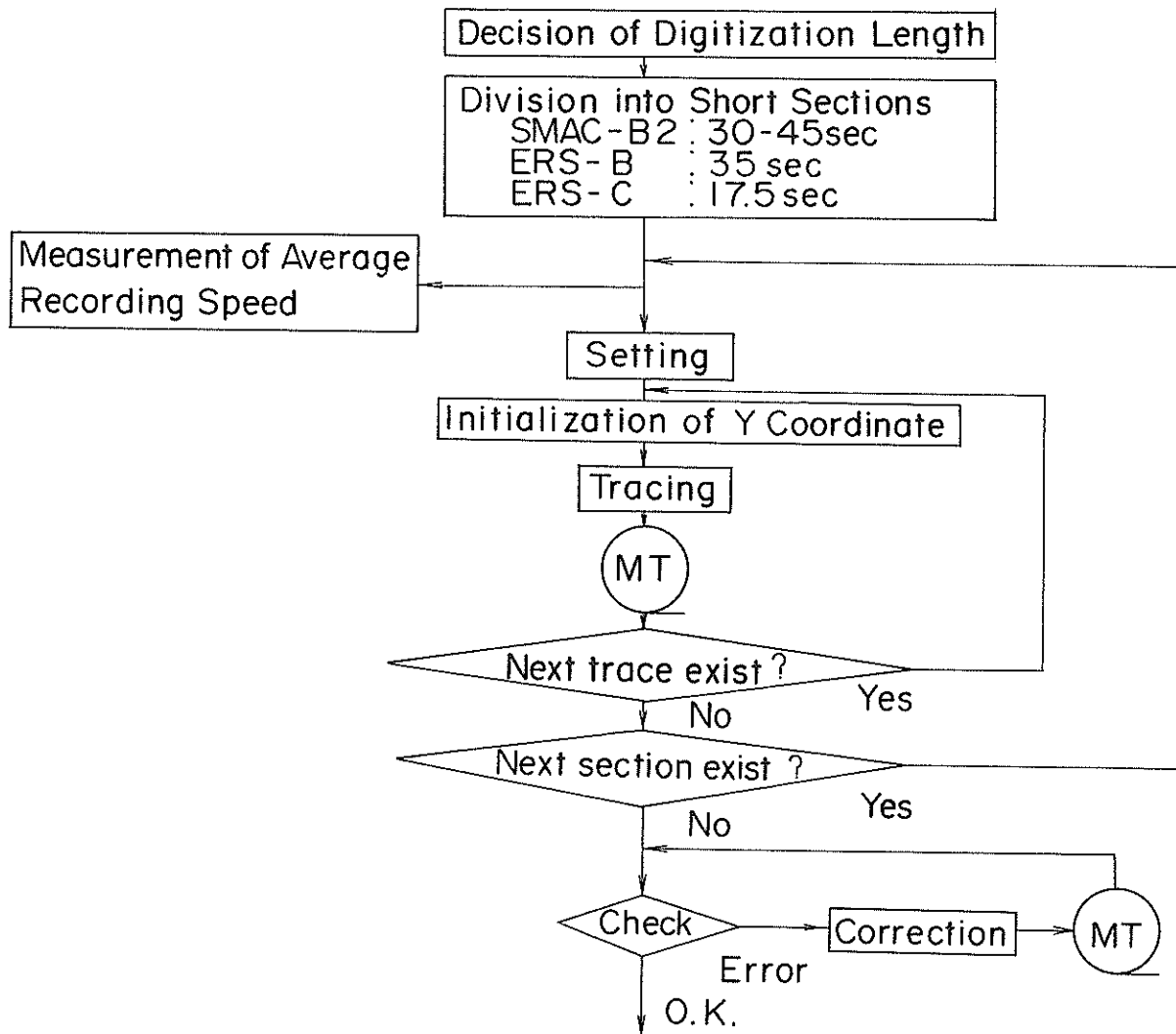


Figure22 Digitization procedure

- Recording of Digitized Data

Digitized data in the memory of the computer are recorded in the magnetic disk with such data as record number, component, station, date and time of the earthquake, time intervals, etc.

(b) ERS-B, -C and -D accelerograph

The records by the ERS-B, -C and -D accelerograph consist of recorded accelerations, fixed traces and timing marks. The fixed traces are recorded by light beams reflected from fixed mirrors attached to the oscillograph frame. They are parallel lines at intervals of 2 mm drawn in the whole breadth of the recording paper. The recorded accelerations and one of the fixed traces located in the center of the oscillogram are digitized. The record to be digitized is divided into some sections because of the limitation of the digitizer table. Length of each section is about 70 cm, which corresponds to about 35 seconds on a record by the ERS-B accelerograph and about 17.5 seconds on a record by the ERS-C and -D accelerograph.

Procedure of setting of a record by the ERS-B, -C and -D accelerograph and the initialization of transverse (vertical) coordinate is similar to that for a record by the SMAC-B2 accelerograph. The record is digitized by an operator in the way described in the preceding section. The accelerations are digitized at intervals of 0.1 mm, which corre-

sponds to 0.005 second on a record by the ERS-B accelerograph and about 0.0025 second on a record by the ERS-C and D accelerograph. The fixed trace is digitized at intervals of about 5 cm, which corresponds to 2.5 seconds on a record by the ERS-B accelerograph and 1.25 seconds on a record by the ERS-C and -D accelerograph. Then the digitized data of the fixed trace are obtained by linear interpolation at intervals of 0.1 mm. The digital unit in the amplitude is 0.1 mm, which corresponds to about 0.1 Gal (=cm/sec²) on a record by the ERS-B accelerograph and about 0.2 Gal or about 1.0 Gal on a record by the ERS-C and -D accelerograph. In the case of the ERS-C and -D accelerographs, sensitivities of the galvanometers are calibrated for each recording with a calibration signal before resetting paper drive.

Timing marks of the records by the ERS-C and -D accelerograph, which are pulses at intervals of 0.1 second generated by a crystal timer, are used only to measure the average recording speed because fluctuation of the timing marks is expected as small as that of the digital unit of the digitizer (0.1 mm) according to the results of the tests of the ERS-C and -D accelerographs⁴⁹⁾. In the case of a record by the ERS-B accelerograph, timing marks are not used because accuracy of the timer depends on that of the frequency of the power supply which consists of batteries and a DC-AC inverter.

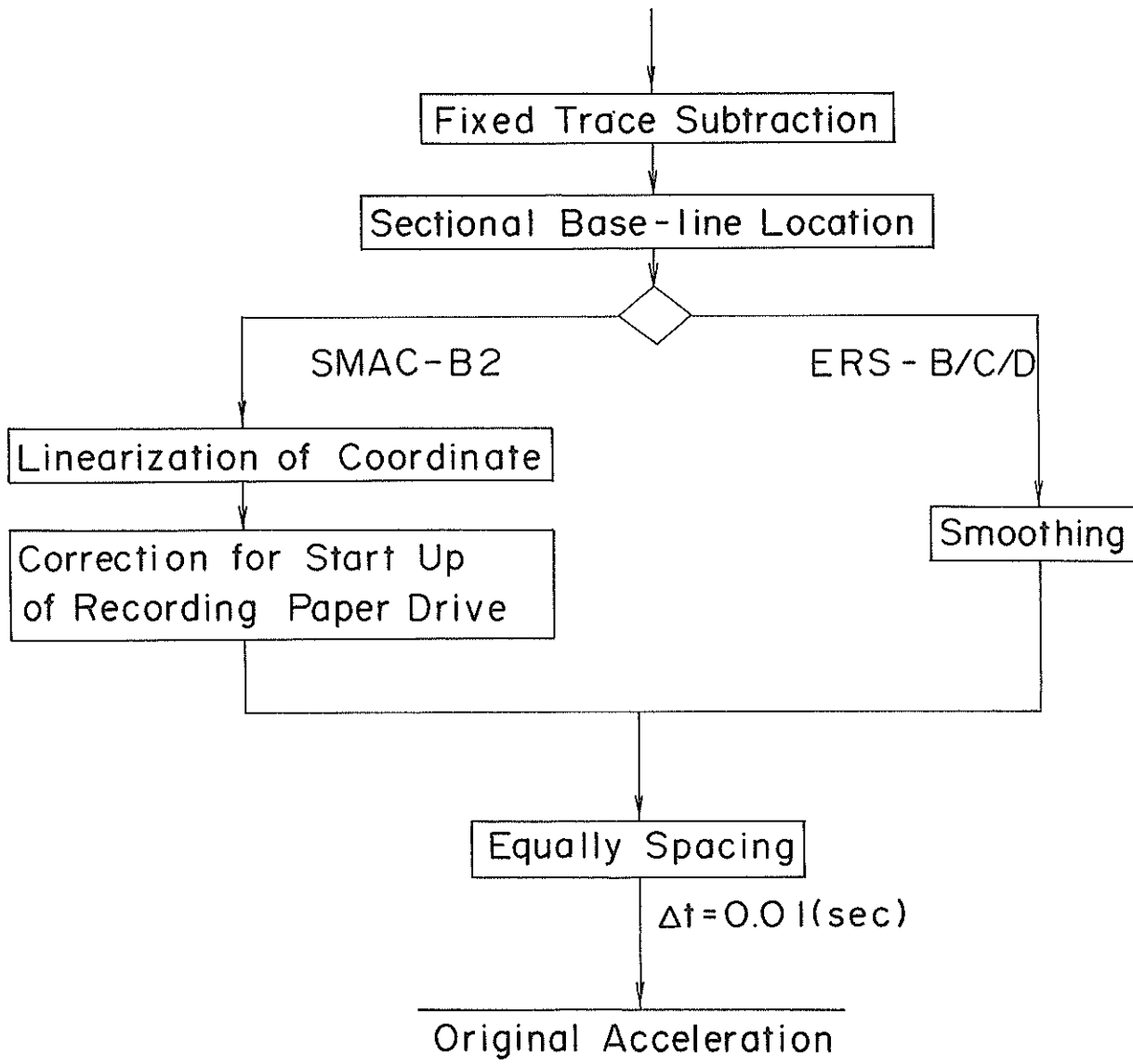


Figure23 Procedure of standard data processing

5. Standard Data Processing

The procedure for the standard data processing, which is shown in Figure 23 and described here, has been applied for records obtained since 1976, although the correction for start up of recording paper drive of the SMAC-B2 accelerograph was slightly modified for the improvement of the accelerograph⁴⁹. The acceleration processed through the standard data processing will be called 'Original Acceleration' hereafter.

Standard data processing for a record by the SMAC-B2 accelerograph is performed under following procedures;

- (1) Fixed Trace Subtraction
- (2) Sectional Base-line Location
- (3) Linearization of Coordinate
- (4) Correction for Start up of Recording Paper Drive
- (6) Equal Spacing

Standard data processing for a record by the ERS-B, -C and -D accelerograph is performed under following procedures;

- (1) Fixed Trace Subtraction
- (2) Sectional Base-line Location
- (5) Smoothing
- (6) Equal Spacing

Standard data processing for the records by the ERS-F and -G accelerograph are described in item (7). Each correction procedure is described briefly as follows.

(1) Fixed Trace Subtraction

This correction is applied in order to eliminate the following errors.

- i) errors caused by the transverse motion of recording paper in the drive mechanism of the accelerograph
- ii) systematic errors caused by an imperfect transverse moving mechanism of the digitizer cross-hair system
- iii) errors of sectional rotation of the record on the digitizer table at the setting

The systematic errors of the digitizer cross-hair system were found to be negligible according to the tests with a straight line made of a stretched steel wire and a stretched gut.

Digitized fixed traces are smoothed by a weighted running average scheme before subtracted from the accelerogram. The weight function is defined as follows;

$$\omega(t) = \begin{cases} \sqrt{\alpha/\pi} \exp(-\alpha t^2) & \text{if } |t| \leq t_0 \\ 0 & \text{otherwise} \end{cases} \quad \text{----- (1)}$$

where $\alpha = (\pi/2)^2$ and $t_0 = \sqrt{\alpha/5} = 0.7$ (s)

At both ends of a section for digitization, α and t_0 in Eq.(1) are redefined by $\alpha = 5/S^2$ and $t_0 = S$, where $S(s)$ is the distance from the end of a section. This weighted running average corresponds to low pass filter of the cut off frequency of about 0.5 Hz. The smoothed fixed traces are subtracted from the accelerogram. In the case of a record by the SMAC-B2 accelerographs, subtraction is made as follows;

- An upper trace is corrected by an upper fixed trace,
- A lower trace is corrected by a lower fixed trace and
- A center trace is corrected by an average of an upper and a lower fixed traces.

In the case of records by the ERS-B, -C and D accelerograph, one fixed trace is subtracted from all the components of an accelerogram.

(2) Sectional Base-line Location

As described previously, base-line is arbitrarily inserted for each section by the initialization of transverse coordinate. Sectional translation brings mainly low frequency errors into the accelerogram and produces an natural response of a low cut filter for integration around a point of junction of digitized sections. Base-line is located so as to make an ideal average of acceleration over almost infinite length zero. On the sectional base-line location, the authors assume that low frequency components up to about $1/T$, where T is the minimum length of sections, are almost none if calculation of spectrum is done over the infinite length for the accelerogram which have been corrected by the fixed trace subtraction and which have an ideal true base-line for each section. Based on the detailed study of the base-line location in the frequency space, the base-line is located sectionally so as to make a weighted average of each sectional acceleration zero. The weight function is defined by

$$u(t) = \Delta t \sqrt{\beta/\pi} \exp(-\beta t^2) \quad \text{-----} \quad (2)$$

where Δt is time interval, $\beta = 20/T^2$ and $T(s)$ is length of each section

The expected error of the location is almost proportional to the quantities of low frequency components up to about $1/T$ (Hz). Because the authors do not have enough space to describe the detailed study, the authors introduce an example calculation to illustrate the difference between the proposed base-line location and the base-line location of least square fit scheme for each section. A sine wave generated by a computer of 100 Gal, 5 Hz and 5000 data with time intervals of 0.01 second is divided into two sections; one section is the first 2510 data and the other is the last 2490 data, which are looked upon as a sectionally digitized accelerogram. Sectional base-lines are located by the two method. Displacements are calculated from the two accelerations by the fixed filter method described later and a portion of the results including the junction of two sections are shown in Figure 24 and Figure 25, respectively. The time of 10.1 seconds is the junction in these figures. These figures indicate that the proposed base-line location is much better in this case because true displacement is a sine wave.

(3) Linearization of Coordinate

This correction is applied to a record by the SMAC-B2 accelerograph to obtain a corrected longitudinal (X) coordinate of each datum. Transverse (Y) coordinate of the pivot of the recording pen is calculated from the digitized arc trace as shown in Figure 26. Let $r(\text{mm})$ denotes the radius of the arc which is the length of the arm of the recording pen, $y(\text{mm})$ denotes Y coordinate of a point whose X coordinate is to be corrected, $a(\text{mm})$ denotes Y co-

ordinate of the center of the arc which is the pivot of the pen and e denotes error of X coordinate of the point to be corrected, then we have the following equation.

$$e = r - \sqrt{r^2 - (y - a)^2} \quad \text{-----} \quad (3)$$

Although the arc trace is digitized with arbitrarily determined base-line, the linearization of coordinate is uniformly performed because $(y-a)$ in the equation remains constant for any base-line. $a(\text{mm})$ in the equation will be set to zero if arc traces are accidentally not drawn or length of the arc trace is short which means the case the maximum difference of X coordinates of the arc trace is less than 0.5 mm.

(4) Correction for start up of recording paper drive

The variation of recording paper speed of the SMAC-B2 accelerograph is represented by the following equation which is based on the tests conducted at the Laboratory shown in Figure 27.

$$v = \begin{cases} \left[1 - 1/b^2 (t - t_0)^2 \right] v_a & \text{if } 0 \leq t \leq t_0 \\ v_a & \text{if } t_0 < t \end{cases} \quad \text{-----} \quad (4)$$

- where v : paper speed at time t (cm/s)
- v_a : paper speed after reaching constant speed (cm/s)
- t : time after triggering (s)
- t_0 : constant (s)
- b : constant (s)

If t_0 and b are given, the correction for the start up of recording paper drive is simple problem. For the correction of the digitized records in the preceding annual report, $t_0 = 2.0(\text{s})$ and $b = 2.0(\text{s})$ were used. After the annual report had been published, it was found that more appropriate correction would be possible with a slight modification of t_0 value. For the correction of the most of the digitized records in this report, $t_0 = 1.9(\text{s})$ is used.

(5) Smoothing

Smoothing is applied to a record by the ERS-B, -C and -D accelerograph. A record by the ERS-B, -C and -D accelerograph is digitized at intervals of 0.1 mm which correspond to about 0.005 second on a record by the ERS-B accelerograph and corresponds to about 0.0025 second on a record by the ERS-C and -D accelerograph. Frequency components higher than about 50 Hz are eliminated because there are almost no significant components of seismic acceleration over 50 Hz for the most of the record obtained by the ERS-B, -C and -D accelerograph so far.

The weight function is defined by

$$g(t) = \begin{cases} f_0 + f_1 & \text{if } t = 0 \\ \frac{2}{f_1 - f_0} \left[\frac{\cos(2\pi f_0 t) - \cos(2\pi f_1 t)}{(2\pi t)^2} \right] & \text{if } 0 < |t| \leq 1.0 \\ 0 & \text{otherwise} \end{cases} \quad \text{-----} \quad (5)$$

where $f_0 = 45 (\text{Hz})$ and $f_1 = 55 (\text{Hz})$

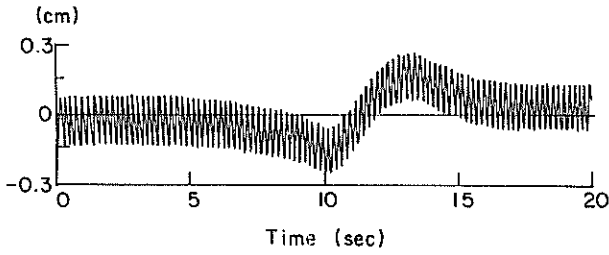


Figure 24 Integrated displacement from the acceleration record with sectionally located base-lines by a least square fit scheme

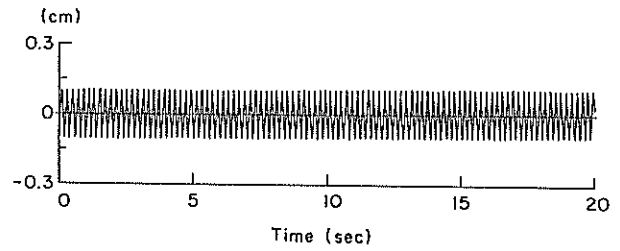


Figure 25 Integrated displacement from the acceleration record with sectionally located base-lines by proposed method

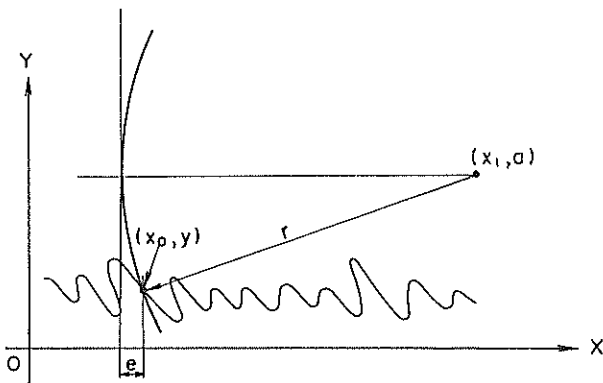


Figure 26 Linearization of coordinate

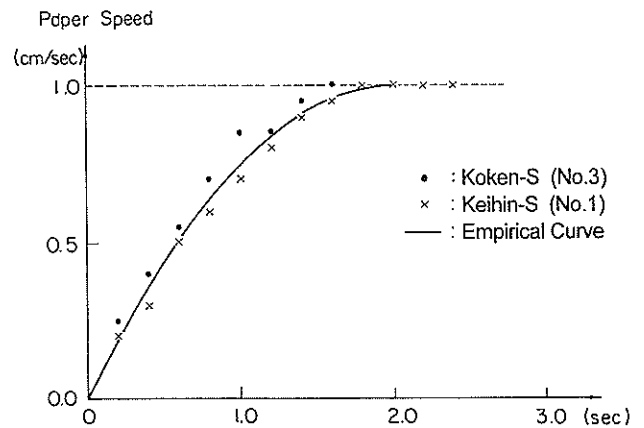


Figure 27 Variable recording speed on start up of recording paper drive

The filter corresponding to this weighted running average, which is shown in Figure 28, is approximately expressed as follows. Errors of the approximation are less than 0.3 %.

$$G(f) = \begin{cases} 1 & \text{if } |f| \leq f_0 \\ \frac{f_1 - |f|}{f_1 - f_0} & \text{if } f_0 < |f| \leq f_1 \\ 0 & \text{if } f_1 < |f| \end{cases} \quad \text{----- (6)}$$

where $f_0 = 45(\text{Hz})$ and $f_1 = 55(\text{Hz})$

(6) Equal Spacing

Data are equally spaced at intervals of 0.01 second by means of linear interpolation. A record by the SMAC-B2 accelerograph is digitized at intervals of 0.1 mm and is processed through the linearization of coordinate. The data processed through the linearization of coordinate are unequally spaced data, whose interval of data are longer than 0.01 second on portions of accelerogram where absolute value of acceleration decreases and intervals of data are shorter than 0.01 second elsewhere.

A record by the ERS-B, -C and -D accelerograph is digitized at intervals of 0.1 mm, which corresponds to about 0.005 second on a record by the ERS-B accelerograph and about 0.0025 second on a record by the ERS-C and -D accelerograph. There is no possibility of aliasing by the equal spacing at the interval of 0.01 seconds because their high frequency components over 50 Hz are eliminated by the smoothing. High density of sampling at digitization enables us to separate high frequency components which are possibly contaminated by digitization errors and assures us much accuracy of the interpolation.

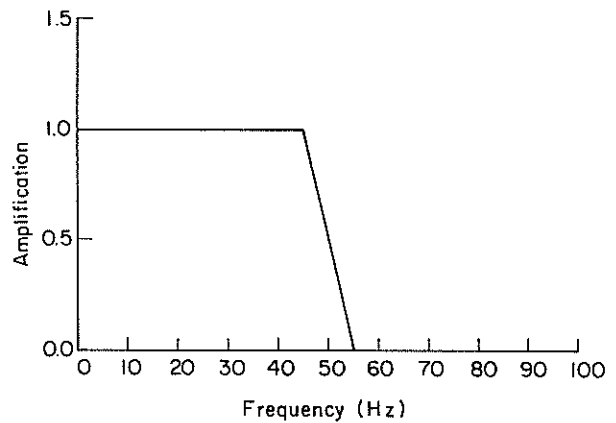


Figure28 Filter for the smoothing

(7) Processing for the records by the ERS-F and -G accelerograph

Standard data processing and preliminary analyses described later for the records by the ERS-F and -G accelerograph are almost the same as those by ERS-B, -C and -D accelerograph. The differences are as follows;

- Overall base-line correction is applied for the data at the standard data processing.
- No smoothing is applied for the data at the standard data processing.
- As an instrument correction at the preliminary analyses, correction for the phase is applied but no correction is applied for the amplitude at the preliminary analyses.
- Low pass filter with cut-off frequency of 25 Hz and roll-off frequency of 40 Hz are applied by using a digital filter of cosine shape in frequency domain at the preliminary analyses.
- As the high pass filtering at the preliminary analyses, parameter E for the Variable Filter in Eq.(20), which is to be described later, is determined by the following equation;

$$E = (p \cdot 0.001) \cdot 0.02236 \quad \text{-----} \quad (7)$$

in which $p (=1000 \text{ Gal}/2^{16})$ is the sensitivity of the ERS-F and -G accelerograph.

The factors in Eq.(7) was obtained by the study on the noise level obtained by the power spectra of the noise under the conditions with connectors of signal conditioner in short circuit.

6. Preliminary Analyses

The Standard procedures of the preliminary analyses described here have been applied for records obtained since 1976^(50,51). The standard procedures of preliminary analyses consist of filtering for instrument correction, filtering for correction of low or high frequency components, integration, calculation of response spectra and Fourier spectra. The flow of the preliminary analyses is shown in Figure 29.

(1) Methods of Correction and Integration

Instrument correction, filtering, integration are applied in frequency domain. FFT is applied for the accelerogram which is extended with a section of zero outside the digitized portion in order to avoid link effect. The length of section of zero L (s) is determined so as to meet the following condition.

$$L > \max [2/3T, 10.0] \quad \text{-----} \quad (8)$$

where T (s) is the minimum length of sections made by the division of an accelerogram for the digitization. This condition is based on the examination of impulse responses of the high pass filters for integration to be described later. Length of the section of zero L is decided so as to make calculation time of FFT short as much as possible in the given memory size of the computer.

(2) Filters for Instrument Correction and Supplementary Filter

(a) Filters for a record by the SMAC-B2 accelerograph

The filter for instrument correction $A_s(f)$ is defined by the inverse of the frequency characteristics of the transducer of the SMAC-B2 accelerograph as follows.

$$A_s(f) = 1 - \left(\frac{f}{f_s}\right)^2 + 2h_s \left(\frac{f}{f_s}\right) i \quad \text{-----} \quad (9)$$

where $f_s = 1/0.14 = 7.1(\text{Hz})$ and $h_s = 1.0$

The supplementary filter $B_s(f)$ is defined by

$$B_s(f) = \begin{cases} 1 & \text{if } |f| \leq f_o \\ \left[1 + (|A_s(f)| - 1) \exp\left\{-\frac{(|f| - f_o)^2}{20}\right\} \right] \frac{1}{|A_s(f)|} & \text{otherwise} \end{cases} \quad \text{-----} \quad (10)$$

where $f_o = 10(\text{Hz})$

The supplementary filter is designed to suppress high frequency digitization noise and at the same time preserve high frequency components of an accelerogram in order to lessen an abnormal response of the filter to discontinuities at both ends of digitized portion of the accelerogram. The filter for instrument correction $A_s(f)$ and the supplementary filter $B_s(f)$ are shown in Figure 30 and Figure 31, respectively. Combined filter by $A_s(f)$ and $B_s(f)$, which is shown in Figure 32, is applied for overall instrument correction for records by the SMAC-B2 accelerograph.

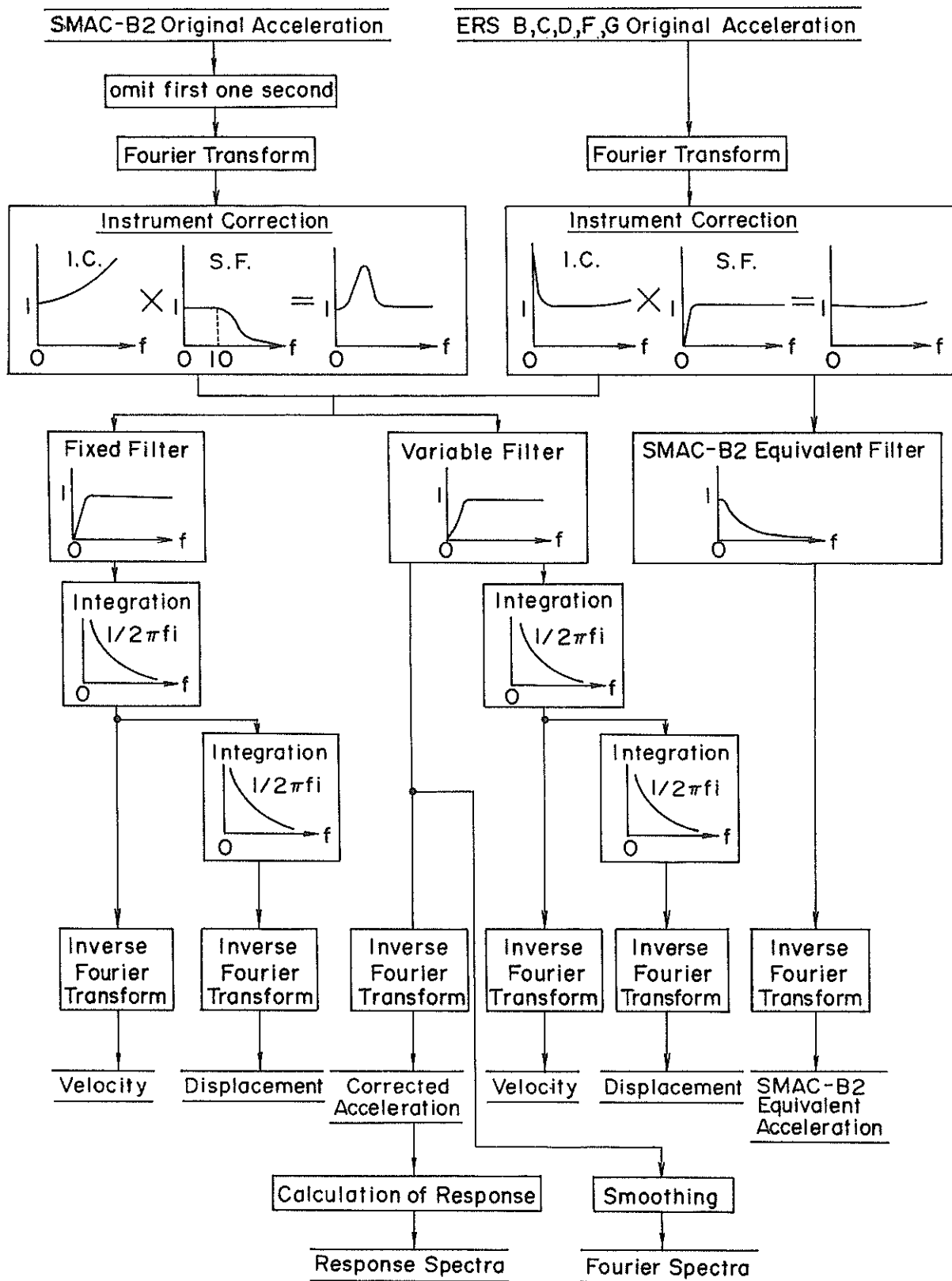


Figure29 Procedure of preliminary analyses

(b) Filters for a record by the ERS-B, -C and -D accelerograph

The filter for the instrument correction $A_E(f)$ is defined by following equations;

$$A_E(f) = A_P(f) \cdot A_G(f) \quad \text{----- (11)}$$

$$A_P(f) = 1 + \frac{i}{2h_P} \left(\frac{f}{f_P} - \frac{f_P}{f} \right) \quad \text{----- (12)}$$

$$A_G(f) = 1 - \left(\frac{f}{f_G} \right)^2 + 2h_G \left(\frac{f}{f_G} \right) i \quad \text{----- (13)}$$

where for a record by the ERS - B accelerograph

$$f_P = 2.0(\text{Hz}), h_P = 17, f_G = 100(\text{Hz}) \text{ and } h_G = 0.7$$

for a record by The ERS - C accelerograph

$$f_P = 3.0(\text{Hz}), h_P = 17, f_G = 250(\text{Hz}) \text{ and } h_G = 0.7$$

for a record by The ERS - D accelerograph

$$f_P = 5.0(\text{Hz}), h_P = 10, f_G = 100(\text{Hz}) \text{ and } h_G = 0.7$$

In the above equations, $1/A_P(f)$ means frequency characteristics of the pick up of the accelerograph and $1/A_G(f)$ means those of the galvanometer. Filters for instrument correction $A_E(f)$ are shown in Figure 33 for 3 types of accelerograph.

The supplementary filter $B_E(f)$ is defined by

$$B_E(f) = \begin{cases} 1/|A_P(f)| & \text{if } |f| \leq f_P \\ 1 & \text{otherwise} \end{cases} \quad \text{----- (14)}$$

where $A_P(f)$: Filter for the instrument correction of the pick up

f_P : Characteristic frequency of the pick up of each accelerograph

The supplementary filter is designed to suppress low frequency digitization errors. The supplementary filters $B_E(f)$ are shown in Figure 34. For overall instrument correction of records obtained by ERS-B, -C and -D accelerograph, combined filters by $A_E(f)$ and $B_E(f)$, which is shown in Figure 35, are applied.

(c) Filters for a record by the ERS-F and -G accelerograph

As mentioned earlier, correction for the frequency characteristics of phase, shown in Figure 14 (b), is only applied for the data as a instrument correction and no correction is applied for the amplitude. As for the amplitude, however, components in high frequency range is cut off by the following equations because there is no significant information found in high frequency range so far.

$$Af(f) = \begin{cases} 1 & \text{if } |f| \leq f_1 \\ \frac{1}{2} \left[\cos \left(p \frac{f - f_1}{f_2 - f_1} \right) + 1 \right] & \text{if } f_1 < |f| \leq f_2 \\ 0 & \text{if } |f| > f_2 \end{cases} \quad \text{----- (15)}$$

where $f_1 = 25(\text{Hz})$ and $f_2 = 40(\text{Hz})$

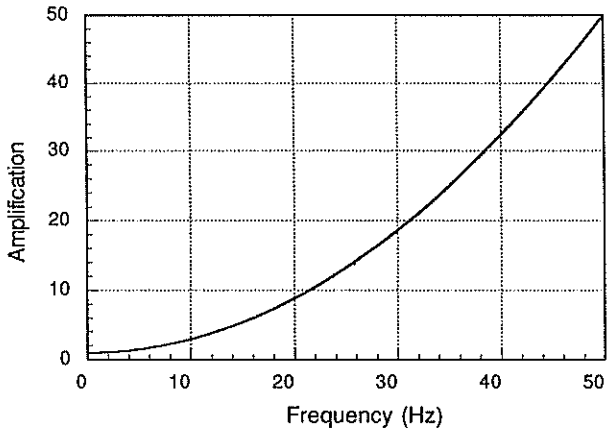


Figure30 The filter for instrument correction for records by the SMAC-B2 accelerograph

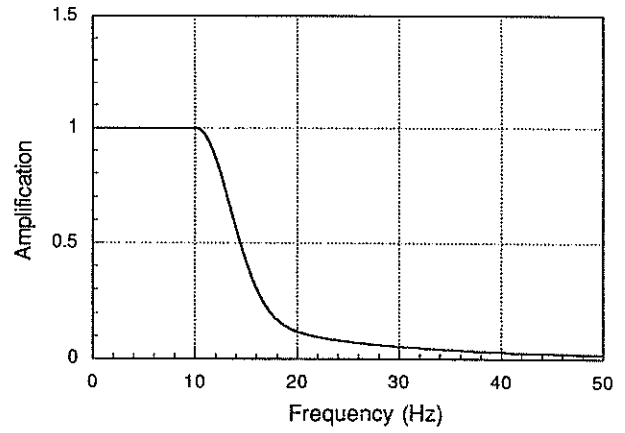


Figure31 The supplementary filter for records by the SMAC-B2 accelerograph

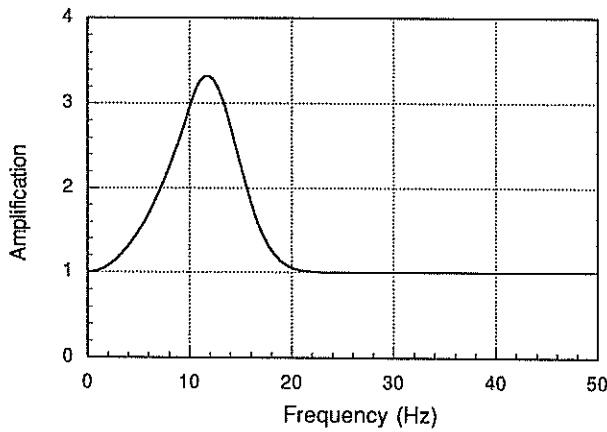


Figure32 The combined filter for records by the SMAC-B2 accelerograph

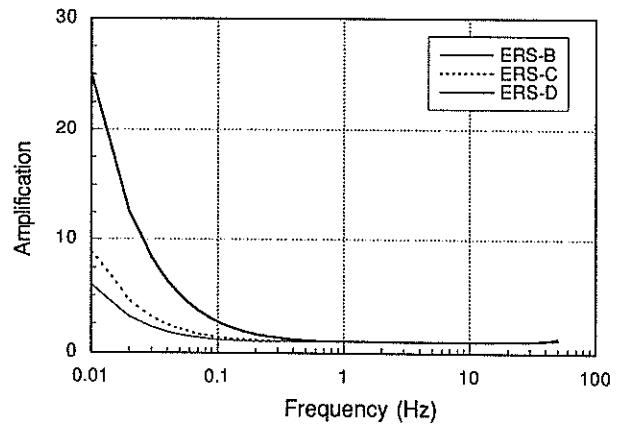


Figure33 The filter for instrument correction for records by the ERS-B, -C and -D accelerograph

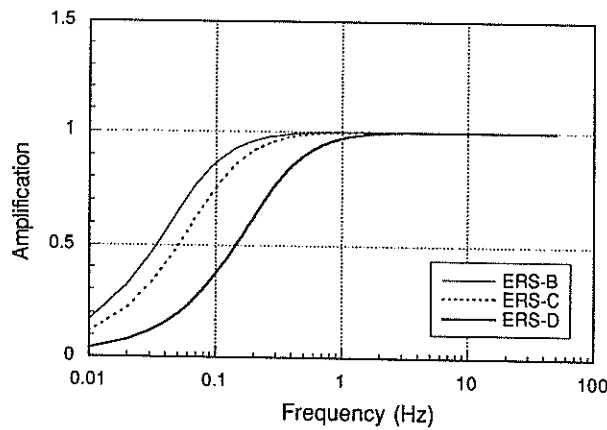


Figure34 The supplementary filter for records by the ERS-B, -C and -D accelerograph

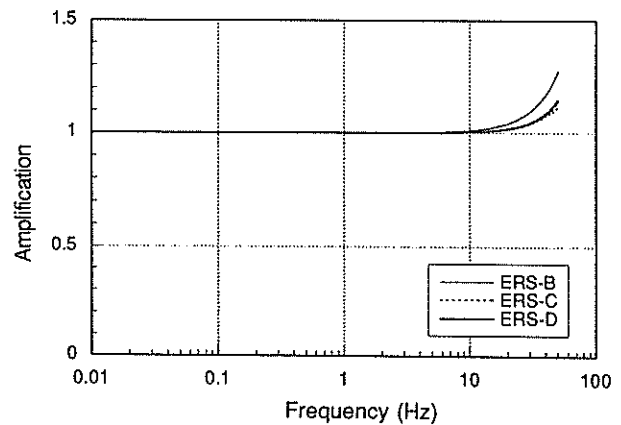


Figure35 The combined filter for records by the ERS-B, -C and -D accelerograph

(3) SMAC-B2 Equivalent Filter

Frequency characteristics of SMAC-B2 accelerograph are different from those of ERS type accelerograph. In order to make it easy to compare the accelerograms by these different types of accelerographs, a filter defined in the following equation is applied for records by the ERS type accelerograph.

$$S(f) = \frac{1}{1 - \left(\frac{f}{f_s}\right)^2 + 2h_s \left(\frac{f}{f_s}\right)i} \quad \text{----- (16)}$$

where $f_s = 1/0.14 = 7.1(\text{Hz})$ and $h_s = 1.0$

This filter is shown in Figure 36 and has the same frequency characteristics as that of the SMAC-B2 accelerograph. The filter is applied for the acceleration records by the ERS type accelerograph processed through the filter for instrument correction and the supplementary filter. Acceleration processed through this filter will be called 'SMAC-B2 Equivalent Acceleration' in this report. This acceleration can be compared with the 'Original Acceleration' by the SMAC-B2 accelerograph. Although acceleration processed by this filter can not represent accurate acceleration and its maximum acceleration will be smaller than that of a record through instrument correction especially in high frequency range, all the accelerograms by this procedure can be directly compared with each other.

(4) High pass filters for integration

Processed through the preliminary correction procedure, a digitized accelerogram is expected to have only such errors as random digitization errors and errors of sectional base-line location. Errors of sectional base-line location affect mainly to frequency components lower than about $1/T$, where T is the length of a section of an accelerogram divided for digitization.

As a result of the examination of random digitization errors, frequency characteristics of Signal-to-Noise (SN) ratio calculated for each frequency are found to be similar to those of digitized acceleration. In other words, ratio of digitized acceleration to digitization errors calculated for each frequency is large if the corresponding frequency components of the digitized acceleration is large. For the frequency components higher than about $1/T$, the result of the examination of digitization errors may remain valid. The result implies that SN ratio of a frequency component varies with the frequency characteristics of accelerogram to be digitized.

The cut-off frequency of a high pass filter for integration of a digitized accelerogram should be varied in accordance with frequency characteristics of an accelerogram from such a point of view that SN ratio should be kept higher than some constant level for every frequency component and at the same time the physically real signals should be preserved as much as possible. On the other hand, cut-off frequency of the filter should be kept constant for any accelerograms from such a point of view that the preserved real seismic signals should be filtered out by the same filter for the purpose of comparison between two or more velocities or displacements even if integrated errors are more or less included in them.

In order to satisfy a wide range of applications of the strong-motion records from the various view points, the authors proposed two methods of correction of an accelerogram to obtain integrated velocities and displacements. One is a method with a fixed filter and the other is a method with a variable filter.

(a) Fixed filter

This filter is defined by the following equation.

$$H_1(f) = \frac{1}{1 - \left(\frac{f_0}{f}\right)^2 - 2h\left(\frac{f_0}{f}\right)i} \cdot \frac{1}{\sqrt{1 + \left(\frac{f_1}{f}\right)^2}} \quad (17)$$

where $f_0 = 1/6(\text{Hz})$, $h = 0.552$ and $f_1 = 0.1(\text{Hz})$

This filter is designed to make it easy to compare the integrated displacement with records obtained by the one magnification strong-motion seismometer ($T=6$ seconds and $h=0.552$) deployed by the Japan Meteorological Agency (JMA). Cut-off frequency (3 dB down) of this filter is 0.154 Hz. This filter is shown in Figure 37.

(b) Variable filter

This filter is defined by the following equation;

$$H_2(f) = \left[1 - \exp\left\{-\left(\frac{f}{f_c}\right)^2\right\} \right]^2 \quad (18)$$

The parameter f_c in the equation varies so as to make σ equal to E , where σ is defined by

$$\sigma^2 = \frac{1}{M} \int_{-\infty}^{\infty} |x(f)|^2 \cdot \left[1 - \exp\left\{-(fT)^2\right\} \right]^4 \cdot [1 - H_2(f)]^2 df \quad (19)$$

where M is the length of whole digitized portion,

T is the minimum length of a section of accelerogram,

$X(f)$ is Fourier Transform of the original acceleration and

E is the value listed below;

for a record by the SMAC-B2 accelerograph

$$E = 0.5 (\text{Gal})$$

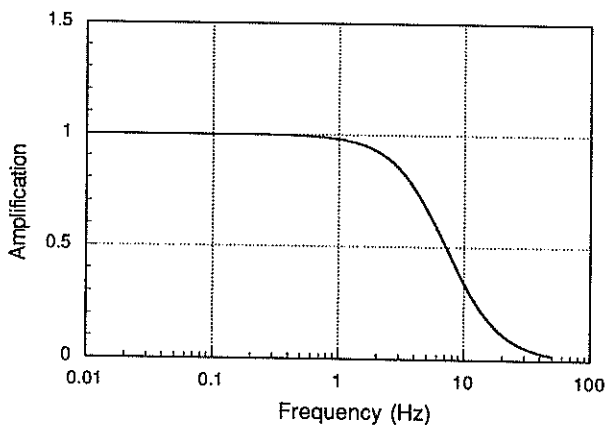


Figure36 The SMAC-B2 equivalent filter

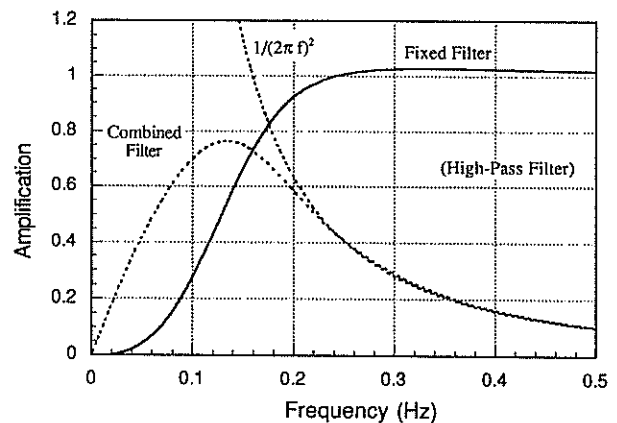


Figure37 The fixed filter and the combined filter for double integral

for a record by the ERS-B, -C and -D accelerograph

$$E = 0.05p \text{ (Gal)}$$

where p (Gal/mm) is the sensitivity of the ERS-B, -C and -D accelerograph

for a record by the ERS-F and -G accelerograph

$$E = (p \cdot 0.001) \cdot 0.02236 \text{ (Gal)}$$

where p (1000 Gal/2⁶) is the sensitivity of the ERS-F and -G accelerograph

Cut-off frequency (3 dB down) of this filter is $1.36f_c$. This filter is shown in Figure 38 and Figure 39.

Decision procedure of f_c is illustrated in Figure 40. f_c is fundamentally determined so as to filter out some constant amount of low frequency components of an accelerogram higher than about $1/T$. The greater low frequency components of an accelerogram are, the lower f_c should be. Because the greater low frequency components of an accelerogram are, the higher SN ratio of these components are. Low frequency components lower than about $1/T$ are eliminated for the decision procedure of f_c because they are possible to be contaminated by the errors at sectional base-line location and the relation between the SN ratio and the quantity of a frequency component of an accelerogram is afraid no longer remaining valid.

This decision procedure of f_c is, however, a compromise between such a view point as to keep SN ratio over some constant level for every frequency component and keep f_c to be a constant. The reason why such a compromised method is proposed is that the compromise makes decision procedure of f_c more stable against possible fluctuation of the relation between quantity of a frequency component of an accelerogram and the SN ratio. The relation may, to some extent, depend on frequency characteristics of an accelerogram to be digitized, digitized length of an accelerogram, non-stationarity of an accelerogram, etc. and the relation itself is valid only in a stochastic sense.

The reason why a fixed low pass supplementary filter is proposed instead of a variable one for a record by the SMAC-B2 accelerograph is that the possible fluctuation of the relation is expected to be greater for high frequency components. Slope of both of the high pass filters proposed here are designed to be mild in order to lessen an artificial predominant frequency component around the cut-off frequency.

(5) Outputs of Preliminary Analyses

(a) Acceleration, Velocity and Displacement

A portion of first one second of the original acceleration of the SMAC-B2 accelerograph is omitted for the instrument correction and the integration because even a slight difference of start up of recording paper drive between SMAC-B2 accelerographs and even a small difference of selection of starting point of digitization may sensitively affect accuracy of the portion of first short section processed through the correction of start up of the recording paper drive. In the case of the original acceleration of the ERS type accelerograph, no data is omitted. These accelerations are processed by the methods of correction and integration described previously. The calculated results are shown in figures and tables as results of preliminary analyses shown in the later part of this report.

In this report, 'Corrected Acceleration' denotes acceleration with instrument correction processed through the variable filter and 'SMAC-B2 Equivalent Acceleration' denotes acceleration obtained by the SMAC-B2 equivalent filter as shown in Figure 29. Integrated velocities and displacements are calculated with both the fixed filter and the variable filter. The parameter f_c for cut-off frequency of the variable filter is shown in the tables on the results of preliminary analyses.

The corrected acceleration of the different types of accelerographs can not necessarily be compared with each other because the difference of the supplementary filters produces difference mainly on the high frequency components over 10 Hz of the filtered accelerations. Instead of comparison of the corrected accelerations, SMAC-B2 equivalent acceleration can be freely compared with the original acceleration of the SMAC-B2 accelerograph except for the

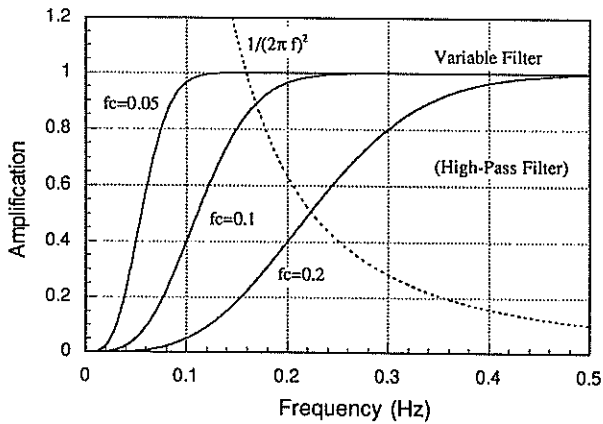


Figure 38 The variable filter and double integral

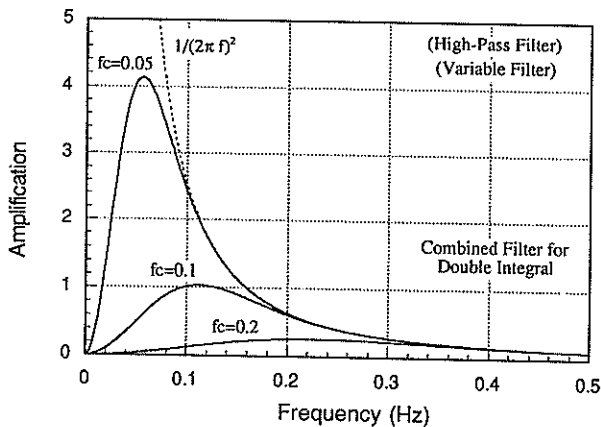
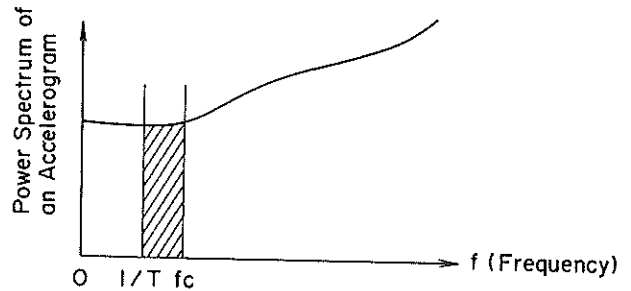


Figure 39 The combinend filter of the variable filter for double integral

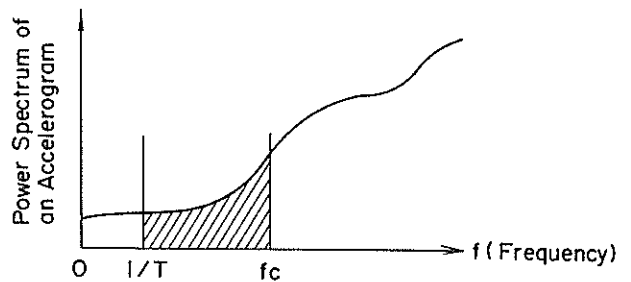


Figure 40 Simplified illustration of decision procedure of f_c

low frequency components lower than about 0.1 Hz.

(b) Response Spectra

Response spectra are calculated from the corrected acceleration, which is an acceleration with instrument correction processed through the variable filter as described previously. The response spectra in the previous annual reports before 1968 were calculated from the digitized records by a digital computer using Runge-Kuta-Gill method to integrate numerically the equation of motion of the oscillator. The response spectra in the present report are calculated with a step by step calculation of the exact solution to the governing differential equation⁵¹. No significant difference was seen in the results calculated by the both methods, according to the trial calculations.

The time interval of each step of the calculation is 0.01 second for the oscillators of natural periods longer than 0.2 second. For the oscillators of shorter periods, the small time intervals are selected to that one cycle of the undamped free oscillation of the oscillator is covered at least by 20 steps of the numerical calculation to maintain the necessary accuracy. In these calculation, the digitized records at smaller time intervals are made by means of the interpolation in the computer.

To calculate response spectra, entire length of the record is not necessary and the last part of the record after the maximum response have appeared is in effect meaningless in the calculation. Besides, the shorter record is more

preferable from view point of the calculation time. On some long records, their beginning parts of small acceleration are not used in the calculation so far as it is thought that the neglected parts do not affect the results of the calculation. In this report, the whole record length is adopted as length of calculating response spectra for the records less than 60 seconds. For the records of which time duration is more than 60 seconds, the length of 60 seconds which includes portions of main strong-motion is adopted as length of calculation. Acceleration ratio, absolute acceleration response, relative velocity response and relative displacement response are presented in this report as results of response spectra of 0%, 1% and 5% damping.

Response spectra of the period longer than about $1/f_c$ are influenced by the high pass filter ($1.36/f_c$ is the period of 3 dB down of the filter); i.e., calculated response spectra is true if real seismic signals do not exist in the period longer than about $1/f_c$ and calculated response spectra are smaller than the true value if real seismic signals do exist. In the case of the corrected acceleration by the SMAC-B2 accelerograph, response spectra of the period shorter than about 0.1 sec is also influenced by the low pass filter. Users of the response spectra should be careful about these characteristics of the response spectra calculated for the corrected acceleration and difference between the response spectra for the corrected acceleration and those for the uncorrected acceleration which had been calculated so far.

(c) Fourier Spectrum

The Fourier spectra are calculated by the FFT from the corrected acceleration. The time length for calculation is identical with the time length for calculating response spectra. The spectra in this report, however, are multiplied by the length of the record for calculation and then smoothed with the Parzen window of 1 Hz band width.

(d) Loci

The loci of accelerations, velocities and displacements in horizontal plane are included in this report. The records used for plotting loci are corrected accelerations, integrated velocities and displacements processed through the variable filter.

7. Summary of Observation

Strong-motion earthquakes and earthquake responses of structures have been observed in the major ports in Japan since 1962. 5391 accelerograms have been obtained by the end of 1997 in the network of the Port and Harbour Research Institute. As of December 1997, 95 strong-motion accelerographs have been installed in 59 ports in Japan. 65 accelerographs out of 95 are installed at ground surface, 22 accelerographs are in ground by using bore-hole and the rest 8 are on structures such as quay walls.

This report presents all the records obtained in 1997. The records obtained in 1997 are listed in the tables of Strong-Motion Earthquake Observation Results with their maximum accelerations, being classified in accordance with earthquakes. For the records of ground motions with maximum accelerations exceeding 20 Gals (=cm/sec²), computer plots of reproduced acceleration are presented. For the records of ground motions with maximum accelerations exceeding 50 Gals, computer plots of reproduced accelerograms, integrated velocities and displacements, response spectra, Fourier spectra and loci of accelerations, velocities and displacements in horizontal plane are presented.

In Table 8, a statistical summary (total number of records) of the strong-motion observation in the network is given at the end of 1997. In Table 9, record numbers of accelerograms of which digitized records and spectra have been published by the end of 1997 are shown. The number in the parentheses behind each record number shows the number of the Technical Note of the Port and Harbour Research Institute in which the record is presented.

(Received on March 30, 1999)

Table 8 Statistical Summary of Records

(December 1997)

Name of Station	Total Number of Records	Number of Records ($20 \leq \text{Max. Accel.} < 50\text{Gals}$)	Number of Records ($\text{Max. Accel.} \geq 50\text{Gals}$)
ABASHIRI-G	0	0	0
AKITA-GB	4	1	0
AKITA-G	4	0	1
AKITA-S*	33	7	2
AMAGASAKI-G	25	9	2
AMAGASAKI-S*	9	2	0
AOMORI-G	7	3	1
AOMORI-S*	48	17	6
CHIBA-S	99	19	4
HACHINOHE-GB	0	0	0
HACHINOHE-G	0	0	0
HACHINOHE-JI-S*	24	11	8
HACHINOHE-S*	111	16	5
HAKODATE-FB	17	3	1
HAKODATE-F	17	3	2
HAKODATE-FR	18	5	2
HAKODATE-M	50	17	6
HANASAKI-F	52	11	3
HANASAKI-M*	36	21	7
HIRARA-G	6	2	1
HIRARA-S*	5	1	0
HIROSHIMA-G	9	2	0
HIROSHIMA-S*	9	5	4
HIROSHIMA-JI-S*	5	0	0
HITACHINAKA-F	216	110	30
HOSOSHIMA-F	12	1	0
HOSOSHIMA-S*	54	19	7
ISHIGAKI-G	7	1	0
ISHIGAKI-S*	5	1	0
INAE-S*	23	7	0
INAE-SANBASHI-M*	20	10	1
INAE-YAITA-M*	30	13	3
KAGOSHIMA-G	4	2	1
KAGOSHIMA-S*	26	4	0
KAMAISHI-M	46	20	1
KAMAISHI-MB	46	4	1
KANAZAWA-G	1	1	0
KANAZAWA-S*	9	3	1
KASHIMA-S*	32	9	3
KASHIMA-JI-S*	30	6	3
KASHIMA-ZOKAN-S	136	33	12
KAWASAKI-FB	52	5	3
KAWASAKI-F	52	10	4
KAWASAKI-FR	52	17	5
KAWASAKI-CHI-M*	187	22	2
KAWASAKI-KO-M*	107	28	6
KEIHIN-JI-S*	133	19	2
KINUURA-JI-S	25	5	1
KINUURA-S*	8	4	2
KOBE-DAI6-S*	13	3	0
KOBE-DAI8-G	1	0	1
KOBE-DAI8-S*	18	2	1

(to be continued)

(Table 8 Continued)

(December 1997)

Name of Station	Total Number of Records	Number of Records ($20 \leq \text{Max. Accel.} < 50\text{Gals}$)	Number of Records ($\text{Max. Accel.} \geq 50\text{Gals}$)
KOBE-JI-GB80	0	0	0
KOBE-JI-GB40	0	0	0
KOBE-JI-G	0	0	0
KOBE-JI-S	18	6	1
KOBE-MAYA-DAI1-M*	16	7	2
KOBE-MAYA-DAI2-M*	21	7	1
KOBE-MAYA-G	0	0	0
KOBE-MAYA-M*	22	4	1
KOCHI-G	3	1	0
KOCHI-S*	21	3	1
KOCHI-JI-S*	13	3	0
KOKEN-G	1	1	1
KOKEN-M*	60	5	0
KOKEN-S	34	6	2
KOMATSUJIMA-G	3	2	2
KOMATSUJIMA-S*	17	2	0
KUSHIRO-GB	22	3	2
KUSHIRO-G	22	8	4
KUSHIRO-S*	49	16	6
KUSHIRO-JI-S*	14	7	3
MATSUYAMA-G	10	5	0
MATSUYAMA-S*	25	4	2
MIKAWA-GB	4	0	0
MIKAWA-G	4	0	1
MINAMATA-M*	3	0	0
MIYAKO-G	31	14	7
MIYAKO-S*	49	28	12
MIYAZAKI-GB	8	2	1
MIYAZAKI-G	8	2	3
MIYAZAKI-M*	50	10	4
MONBETSU-G	0	0	0
MURORAN-G	42	11	5
MURORAN-S*	69	14	6
NAGOYA-INAE-G	1	0	1
NAGOYA-SORAMI-GB	1	1	0
NAGOYA-SORAMI-G	1	0	1
NAGOYA-ZOKAN-S*	26	5	2
NAHA-GB	13	0	0
NAHA-G	13	1	0
NAHA-S*	1	0	0
NAHA-ZOKAN-S*	2	1	0
NAKAGUSUKU-G	2	0	0
NIIGATA-G	26	4	1
NIIGATA-S*	12	1	0
NIIGATA-JI-S*	5	1	0
OFUNATO-S*	21	3	2
OFUNATO-BOCHI-S	73	16	5
OFUNATO-BO-S	119	41	24
OFUNATO-MOUND-M	82	27	8
OITA-G	4	2	1
OITA-S*	13	7	4
OKITSU-S*	28	4	0

(to be continued)

(Table 8 Continued)

(December 1997)

Name of Station	Total Number of Records	Number of Records ($20 \leq \text{Max. Accel.} < 50 \text{Gals}$)	Number of Records ($\text{Max. Accel.} \geq 50 \text{Gals}$)
OMAEZAKI-M	40	3	0
ONAHAMA-JI-GB	8	1	0
ONAHAMA-JI-G	8	6	2
ONAHAMA-JI-S*	37	25	8
ONAHAMA-S*	67	13	4
OSAKA-CHUO-S*	8	1	0
OSAKA-JI-G	4	2	1
OSAKA-JI-S*	12	1	1
OSAKA-MINAMI-G	4	2	0
OSAKA-MINAMI-S*	0	0	0
OTARU-G	8	2	1
OTARU-S*	13	0	0
ROKKO-GB80	0	0	0
ROKKO-GB40	0	0	0
ROKKO-G	0	0	0
RUMOI-G	0	0	0
SAKAIMINATO-G	6	3	0
SAKAIMINATO-S*	0	0	0
SAKAIMINATO-JI-S*	13	6	3
SAKATA-G	0	0	0
SAKATA-S*	61	6	0
SENDAI-M	93	21	3
SENDAI-MB	93	2	0
SETANA-G	0	0	0
SHIBUSHI-G	6	1	0
SHIBUSHI-S*	15	0	0
SHIMIZU-GB	1	0	0
SHIMIZU-G	1	0	0
SHIMIZU-KOJYO-S*	25	7	4
SHIMIZU-MIHO-S*	26	4	2
SHIMI.-SEKITAN-M*	23	11	5
SHIMI.-SEKITAN-S*	10	5	2
SHINAGAWA-GB	1	0	0
SHINAGAWA-G	2	1	1
SHINAGAWA-M*	1	1	1
SHINAGAWA-MB*	91	2	0
SHINAGAWA-S*	128	31	8
SHIOGAMA-KOJYO-S*	96	20	6
SHIOGAMA-S*	19	1	0
SHIMODA-F	12	1	0
SOMA-S	65	17	7
TAGONOURA-S	61	9	1
TOKACHI-G	4	3	0
TOKACHI-M*	111	61	23
TOMAKOMAI-G	5	1	0
TOMAKOMAI-S*	35	10	7
TOYAMA-GB	1	0	0
TOYAMA-G	1	0	0
TOYAMA-S*	8	3	2
TSURUGA-G	3	1	1
TSURUGA-S*	33	3	1
URAKAWA-S	160	20	7

(to be continued)

(Table 8 Continued)

(December 1997)

Name of Station	Total Number of Records	Number of Records ($20 \leq \text{Max. Accel.} < 50\text{Gals}$)	Number of Records ($\text{Max. Accel.} \geq 50\text{Gals}$)
WAKA.-GANPEKI-S*	7	2	0
WAKAYAMA-G	48	19	15
WAKAYAMA-S*	41	19	3
WAKAYAMA-JI-S*	12	5	4
WAKA.-SUMIKEN-S*	0	0	0
YAMASHITA-FB	84	2	0
YAMASHITA-F	84	17	4
YAMASHITA-FR	84	33	13
YAMASHI.-DAI7-M*	81	6	1
YAMASHI.-DAI6-S*	102	31	11
YAMASHITA-HEN-M*	199	19	6
YAMASHITA-HEN-S*	119	24	8
YOKKA.-CHITOSE-S	16	6	3
YOKKA.-DAI2-M	20	4	2
YOKKA.-SEKITAN-M	55	12	5
YOKKAICHI-JI-S*	5	2	0
TOTAL	5391	1307	437
ERS	2733	675	214
SMAC	2658	632	223

* Strong-motion observation of the stations had already been stopped.

Table 9 Summary of Analyzed Record Numbers

(December 1997)

Name of Station	Record Numbers which had been digitized and analyzed (Ref. No.**)				
AKITA-GB	F-708(892)	F-904(892)			
AKITA-G	F-709(892)	F-905(892)			
AKITA-S*	S-655(160)	S-1567(458)	S-1585(458)	S-1586(458)	
AMAGASAKI-G	F-765(907)	F-803(907)	F-804(907)	F-805(907)	F-808(907)
	F-809(907)	F-810(907)	F-811(907)	F-812(907)	F-813(907)
	F-817(907)	F-818(907)	F-819(907)	F-820(907)	F-821(907)
	F-849(907)	F-850(907)	F-932(907)	F-933(907)	F-934(907)
AOMORI-G	F-680(853)	F-692(892)	F-713(892)		
AOMORI-S*	S-235(80)	S-264(80)	S-670(160)	S-1573(458)	S-1592(458)
	S-2488(777)	S-2523(778)	S-2530(778)		
CHIBA-S	S-1378(374)	S-1545(487)	S-1884(547)	S-2107(619)	
HACHINOHE-S*	S-252(80)	S-669(160)	S-857(202)	S-1202(319)	S-1453(426)
	S-1575(458)				
HACHINOHE-JI-S*	S-1968(618)	S-1984(618)	S-2261(676)	S-2486(777)	S-2582(853)
	S-2597(892)	S-2598(892)	S-2606(892)		
HAKODATE-FB	F-508(777)	F-541(778)	F-542(776)	F-544(778)	F-667(853)
	F-687(892)	F-888(892)			
HAKODATE-F	F-545(778)	F-546(776)	F-548(778)	F-603(778)	F-668(853)
	F-689(892)	F-891(892)			
HAKODATE-FR	F-509(777)	F-549(778)	F-550(776)	F-552(778)	F-604(778)
HAKODATE-M	M-357(374)	M-523(442)	M-630(458)	M-639(458)	M-1444(777)
	M-1472(778)	M-1473(776)	M-1476(778)	M-1520(853)	
HANASAKI-F	F-478(776)	F-510(777)	F-681(853)	F-773(853)	F-777(853)
HANASAKI-M*	M-106(287)	M-262(338)	M-496(426)	M-887(547)	M-1014(588)
	M-1017(588)	M-1296(676)			
HIROSHIMA-G	F-790(907)				
HIROSHIMA-S*	S-364(98)	S-1306(338)	S-1623(487)		
HITACHINAKA-F	F-12(588)	F-15(588)	F-19(588)	F-34(618)	F-36(618)
	F-43(618)	F-46(618)	F-107(649)	F-174(649)	F-358(705)
	F-384(705)	F-423(727)	F-456(727)	F-483(776)	F-525(777)
	F-756(909)	F-885(909)	F-1063(909)		
HOSOSHIMA-S*	S-213(98)	S-453(100)	S-544(116)	S-545(116)	S-1231(338)
	S-1625(487)	S-1729(503)	S-2022(618)		
INAE-YAITA-M*	M-1553(907)				
KAMAISHI-M	M-1494(776)	M-1447(777)	M-1523(853)	M-1537(892)	
KAMAISHI-MB	M-1075(618)	M-1448(777)	M-1524(853)		
KANAZAWA-G	F-800(907)				
KANAZAWA-S*	S-2506(776)				
KASHIMA-S*	S-196(64)	S-612(136)	S-647(136)		

(to be continued)

(Table 9 Continued)

(December 1997)

Name of Station	Record Numbers which had been digitized and analyzed (Ref. No.**)				
KASHIMA-JI-S*	S-770(181)	S-813(202)	S-845(202)	S-882(202)	
KASHIMA-ZOKAN-S	S-1206(319)	S-1506(446)	S-1678(519)	S-1867(547)	S-1910(588)
	S-1957(588)	S-2110(619)	S-2196(676)	S-2206(676)	S-2492(777)
	S-2639(909)	S-2667(909)			
KAWASAKI-FB	F-461(776)				
KAWASAKI-F	F-98(619)	F-123(649)	F-462(776)	F-516(776)	F-739(892)
	F-985(892)	F-991(907)			
KAWASAKI-FR	F-463(776)	F-517(776)			
KAWASAKI-CHI-M*	M-186(317)	M-220(319)	M-406(374)	F-619(487)	
KEIHIN-JI-S*	S-1188(319)	S-1390(374)	S-2112(619)		
KINUURA-JI-S	S-2621(907)				
KINUURA-S*	S-480(100)	S-585(136)			
KOBE-DAI8-G	F-764(907)				
KOBE-JI-S	S-2615(907)	S-2623(907)			
KOBE-MAYA-M*	M-704(487)				
KOCHI-G	F-791(907)				
KOCHI-S*	S-211(98)				
KOCHI-JI-S*	S-1730(503)				
KOKEN-S	S-1046(338)	S-2106(619)	S-2417(776)		
KOKEN-M*	M-170(317)				
KOMATSUJIMA-G	F-794(907)	F-652(840)			
KUSHIRO-GB	F-506(777)	F-527(777)	F-670(853)	F-672(853)	F-674(853)
	F-695(853)	F-697(892)			
KUSHIRO-G	F-507(777)	F-528(777)	F-671(853)	F-673(853)	F-675(853)
	F-696(853)	F-698(892)			
KUSHIRO-S*	S-98(62)	S-369(98)	S-634(136)	S-674(160)	S-733(181)
	S-741(181)				
KUSHIRO-JI-S*	S-1976(618)	S-2171(649)	S-2390(727)		
MATSUYAMA-G	F-792(907)				
MATSUYAMA-S*	S-1303(338)	S-1731(503)	S-1624(487)		
MIYAKO-G	F-582(776)	F-584(776)	F-514(777)	F-587(778)	F-726(892)
	F-730(892)	F-734(892)	F-727(840)		
MIYAKO-S*	S-236(80)	S-271(80)	S-312(80)	S-273(98)	S-420(98)
	S-537(116)	S-1204(319)	S-1104(338)	S-1317(338)	S-1972(618)
	S-2255(676)				
MIYAZAKI-GB	F-1067(909)				
MIYAZAKI-G	F-1052(909)	F-1068(909)			
MIYAZAKI-M*	M-228(338)	M-795(503)	M-877(547)	M-1107(618)	

(to be continued)

(Table 9 Continued)

(December 1997)

Name of Station	Record Numbers which had been digitized and analyzed (Ref. No.**)				
MURORAN-G	F-505(777)	F-554(778)	F-560(778)	F-568(778)	F-679(853)
	F-700(892)	F-701(892)			
MURORAN-S*	S-234(80)	S-241(80)	S-399(80)	S-1425(426)	S-1474(442)
	S-1571(458)	S-1599(458)	S-1979(618)		
NAGOYA-INAE-S*	S-2616(907)				
NAGOYA-ZOKAN-S*	S-578(136)	S-1966(588)			
NIIGATA-G	F-705(892)	F-827(909)			
NIIGATA-S*	S-107(62)				
NIIGATA-JI-S*	S-1203(319)				
OFUNATO-S*	S-140(64)	S-282(98)	S-361(98)		
OFUNATO-BO-S	S-2547(778)				
OFUNATO-BOCHI-S	S-554(116)	S-786(181)	S-1022(287)	S-1210(319)	S-1120(338)
OFUNATO-MOUND-M	M-1493(778)	M-1450(777)			
OITA-G	F-869(907)	F-1115(909)			
OITA-S*	S-924(236)	S-1629(487)	S-1734(503)	S-2021(618)	
OKITSU-S*	S-1071(317)				
ONAHAMA-S*	S-111(62)	S-1043(287)	S-1191(319)	S-1330(338)	
ONAHAMA-JI-S*	S-1330(338)	S-1505(446)	S-1602(487)	S-1633(487)	S-1946(588)
OSAKA-JI-G	F-854(907)	F-855(907)	F-856(907)	F-1041(907)	
OSAKA-JI-S*	S-2618(907)				
OSAKA-MINAMI-G	F-851(907)	F-852(907)	F-853(907)	F-1040(907)	
OTARU-G	F-536(777)	F-538(778)	F-539(778)	F-540(780)	F-676(853)
	F-694(892)				
SAKAIMINATO-G	F-793(907)				
SAKAIMINATO-JI-S*	S-2248(676)	S-2251(676)	S-2383(727)		
SAKATA-S*	S-1568(458)	S-2604(892)			
SENDAI-M	M-572(446)	M-1127(618)	M-1498(776)	M-1445(777)	M-1536(892)
SENDAI-MB	M-1446(777)	M-1547(892)			
SHIMIZU-KOJYO-S*	S-74(62)	S-1063(317)	S-1064(317)		
SHIMIZU-MIHO-S*	S-1066(317)	S-1069(317)			
SHINAGAWA-G	F-1046(909)				
SHINAGAWA-S*	S-340(98)	S-441(98)	S-1394(374)	S-1787(519)	S-1885(547)
	S-2111(619)	S-2130(649)	S-2395(727)	S-2419(778)	
SHIOGAMA-KOJYO-S*	S-782(181)	S-1118(338)	S-1201(319)	S-2006(618)	S-2029(618)
	S-2551(776)	S-2602(892)	S-2612(892)		
SHIOGAMA-S*	S-138(64)				
SOMA-S	S-1872(547)	S-2001(618)	S-2031(618)	S-2051(618)	S-2096(618)
	S-2220(676)	S-2487(777)	S-2584(853)	S-2610(892)	S-2656(909)
TAGONOURA-S	S-1055(317)	S-2653(909)			

(to be continued)

(Table 9 Continued)

(December 1997)

Name of Station	Record Numbers which had been digitized and analyzed (Ref. No.**)				
TOKACHI-M*	M-125(287)	M-145(287)	M-247(338)	M-260(338)	M-340(338)
	M-341(374)	M-439(426)	M-521(442)	M-522(442)	M-540(446)
	M-636(487)	M-703(487)	M-911(547)	M-972(547)	M-1078(618)
	M-1200(649)	M-1242(649)	M-1383(727)	M-1416(776)	M-1459(776)
	M-1443(777)	M-1519(853)	M-1534(892)	M-1511(840)	M-1564(909)
TOMAKOMAI-S*	S-877(202)	S-1418(426)	S-1472(442)	S-1977(618)	S-2491(777)
	S-2528(778)	S-2531(778)	S-2581(853)	S-2600(892)	
TOYAMA-GB	F-787(907)				
TOYAMA-G	F-788(907)				
TOYAMA-S*	S-1892(547)	S-2502(776)			
TSURUGA-G	F-789(907)				
TSURUGA-S*	S-1549(487)				
URAKAWA-S	S-1978(618)	S-2186(676)	S-2401(727)	S-2458(776)	S-2490(777)
	S-2580(853)	S-2599(892)	S-2608(892)		
WAKAYAMA-G	F-497(776)	F-503(776)	F-660(840)	F-715(840)	F718(840)
	F-795(907)	F-937(907)	F-943(909)	F-944(909)	F-948(909)
	F-950(909)	F-1029(909)	F-1030(909)	F-1071(909)	
WAKAYAMA-S*	S-945(236)	S-1028(287)	S-1031(287)		
WAKAYAMA-JI-S*	S-265(98)	S-266(98)	S-788(181)		
YAMASHITA-FB	F-753(853)				
YAMASHITA-F	F-95(619)	F-168(649)	F-325(676)	F-878(909)	
YAMASHITA-HEN-S*	S-412(98)	S-658(160)	S-1058(317)	S-1189(319)	S-1362(374)
	S-1386(374)	S-1614(487)	S-2113(619)	S-2155(649)	
YAMASHITA-HEN-M*	M-217(319)	M-403(374)	M-1022(588)	M-1056(588)	M-1183(619)
	M-1195(649)	M-1226(649)			
YOKKA.-CHITOSE-S	S-577(136)	S-2619(907)			
YOKKA.-SEKITAN-M	M-1555(907)				

* Strong-motion observation of the stations had already been stopped.

** The numbers correspond to those of the Technical Note of the Port and Harbour Research Institute, in which results of preliminary analysis are presented.

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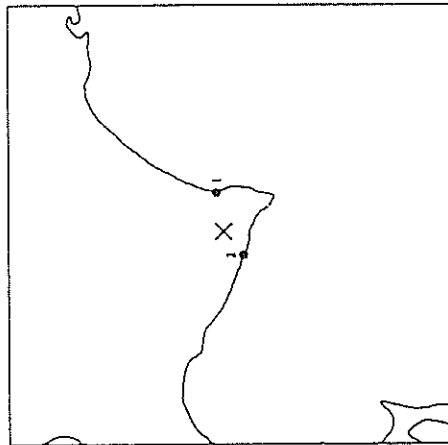
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- 45) Yoshiko Yokoyama and Eiichi Kurata: Site Characteristics of Strong-Motion Earthquake Stations in Ports and Harbours in Japan (Part 4), Technical Note of the Port and Harbour Research Institute, No.298, June 1978.
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- 48) Jishin-Kazan-Gaikyo of the Japan Meteorological Agency, The Japan Meteorological Agency, 1997.
- 49) Susumu Iai, Eiichi Kurata and Hajime Tsuchida: Digitization and Correction of Strong-Motion Accelerograms, Technical Note of the Port and Harbour Research Institute, No.286, March 1978.
- 50) Susumu Iai and Eiichi Kurata: Integration of Strong-Motion Accelerograms, Proceedings of the 5th Japan Earthquake Engineering Symposium, November 1978, pp.255-232.
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Strong-Motion Earthquake Observation Results(1997)

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

18:02 JAN. 7, 1997
 HIDAKA MOUNTAINS REGION
 JWA INTENSITIES
 III : URAKAWA, HIROO
 I : TOMAKOMAI, OBIHIRO,
 KUSHIRO

EPICENTER : 42 16.2'N 142 59.2'E
 DEPTH : 65.2KM MAGNITUDE : 4.5

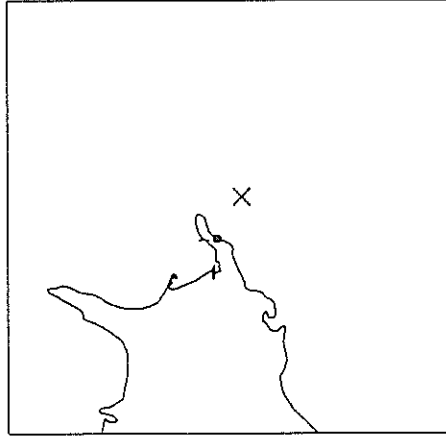


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 TOKACHI-G	ON GROUND	F-1094	40 43 25	27
2 URAKAWA-S	ON GROUND	S-2668	32 20 5	21

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

04:19 JAN. 11, 1997
 OFF NEMURO PENINSULA
 JWA INTENSITIES
 II : KUSHIRO, NEMURO
 I : TOMAKOMAI, URAKAWA,
 OBIHIRO, HIROO, HACHIROHE

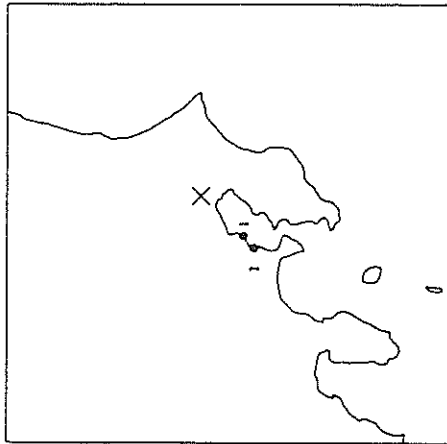
EPICENTER : 43 5.6'N 145 54.3'E
 DEPTH : 82.5KM MAGNITUDE : 5.2



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 HARASAKI-F	ON GROUND	F-1188	42 28 15	32

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

00:26 JAN. 27.1997
 JWA INTENSITIES
 NORTHERN CHIBA PREF
 I : NIKKO, CHIBA, TOKYO,
 YOKOHAMA
 II : MITO, TATEYAMA
 EPICENTER : 35 45.2'N 140 4.7 'E
 DEPTH : 77.5KM MAGNITUDE : 4.1



STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWASAKI-FR	ON STRUC.	F-1164	1	39
1 KAWASAKI-F	ON GROUND	F-1163	6 11 3	39
1 KAWASAKI-FB	IN GROUND	F-1162	1	39
2 YAMASHITA-FR	ON STRUC.	F-1128	20 9 3	50
2 YAMASHITA-F	ON GROUND	F-1127	11 6 4	50
2 YAMASHITA-FB	IN GROUND	F-1126	3 2 1	50

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

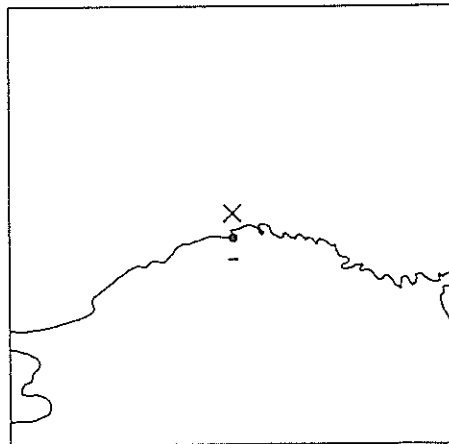
10:51 JAN. 30.1997
 JWA INTENSITIES
 NW WAKAYAMA PREF
 I : WAKAYAMA
 II :
 EPICENTER : 34 12.9'N 135 8.5 'E
 DEPTH : 10.3KM MAGNITUDE : 3.2



STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL) (NS) (EW) (UD)	DIST. (KM)
1 WAKAYAMA-G	ON GROUND	F-1125	23 24 161	0

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

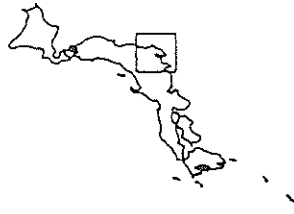
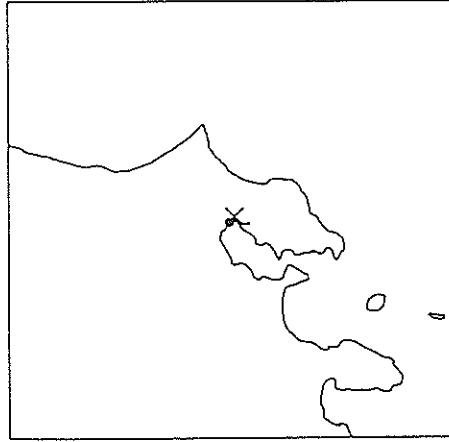
20:12 FEB. 11, 1997
 JWA INTENSITIES
 II : MIYAKO
 E OFF IWATE PREF
 EPICENTER : 39 37.8'N 142 9.7 'E
 DEPTH : 12.7KM MAGNITUDE : 3.9



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 MIYAKO-G	ON GROUND	F-1124	100 113 32	16

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

10:04 FEB. 19, 1997
 JWA INTENSITIES
 II : CHIBA, TOKYO
 I : MITO, NIKKO, TATEYAMA,
 YOKOHAMA
 CENTRAL CHIBA PREF
 EPICENTER : 35 33.8'N 140 8.9 'E
 DEPTH : 76.5KM MAGNITUDE : 4.0

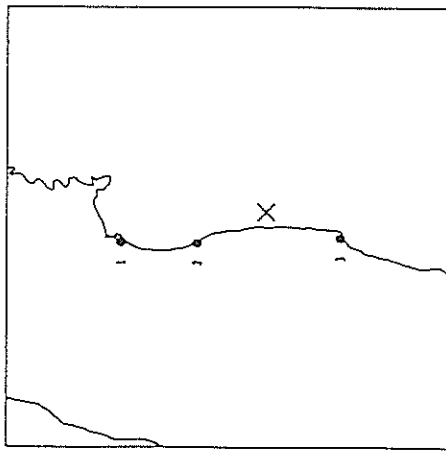


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 CHIBA-S	ON GROUND	S-2670	6 6 1	5

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

05:21 FEB. 20,1997
 E OFF FUKUSHIMA PREF
 EPICENTER : 37 23.1'N 141 9.5 'E
 DEPTH : 88.5KM MAGNITUDE : 5.3

JMA INTENSITIES
 III : SHIRAKAWA, SENDAI, MITO
 II : OFUKATO, MORIOKA,
 ISHINOWAKI, SHINJO,
 YAMAGATA, FUKUSHIMA,
 NIKKO

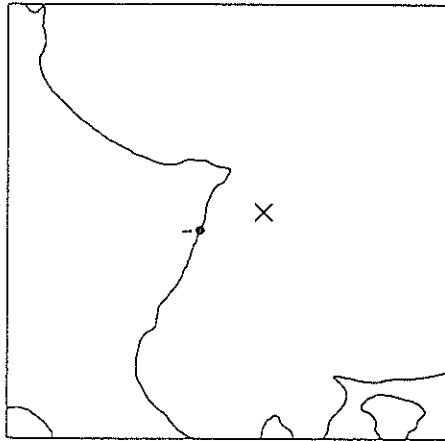


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 SENDAI-MB	IN GROUND	M-1575	9 10 7	100
1 SENDAI-M	ON GROUND	M-1574	10 11 7	100
2 SOMA-S	ON GROUND	S-2681	32 31 14	52
3 ONAHAWA-JI-CB	IN GROUND	F-1112	16 17 9	54
3 ONAHAWA-JI-G	ON GROUND	F-1113	60 37 26	54

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

16:55 FEB. 20,1997
 S OFF URAKAWA
 EPICENTER : 41 45.6'N 142 52.2'E
 DEPTH : 49.3KM MAGNITUDE : 5.7

JMA INTENSITIES
 V : URAKAWA
 III : HIROO, MUTSU
 II : HAKODATE, OTARU,
 TOYAKOWAI, OBIHIRO,
 AOHORI, HACHINOHE,
 MORIOKA

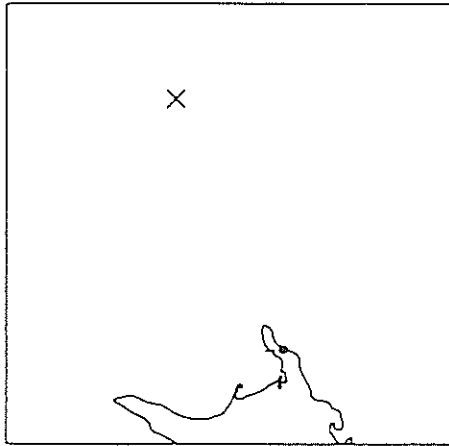


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 URAKAWA-S	ON GROUND	S-2669	49 50 12	45

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

20:32 FEB. 28, 1997
 E OFF HOKKAIDO
 EPICENTER : 43 42.2'N 147 49.0'E
 DEPTH : 6.0KM MAGNITUDE : 5.6

JMA INTENSITIES
 II : URAKAWA, KUSHIRO, NEMURO
 I : TOMAKOMAI, OBIHIRO, HIROO,
 AOMORI, MUTSU, HACHINOHE,
 MORIOKA

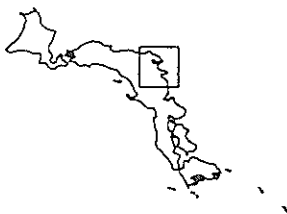
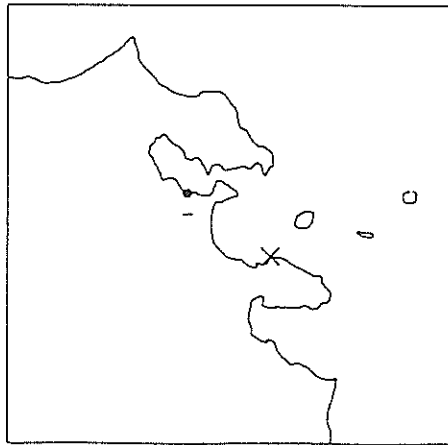


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	MAX. ACC. (GAL)	DIST. (KM)
1 HANASAKI-F	ON GROUND	F-1191	6 6 2	2	185

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

14:20 MAR. 3 .1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.3'N 139 9.5' E
 DEPTH : 3.8KM MAGNITUDE : 3.8

JWA INTENSITIES
 II : YOKOHAMA
 I : TATEYAMA, WISHIWA

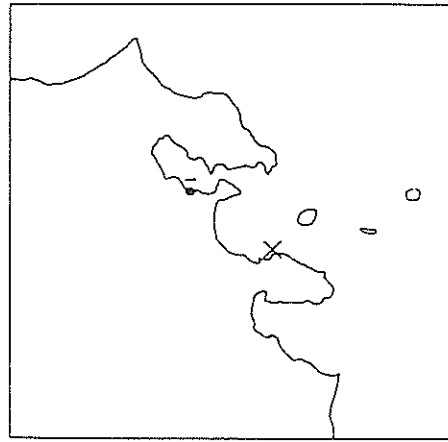


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-1131	7 8 1	71
1 YAMASHITA-F	ON GROUND	F-1130	3 7 2	71
1 YAMASHITA-FB	IN GROUND	F-1129	1 2	71

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

20:10 MAR. 3 .1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.4'N 139 11.0' E
 DEPTH : 3.9KM MAGNITUDE : 4.4

JWA INTENSITIES
 II : TATEYAMA, YOKOHAMA, WISHIWA
 I : TOKYO, KOFU

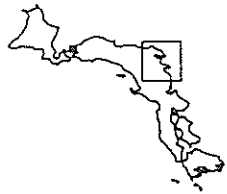
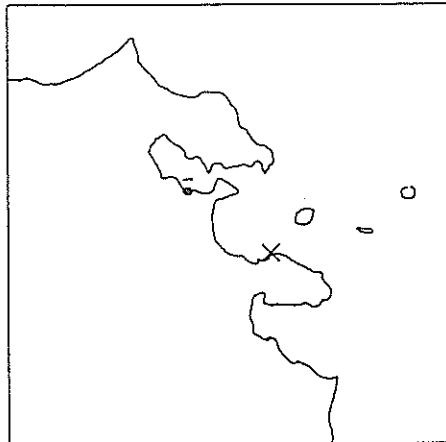


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FB	IN GROUND	P-1132	1 2 1	69
1 YAMASHITA-FR	ON STRUC.	F-1134	6 7 2	69
1 YAMASHITA-F	ON GROUND	P-1133	4 6 3	69

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

23:09 MAR. 3, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.4' N 139 9.7' E
 DEPTH : 0.1KM MAGNITUDE : 5.3

JWA INTERSITIES
 II : TATEYAMA, TOKYO
 I : CHIBA, NIJIMA,
 MIYAKEJIMA, KOFU,
 SHIZUOKA

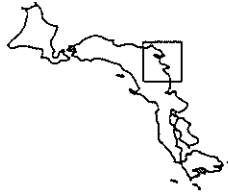
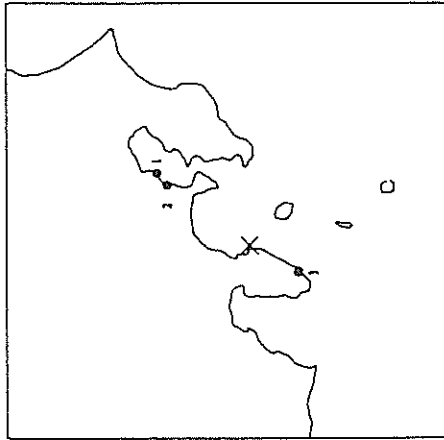


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	MAX. ACC. (OAL) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FB	1K GROUND	F-1135	4	3	71
1 YAMASHITA-FR	ON STRUC.	F-1137	20	14	71
1 YAMASHITA-F	ON GROUND	F-1136	20	11	71

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

00:30 MAR. 4, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.7' N 139 10.5' E
 DEPTH : 0.0KM MAGNITUDE : 4.7

JWA INTERSITIES
 III : TATEYAMA, YOKOHAMA,
 WASHIMA
 II : TOKYO, KOFU
 I : NIKKO, CHIBA, IIDA,
 KARUIZAWA, SHIZUOKA



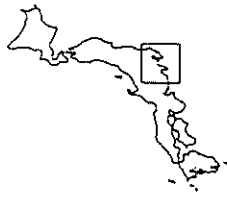
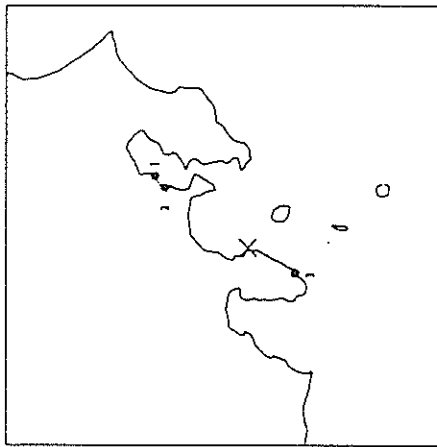
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	MAX. ACC. (OAL) (EW) (UD)	DIST. (KM)
1 KAWASAKI-F	ON GROUND	F-1166	4	6	80
1 KAWASAKI-FR	ON STRUC.	F-1167	1	1	80
1 KAWASAKI-FB	1K GROUND	F-1165	1	1	80
2 YAMASHITA-FR	ON STRUC.	F-1140	73	27	69
2 YAMASHITA-F	ON GROUND	F-1139	25	16	69
2 YAMASHITA-FB	1K GROUND	F-1138	6	4	69
3 SHIMODA-F	ON GROUND	F-1239	7	11	38

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

12:51 MAR. 4, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.1'N 139 10.4'E
 DEPTH : 2.6KM MAGNITUDE : 5.7

JMA INTENSITIES

IV : TATEYAMA
 III : YOKOHAMA, NISHIMA
 II : TOKYO, KOFU, NIJJIMA
 I : MIKKO, CHICHIBU, KUNAGAYA,
 CHIBA, KAWAGUCHIKO,
 KARUIZAWA, IIDA, SHIZUOKA,
 OVAEZAKI



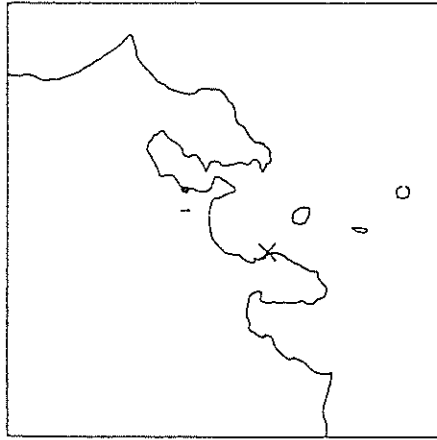
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWASAKI-FR	ON STRUC.	F-1170		81
1 KAWASAKI-F	ON GROUND	F-1169	5 8 2	81
1 KAWASAKI-FB	IN GROUND	F-1168		81
2 YAWASHITA-FR	ON STRUC.	F-1143	24 25 6	70
2 YAWASHITA-F	ON GROUND	F-1142	15 22 11	70
2 YAWASHITA-FB	IN GROUND	F-1141	5 8 2	70
3 SHIYODA-F	ON GROUND	F-1240	8 9 7	37

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

22:43 MAR. 5, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.5'N 139 9.5'E
 DEPTH : 3.3KM MAGNITUDE : 4.3

JMA INTENSITIES

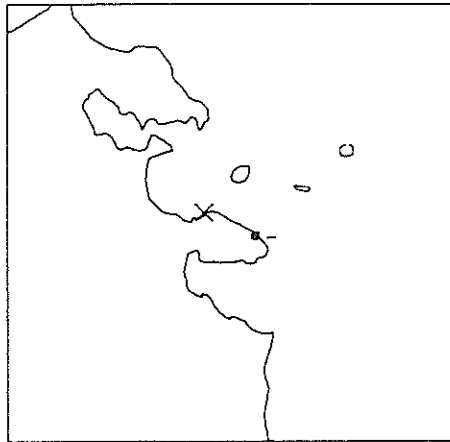
III : OSHIMA
 II : TATEYAMA, YOKOHAMA,
 MISHIMA
 I : TOKYO, NIJJIMA, KOFU



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 YAWASHITA-FR	ON STRUC.	F-1146	14 6 1	71
1 YAWASHITA-F	ON GROUND	F-1145	5 5 2	71
1 YAWASHITA-FB	IN GROUND	F-1144	2 1 1	71

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

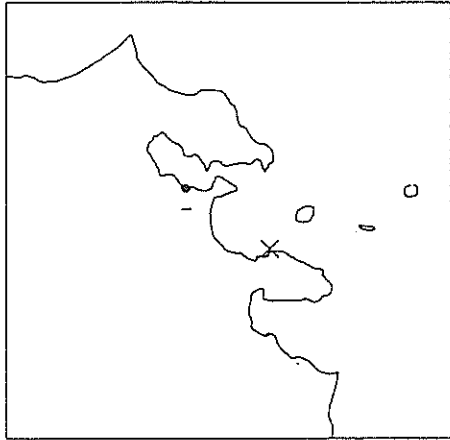
16:33 MAR. 7, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 58.0'N 139 9.0' E
 DEPTH : 1.5KM MAGNITUDE : 4.5
 JVA INTENSITIES
 III : OSHIMA, MISHIMA
 II : TATEYAMA, YOKOHAMA
 I : TOKYO, NIJIMA, KOFU, BIDA,
 SHIZUOKA, OMAEZAKI



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 SHIMODA-F	ON GROUND	F-1241	5 10 7	37

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

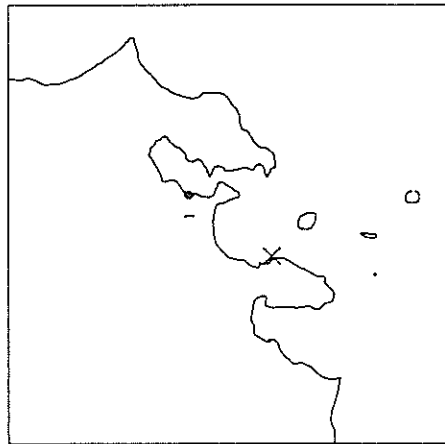
21:35 MAR. 7, 1997
 E OFF IZU PENINSULA
 EPICENTER : 34 57.7'N 139 10.1' E
 DEPTH : 2.5KM MAGNITUDE : 4.3
 JVA INTENSITIES
 III : OSHIMA
 II : TATEYAMA, YOKOHAMA,
 MISHIMA
 I : TOKYO, NIJIMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 YAWASHITA-FR	ON STRUC.	F-1149	9 9 2	70
1 YAWASHITA-F	ON GROUND	F-1148	7 5 3	70
1 YAWASHITA-FB	IN GROUND	F-1147	2 1 1	70

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

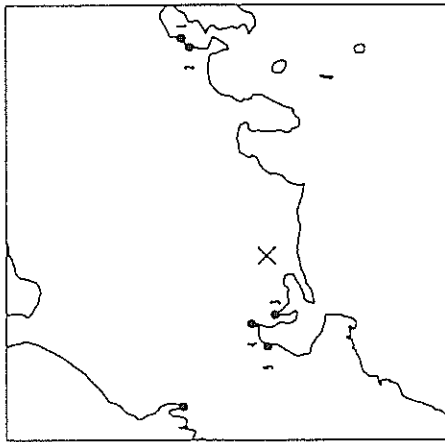
23:53 MAR. 8 .1997 JVA INTENSITIES
 E OFF IZU PENINSULA
 EPICENTER : 34 57.6 N 139 9.9 'E
 DEPTH : 2.7KM MAGNITUDE : 4.0
 II : OSHIMA
 I : TATEYAMA, TOKYO, YOKOHAMA,
 WISHIMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-1152	8 5 1	70
1 YAMASHITA-F	ON GROUND	F-1151	8 2 2	70
1 YAMASHITA-FB	IN GROUND	F-1150	2 1 1	70

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

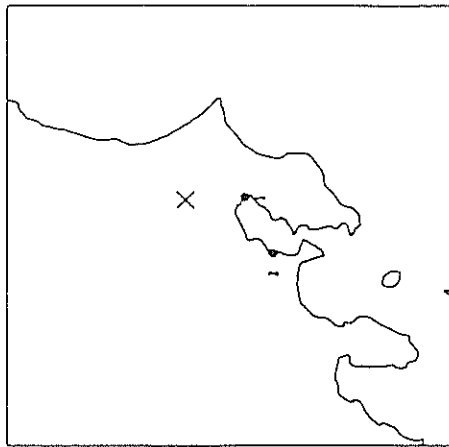
14:51 MAR. 16.1997 JVA INTENSITIES
 NE AICHI PREF
 EPICENTER : 34 55.5 N 137 31.7 E
 DEPTH : 39.1KM MAGNITUDE : 5.8
 IV : NAGOYA
 III : YOKOHAMA, FUKUI, TSURUGA,
 KOFU, SUWA, IIDA, GIFU,
 MISHIMA, SHIZUOKA,
 HAKAMATSU, YOKKAICHI,
 TOYOOKA, NARA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWASAKI-FR	ON STRUC.	F-1173	1 1 1	212
1 KAWASAKI-F	ON GROUND	F-1172	6 5 2	212
1 KAWASAKI-FB	IN GROUND	F-1171		212
2 YAMASHITA-FR	ON STRUC.	F-1155	16 11 2	202
2 YAMASHITA-F	ON GROUND	F-1154	8 10 2	202
2 YAMASHITA-FB	IN GROUND	F-1153	2 4 1	202
3 KINUURA-JI-S	ON GROUND	S-2672	76 138 31	53
3 MIKAWA-GB	IN GROUND	F-1118	17 15 10	53
3 MIKAWA-G	ON GROUND	F-1119	177 148 101	53
4 NAGOYA-INA-E-G	ON STRUC.	F-1122	49 98 52	62
4 NAGOYA-SORAMI-G	ON GROUND	F-1121	89 101 32	63
4 NAGOYA-SORAMI-GB	IN GROUND	F-1120	42 28 14	63
5 YOKKA.-CHITOSE-S	ON GROUND	S-2671	52 29 13	80
5 YOKKA.-SEKITAN-M	ON STRUC.	M-1582	102 88 81	81
6 TSURUGA-O	ON GROUND	P-1117	18 25 5	155

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

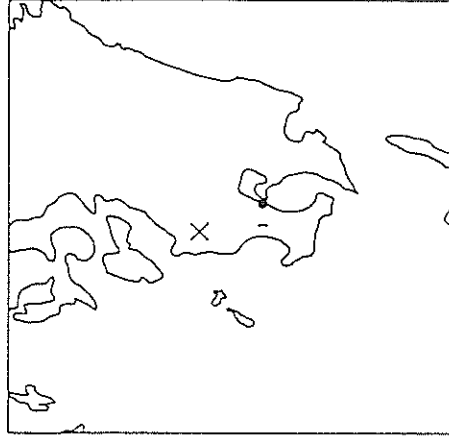
14:58 MAR. 23, 1997
 SOUTHERN IBARAKI PREF
 EPICENTER : 35 57.9'N 140 6.6'E
 DEPTH : 71.5KM MAGNITUDE : 5.0



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 CHIBA-S	ON GROUND	S-2673	6 9 6	6 9 6	40
2 YAMASHITA-FR	ON STRUC.	F-1158	35 17 4	35 17 4	70
2 YAMASHITA-F	ON GROUND	F-1157	11 13 5	11 13 5	70
2 YAMASHITA-FB	IN GROUND	F-1156	3 3 2	3 3 2	70

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

17:31 MAR. 26, 1997
 NW KAGOSHIMA PREF
 EPICENTER : 31 58.2'N 130 21.7'E
 DEPTH : 11.9KM MAGNITUDE : 6.5



JMA INTENSITIES
 V : KAGOSHIMA, AKURE
 IV : KUMAKOTO, HITOYOSHI,
 USHIBUKA, MIYAKOROJO,
 MAKURAZAKI
 III : FUKUOKA, SAGA, NAGASAKI,
 KUMAMOTO, OITA, MIYAZAKI
 II : KURE, UWAJIMA,
 SHIMONOSEKI, SASEBO,
 HIRADO, NOBERAKA

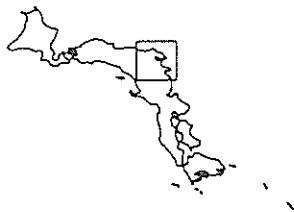
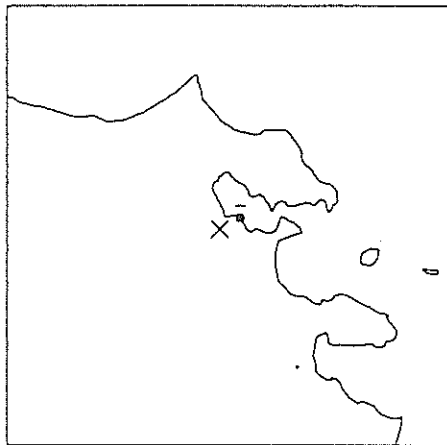
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAGOSHIMA-G	ON GROUND	F-1123	60 50 23	60 50 23	47

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

18:30 MAR. 26.1997
 TOKYO PREF
 EPICENTER : 35 38.1'N 139 41.1'E
 DEPTH : 39.6KM MAGNITUDE : 3.7

JMA INTENSITIES

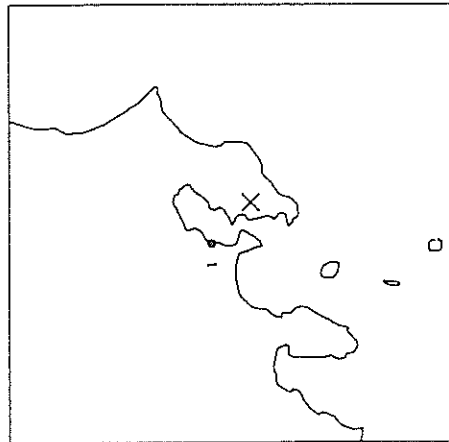
II : TOKYO, YOKOHAMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWASAKI-FR	ON STRUC.	F-1176	5 6 3	15
1 KAWASAKI-F	ON GROUND	F-1175		15
1 KAWASAKI-PB	IN GROUND	F-1174		15

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

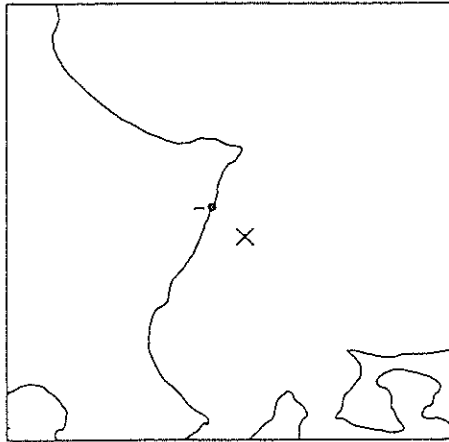
13:43 APR. 10, 1997 JMA INTENSITIES
 SOUTHERN BOSO PENINSULA
 EPICENTER : 35 11.3'N 139 57.0'E
 DEPTH : 78.8KM MAGNITUDE : 3.7
 II : YOKOHAMA
 I : TATEYAMA, TOKYO, OSHIMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-11161	12 5 2	38
1 YAMASHITA-F	ON GROUND	F-11160	7 3 3	38
1 YAMASHITA-FB	IN GROUND	F-11159	2 1	38

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

10:19 APR. 13, 1997 JMA INTENSITIES
 S OFF URAKAWA
 EPICENTER : 41 58.0'N 142 30.0'E
 DEPTH : 62.2KM MAGNITUDE : 4.1
 III : URAKAWA
 I : HIROO



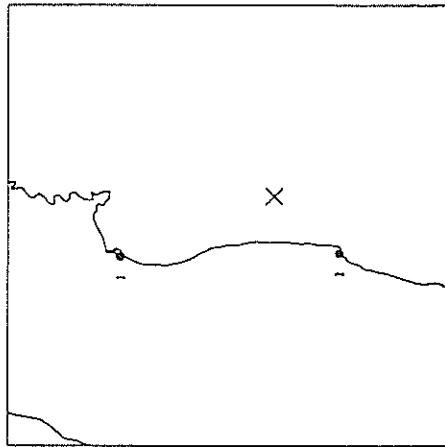
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 URAKAWA-S	ON GROUND	S-2674	4 6 3	30

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

20:07 APR. 28, 1997
 E OFF FUKUSHIMA PREF
 EPICENTER : 37 18.5'N 141 23.6'E
 DEPTH : 53.9KM MAGNITUDE : 4.4

JVA INTENSITIES

II : SENDAI,SHIRAKAWA
 I : FUKUSHIMA,MITO

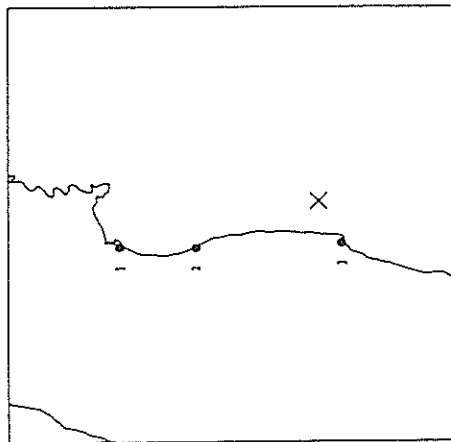


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 SENDAI-WB	IN GROUND	M-1578	2 2 1	113
1 SENDAI-W	ON GROUND	M-1577	5 3 2	113
2 OXAHAWA-JI-G	ON GROUND	F-1178	26 26 12	59
2 OXAHAWA-JI-GB	IN GROUND	F-1177	9 10 5	59

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

07:59 MAY 12.1997
 E OFF FUKUSHIMA PREF
 EPICENTER : 37 3.5 'N 141 15.0 'E
 DEPTH : 54.1KM MAGNITUDE : 5.5

JMA INTENSITIES
 IV : SHIRAKAWA
 III : SENDAI, FUKUSHIMA, MITO
 II : OFUNATO, MORIOKA,
 ISHINOWAKI, SAKATA,
 YAMAGATA, NIKKO,
 UTSUNOMIYA, TOKYO,
 YOKOHAMA
 I : MIYAKO, AKITA, YAMAGATA,
 FUKUSHIMA, CHICHIBU

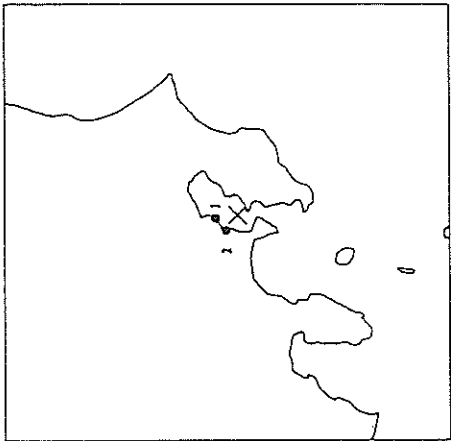


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 SENDAI-M	ON GROUND	M-1601	24 17 7	137
1 SENDAI-MB	IN GROUND	M-1600	7 6 4	137
2 SOMA-S	ON GROUND	S-2675	19 26 14	89
3 ONAHAMA-J1-GB	IN GROUND	F-1179	29 18 10	33
3 ONAHAMA-J1-G	ON GROUND	F-1180	87 86 38	33

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

12:13 MAY 12.1997
 TOKYO BAY REGION
 EPICENTER : 35 22.3 'N 139 46.3 'E
 DEPTH : 61.4KM MAGNITUDE : 3.6

JMA INTENSITIES
 II : TOKYO, YOKOHAMA
 I : TATEYAMA, OSHIMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 KAWASAKI-FR	ON STRUC.	F-1262	16 15 7	14
1 KAWASAKI-F	ON GROUND	F-1261	16 15 7	14
1 KAWASAKI-FB	IN GROUND	F-1260	3 5 6	14
2 YAMASHITA-F	ON GROUND	F-1243	6 6 6	12
2 YAMASHITA-FR	ON STRUC.	F-1244	6 6 6	12
2 YAMASHITA-FB	IN GROUND	F-1242	1 1 1	12

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

14:38 MAY 13, 1997

NW KAGOSHIMA PREF

EPICENTER : 31 56.7' N 130 18.3' E

DEPTH : 9.2KM MAGNITUDE : 6.3

JMA INTENSITIES

VI : KAGOSHIMA

V : AKUNE

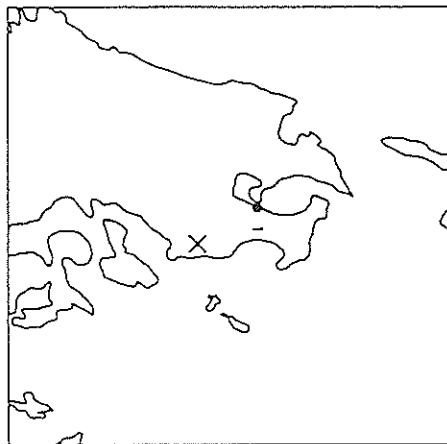
IV : HIROYOSHI, MIYAKONOJO,
MAKURAZAKI

III : FUKUOKA, KUMAMOTO,

USHIBUKA, OITA, MIYAZAKI

II : UWAJIMA, SAGA, SASEBO,

HIRADO, NAGASAKI



STATION	CONDITION	MAX. ACC. (GAL)	DIST. (KM)
1 KAGOSHIMA-G	ON GROUND	45 50 27	47

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

02:50 MAY 24, 1997

ENSYUNADA

EPICENTER : 34 29.9' N 137 30.2' E

DEPTH : 23.1KM MAGNITUDE : 5.9

JMA INTENSITIES

II : FUKUI, TSURUGA, OVAEZAKI,

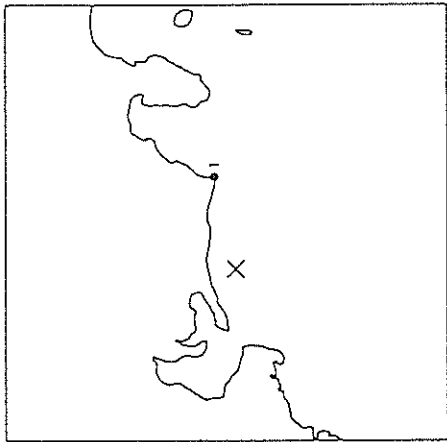
HAWAMATSU, NAGOYA,

YOKKAICHI, TSU, SAKAI,

KARA, WAKAYAMA, TOKUSHIMA

I : FUKUI, SUWA, IIDA, GIFU,

SHIZUOKA, MAIZURU, KYOTO

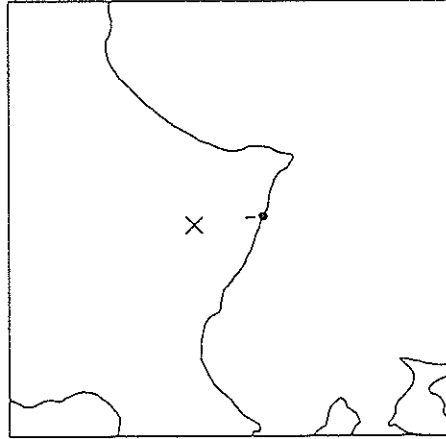
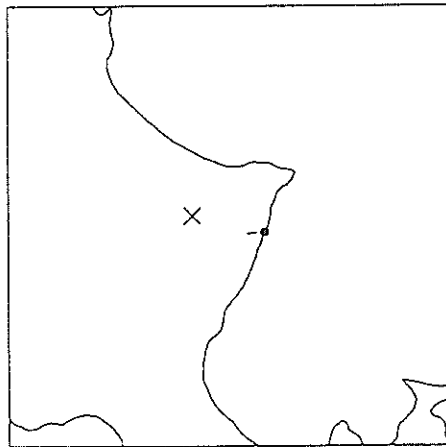


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
1 OVAEZAKI-M	ON GROUND	M-1576	5 3 2	66

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

08:15 JUNE 5 .1997
 HIDAKA MOUNTAINS REGION
 EPICENTER : 42 35.0'N 142 58.3'E
 DEPTH : 106.5KM MAGNITUDE : 4.2

20:38 JUNE 9 .1997
 HIDAKA MOUNTAINS REGION
 EPICENTER : 42 35.5'N 142 45.7'E
 DEPTH : 113.2KM MAGNITUDE : 4.4



STATION
 1 URAKAWA-S ON GROUND
 RECORD NUMBER S-2676
 MAX. ACC. (GAL) (NS) (EW) (UD) 6 6 6 6
 DIST. (KM) 50

STATION
 1 URAKAWA-S ON GROUND
 RECORD NUMBER S-2677
 MAX. ACC. (GAL) (NS) (EW) (UD) 7 6 6 6
 DIST. (KM) 47

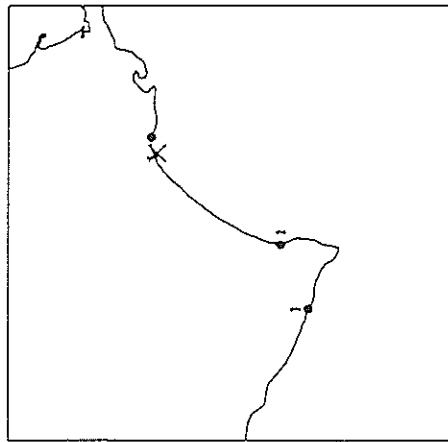
JWA INTENSITIES

II : URAKAWA, OBIHIRO
 I : TOMAKOMAI, HIROO, KUSHIRO,
 HACHIROHE, WUTSU

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

13:54 JUNE 15, 1997
 KUSHIRO REGION
 EPICENTER : 42 58.6'N 144 12.7'E
 DEPTH : 97.6KM MAGNITUDE : 5.1

JMA INTENSITIES
 IV : KUSHIRO
 III : OBIHIRO, HIROO
 II : URAKAWA
 I : ABASHIRI, TOMAKOVAI,
 NUKURO, KOMORI, HACHINOHE,
 MUTSU, OFUNATO, MORIOKA

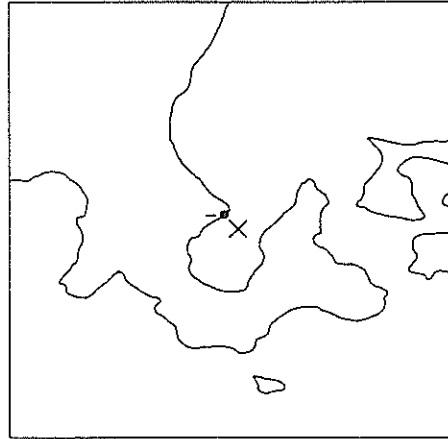


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KUSHIRO-G	ON GROUND	F-1186	54 79 14	12
1 KUSHIRO-GB	IN GROUND	F-1185	11 23 4	12
2 TOKACHI-G	ON GROUND	F-1182	14 33 10	105
3 URAKAWA-S	ON GROUND	S-2678	7 7 6	148

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

09:16 JUNE 17, 1997
 UCHIURA BAY REGION
 EPICENTER : 42 16.1'N 140 49.4'E
 DEPTH : 9.6KM MAGNITUDE : 3.5

JMA INTENSITIES
 I : MURORAN

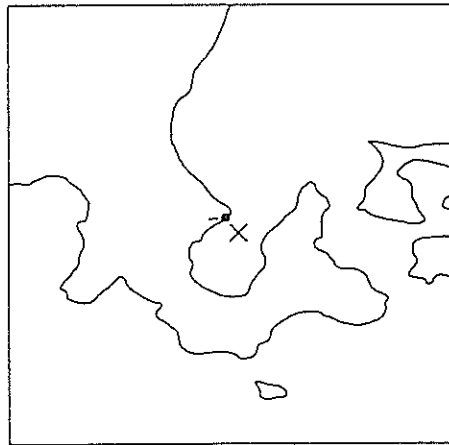


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 MURORAN-G	ON GROUND	F-1266	25 23 8	13

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

09:18 JUNE 17, 1997
 UCHIURA BAY REGION
 EPICENTER : 42 16.3'N 140 49.3'E
 DEPTH : 10.3KM MAGNITUDE : 3.4

JMA INTENSITIES
 II : MURORAN

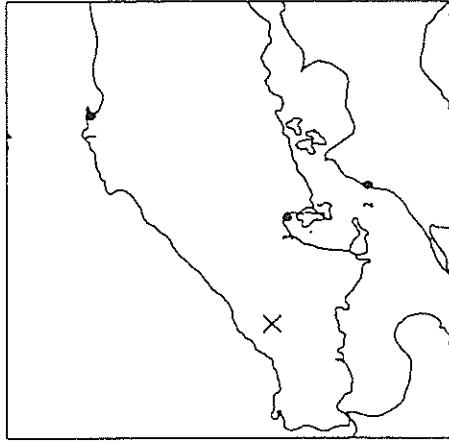


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 MURORAN-G	ON GROUND	F-1267	33 52 13	13

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

18:50 JUNE 25, 1997
 YAMAGUCHI PREF
 EPICENTER : 34 26.3'N 131 40.1'E
 DEPTH : 8.3KM MAGNITUDE : 6.3

JMA INTENSITIES
 IV : MATSUE, YAMAGUCHI,
 SHIMOROSEKI
 III : TOYOOKA, TOTTORI, YONAGO,
 MATSUE, HAWADA, OKAYAMA,
 HIROSHIMA, KURE,
 MATSUYAMA, KOCHI, FUKUOKA,
 SAGA

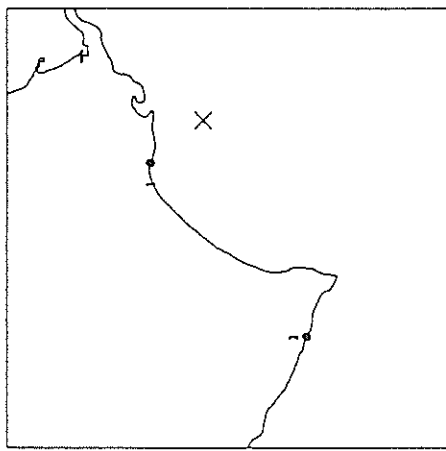


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 SAKAIMINATO-G	ON GROUND	F-1183	29 50 8	189
2 MATSUYAMA-G	ON GROUND	F-1187	28 33 9	116
3 HIROSHIMA-G	ON GROUND	F-1181	22 26 27	74

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

12:40 JULY 1, 1997
 SE OFF TOKACHI
 EPICENTER : 42 38.6'N 144 39.3'E
 DEPTH : 72.5KM MAGNITUDE : 5.1

JWA INTENSITIES
 III : KUSHIRO
 II : URAKAWA, HIROO
 I : TOYAKAWAI, OBIHIRO,
 NEWURO, HACHINOHE, MUTSU,
 OFUNATO, MORIOKA

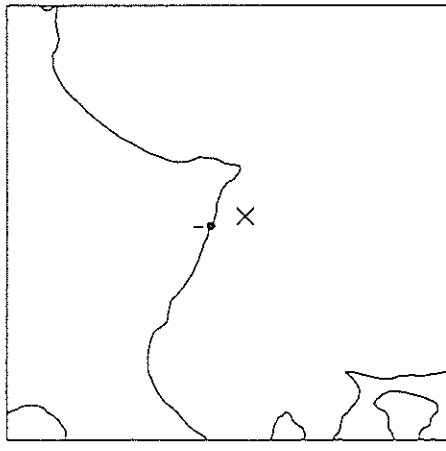


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KUSHIRO-G	ON GROUND	F-1213	24 29 10	46
1 KUSHIRO-GB	IN GROUND	F-1212	12 13 4	46
2 URAKAWA-S	ON GROUND	S-2679	7 7 5	163

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

21:54 JULY 5, 1997
 S OFF URAKAWA
 EPICENTER : 41 56.6'N 142 49.8'E
 DEPTH : 50.9KM MAGNITUDE : 3.8

JWA INTENSITIES
 I : URAKAWA

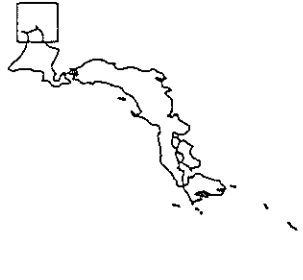
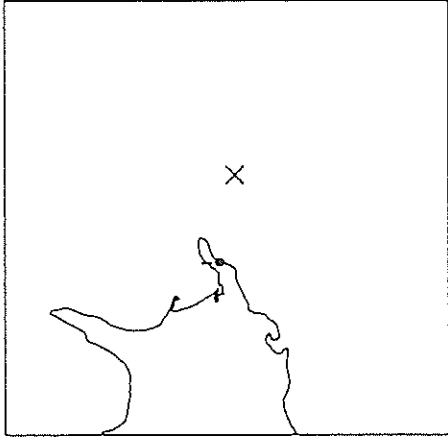
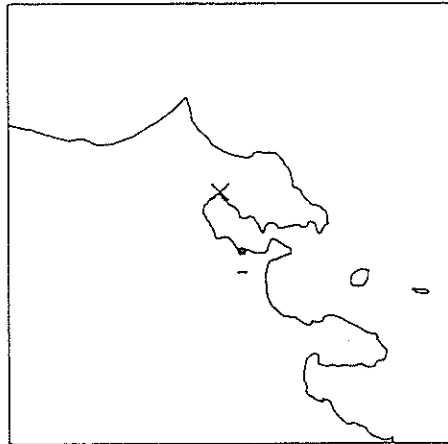


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 URAKAWA-S	ON GROUND	S-2680	7 6 6	24

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

16:36 JULY 9, 1997
 CENTRAL CHIBA PREF
 EPICENTER : 35 33.1'N 140 7.7 'E
 DEPTH : 77.3KM MAGNITUDE : 4.6

01:09 JULY 15, 1997
 OFF NEMURO PENINSULA
 EPICENTER : 43 7.0 'N 146 17.5 'E
 DEPTH : 36.9KM MAGNITUDE : 5.9



STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

JMA INTENSITIES
 II : KUSHIRO, NEMURO
 I : URAKAWA, OBIHIRO, HIROO

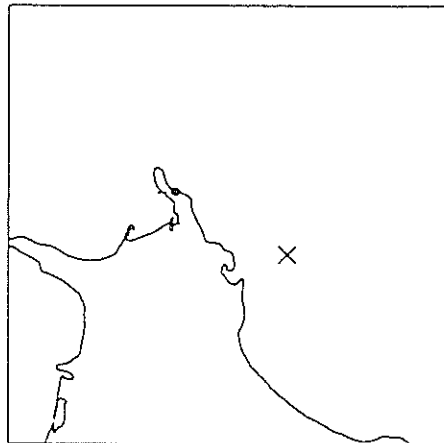
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (MS)	MAX. ACC. (EW) (UD)	MAX. ACC. (GAL)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-1247	19	27	5	43
1 YAMASHITA-F	ON GROUND	F-1246	20	21	6	43
1 YAMASHITA-FB	IN GROUND	F-1245	5	4	3	43

STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (MS)	MAX. ACC. (EW) (UD)	MAX. ACC. (GAL)	DIST. (KM)
1 HAKASAKI-F	ON GROUND	P-1201	11	23	7	59

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

07:04 JULY 23, 1997
 OFF NEMURO PENINSULA
 EPICENTER : 42 38.8'N 144 56.3'E
 DEPTH : 70.3KM MAGNITUDE : 4.3

JVA INTENSITIES
 II : KUSHIRO

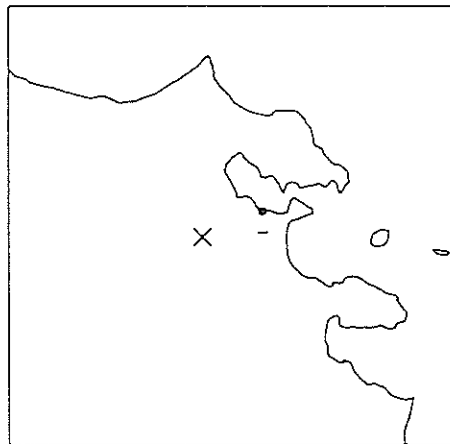


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
			(NS) (EW) (UD)	
1 HANASAKI-F	ON GROUND	F-1202	9 6 4	88

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

05:34 AUG. 9, 1997
 EASTERN SAITAMA PREF
 EPICENTER : 35 49.8'N 139 30.3'E
 DEPTH : 67.4KM MAGNITUDE : 4.7

JMA INTENSITIES
 III : NIKKO, UTSUNOMIYA, TOKYO, YOKOHAMA
 II : SHIRAKAWA, MITO, KUNAGAYA, CHICHIBU, CHIBA, KARUIZAWA

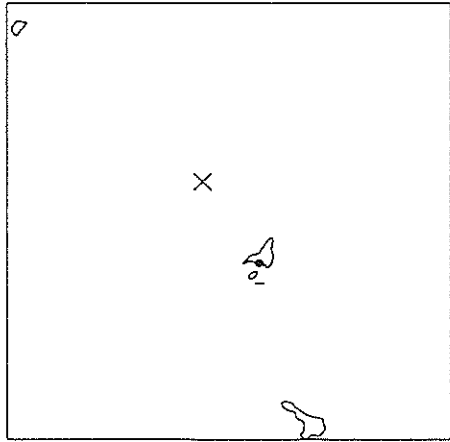


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-1250	13 32 7	45
1 YAMASHITA-F	ON GROUND	F-1249	11 18 7	45
1 YAMASHITA-FB	IN GROUND	F-1248	4 4 2	45

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

13:45 AUG. 13, 1997
 NEAR MIYAKOJIMA ISLAND
 EPICENTER : 25 11.2'N 125 49.0'E
 DEPTH : 94.4KM MAGNITUDE : 6.2

JMA INTENSITIES
 II : ISHIGAKIJIMA
 I : Naha



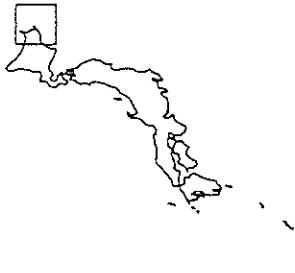
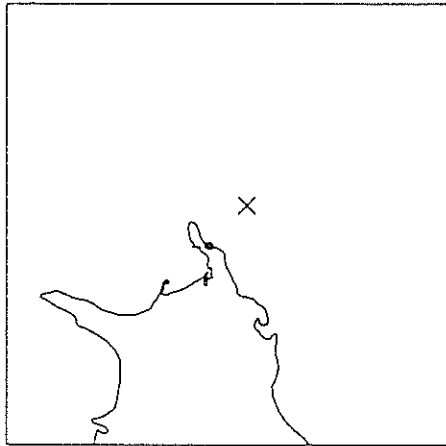
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 HIRARA-G	ON GROUND	F-1224	53 47 24	68

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

15:12 AUG. 15.1997
 OFF NEMURO PENINSULA
 EPICENTER : 43 1.0 'N 145 53.2 'E
 DEPTH : 70.0KM MAGNITUDE : 4.6

JMA INTENSITIES

I : KUSHIRO,NEMURO



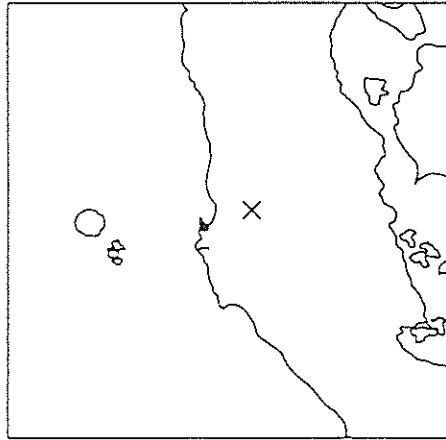
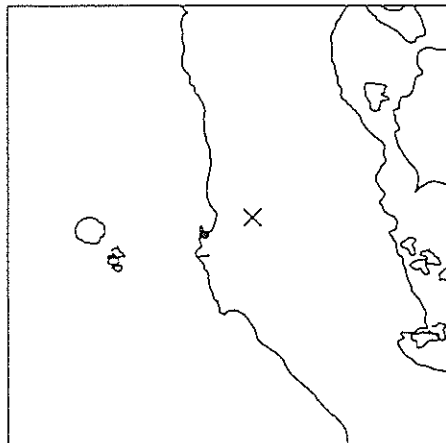
STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL)	DIST.(KM)
			(NS) (EW) (UD)	
1 HANASAKI-F	ON GROUND	F-1203	11 16 6	37

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

02:07 SEP. 2 .1997
 WESTERN TOTTORI PREF
 EPICENTER : 35 15.0'N 133 22.9'E
 DEPTH : 13.0KM MAGNITUDE : 4.1

05:12 SEP. 4 .1997
 WESTERN TOTTORI PREF
 EPICENTER : 35 15.2'N 133 22.8'E
 DEPTH : 12.3KM MAGNITUDE : 4.4

JMA INTENSITIES
 II : OKAYAMA, WATSUE, YONAGO
 I : KOCHI, TOTTORI, TSUYAMA,
 WATSUYAMA, OKAYAMA,
 HIROSHIMA, KURE, TOYOOKA,
 FUKUYAMA, TOKUSHIMA



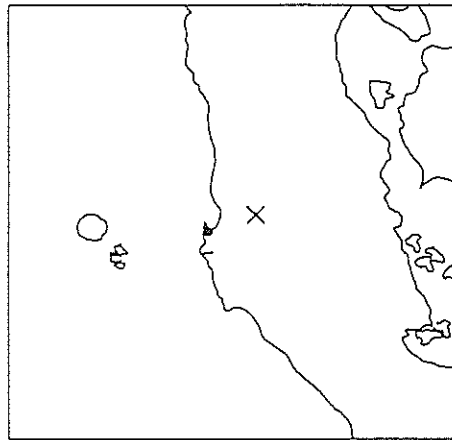
STATION CONDITION RECORD MAX. ACC. (OAL) DIST.
 NUMBER (NS) (EW) (UD) (KM)
 1 SAKAININATO-G ON GROUND F-1206 6 12 3 34

STATION CONDITION RECORD MAX. ACC. (OAL) DIST.
 NUMBER (NS) (EW) (UD) (KM)
 1 SAKAININATO-G ON GROUND F-1207 5 13 4 34

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

05:15 SEP. 4 .1997
 WESTERN TOTTORI PREF
 EPICENTER : 35 15.5'N 133 22.8'E
 DEPTH : 8.9KM MAGNITUDE : 5.1

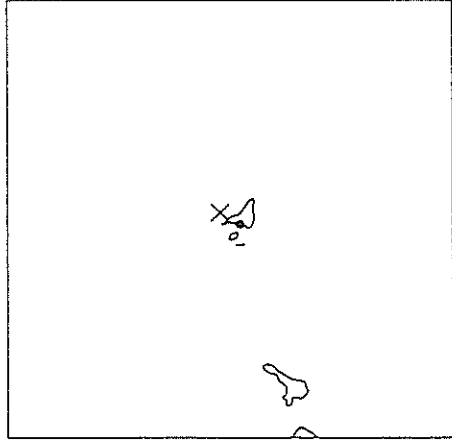
JVA INTENSITIES
 III : YONAGO
 II : TOYOOKA, TOTTORI, MATSUE,
 OKAYAMA, HIROSHIMA,
 FUKUYAMA, KURE, TAKAMATSU
 I : KYOTO, KOBE, TOTTORI



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS)	MAX. ACC. (GAL) (EW)	MAX. ACC. (GAL) (UD)	DIST. (KM)
1 SAKAINIMATO-G	ON GROUND	F-1208	22	34	16	33

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

20:17 SEP. 7 .1997
 NEAR MIYAKOJIMA ISLAND
 EPICENTER : 24 55.6'N 125 21.0'E
 DEPTH : 64.0KM MAGNITUDE : 4.2

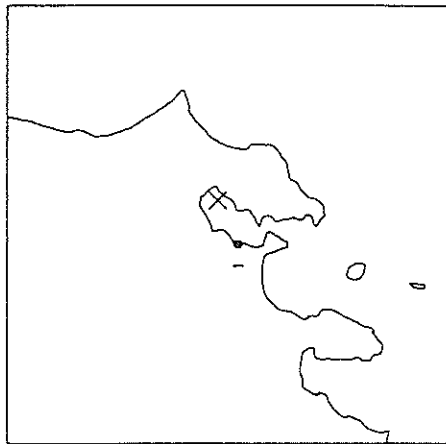


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS)	MAX. ACC. (GAL) (EW)	MAX. ACC. (GAL) (UD)	DIST. (KM)
1 HIRARA-G	ON GROUND	F-1225	20	19	10	15

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

08:40 SEP. 8 .1997
 CENTRAL CHIBA PREF
 EPICENTER : 35 33.3'N 140 0.3 'E
 DEPTH : 108.6KM MAGNITUDE : 5.2

JMA INTENSITIES
 III : TATEYAMA, TOKYO, YOKOHAMA
 II : SHIRAKAWA, MITO, NIKKO,
 UTSUNOMIYA, CHIBA, OSHIMA,
 KOFU, SUWA, MISHIMA
 I : SENDAI, FUKUSHIMA,
 MAEBASHI

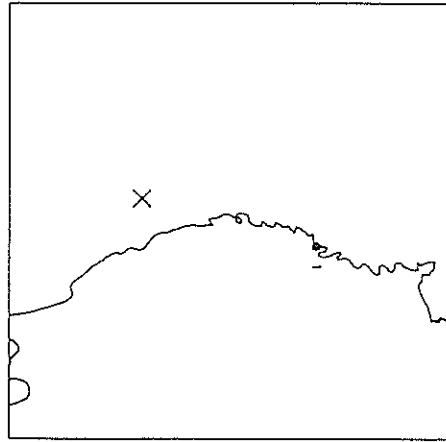


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 YAMASHITA-FR	ON STRUC.	F-1253	38 30 6	32
1 YAMASHITA-F	ON GROUND	F-1252	15 19 9	32
1 YAMASHITA-FB	IN GROUND	F-1251	6 5 2	32

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

11:30 SEP. 23.1997
 NE OFF IWATE PREF
 EPICENTER : 40 2.4 'N 142 14.7'E
 DEPTH : 48.3KM MAGNITUDE : 4.2

JMA INTENSITIES
 II : HACHINOHE, MORIOKA
 I : AOMORI, MIYAKO, OPUKATO



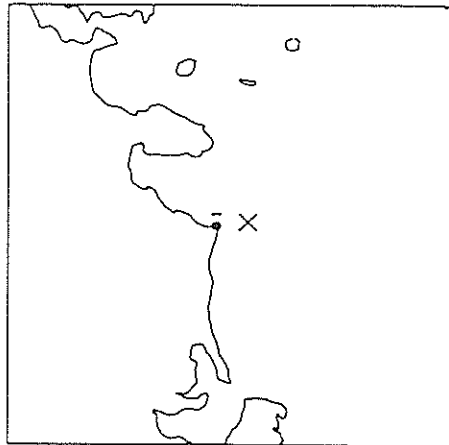
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 OFUNATO-B0-S	ON STRUC.	S-2683	18 61 11	121

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

23:12 SEP. 26.1997
 ENSYUNADA
 EPICENTER : 34 24.7'N 138 14.2'E
 DEPTH : 34.9KM MAGNITUDE : 3.8

JVA INTENSITIES

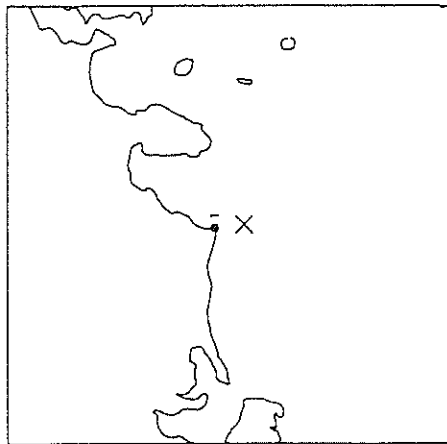
I : SHIZUOKA, OMAEZAKI,
 HAWAATSU



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
			(NS) (EW) (UD)	
1 OMAEZAKI-W	ON GROUND	M-1569	3 4 2	21

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

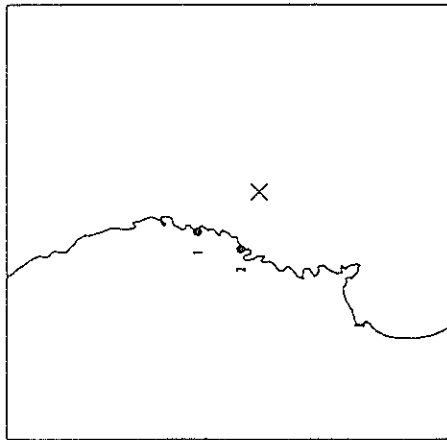
14:44 OCT. 11.1997
 EMSYUNADA
 JMA INTENSITIES
 III : SHIZUOKA, OMAEZAKI,
 HANAYATSU
 II : OSHIMA
 I : TOKYO, YOKOHAMA, KOFU,
 SUWA, KARUIZAWA, IIDA,
 MISHIMA, HAGOYA,
 YOKKAICHI



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 OMAEZAKI-M	ON GROUND	M-1571	24 23 13	20

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

18:45 OCT. 11.1997
 E OFF MIYAGI PREF
 JMA INTENSITIES
 III : OFURATO
 II : HACHINOHE, MIYAO,
 MORIOKA
 I : AOMORI, SENDAI, AKITA,
 SAKATA, YAMAGATA,
 FUKUSHIMA, MITO



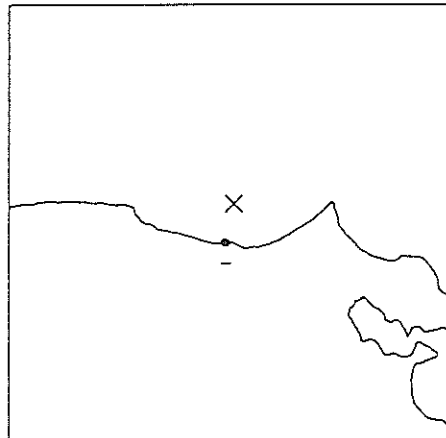
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWAISHI-MB	IN GROUND	M-1581	5 6 4	50
1 KAWAISHI-M	ON GROUND	M-1580	11 11 14	50
2 OFUNATO-MOUND-M	ON STRUC.	M-1579	22 19 18	41

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

23:12 OCT. 20, 1997
 E OFF IBARAKI PREF
 EPICENTER : 36 18.8°N 140 55.0°E
 DEPTH : 42.6KM MAGNITUDE : 4.1

JMA INTENSITIES

II : MITO
 I : FUKUSHIMA, SHIRAKAWA,
 NIKKO, TOKYO



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1230	24 15 29	28

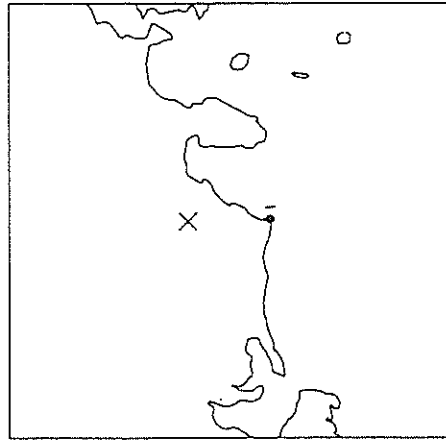
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
1 OMAEZAKI-M	ON GROUND	M-1570	16 7 5	55

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

19:55 OCT. 21, 1997
 CENTRAL SHIZUOKA PREF
 EPICENTER : 35 6.6°N 138 13.9°E
 DEPTH : 33.1KM MAGNITUDE : 4.3

JMA INTENSITIES

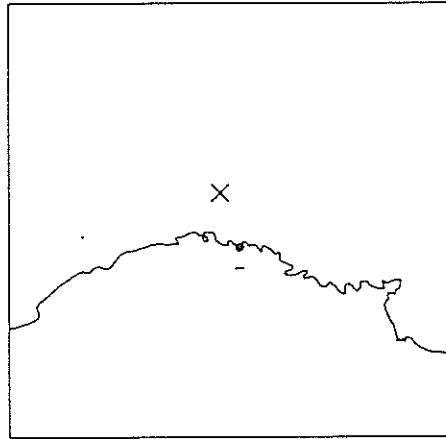
II : IIDA, SHIZUOKA, OMAEZAKI
 I : YOKOHAMA, KAWAGUCHI, KOFU, MISHIMA, HAYAMATSU, NAGOYA, YOKKAICHI



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	DIST. (KM)
1 OMAEZAKI-M	ON GROUND	M-1570	16 7 5	55

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

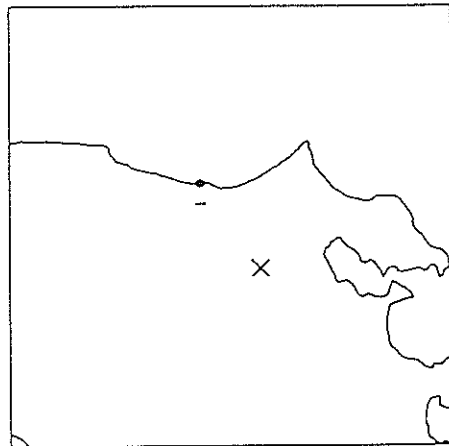
04:38 NOV. 5 .1997 JWA INTENSITIES
 E OFF IWATE PREF I : OFUNATO,NORIOKA,WIYAKO
 EPICENTER : 39 21.0'N 142 20.9'E
 DEPTH : 51.5KM MAGNITUDE : 4.4



STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL)	MAX.ACC.(EW) (UD)	DIST.(KM)
1 KAWAISHI-M	ON GROUND	M-1593	4	5	4
1 KAWAISHI-MB	IN GROUND	M-1592	2	2	2

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

07:13 NOV. 2 .1997 JWA INTENSITIES
 SW IBARAKI PREF II : MITO,NIKKO,UTSUNOMIYA,
 KAWAGAYA,TOKYO,YOKOHAMA
 EPICENTER : 36 3.6 'N 139 55.4'E
 DEPTH : 51.3KM MAGNITUDE : 4.3
 I : CHICHIBU,CHIBA



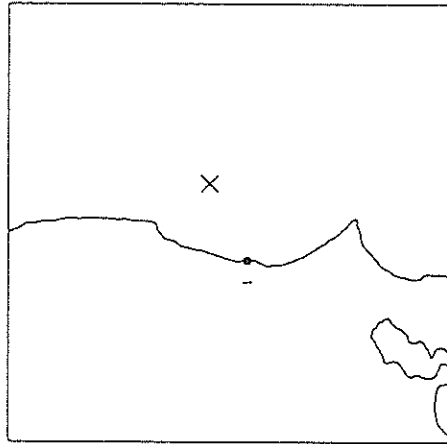
STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL)	MAX.ACC.(EW) (UD)	DIST.(KM)
1 HITACHINAKA-F	ON GROUND	F-1231	22	23	7
					72

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

10:44 NOV. 5 .1997
 E OFF IBARAKI PREF
 EPICENTER : 36 34.8'N 141 13.3'E
 DEPTH : 45.4KM MAGNITUDE : 4.5

JWA INTENSITIES

II : FUKUSHIMA,SHIRAKAWA
 I : MITO,NIKKO,SENDAI



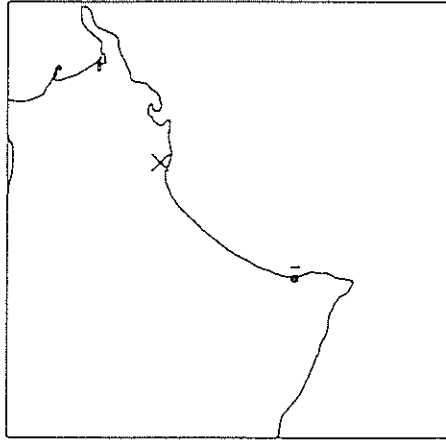
STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL) (NS) (EW) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1232	15 16 6	58

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

05:04 NOV. 6 .1997
 KUSHIRO REGION
 EPICENTER : 43 1.6 'N 144 25.8'E
 DEPTH : 112.5KM MAGNITUDE : 4.9

JWA INTENSITIES

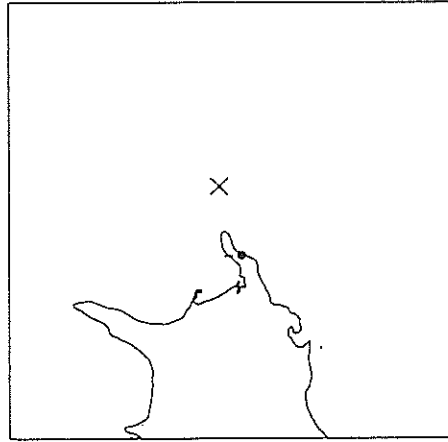
III : OBIHIRO,KUSHIRO
 II : URAKAWA,HIROO



STATION	CONDITION	RECORD NUMBER	MAX.ACC.(GAL) (NS) (EW) (UD)	DIST. (KM)
1 TOKACHI-G	ON GROUND	F-1220	14 16 15	122

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

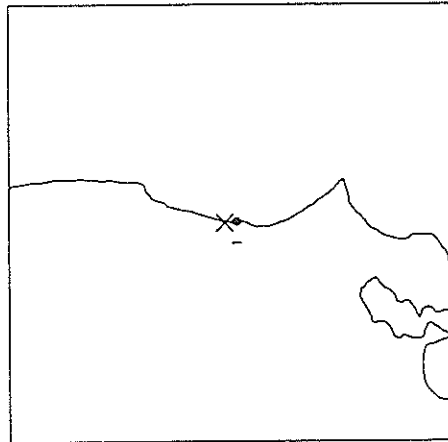
12:21 NOV. 13.1997 JMA INTENSITIES
 OFF NEMURO PENINSULA III : KUSHIRO
 II : NEMURO
 EPICENTER : 43 21.5'N 146 12.5'E
 DEPTH : 60.3KM MAGNITUDE : 4.8



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 HANASAKI-F	ON GROUND	F-1305	12 12 7	50

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

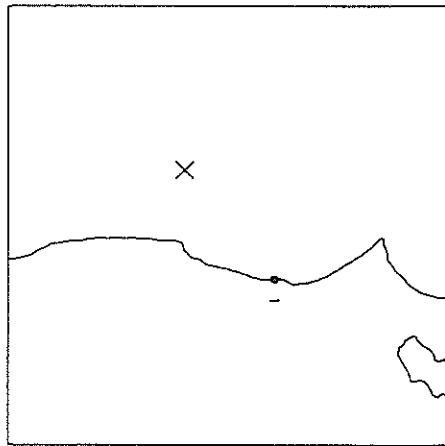
14:16 NOV. 8.1997 JMA INTENSITIES
 NORTHERN IBARAKI PREF II : MITO
 EPICENTER : 36 27.6'N 140 36.9'E
 DEPTH : 57.2KM MAGNITUDE : 3.9



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1233	15 21 10	8

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

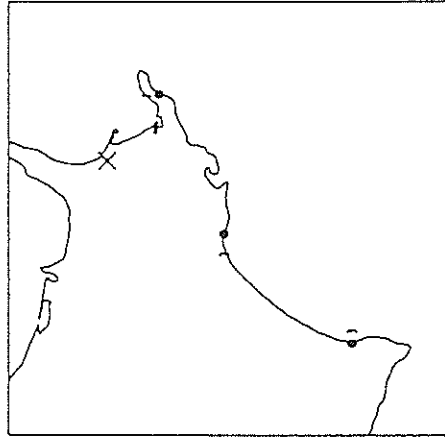
13:42 NOV. 15, 1997 JMA INTENSITIES
 E OFF FUKUSHIMA PREF II : FUKUSHIMA, SHIRAKAWA,
 EPICENTER : 36 52.4' N 141 31.1' E OFUNATO, MITO
 DEPTH : 64.0KM MAGNITUDE : 4.9 I : MORIOKA, ISHINOVAKI,
 SENDAI, NIKKO, YAWAGATA,
 TOKYO, YOKOHAMA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 HITACHINAKA-P	ON GROUND	F-1234	18 23 9	96

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

16:05 NOV. 15, 1997 JMA INTENSITIES
 NEWURO REGION IV : KUSHIRO
 EPICENTER : 43 38.0' N 145 5.3' E II : URAKAWA, OBIHIRO, HIROO,
 DEPTH : 153.1KM MAGNITUDE : 6.1 NEWURO, HACHINOHE, WUTSU,
 MORIOKA
 I : HAKODATE, ASHIKAWA,
 ABASHIRI, TOMAKOMAI,
 AOMORI, OFUNATO

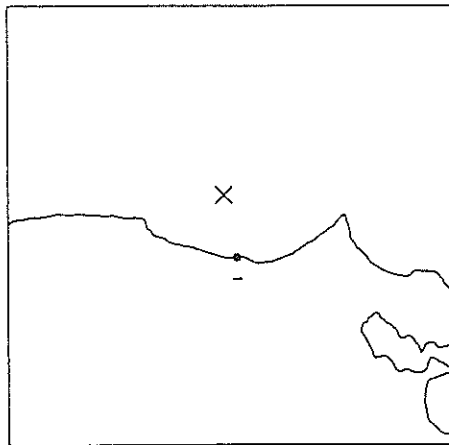


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 HAKASAKI-F	ON GROUND	F-1301	14 20 7	57
2 KUSHIRO-GB	IN GROUND	F-1214	11 17 4	93
2 KUSHIRO-G	ON GROUND	F-1215	28 54 13	93
3 TOYACHI-G	ON GROUND	F-1221	18 21 20	208

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

00:10 NOV. 22.1997
 E OFF IBARAKI PREF
 EPICENTER : 36 26.2'N 141 5.6 'E
 DEPTH : 44.6KM MAGNITUDE : 3.8

JMA INTENSITIES
 I : MITO



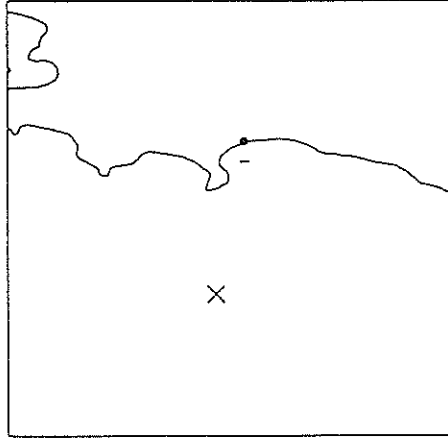
STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS)	MAX. ACC. (GAL) (EW)	MAX. ACC. (GAL) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1235	10	10	5	42

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

12:50 NOV. 23.1997
 W OFF AKITA PREF
 EPICENTER : 39 58.5'N 138 50.8 'E
 DEPTH : 40.8KM MAGNITUDE : 5.6

JMA INTENSITIES

IV : AKITA
 III : SAKATA
 II : MORIOKA, WUTSU, YAMAGATA
 I : HACHINOHE, SHINJO, SENDAI, NIIGATA

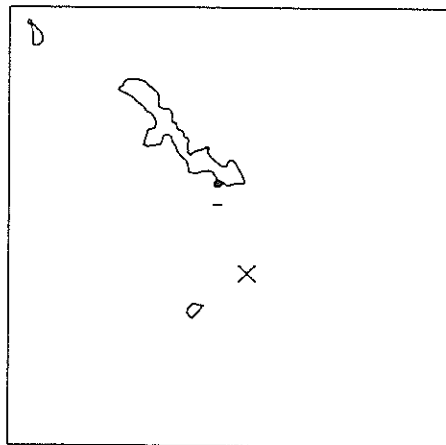


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS)	MAX. ACC. (GAL) (EW)	MAX. ACC. (GAL) (UD)	DIST. (KM)
1 AKITA-G	ON GROUND	F-1227	47	137	15	107
1 AKITA-GB	IN GROUND	F-1226	18	38	13	107

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

03:23 NOV. 26.1997
 NEAR OXIRAWAJIWA ISLAND
 EPICENTER : 26 2.3 'N 127 4.2 'E
 DEPTH : 17.0KM MAGNITUDE : 3.8

JWA INTENSITIES
 II : NAHA

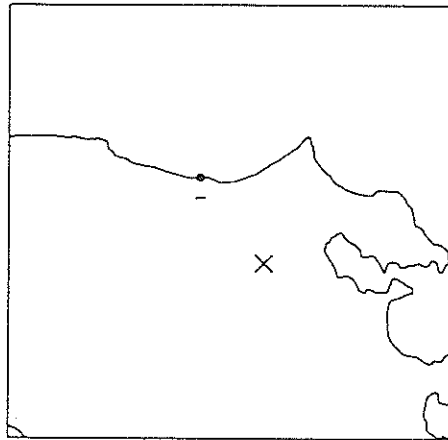


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 NAHA-G	ON GROUND	F-1223	16 10 3	64
1 NAHA-GB	IN GROUND	F-1222	9 3 1	64

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

09:39 NOV. 29.1997
 SW IBARAKI PREF
 EPICENTER : 36 2.4 'N 139 54.9 'E
 DEPTH : 49.9KM MAGNITUDE : 4.3

JWA INTENSITIES
 II : MITO,HIKKO,UTSUNOMIYA,
 KUMAGAYA,TOKYO,YOKOHAMA
 I : CHIBA,SHIRAKAWA,KOFU

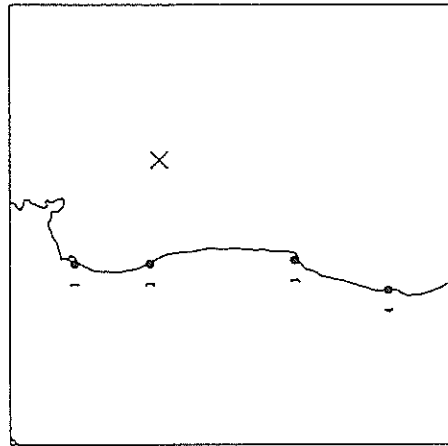


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL) (NS) (EW) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1236	10 8 6	73

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

12:50 DEC. 7, 1997
 E OFF FUKUSHIMA PREF
 EPICENTER : 37 42.9°N 141 46.7°E
 DEPTH : 83.4KM MAGNITUDE : 5.3

JVA INTENSITIES
 III : ISHIHAWAKI, SENDAI,
 MORIOKA, YAMAGATA,
 FUKUSHIMA, SHIRAKAWA
 II : OFUNATO, SAKATA, SHINJO,
 MIKKO, MITO, MAEBASHI
 I : MIYAKO, UTSUNOMIYA

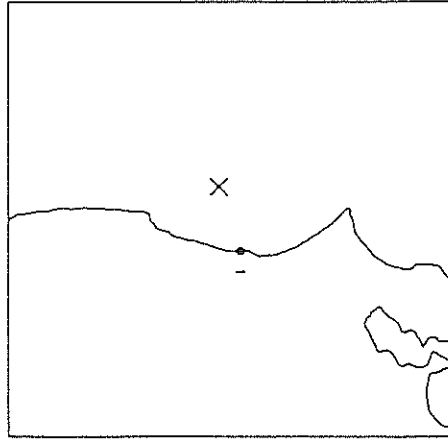


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 SENDAI-WB	IN GROUND	M-1573	17 17 9	91
1 SENDAI-N	ON GROUND	M-1572	46 40 16	91
2 SOMA-S	ON GROUND	S-2682	31 26 14	72
3 ORAHAMA-JI-G	ON GROUND	F-1211	19 28 11	115
3 ORAHAMA-JI-GB	IN GROUND	F-1210	9 6 4	115
4 HITACHINAKA-F	ON GROUND	F-1237	17 24 9	180

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

04:21 DEC. 10, 1997
 E OFF IBARAKI PREF
 EPICENTER : 36 29.1°N 141 6.8°E
 DEPTH : 41.3KM MAGNITUDE : 4.0

JVA INTENSITIES
 I : MITO

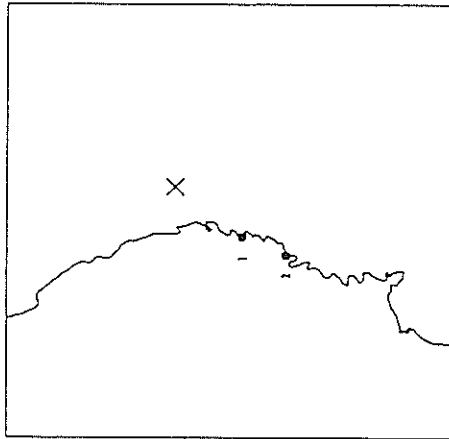


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (NS) (EW) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1238	16 16 8	45

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

15:45 DEC. 13, 1997
 E OFF IWATE PREF
 EPICENTER : 39 38.2'N 142 21.3'E
 DEPTH : 77.6KM MAGNITUDE : 4.6

JMA INTENSITIES
 III : OFUJATO
 II : WIYAKO, MORIOKA
 I : ISHINOVAKI, HACHINONE,
 AOMORI, MUTSU, KUSHIRO

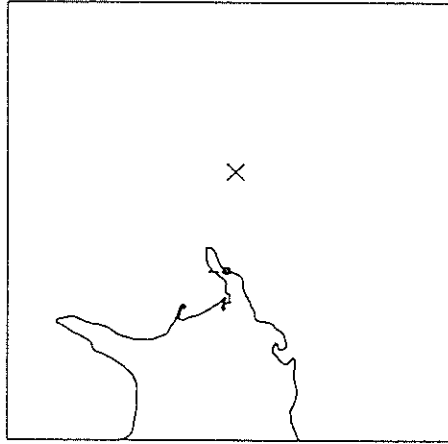


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 KAWAISHI-W	ON GROUND	M-1596	7 9 6	56
1 KAWAISHI-WB	IN GROUND	M-1595	4 3 3	56
2 OFUNATO-WOUND-W	ON STRUC.	M-1594	21 12	87

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

06:03 DEC. 22, 1997
 OFF NEHURO PENINSULA
 EPICENTER : 43 8.4'N 146 25.1'E
 DEPTH : 52.1KM MAGNITUDE : 5.0

JMA INTENSITIES
 II : NEHURO
 I : KUSHIRO

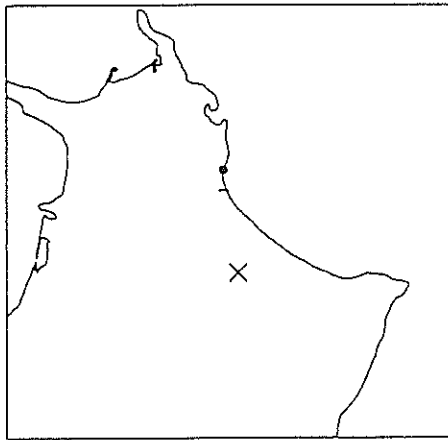


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (OAL) (NS) (EW) (UD)	DIST. (KM)
1 HANASAKI-F	ON GROUND	P-1299	21 19 6	68

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

04:08 DEC. 23, 1997
 TOYACHI REGION
 EPICENTER : 42 58.7'N 143 29.3'E
 DEPTH : 113.3KM MAGNITUDE : 5.1

JMA INTENSITIES
 III : KUSHIRO
 II : URAKAWA, OBIHIRO, HIROO
 I : TOMAKOMAI, AOMORI,
 HACHINOHE, NITSU, MIYAKO,
 OFUNATO, MORIOKA

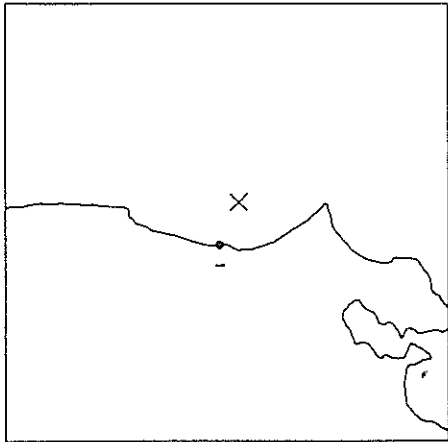


STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	MAX. ACC. (EW) (UD)	DIST. (KM)
1 KUSHIRO-G	ON GROUND	F-1217	21	17	5
1 KUSHIRO-OB	IN GROUND	F-1216	7	6	2

STRONG-MOTION EARTHQUAKE OBSERVATION RESULTS

15:18 DEC. 23, 1997
 E OFF IBARAKI PREF
 EPICENTER : 36 14.7'N 140 56.1'E
 DEPTH : 42.2KM MAGNITUDE : 4.2

JMA INTENSITIES
 II : WITO
 I : SHIRAKAWA



STATION	CONDITION	RECORD NUMBER	MAX. ACC. (GAL)	MAX. ACC. (EW) (UD)	DIST. (KM)
1 HITACHINAKA-F	ON GROUND	F-1279	35	21	7

Results of Preliminary Analyses (1997)

RECORD NUMBER : F-1094

STATION : TOKACHI-G

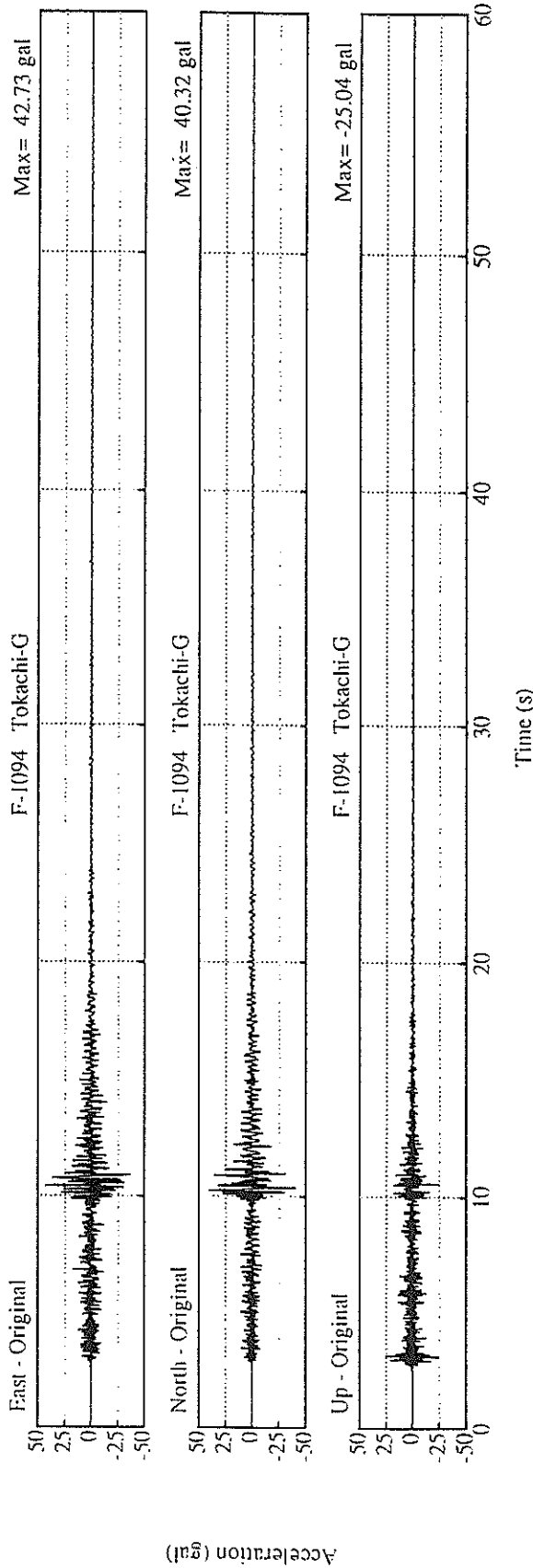
EARTHQUAKE DATA

 DATE AND TIME 18: 2 JAN. 7, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION HIDAKA MOUNTAINS REGION
 LATITUDE 42° 16.2' N
 LONGITUDE 142° 59.2' E
 DEPTH 65.2KM
 JMA MAGNITUDE 4.5

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	40.3	42.7	25.0	50.6

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : S-2668

STATION : URAKAWA-S

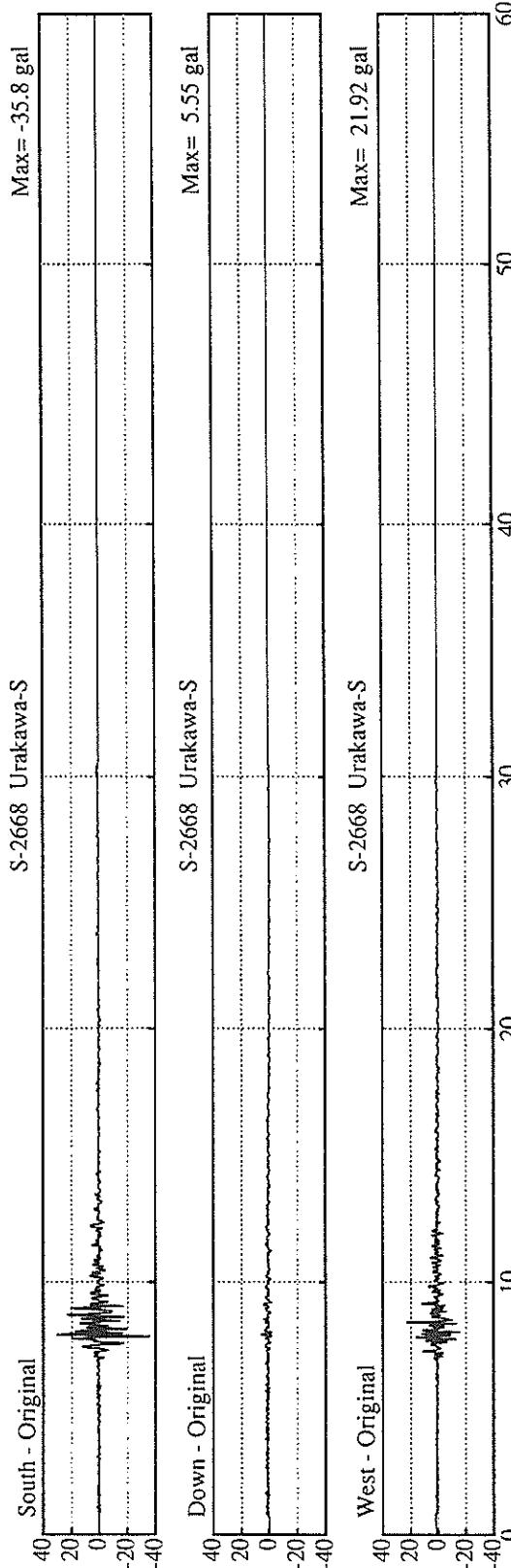
EARTHQUAKE DATA

 DATE AND TIME 18: 2 JAN. 7,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION HIDAKA MOUNTAINS REGION
 LATITUDE 42°16.2' N
 LONGITUDE 142°59.2' E
 DEPTH 65.2KM
 JMA MAGNITUDE 4.5

PEAK VALUES OF COMPONENTS

	N	S	E	W	U	D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	35.8		21.9		5.6		36.5

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1188

STATION : HANASAKI-F

EARTHQUAKE DATA

DATE AND TIME 4:19 JAN.11,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION

OFF NEMURO PENINSULA

LATITUDE

43° 5.6' N

LONGITUDE

145° 54.3' E

DEPTH

82.5KM

JMA MAGNITUDE

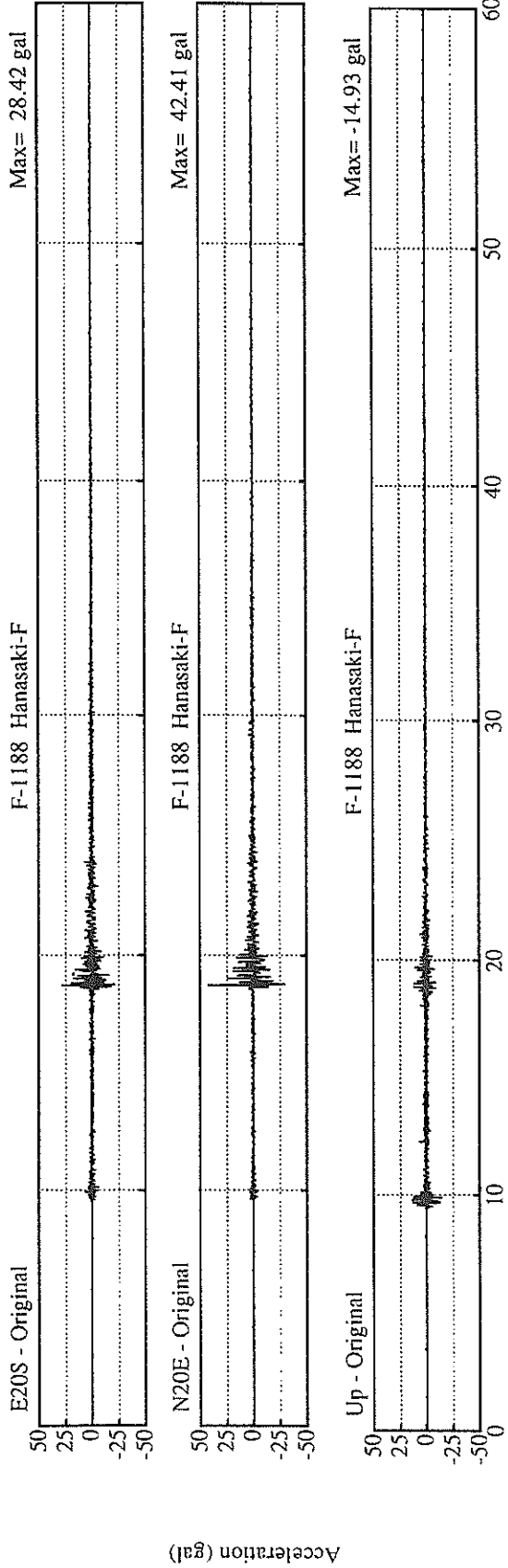
5.2

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
42.4	28.4	14.9	51.0

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1125

STATION : WAKAYAMA-G

EARTHQUAKE DATA

 DATE AND TIME 10:51 JAN.30,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NW WAKAYAMA PREF
 LATITUDE 34°12.9' N
 LONGITUDE 135° 8.5' E
 DEPTH 10.3KM
 JMA MAGNITUDE 3.2

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
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PARAMETER OF THE VARIABLE FILTER

FC (HZ)	4.559	4.846	4.980	
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MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	5.9	6.4	29.4	6.7
ORIGINAL	22.8	23.7	161.3	29.2
CORRECTED	23.7	26.0	165.3	27.9

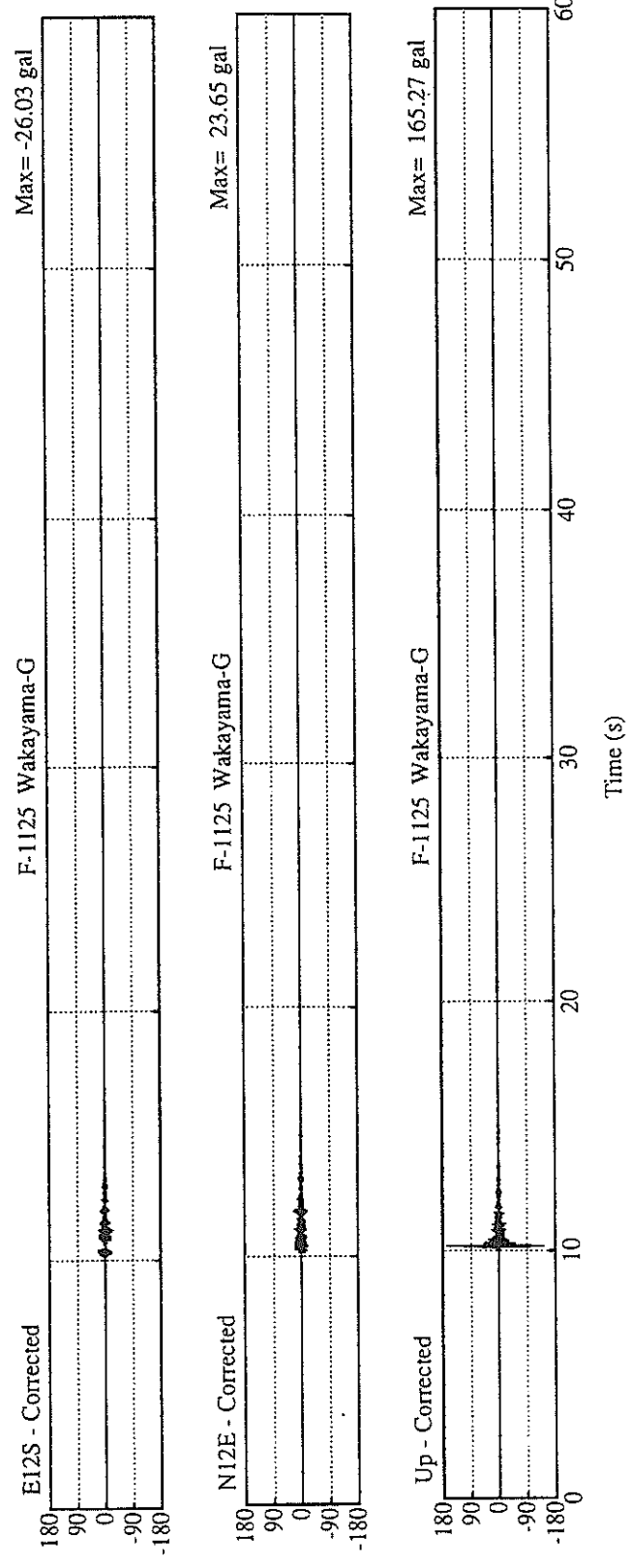
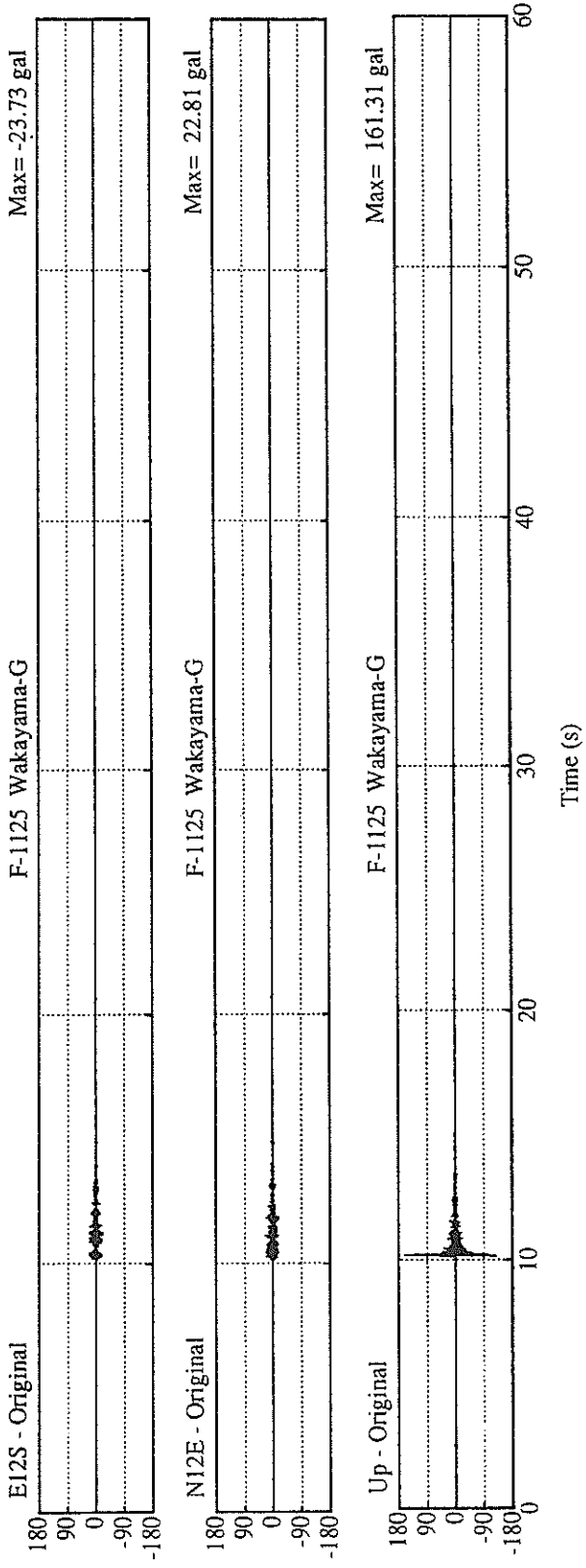
MAXIMUM VELOCITY (CM/SEC)

FIXED FILTER	0.31	0.31	1.56	0.35
VARIABLE FILTER	0.30	0.29	1.52	0.30

MAXIMUM DISPLACEMENT (CM)

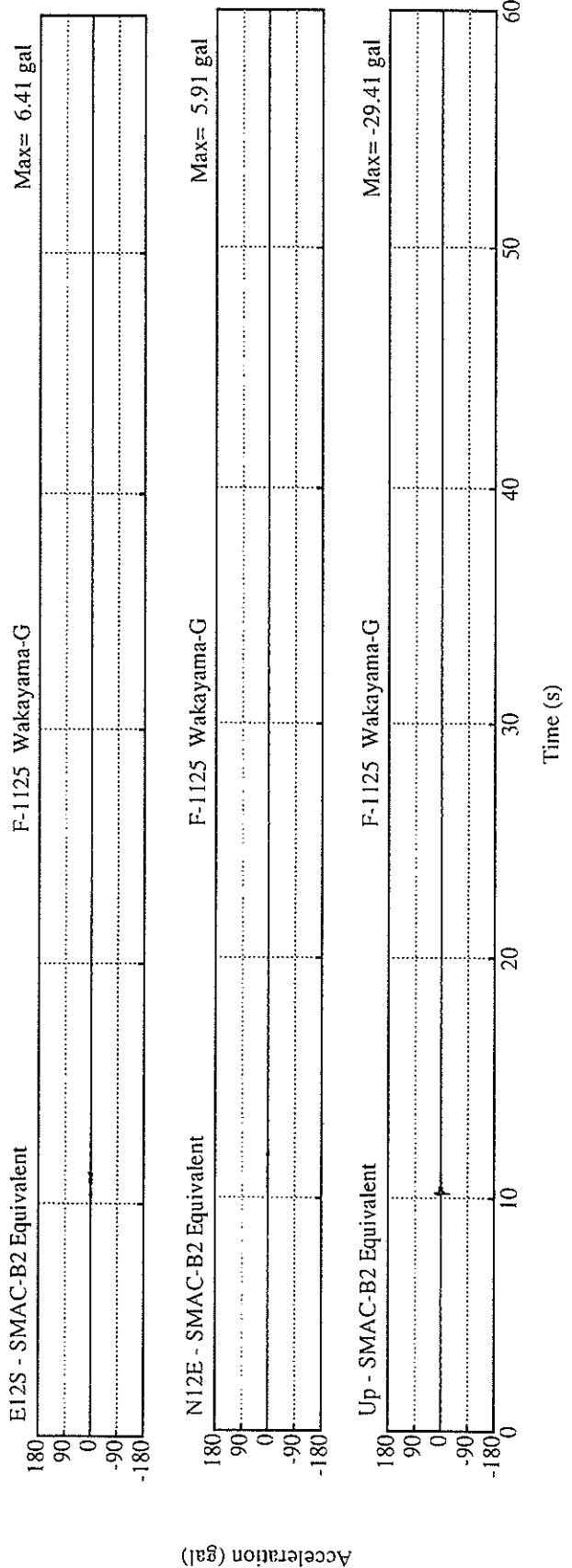
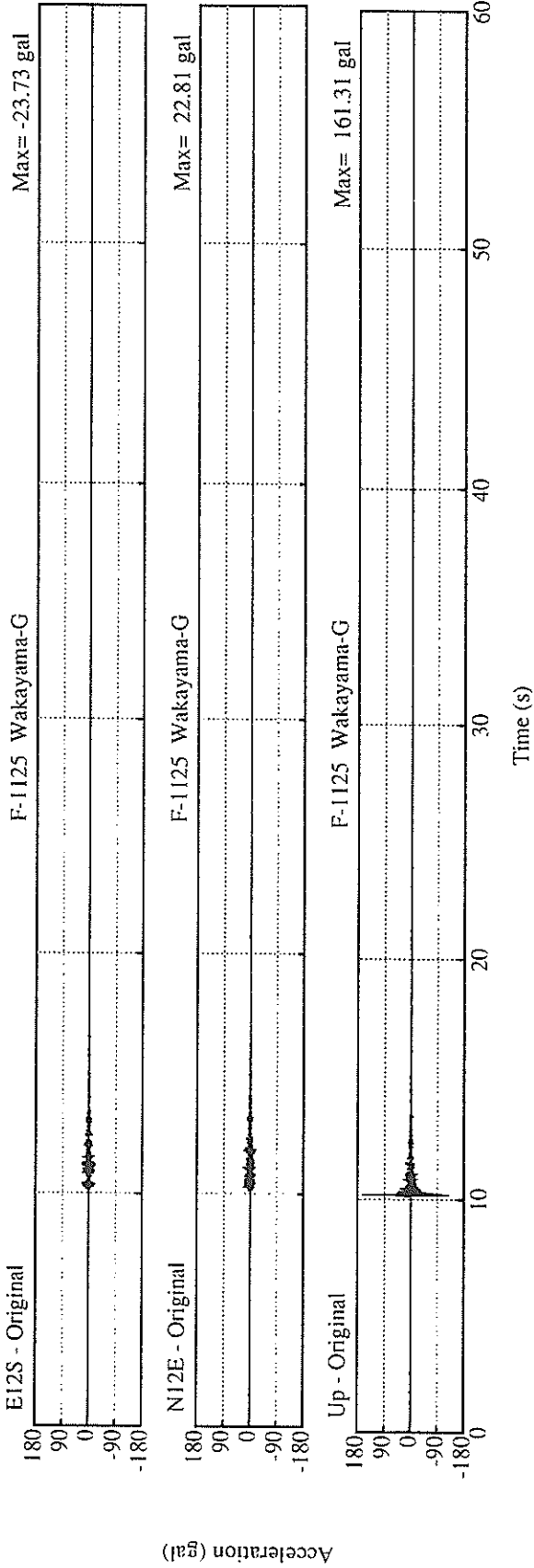
FIXED FILTER	0.02	0.02	0.02	0.02
VARIABLE FILTER	0.00	0.00	0.02	0.00

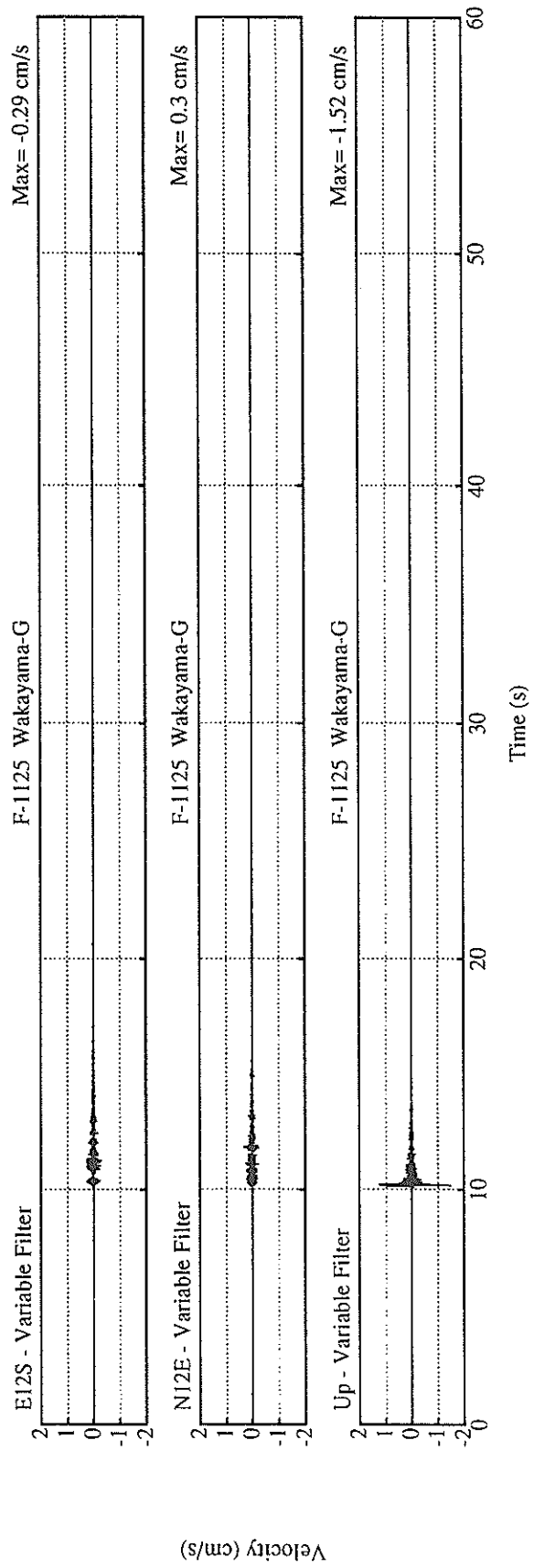
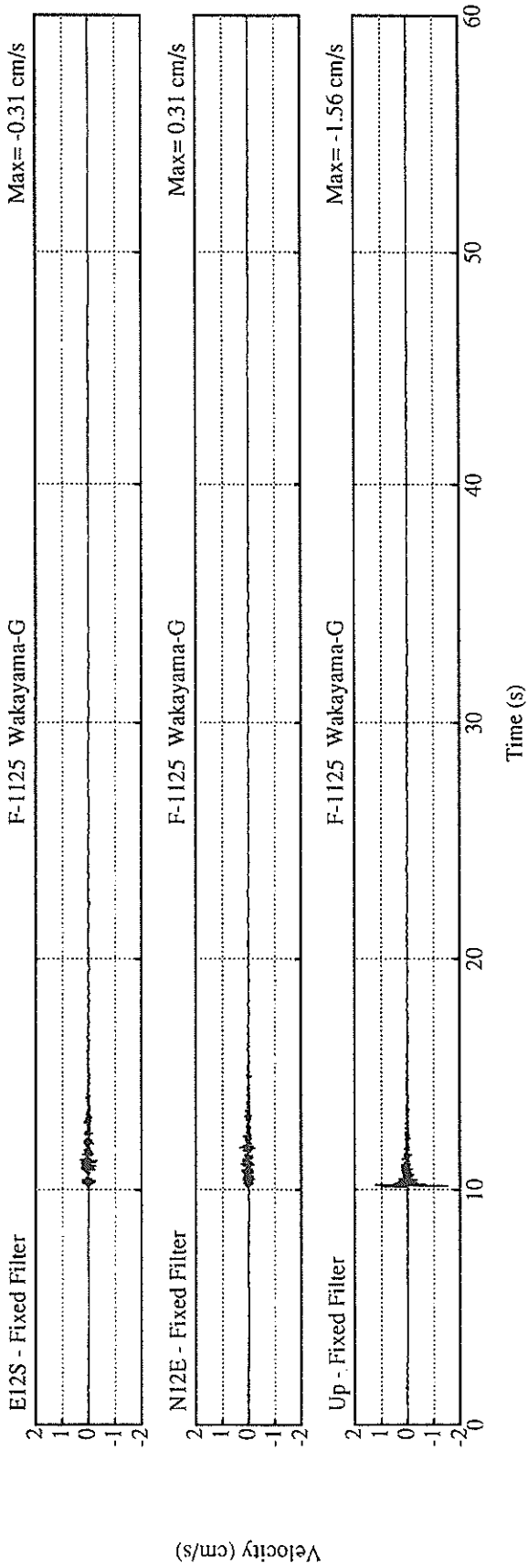
* RESULTANT OF HORIZONTAL COMPONENTS

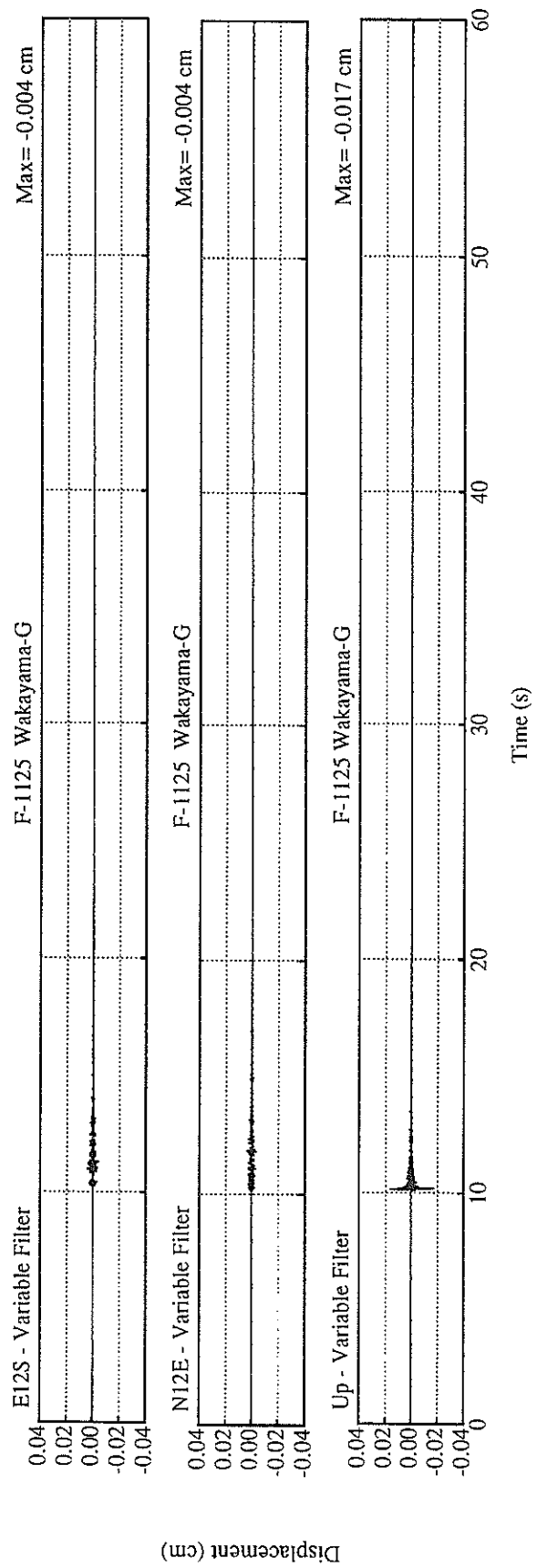
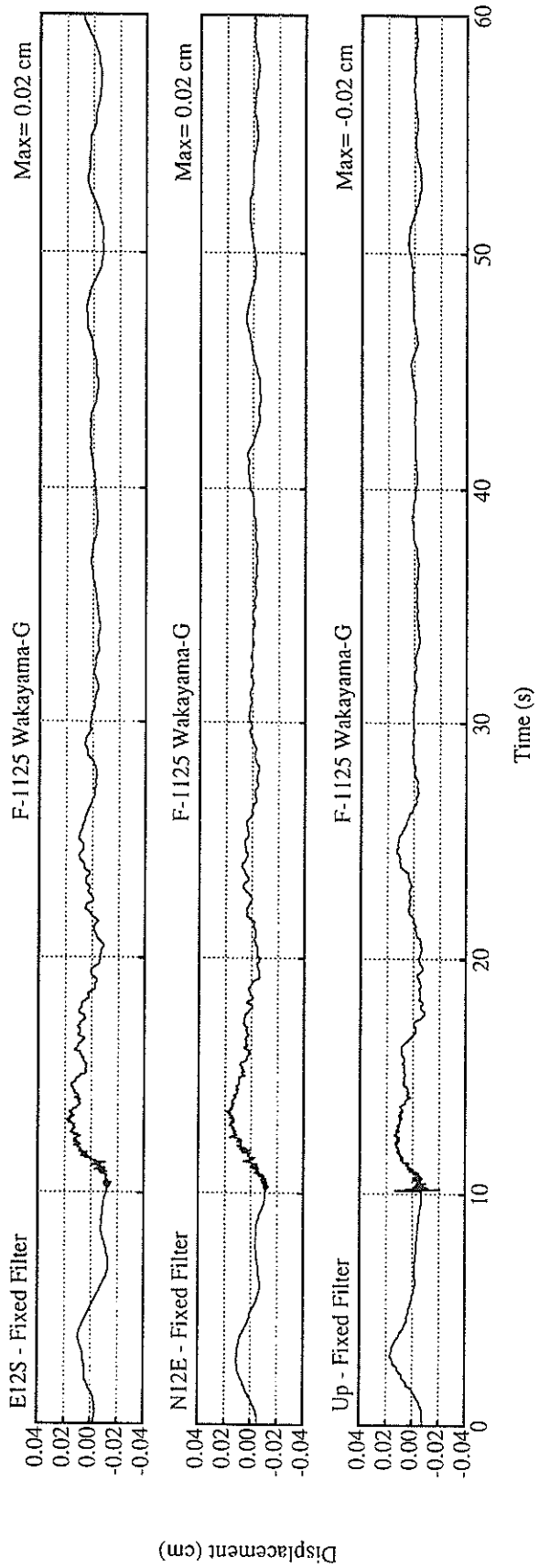


Acceleration (gal)

Acceleration (gal)

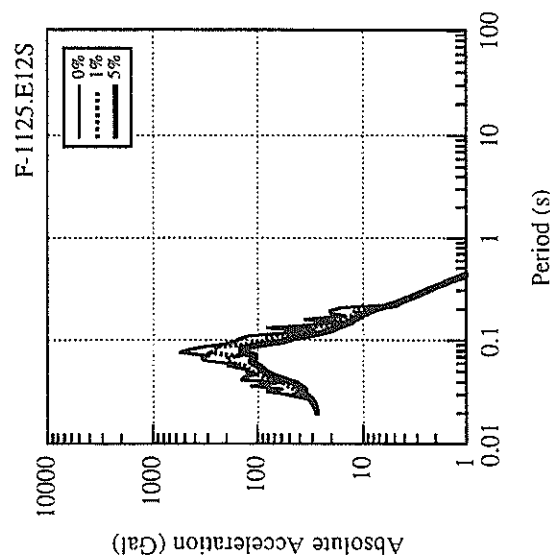
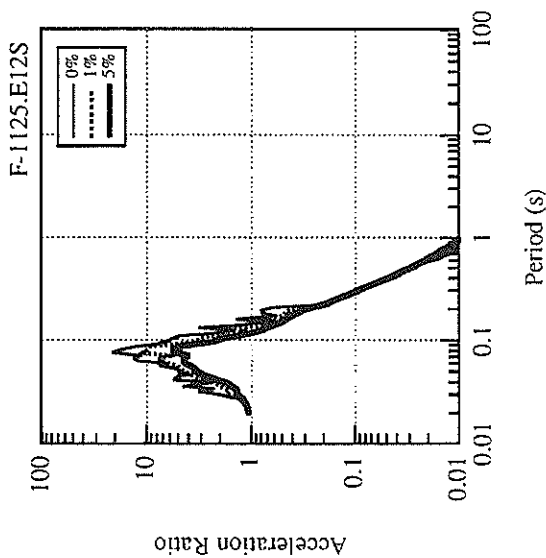
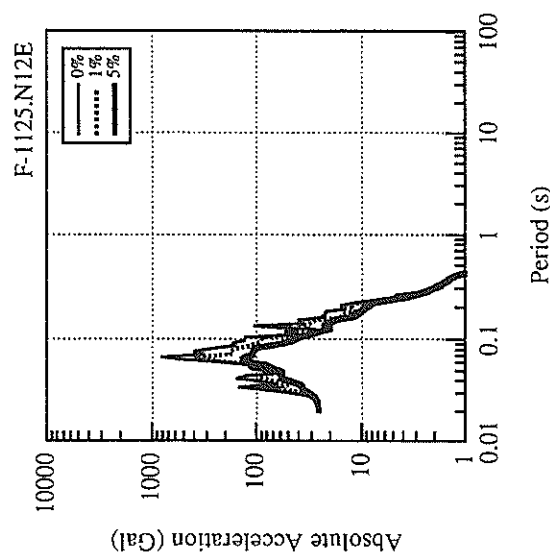
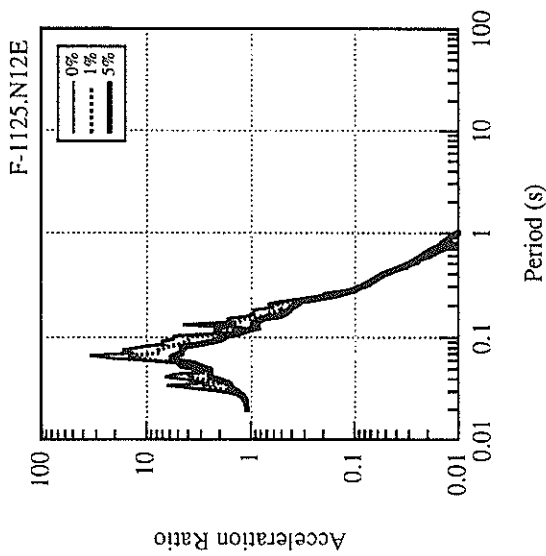
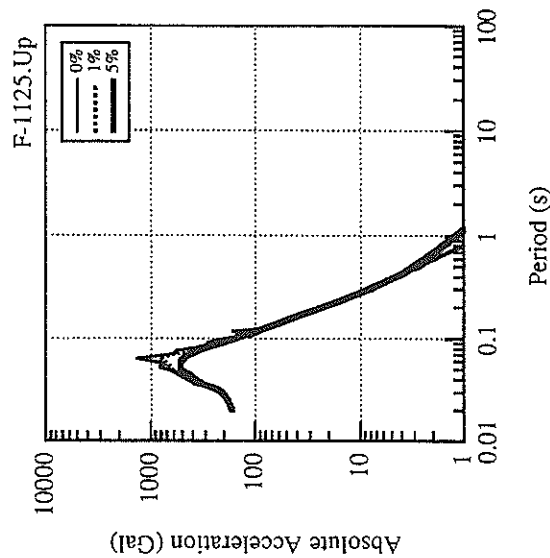
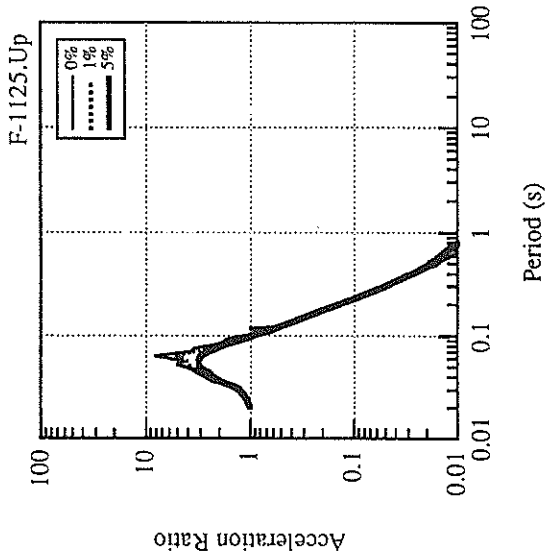


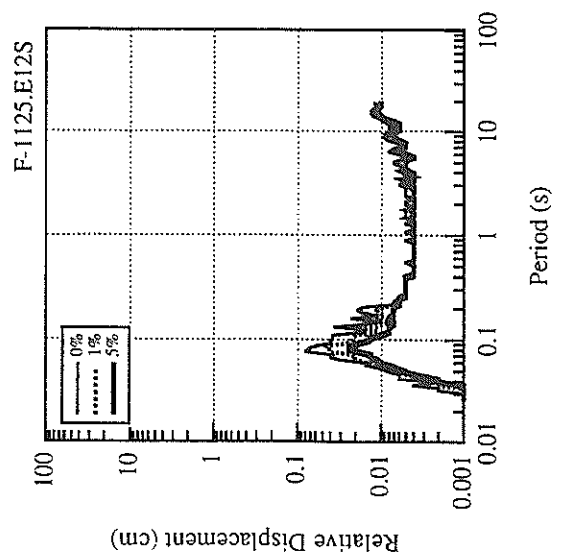
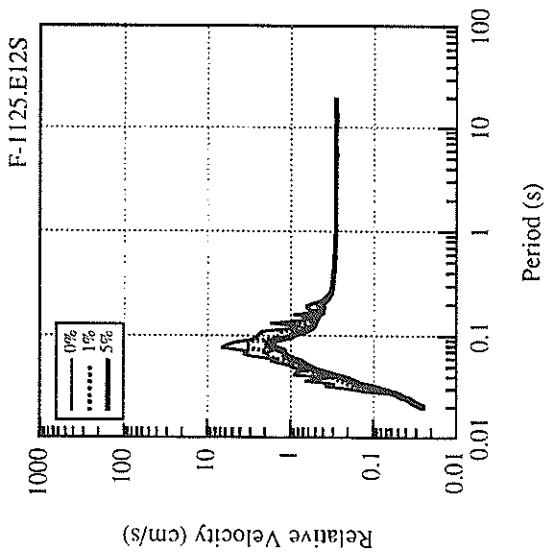
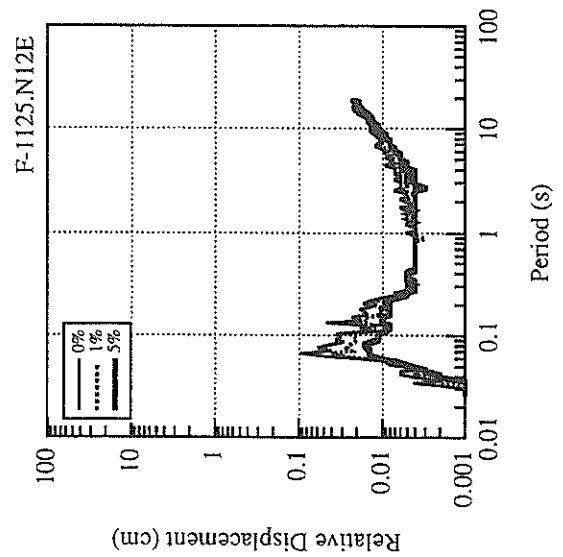
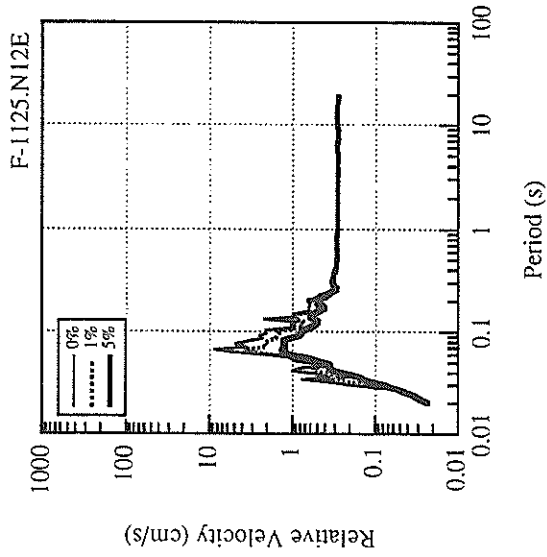
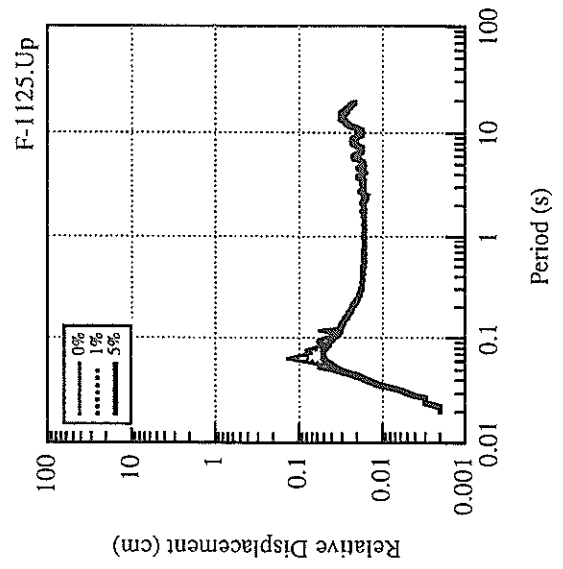
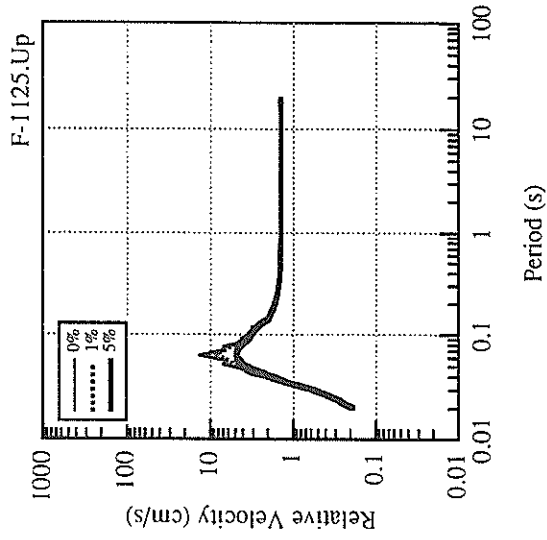


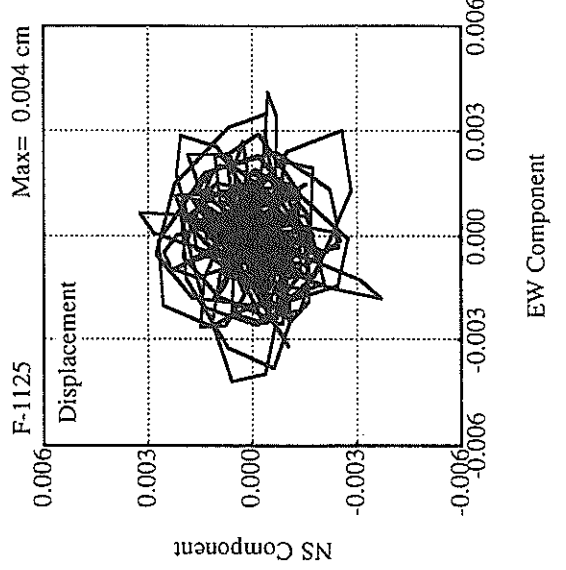
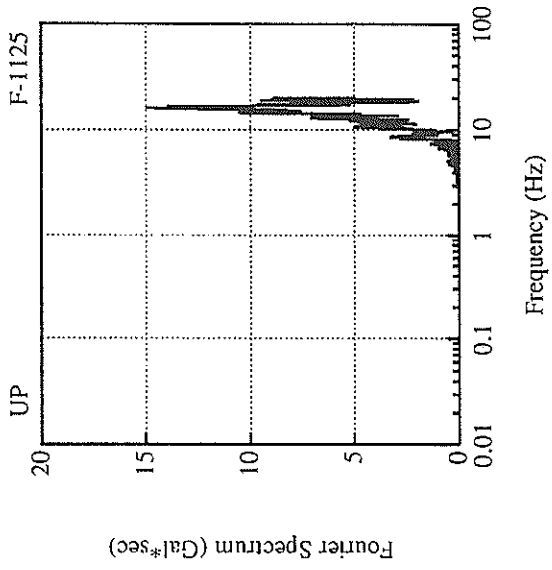
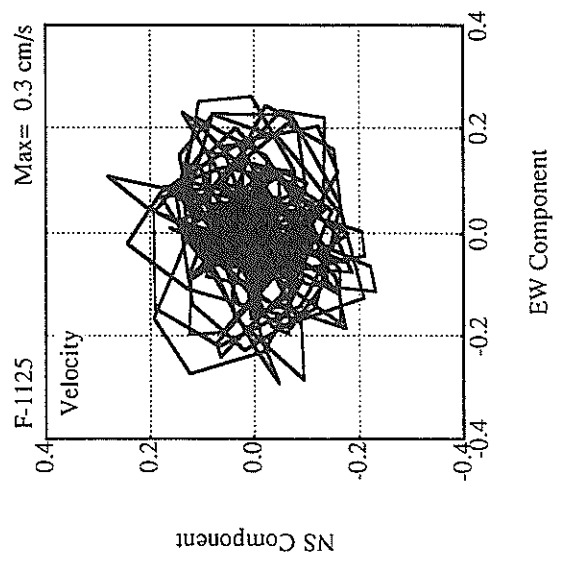
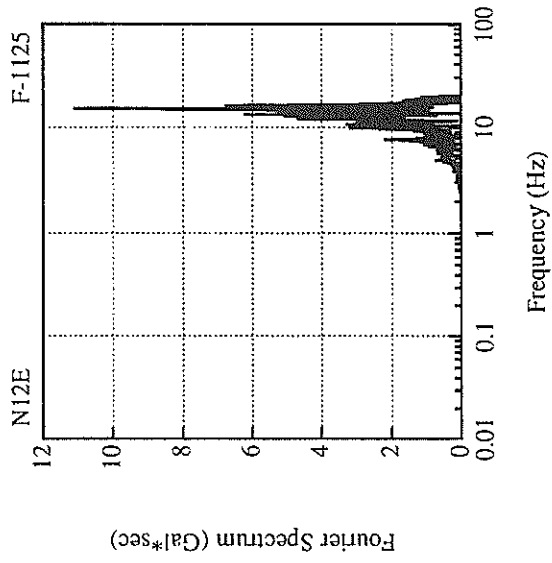
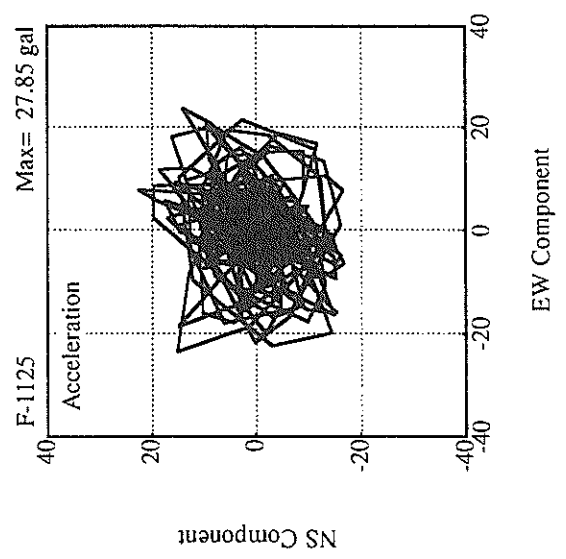
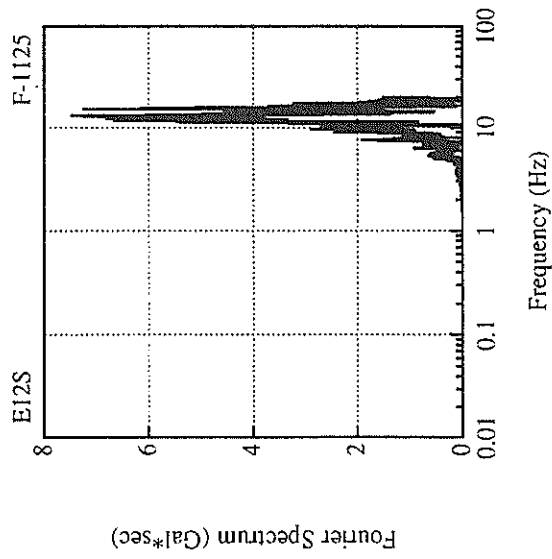


Displacement (cm)

Displacement (cm)







RECORD NUMBER : F-1124

STATION : MIYAKO-G

 EARTHQUAKE DATA

 DATE AND TIME 20:12 FEB.11,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF IWATE PREF
 LATITUDE 39°37.8' N
 LONGITUDE 142° 9.7' E
 DEPTH 12.7KM
 JMA MAGNITUDE 3.9

PEAK VALUES OF COMPONENTS

 N S E W U D HORIZONTAL*

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 2.508 2.148

MAXIMUM ACCELERATION (GAL)

 SMAC-B2 EQUIVALENT 43.3 50.5 66.6
 ORIGINAL 99.5 112.9 139.9
 CORRECTED 98.2 109.6 134.9

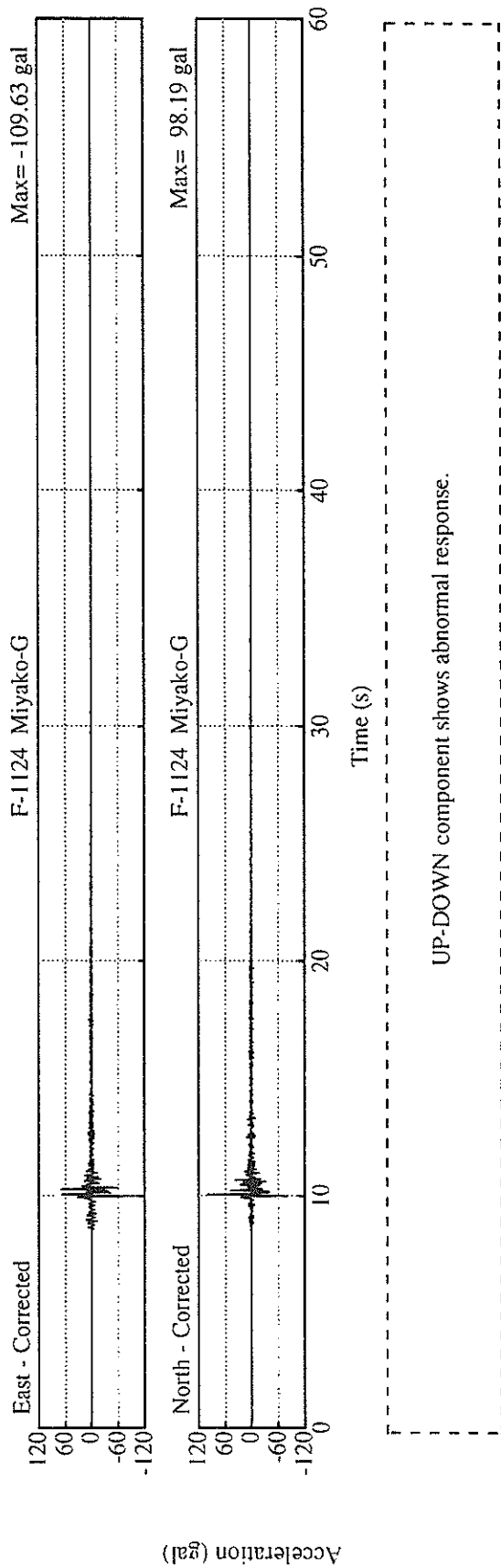
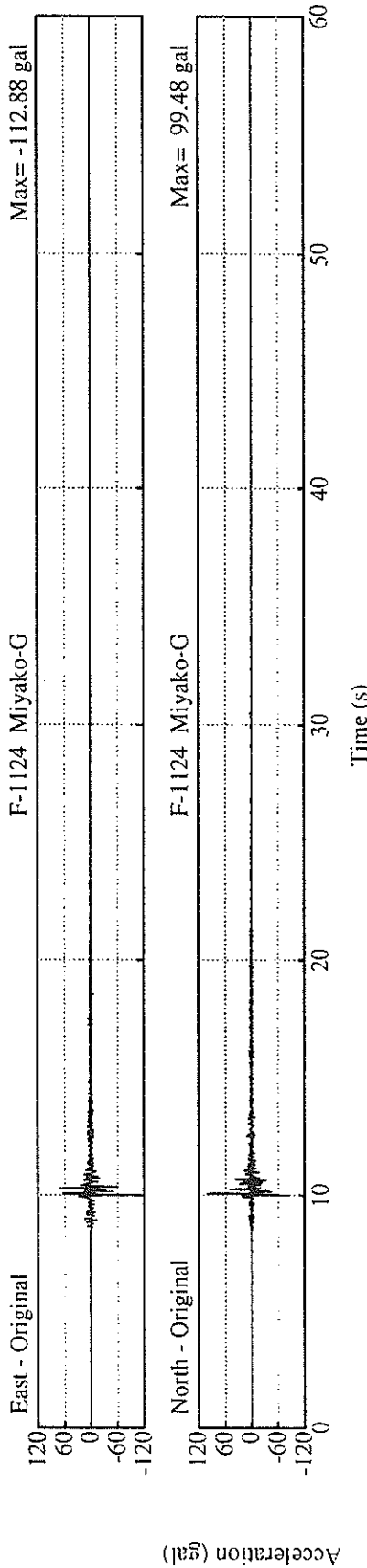
MAXIMUM VELOCITY (CM/SEC)

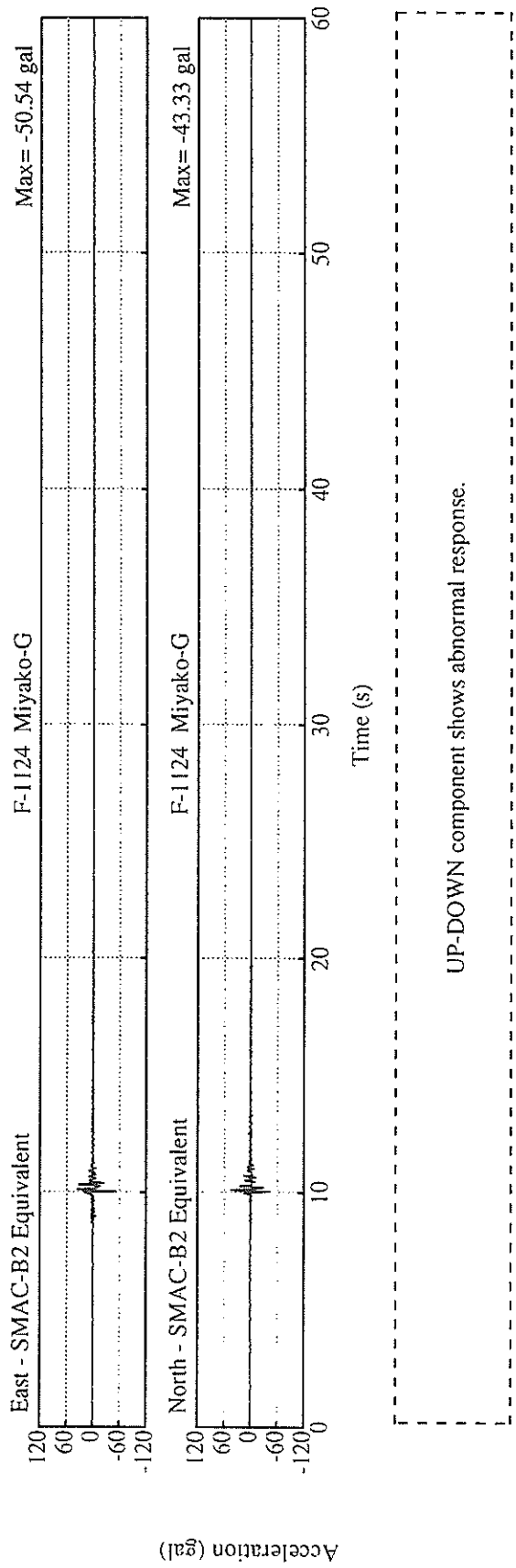
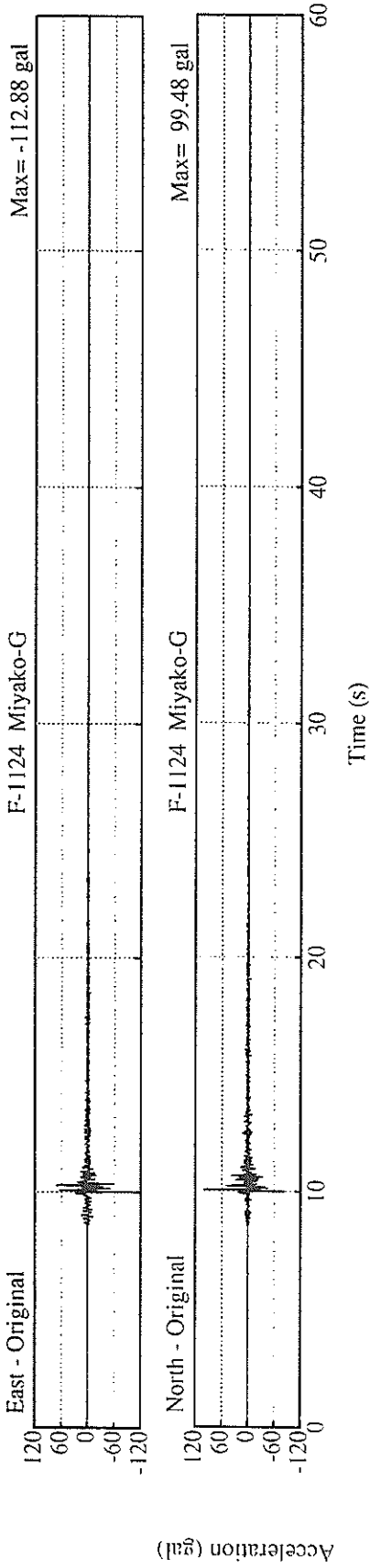
 FIXED FILTER 2.28 2.33 3.26
 VARIABLE FILTER 2.18 2.21 3.11

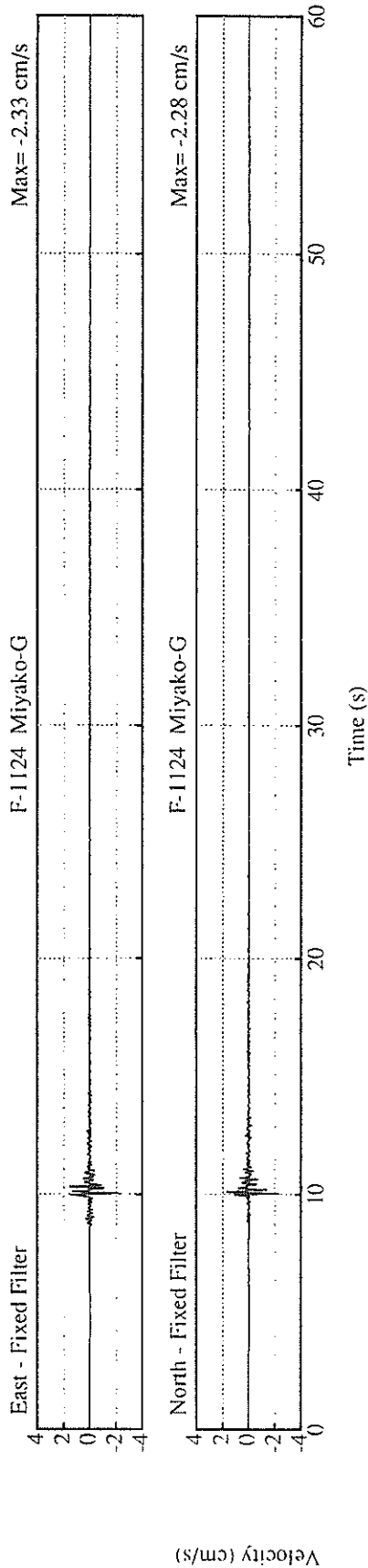
MAXIMUM DISPLACEMENT (CM)

 FIXED FILTER 0.06 0.08 0.09
 VARIABLE FILTER 0.06 0.06 0.08

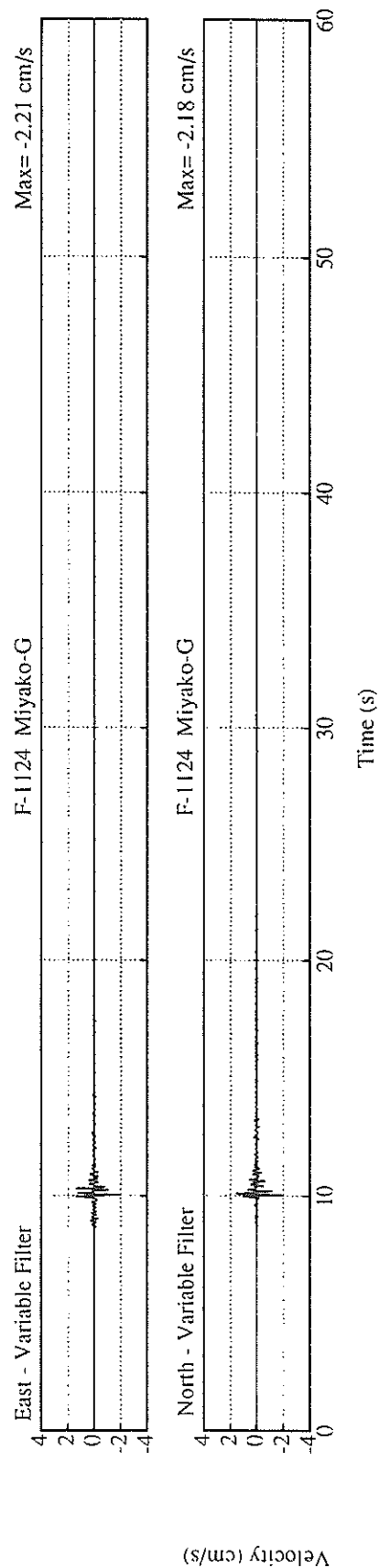
* RESULTANT OF HORIZONTAL COMPONENTS



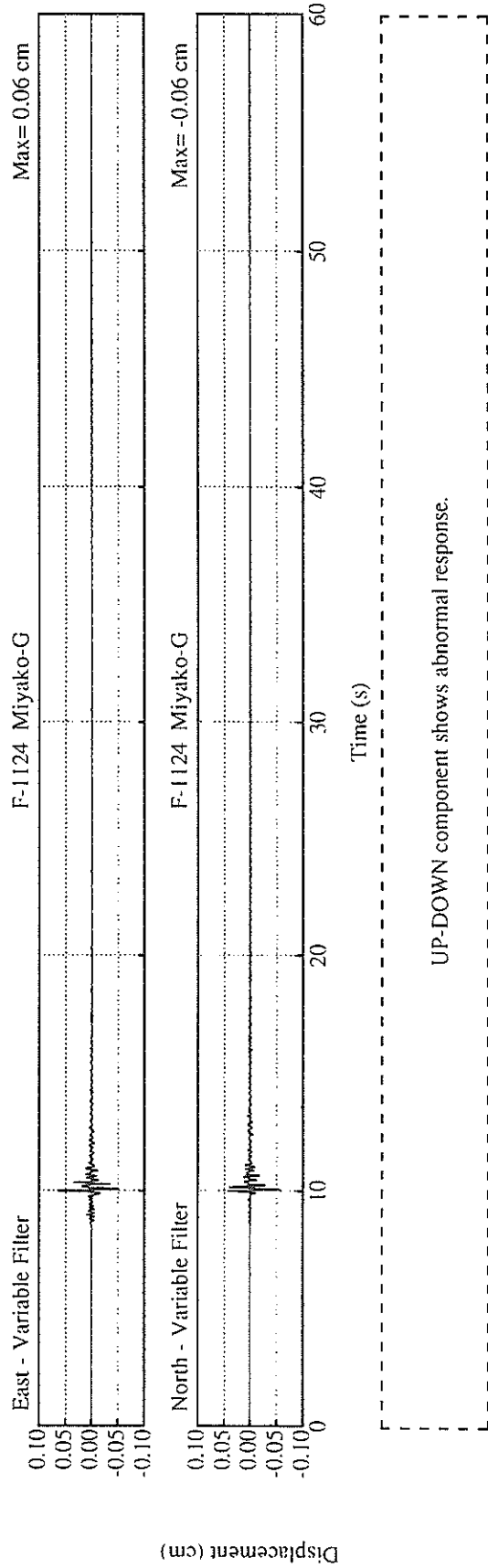
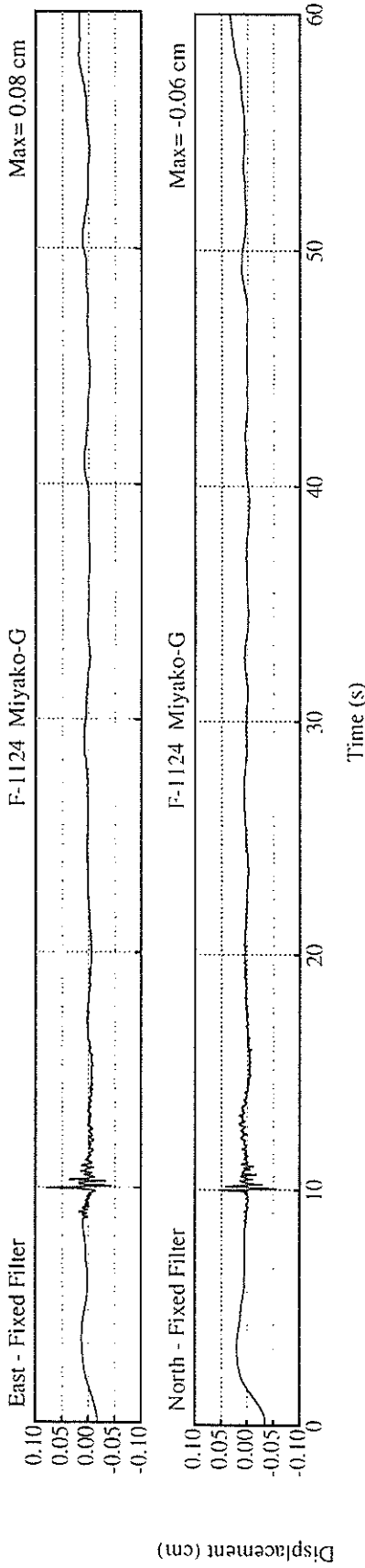


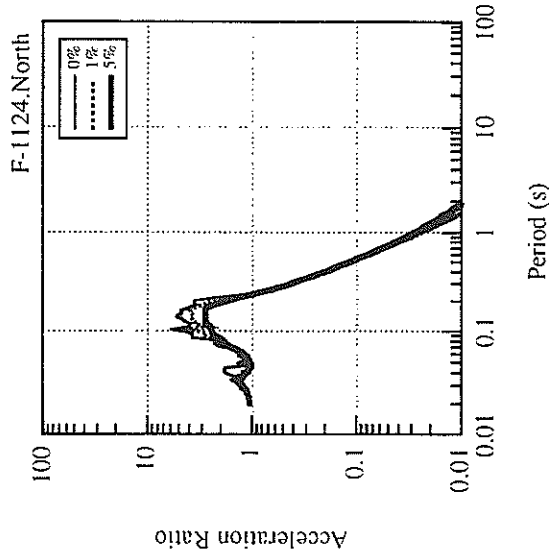


UP-DOWN component shows abnormal response.

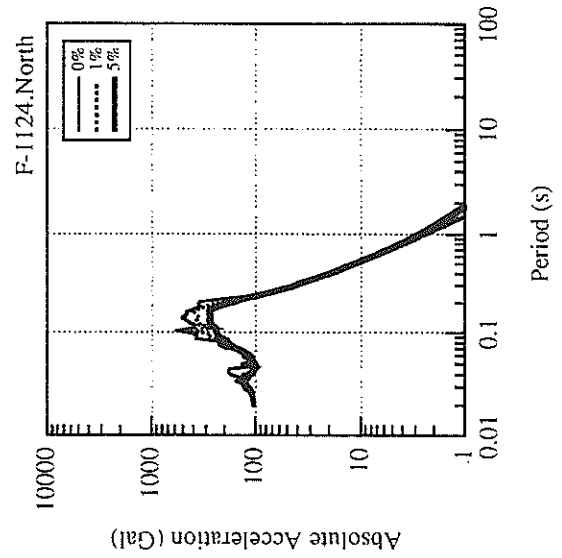


UP-DOWN component shows abnormal response.

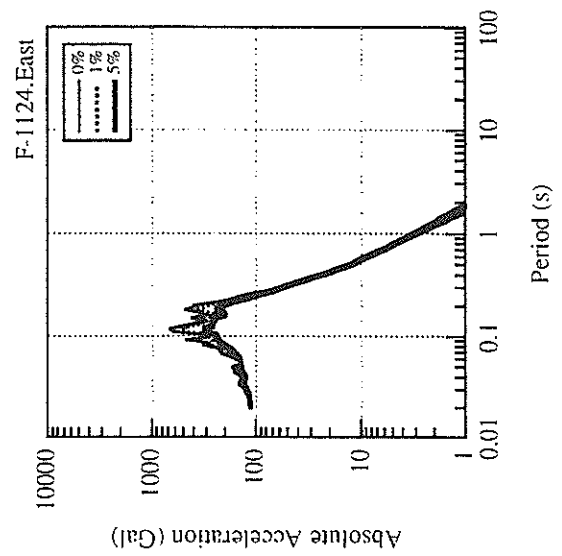
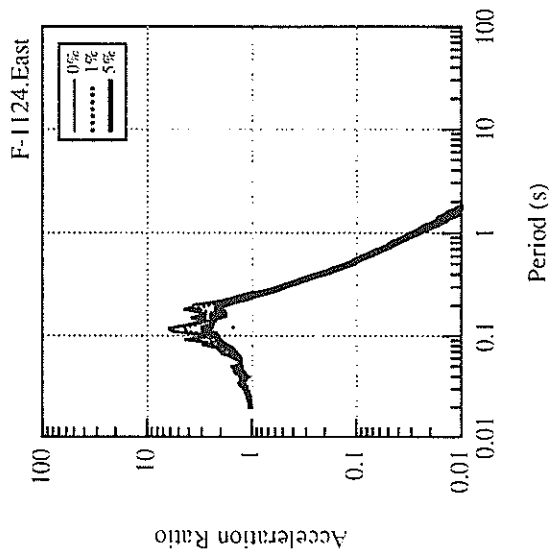


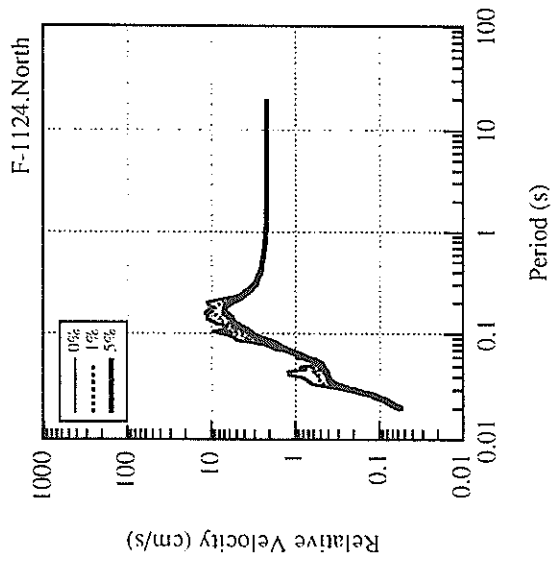


UP-DOWN component shows abnormal response.

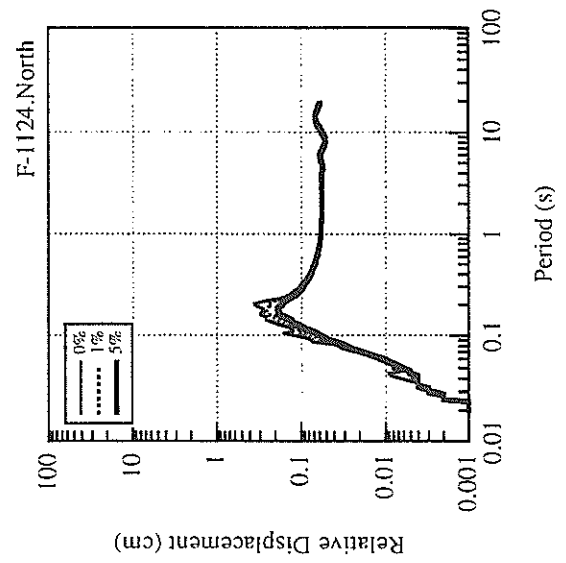


UP-DOWN component shows abnormal response.

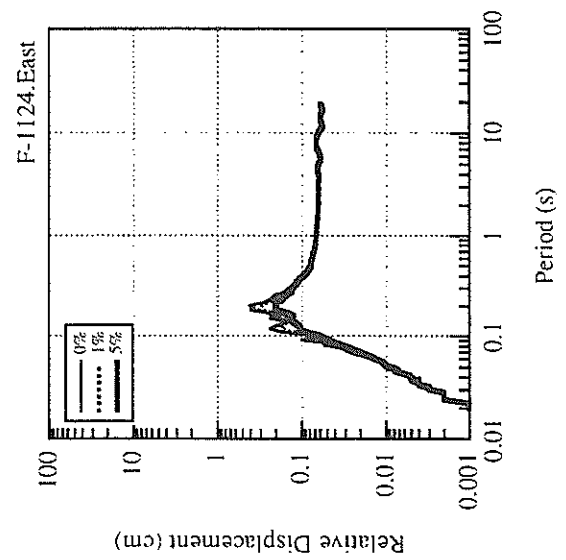
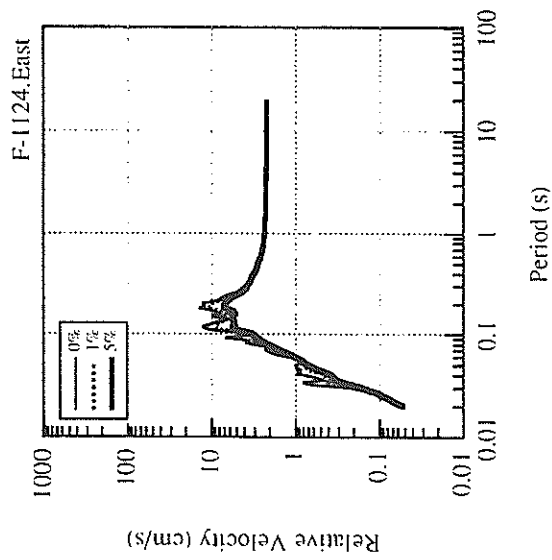


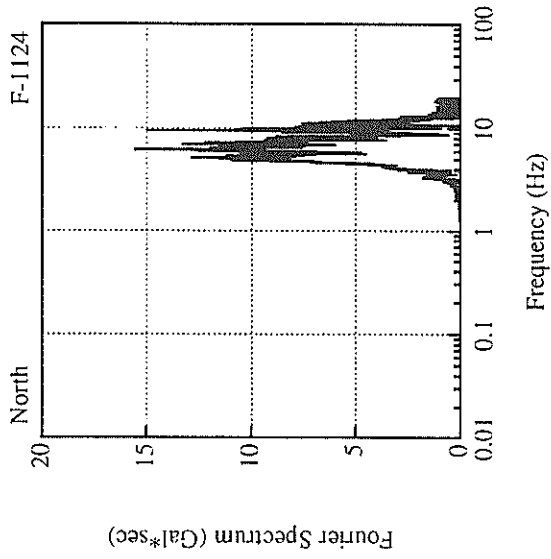
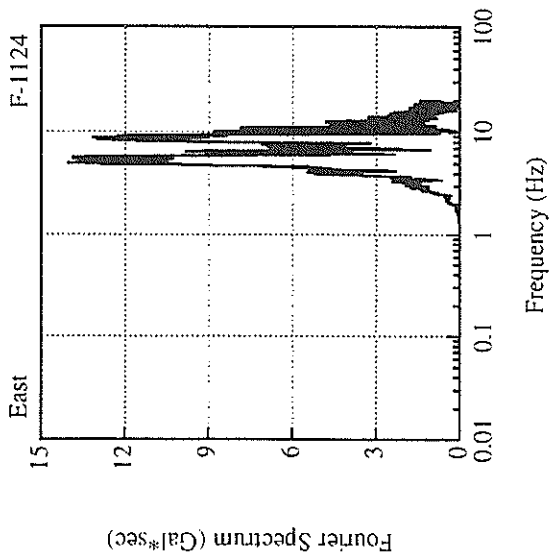


UP-DOWN component shows abnormal response.

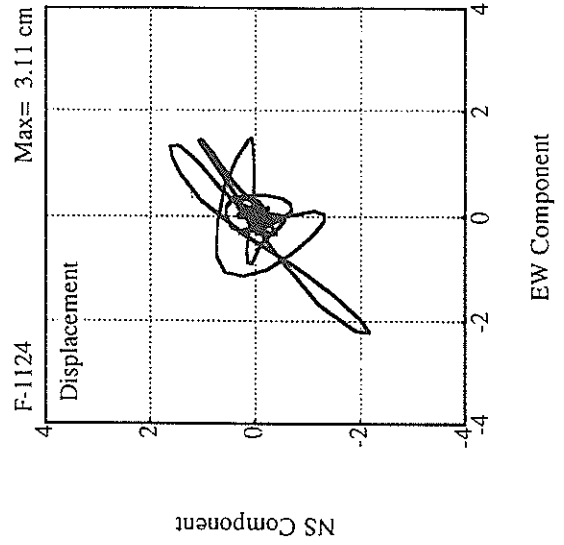
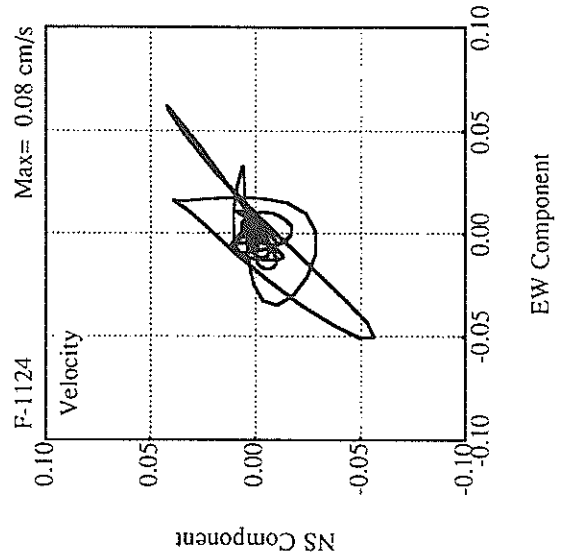
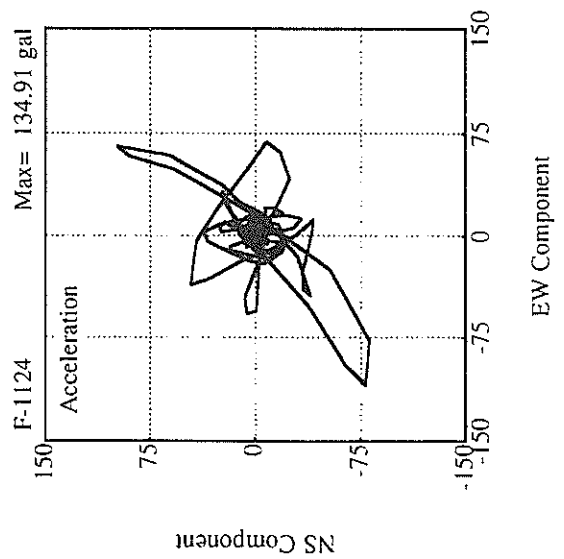


UP-DOWN component shows abnormal response.





UP-DOWN component shows
abnormal response



RECORD NUMBER : F-1113

STATION : ONAHAMA-JI-G

EARTHQUAKE DATA

DATE AND TIME : 5:21 FEB.20,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : E OFF FUKUSHIMA PREF

LATITUDE : 37°23.1' N

LONGITUDE : 141°9.5' E

DEPTH : 88.5KM

JMA MAGNITUDE : 5.3

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.823	0.817	1.183	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) : 0.823 0.817 1.183

MAXIMUM ACCELERATION (GAL)

	N S	E W	U D	HORIZONTAL*
SMAC-B2 EQUIVALENT	35.1	20.1	12.3	37.5
ORIGINAL	60.2	36.6	26.3	61.0
CORRECTED	60.4	36.5	27.3	61.3

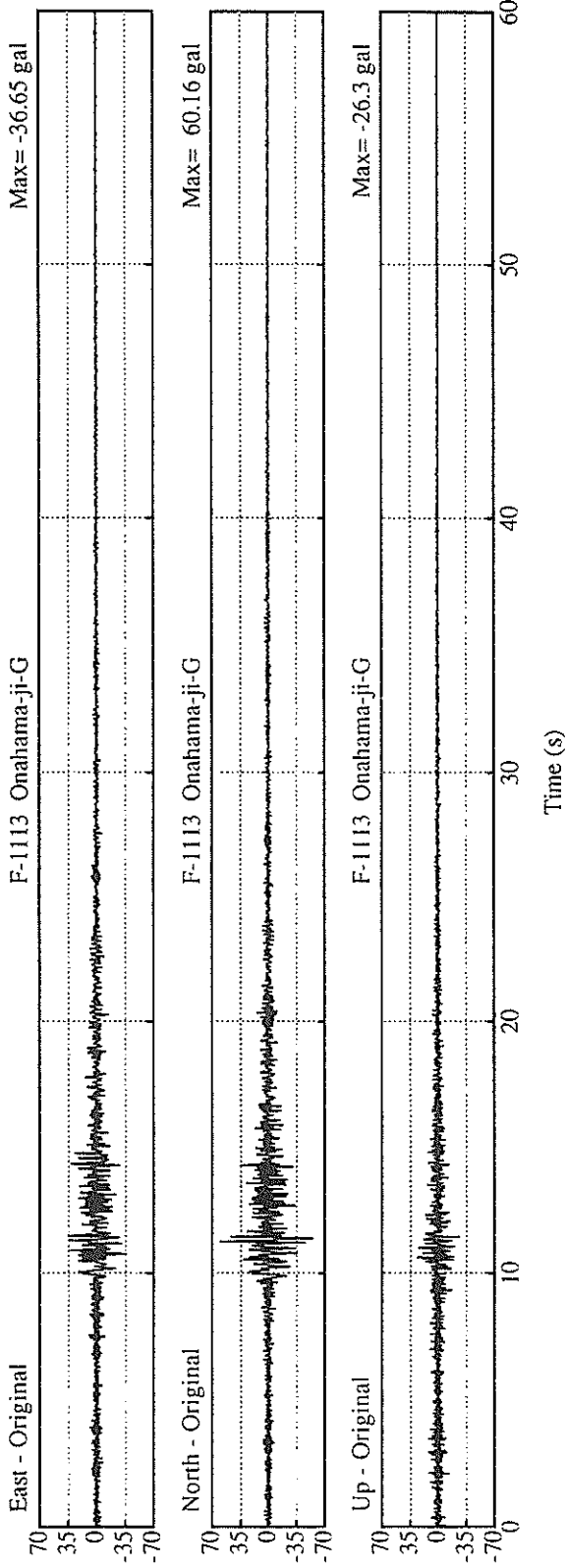
MAXIMUM VELOCITY (CM/SEC)

	N S	E W	U D	HORIZONTAL*
FIXED FILTER	1.78	1.64	0.63	1.90
VARIABLE FILTER	1.67	1.43	0.62	1.86

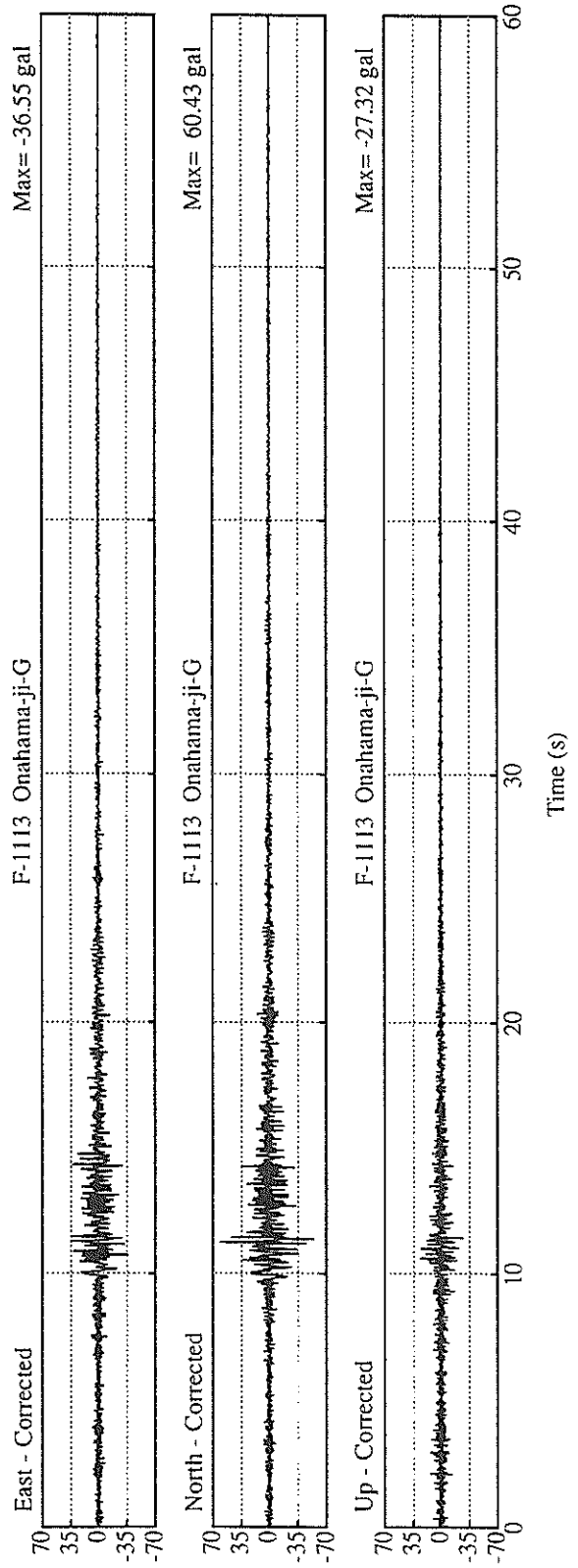
MAXIMUM DISPLACEMENT (CM)

	N S	E W	U D	HORIZONTAL*
FIXED FILTER	0.18	0.15	0.04	0.19
VARIABLE FILTER	0.11	0.10	0.03	0.14

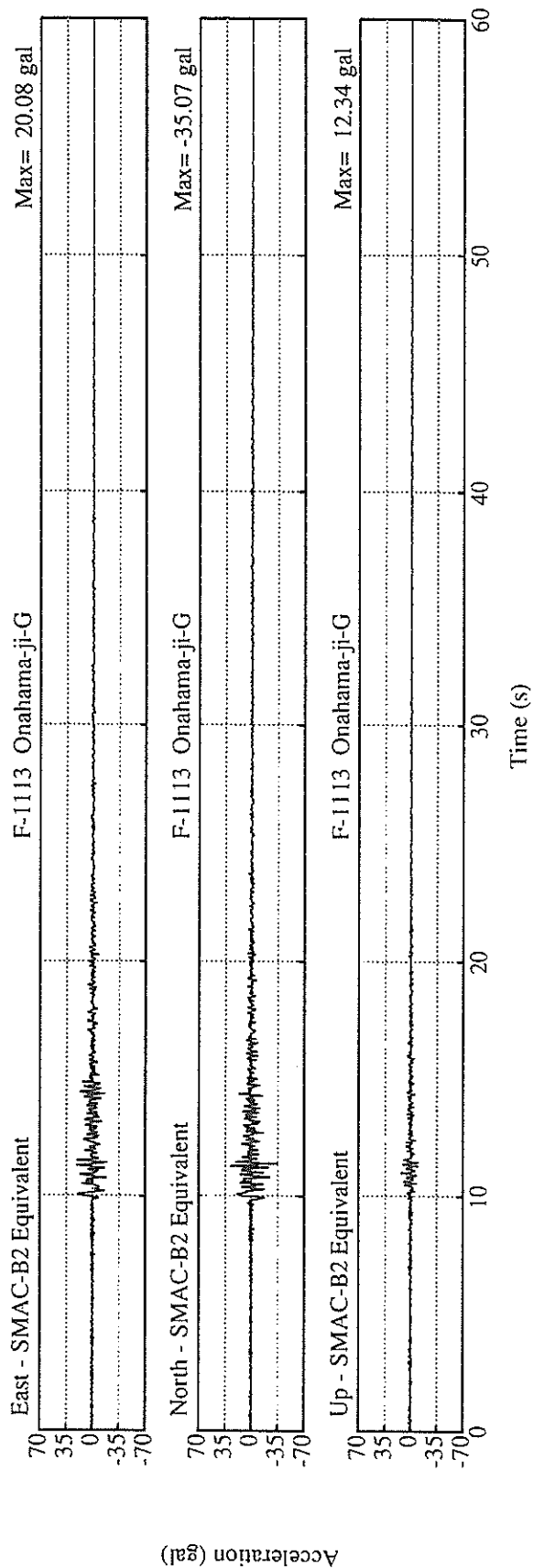
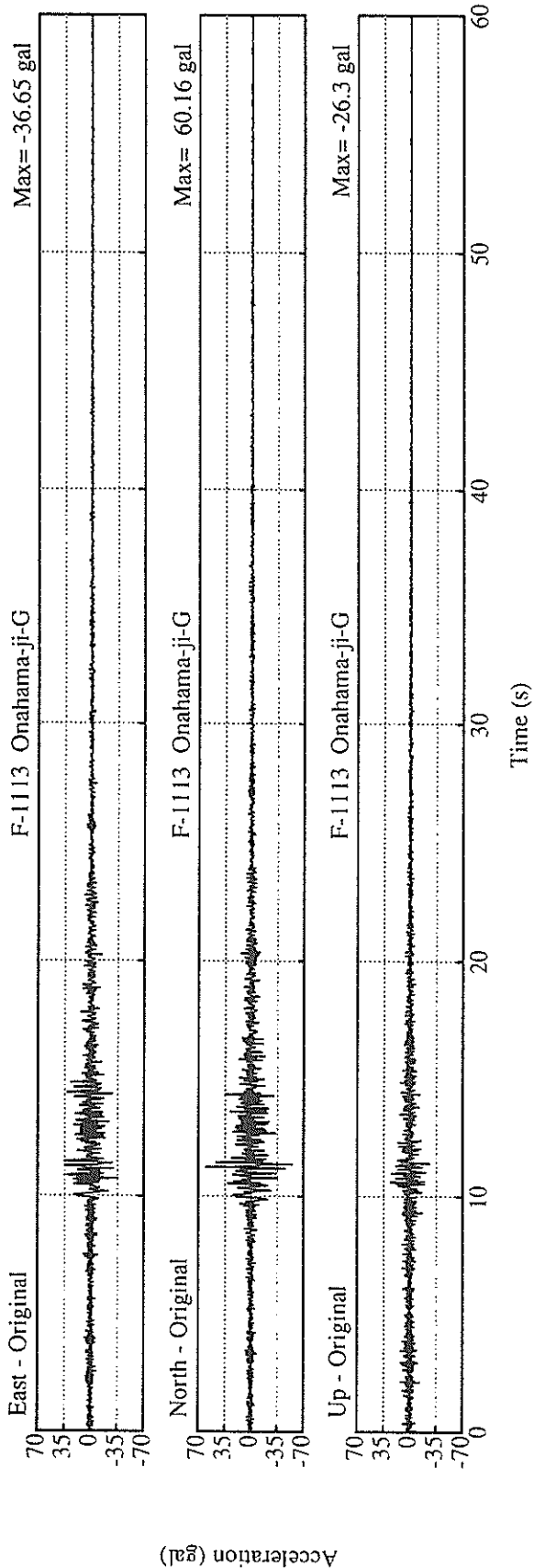
* RESULTANT OF HORIZONTAL COMPONENTS

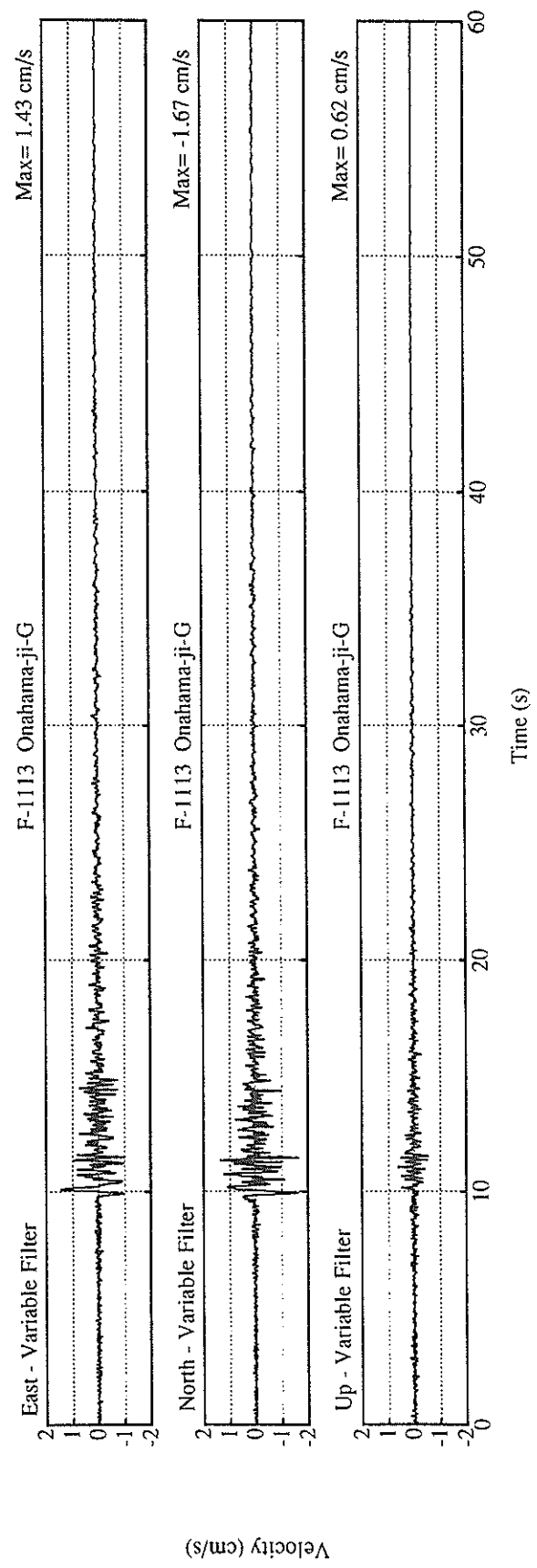
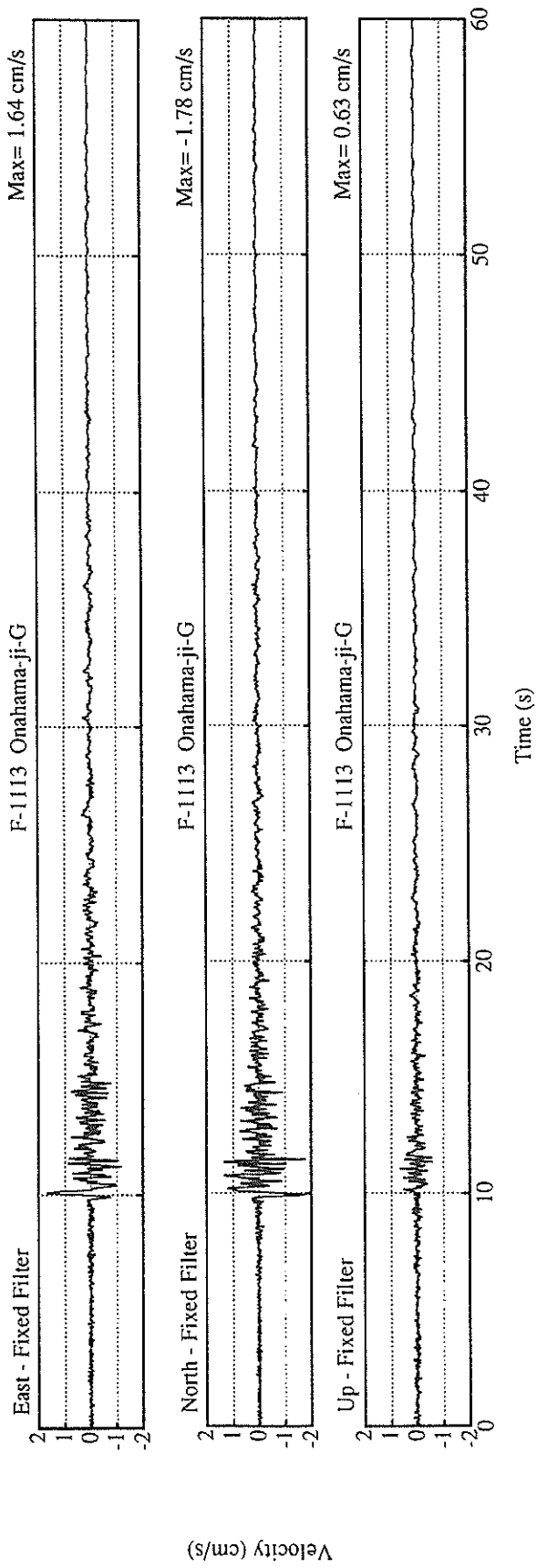


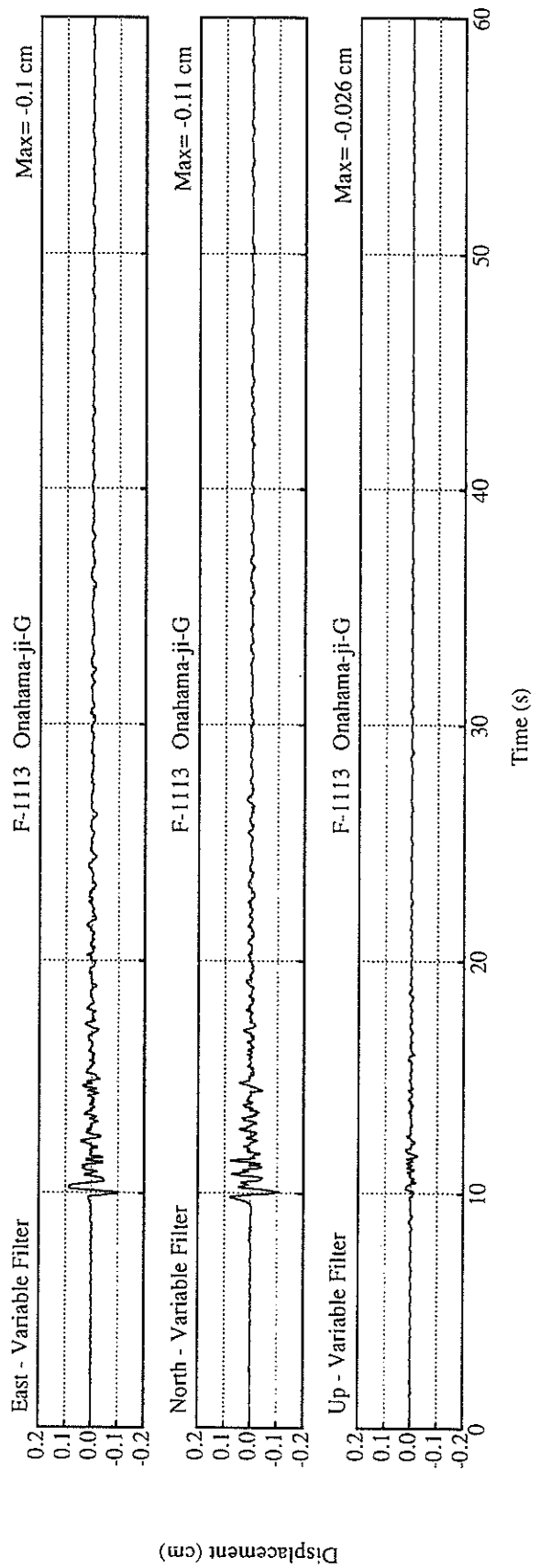
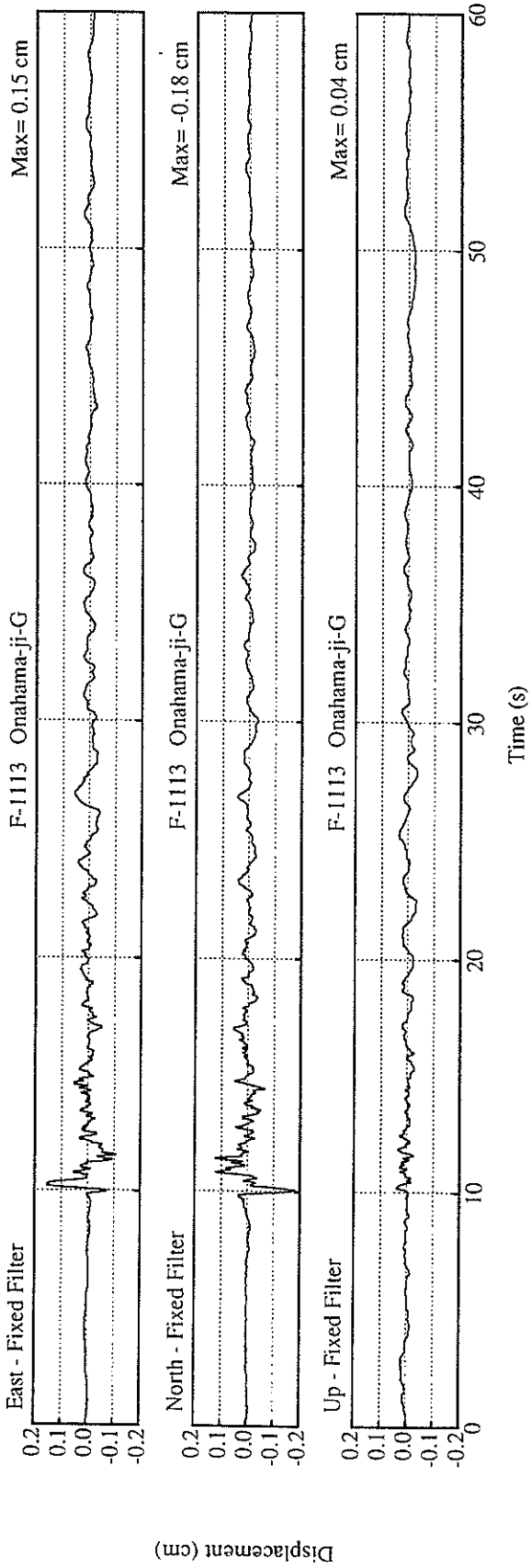
Acceleration (gal)

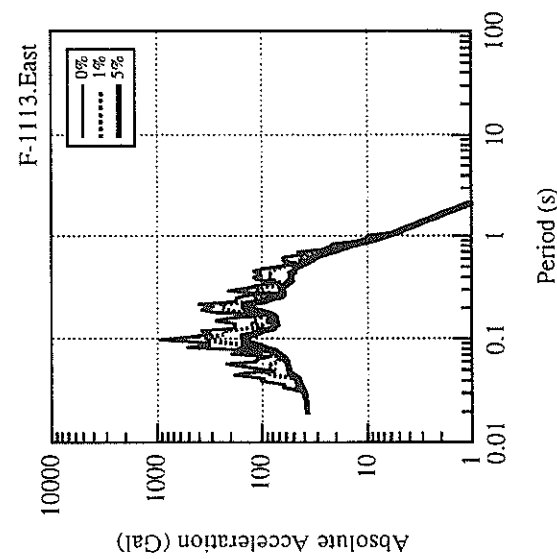
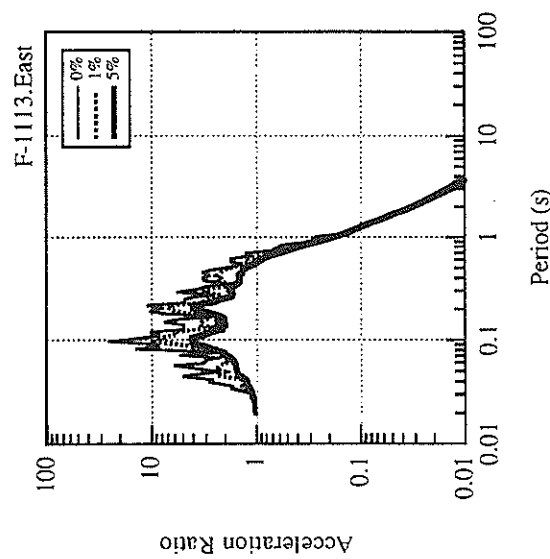
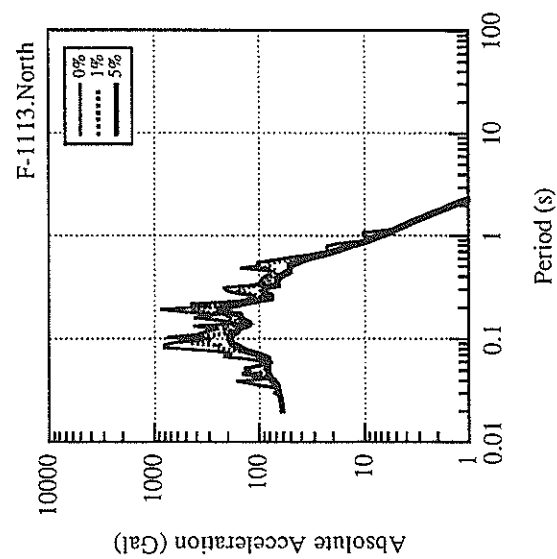
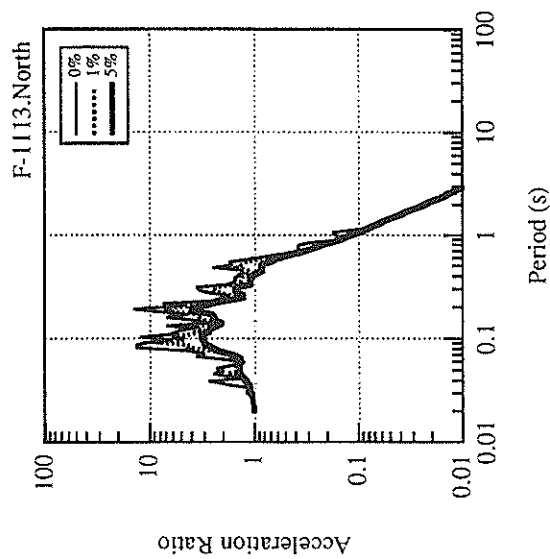
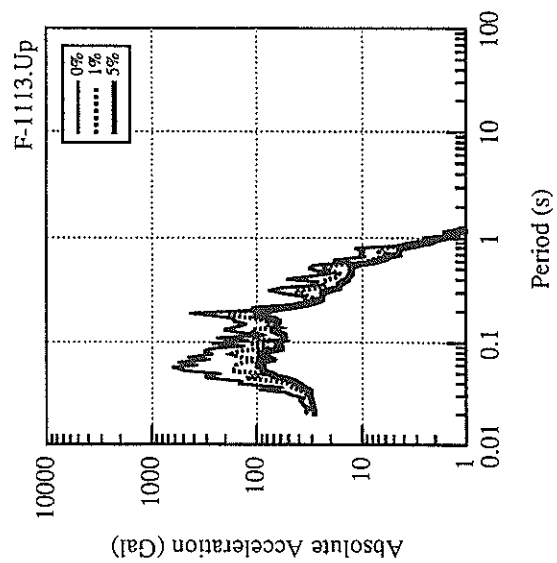
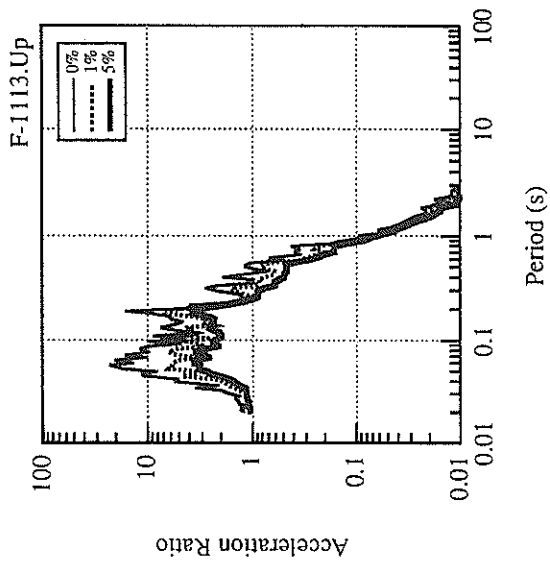


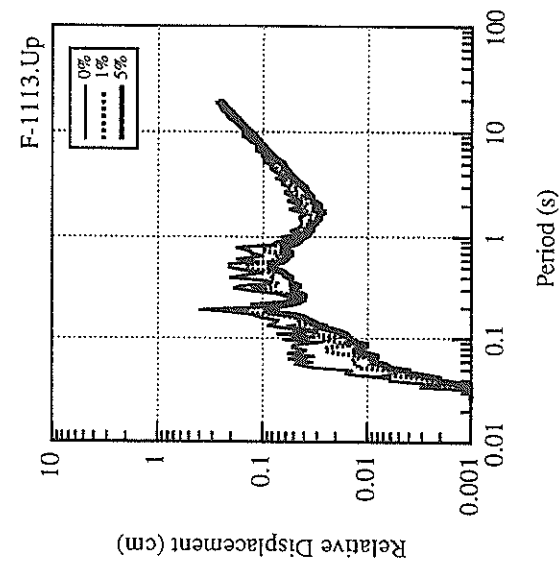
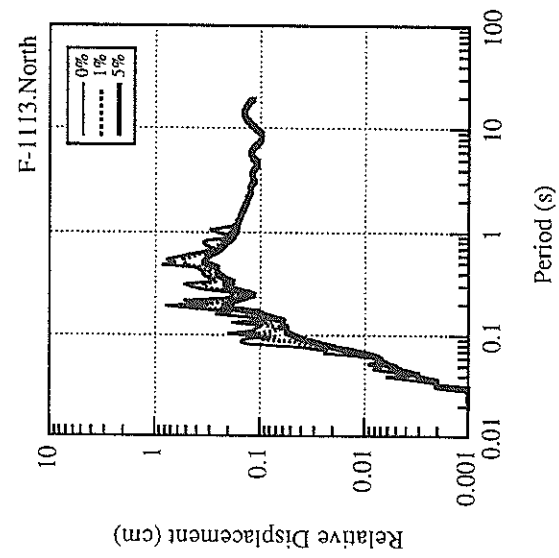
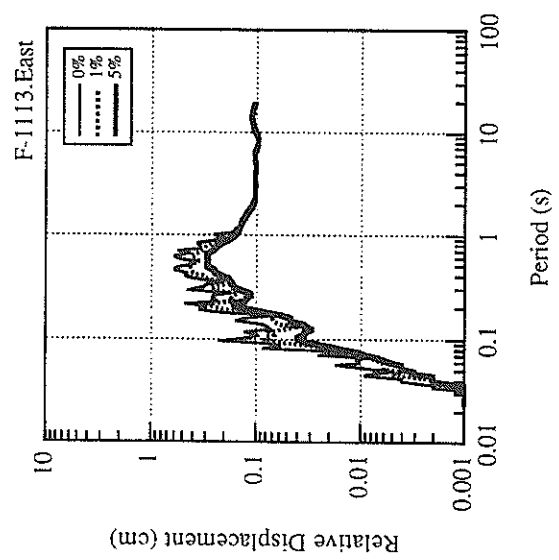
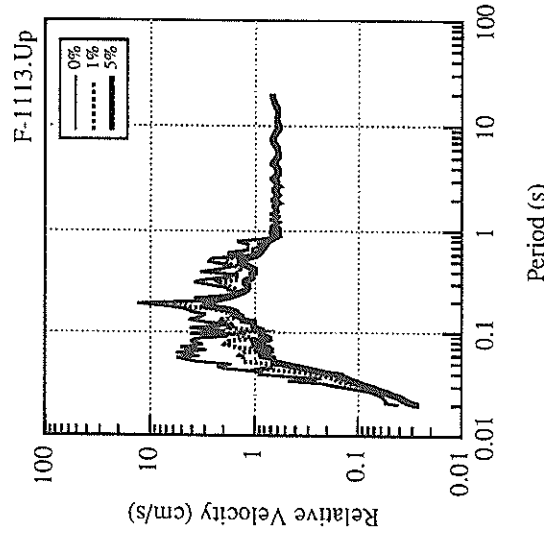
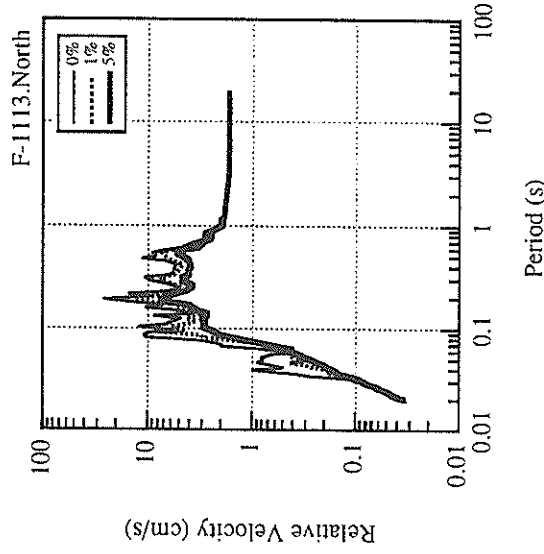
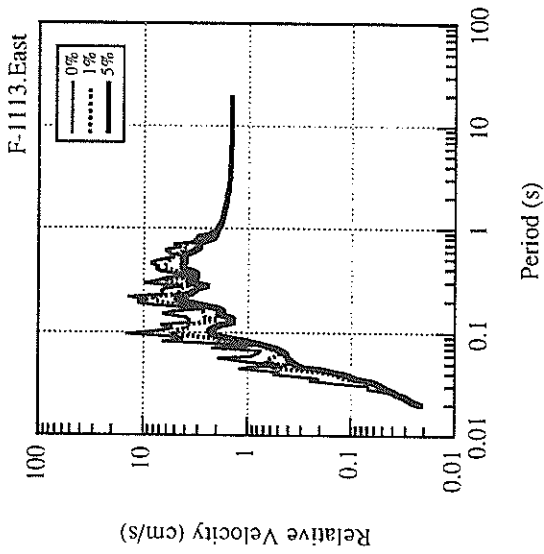
Acceleration (gal)

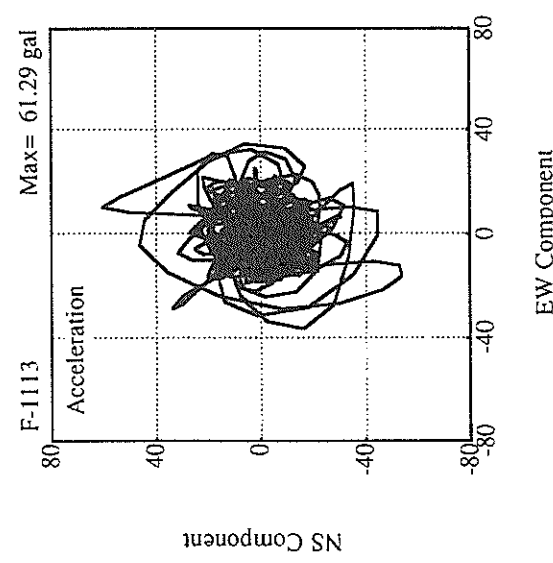
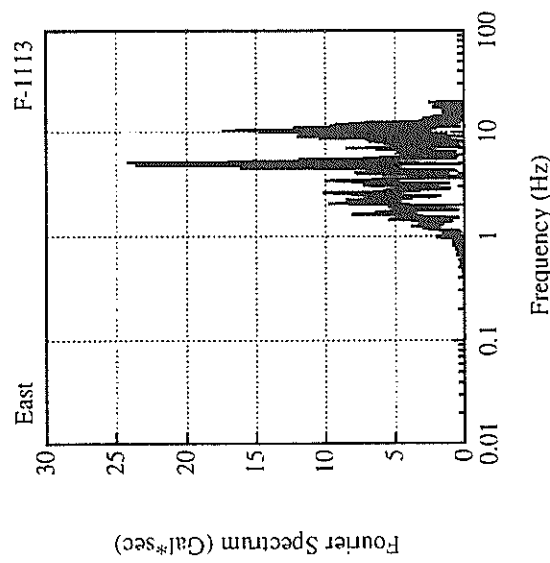
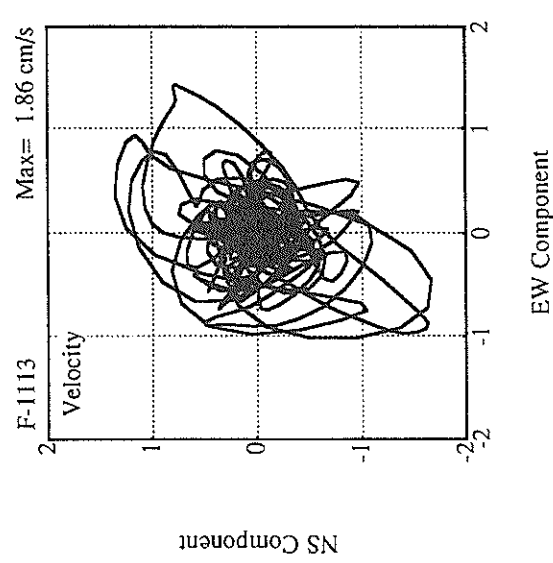
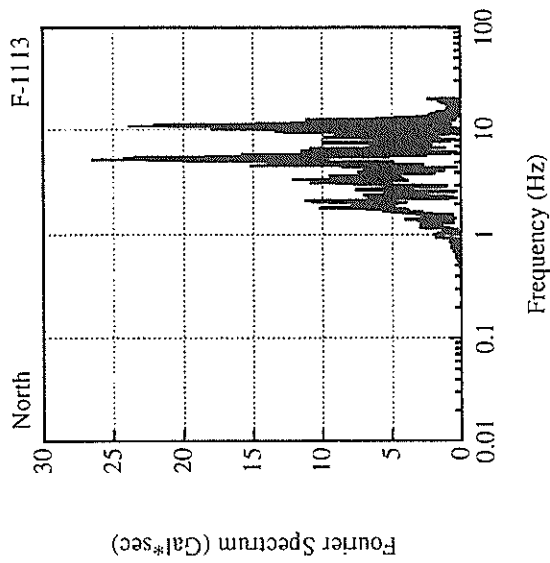
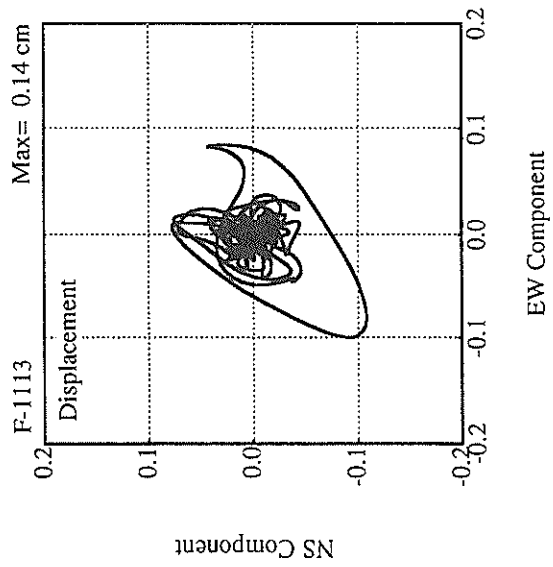
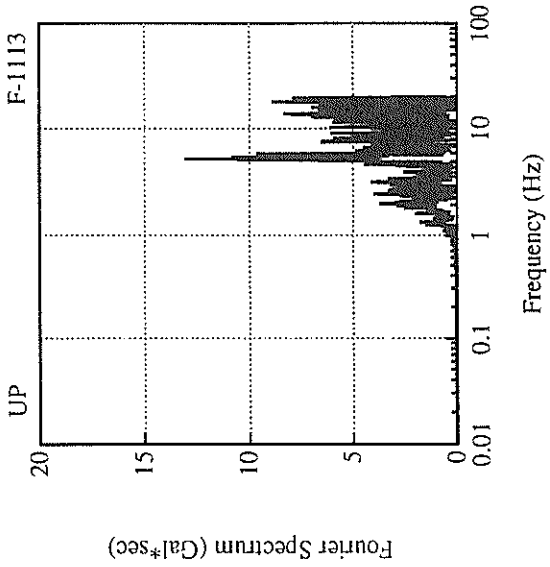












RECORD NUMBER : S-2681

STATION : SOMA-S

EARTHQUAKE DATA

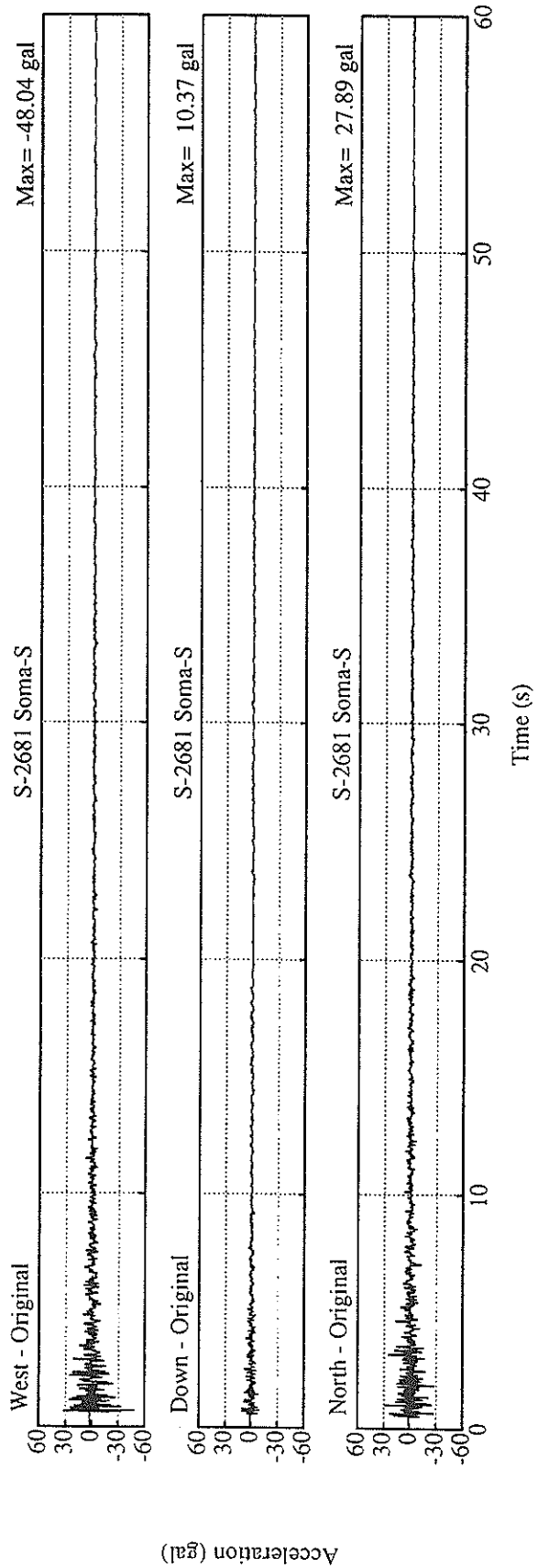
 DATE AND TIME 5:21 FEB.20,1997
 LOCATION OF HYPOCENTER E OFF FUKUSHIMA PREF
 EPICENTRAL REGION 37.23.1' N
 LATITUDE 141.9.5' E
 LONGITUDE 88.5KM
 DEPTH 5.3
 JMA MAGNITUDE 5.3

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
27.9	48.0	10.4	48.3

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : S-2669

STATION : URAKAWA-S

EARTHQUAKE DATA

 DATE AND TIME 16:55 FEB.20,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION S OFF URAKAWA
 LATITUDE 41°45.6' N
 LONGITUDE 142°52.2' E
 DEPTH 49.3KM
 JMA MAGNITUDE 5.7

PEAK VALUES OF COMPONENTS

 N S E W U D HORIZONTAL*

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.450 0.547 0.767

MAXIMUM ACCELERATION (GAL)

ORIGINAL 48.0 54.1 12.3 54.1
 CORRECTED 72.7 76.2 15.9 83.3

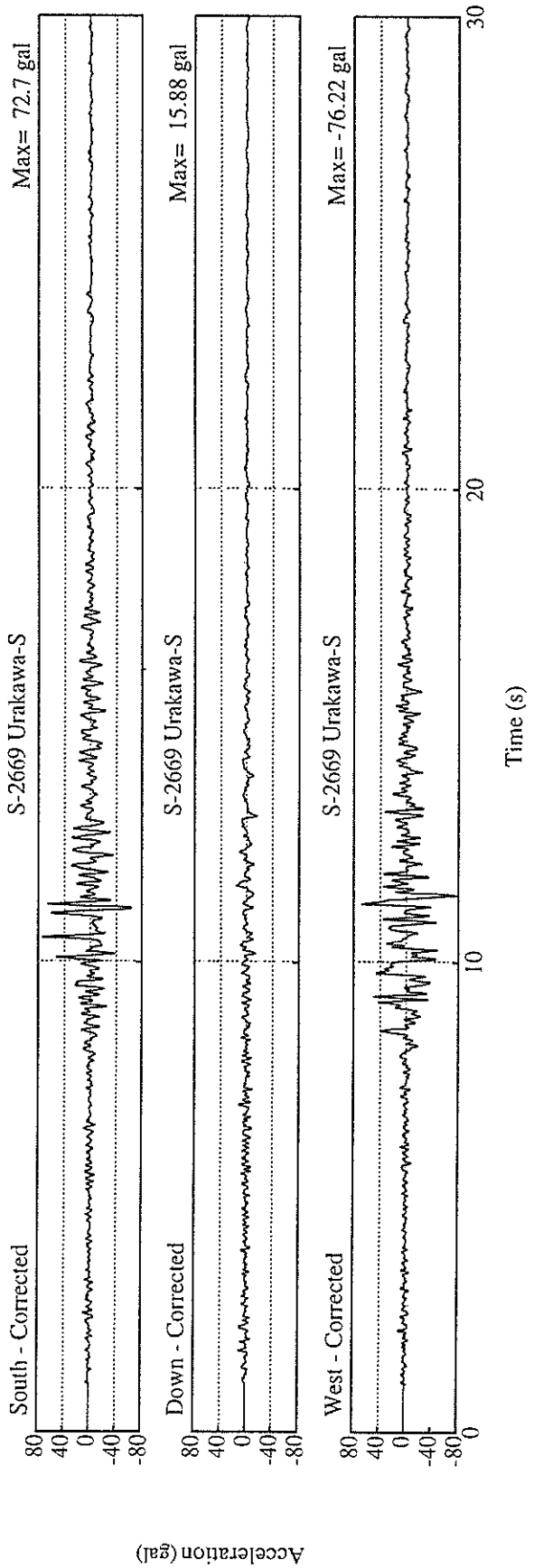
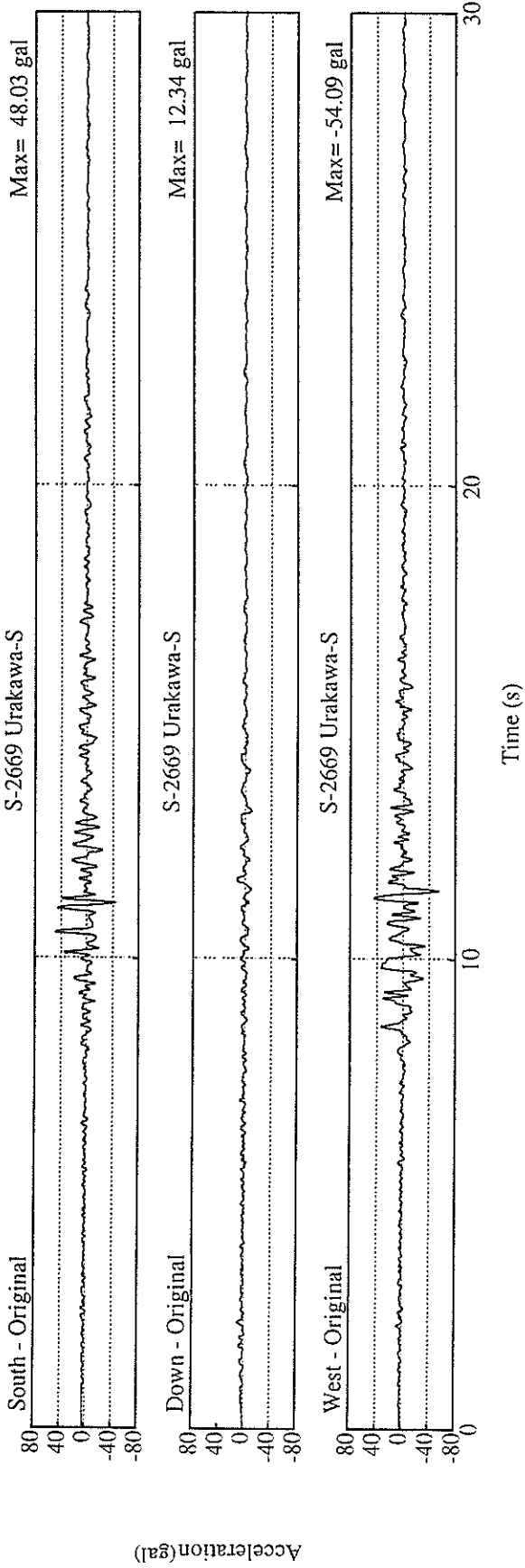
MAXIMUM VELOCITY (CM/SEC)

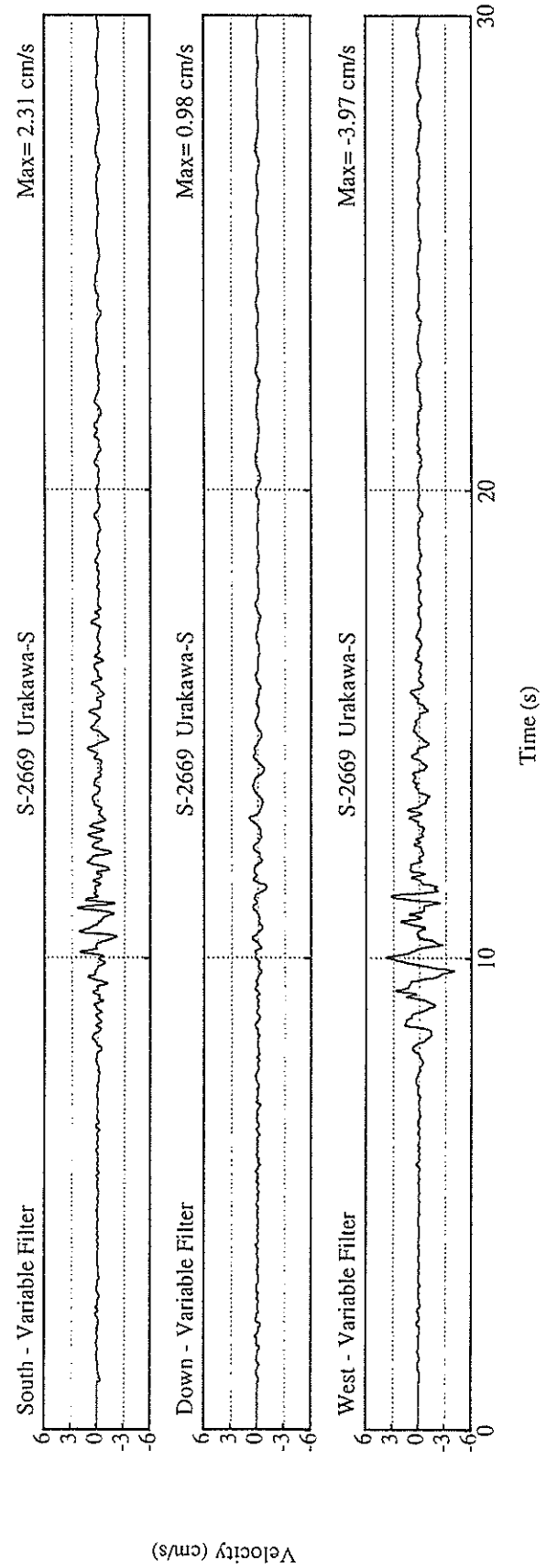
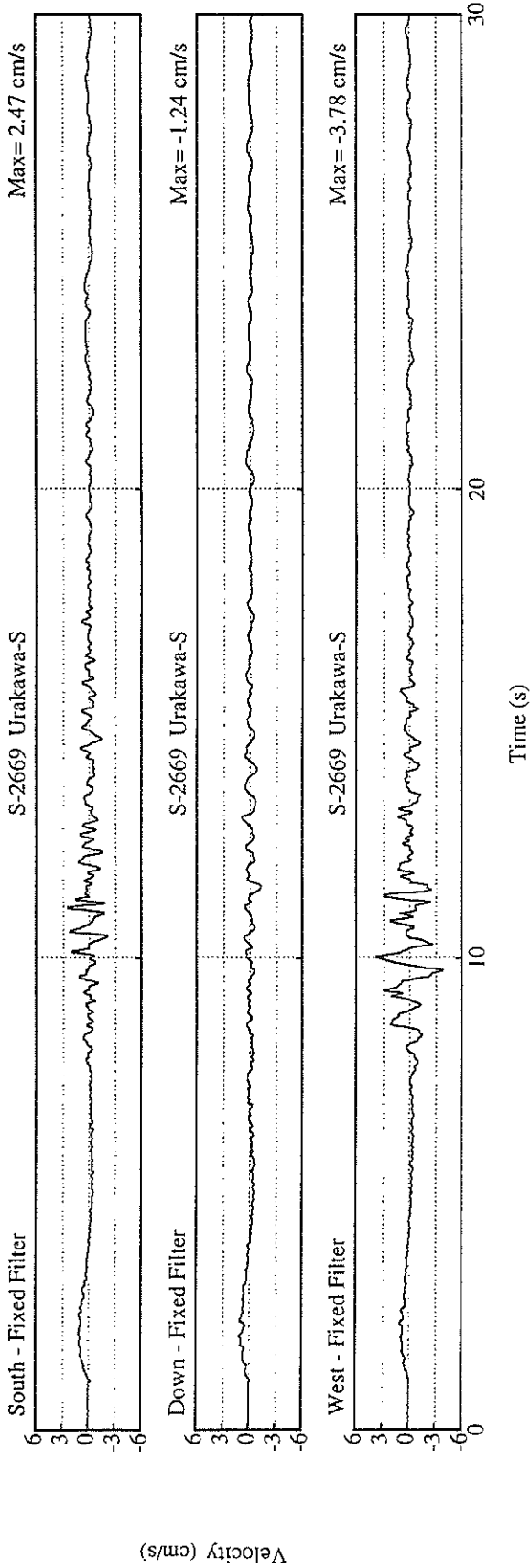
FIXED FILTER 2.47 3.78 1.24 3.79
 VARIABLE FILTER 2.31 3.97 0.98 3.98

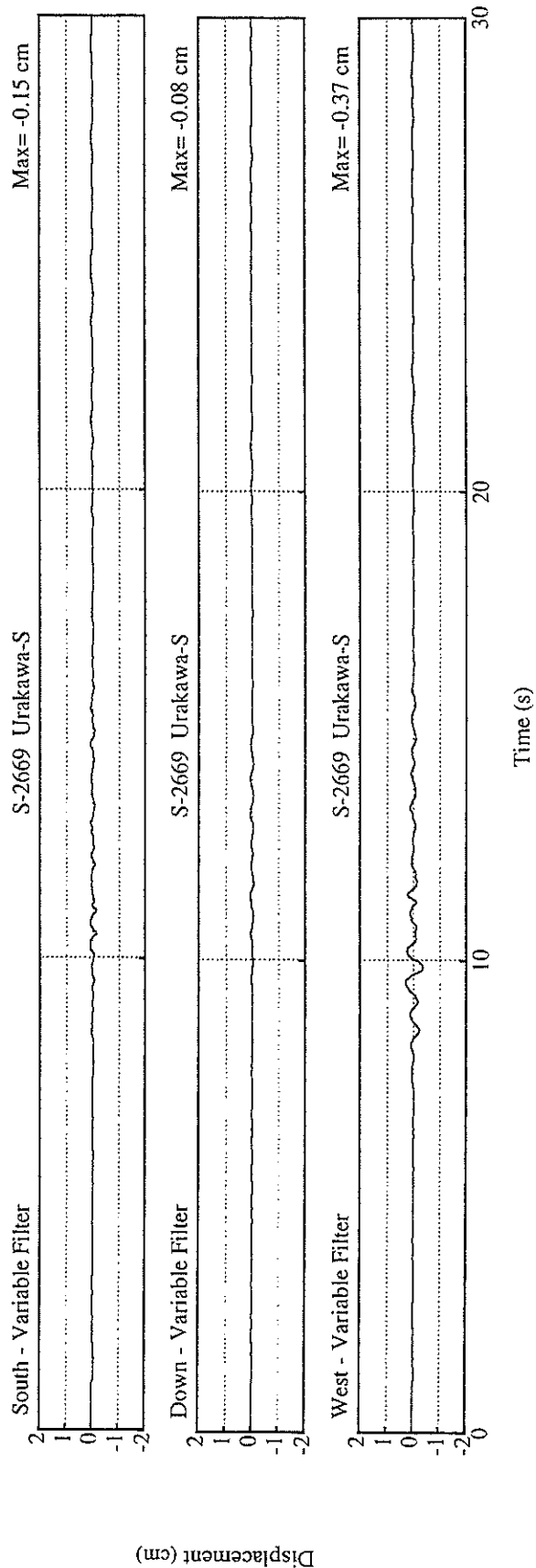
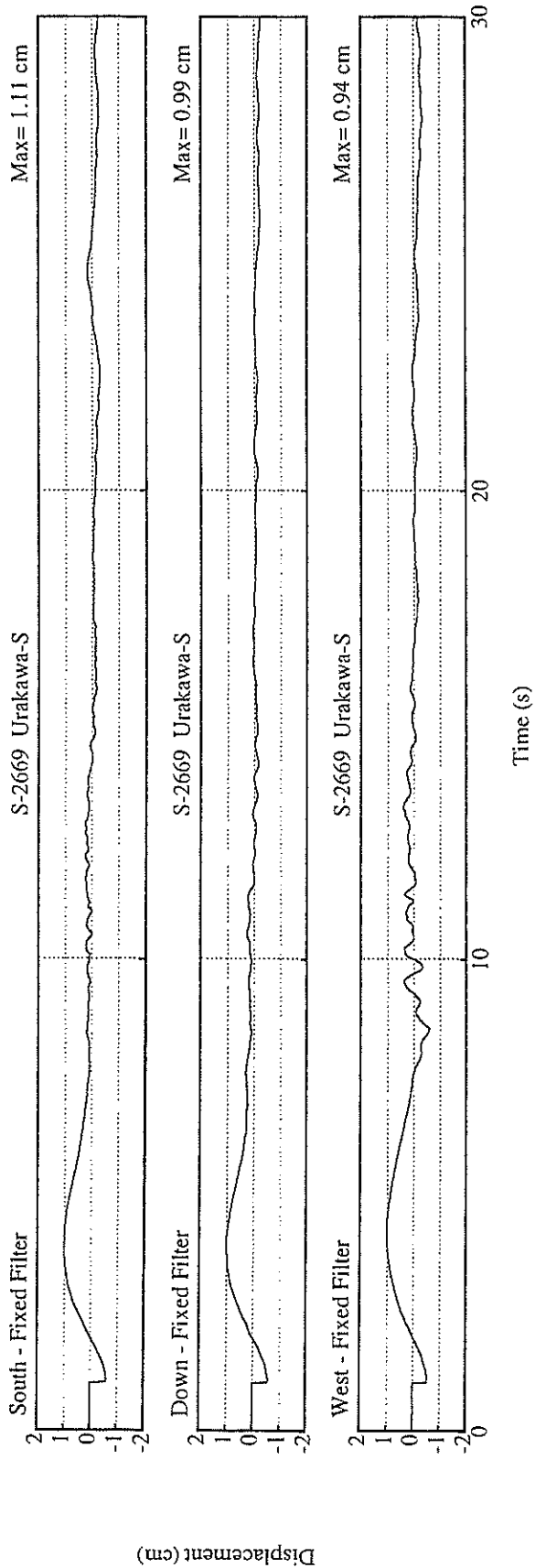
MAXIMUM DISPLACEMENT (CM)

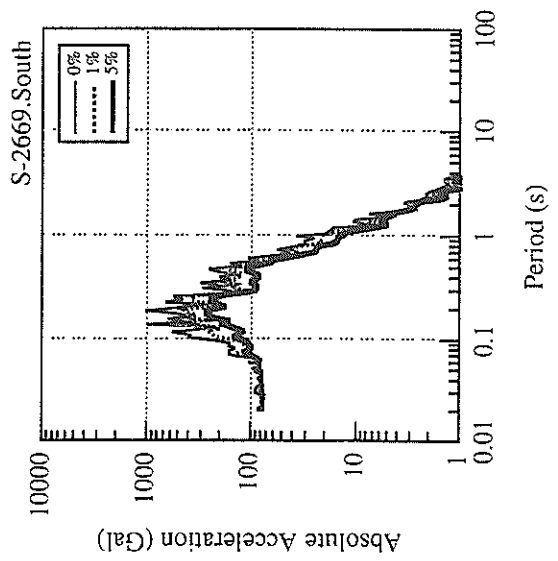
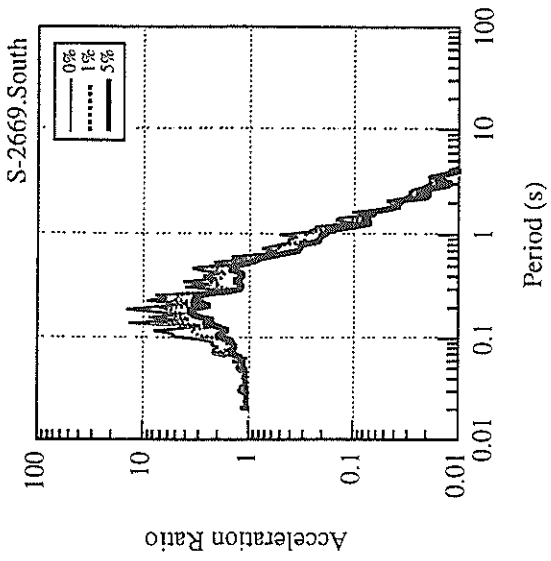
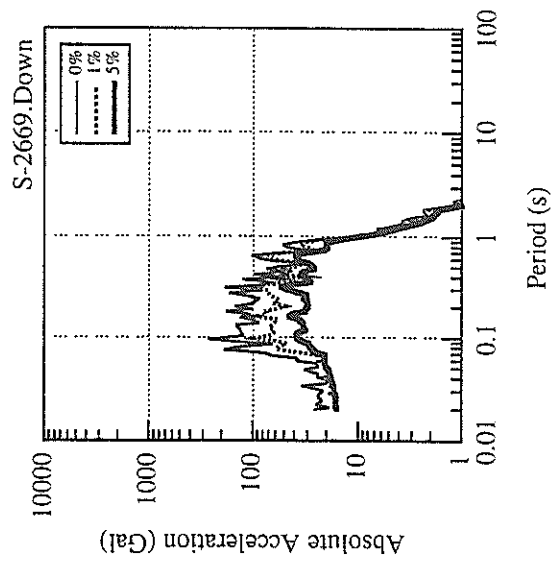
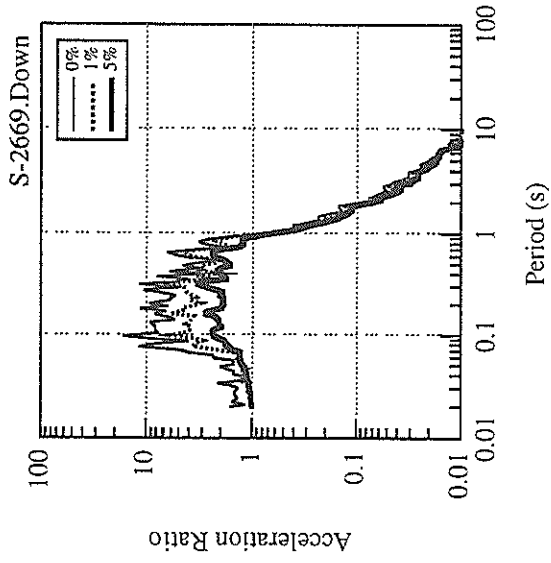
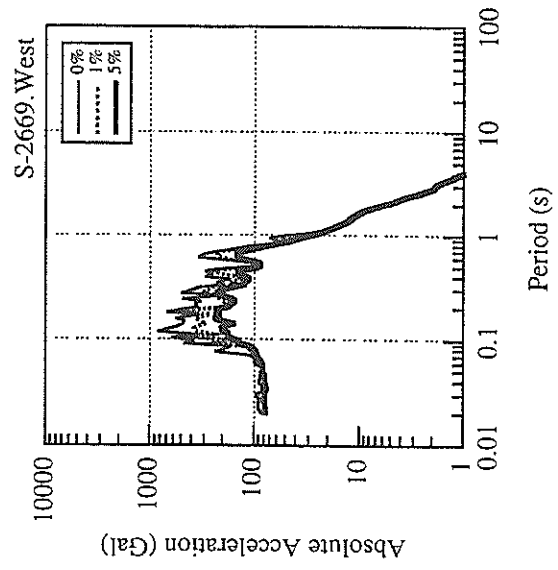
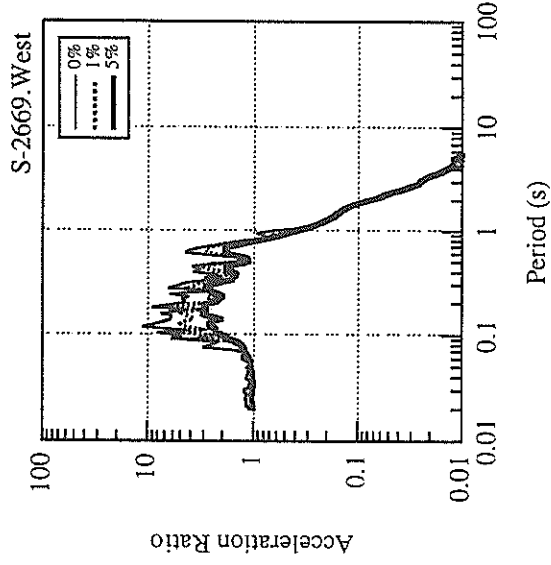
FIXED FILTER 1.11 0.94 0.99 1.45
 VARIABLE FILTER 0.15 0.37 0.08 0.37

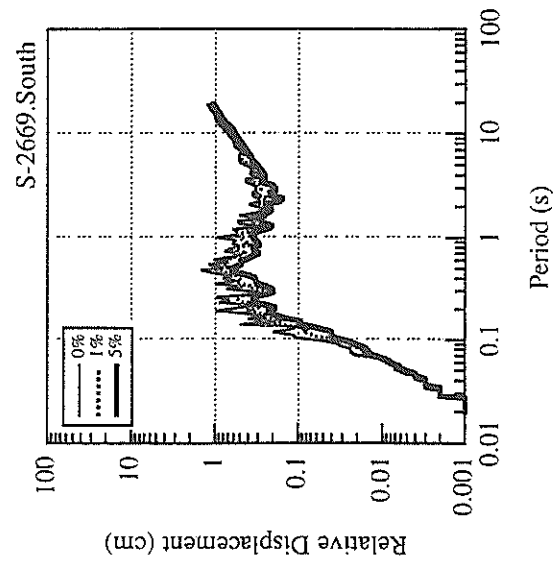
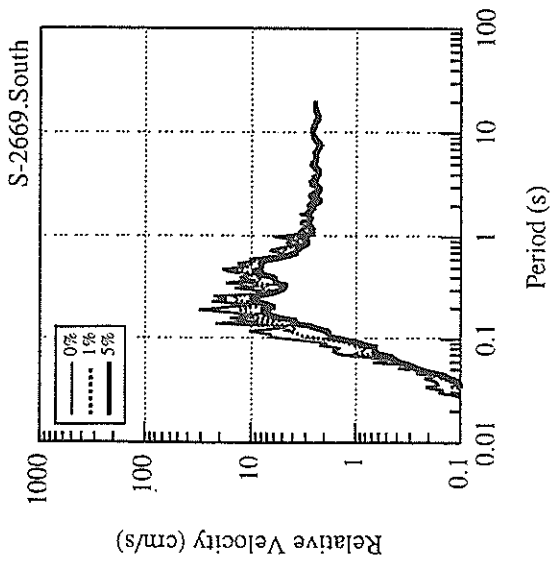
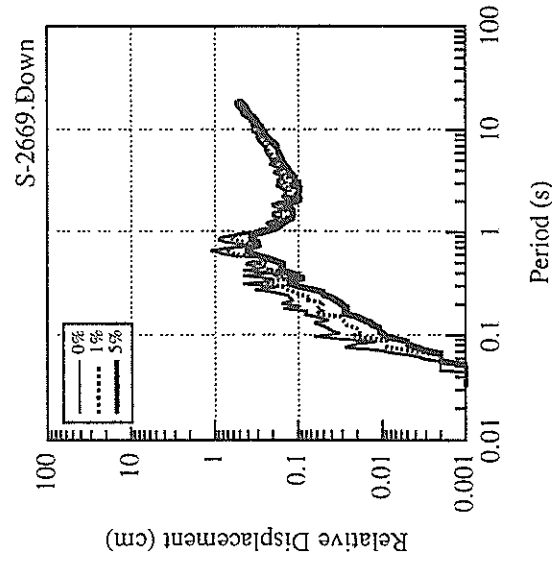
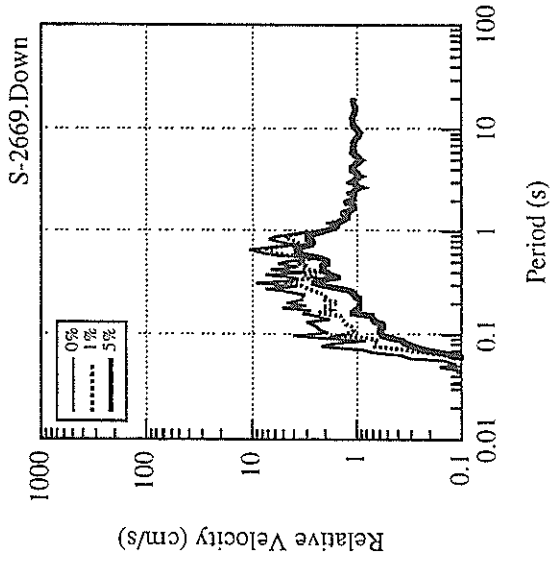
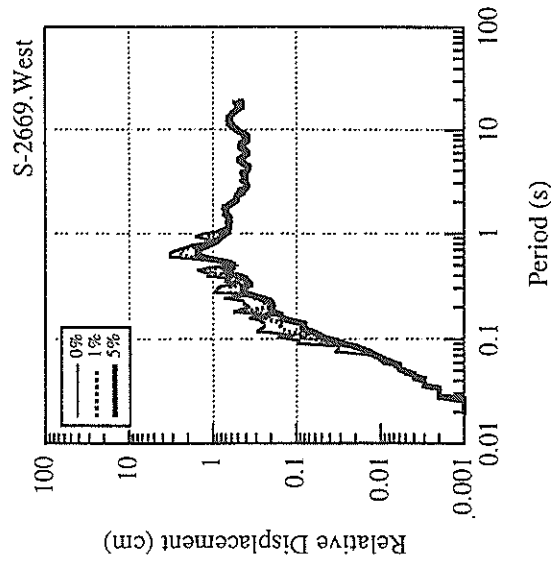
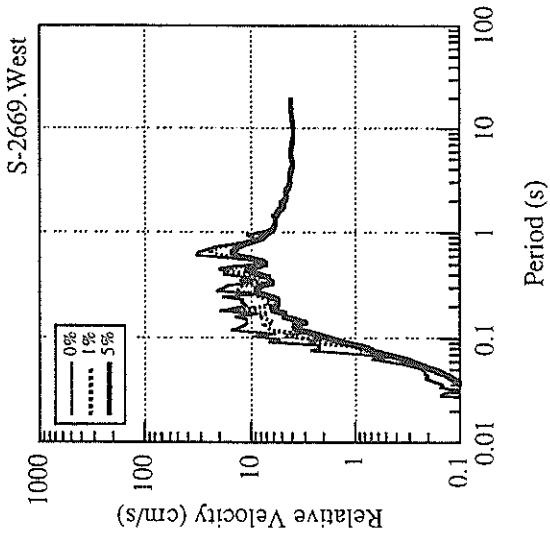
* RESULTANT OF HORIZONTAL COMPONENTS

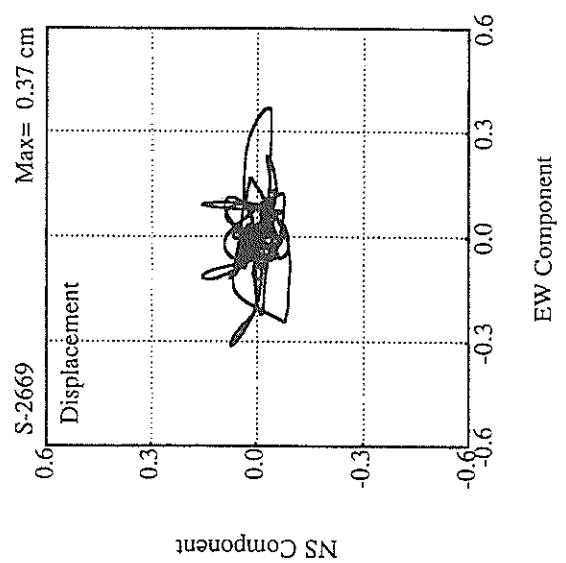
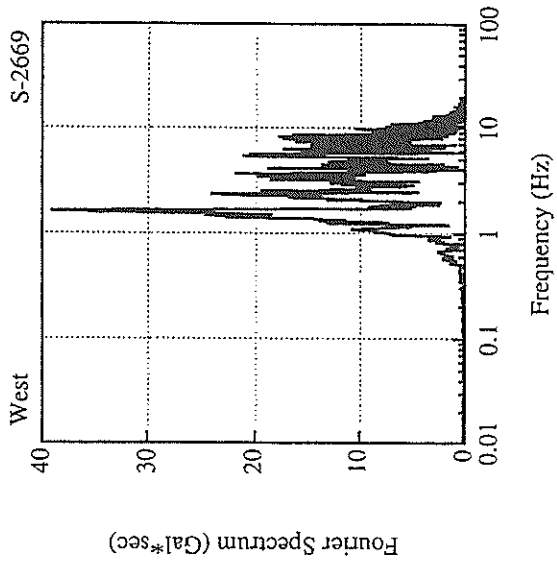
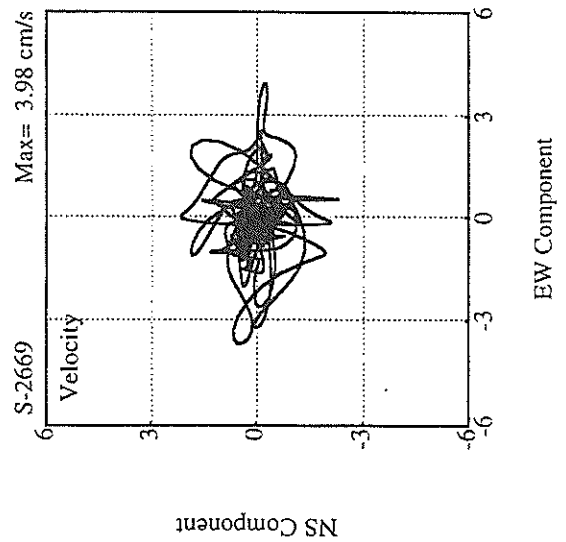
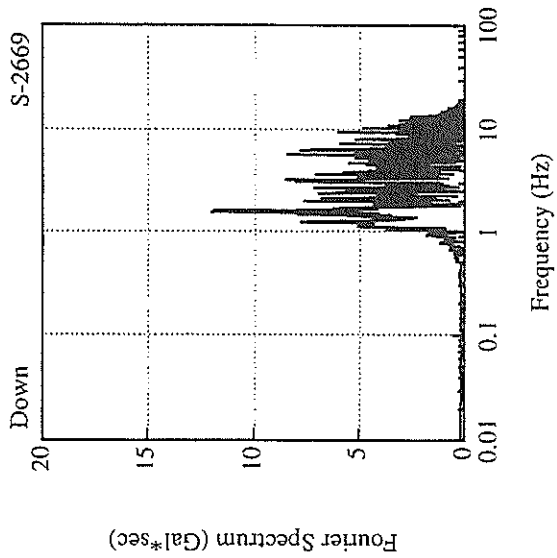
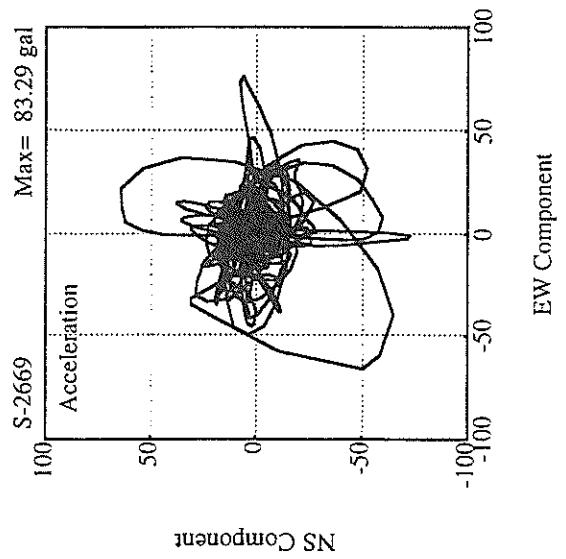
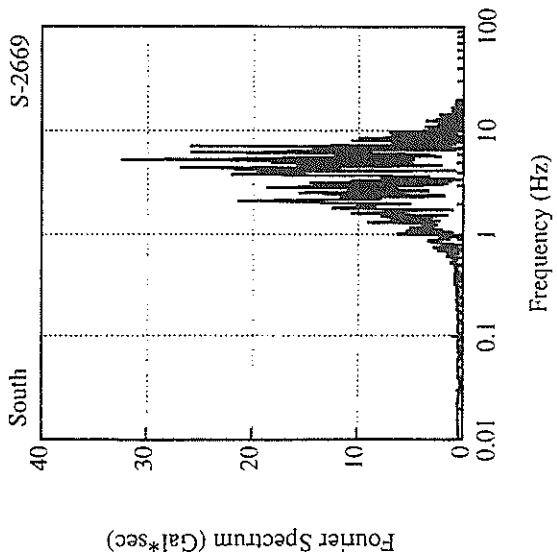












RECORD NUMBER : F-1139

STATION : YAMASHITA-F

EARTHQUAKE DATA

DATE AND TIME : 0:30 MAR. 4, 1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : E OFF IZU PENINSULA

LATITUDE : 34° 57.7' N

LONGITUDE : 139° 10.5' E

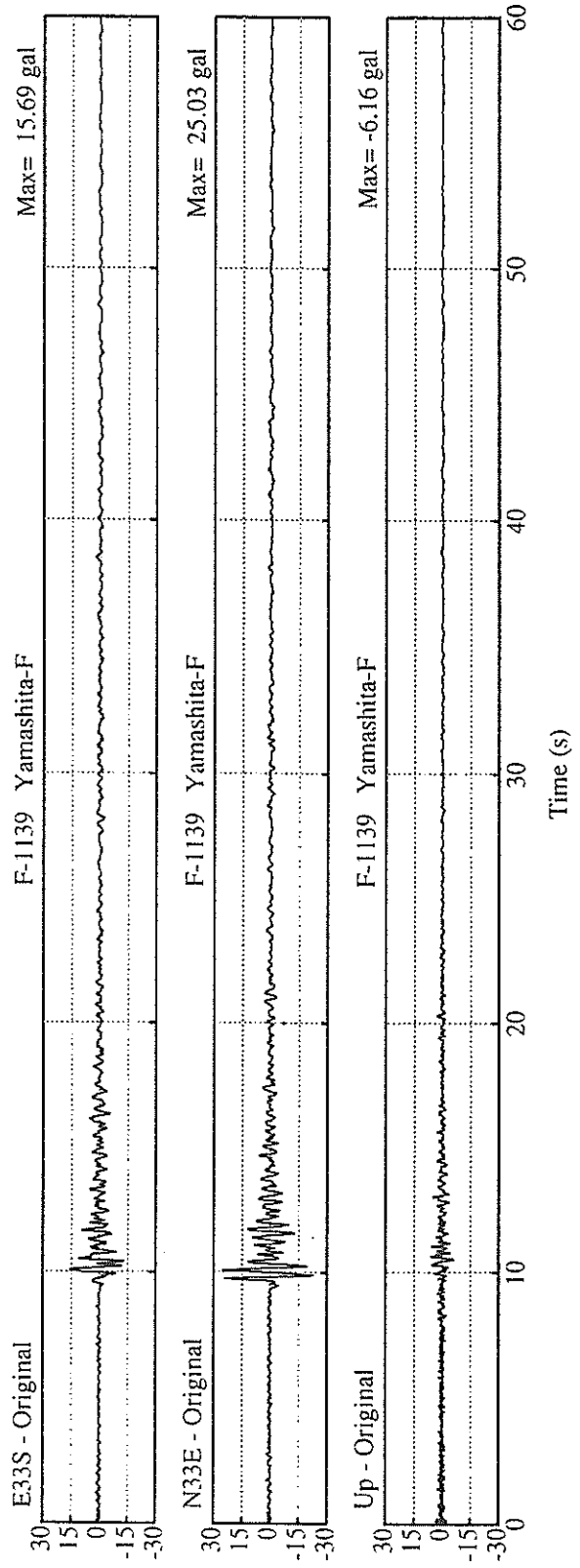
DEPTH : 0.0KM

JMA MAGNITUDE : 4.7

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	25.0	15.7	6.2	29.2

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1142

STATION : YAMASHITA-F

EARTHQUAKE DATA

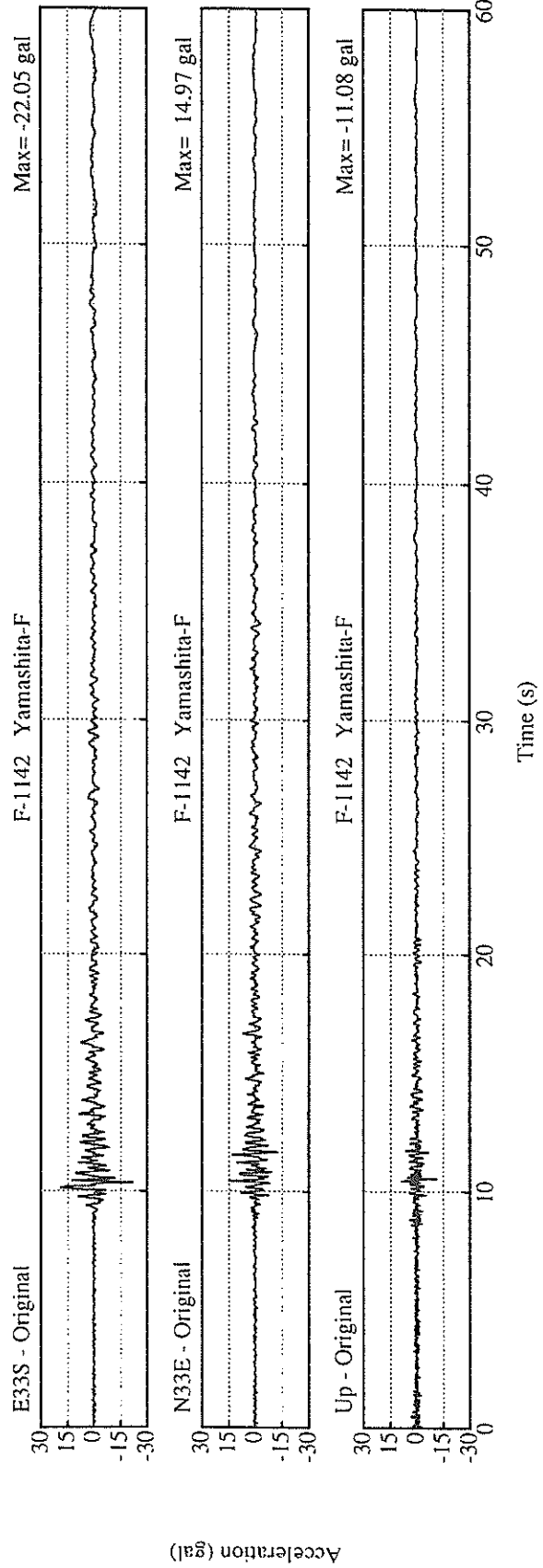
 DATE AND TIME 12:51 MAR. 4,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF IZU PENINSULA
 LATITUDE 34° 57.1' N
 LONGITUDE 139° 10.4' E
 DEPTH 2.6KM
 JMA MAGNITUDE 5.7

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
15.0	22.0	11.1	23.2

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1117

STATION : TSURUGA-G

EARTHQUAKE DATA

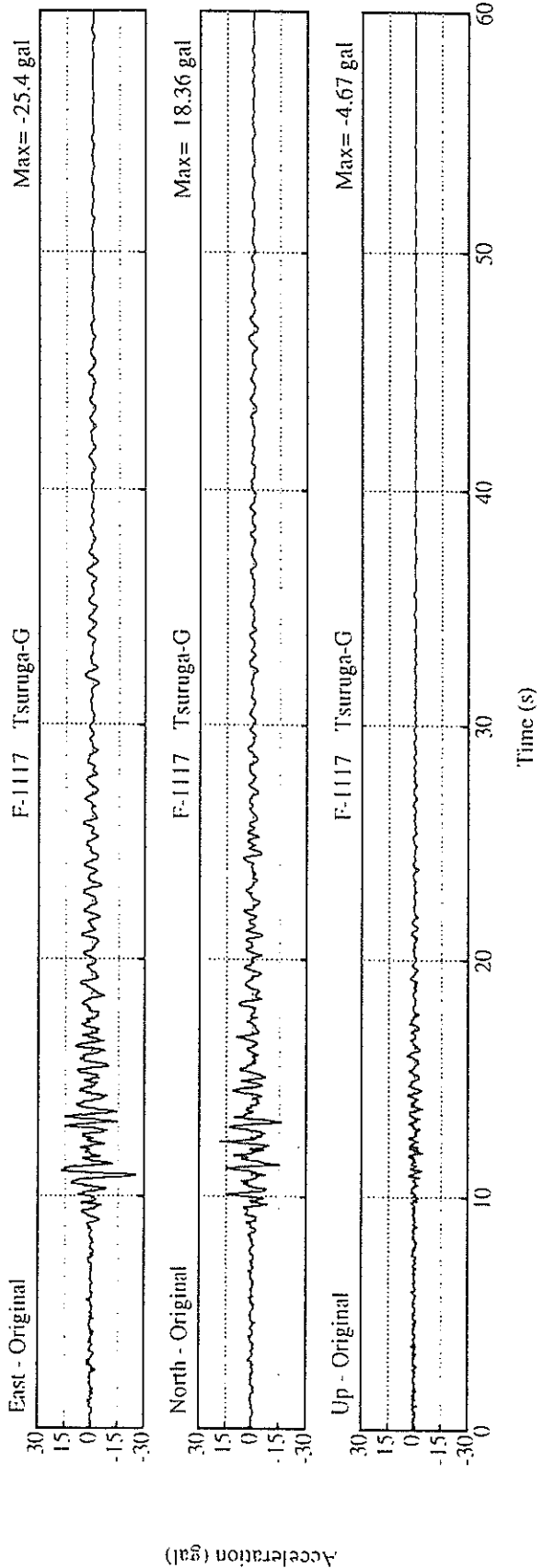
 DATE AND TIME 14:51 MAR.16,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NE AICHI PREF
 LATITUDE 34°55.5' N
 LONGITUDE 137°31.7' E
 DEPTH 39.1KM
 JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
18.4	25.4	4.7	26.3

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1119
 STATION : MIKAWA-G

EARTHQUAKE DATA

 DATE AND TIME 14:51 MAR.16,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NE AICHI PREF
 LATITUDE 34°55.5' N
 LONGITUDE 137°31.7' E
 DEPTH 39.1KM
 JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

 N S E W U D HORIZONTAL*

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.286 0.366 0.372

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT 121.2 108.4 34.5 136.8
 ORIGINAL 177.2 148.2 100.7 194.4
 CORRECTED 175.7 152.8 87.0 194.3

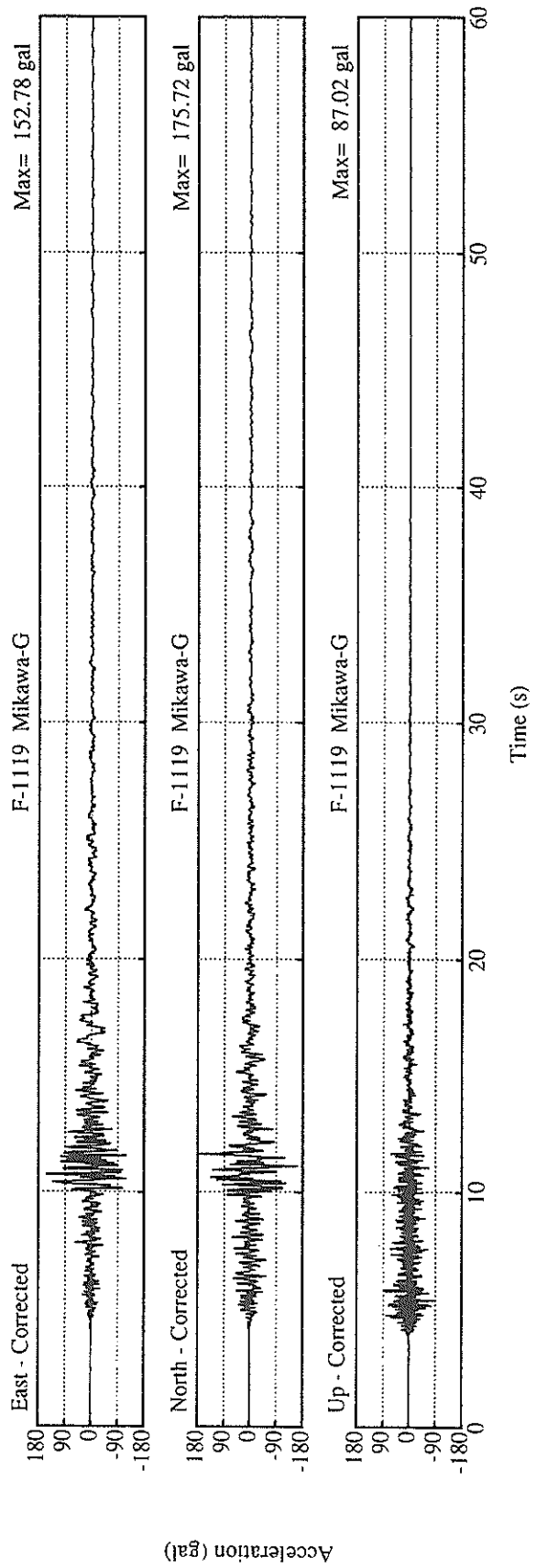
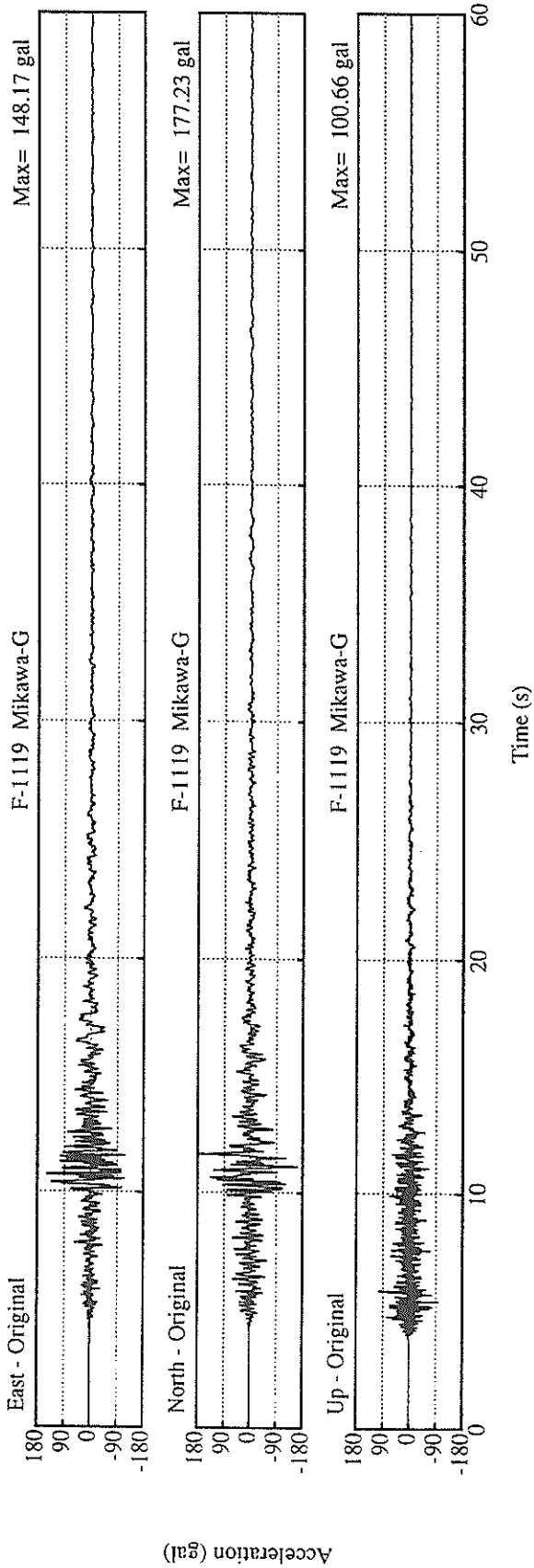
MAXIMUM VELOCITY (CM/SEC)

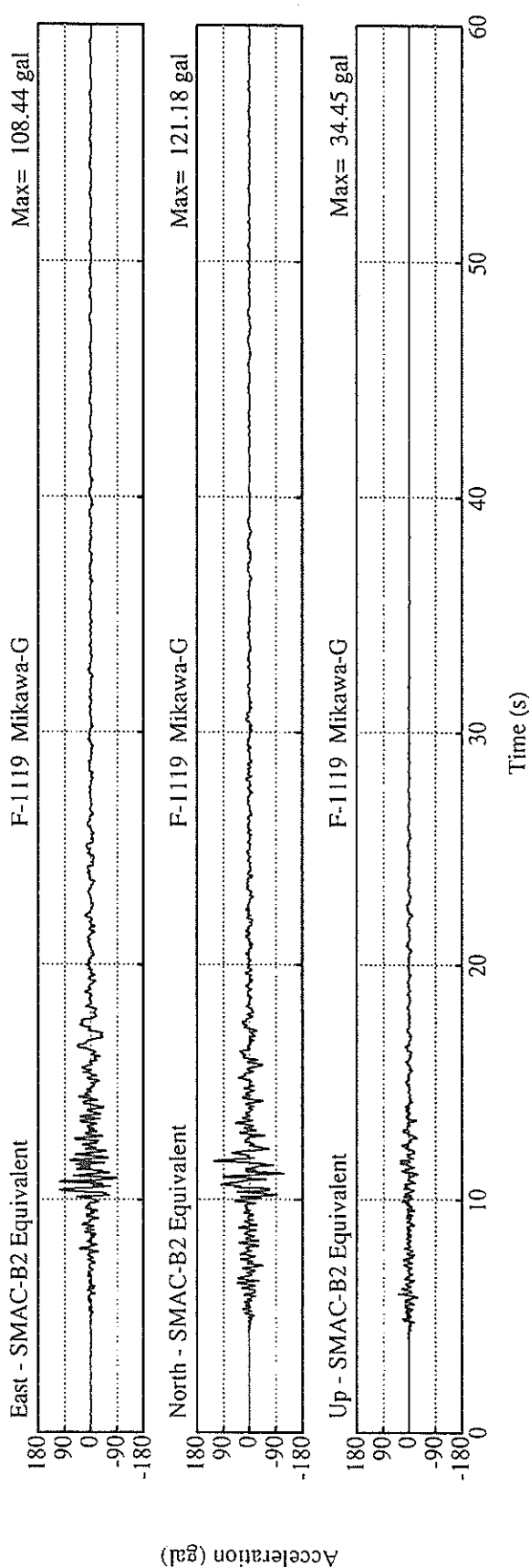
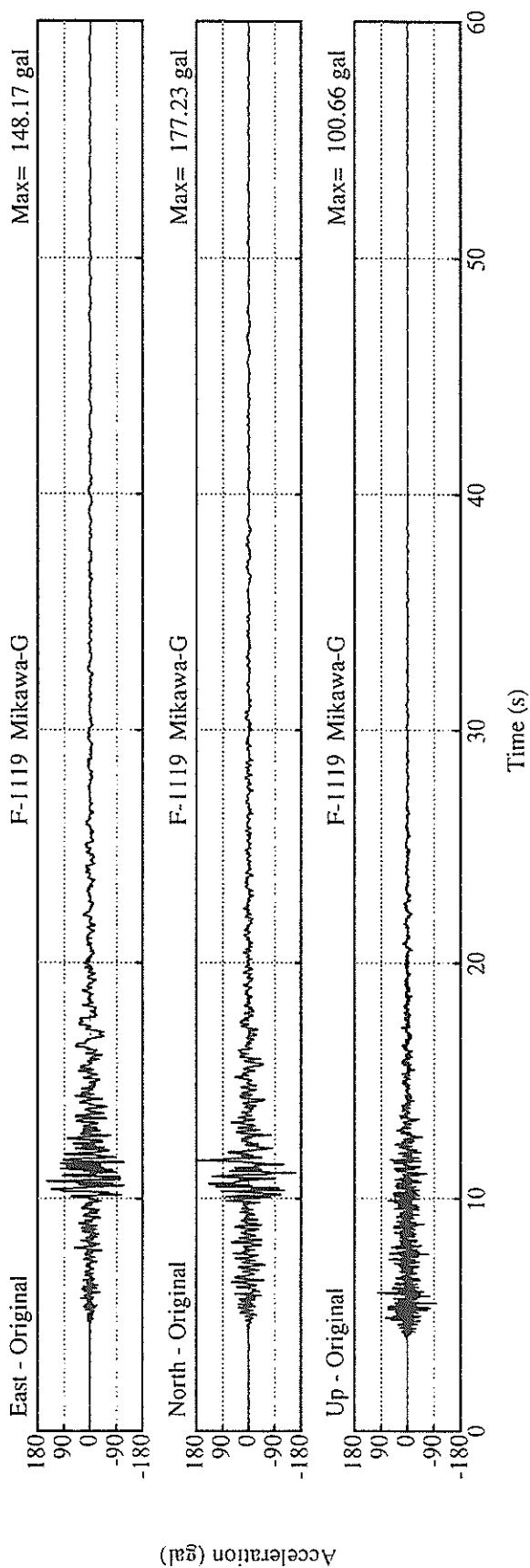
FIXED FILTER 12.28 8.30 3.27 14.32
 VARIABLE FILTER 12.13 8.42 3.20 13.78

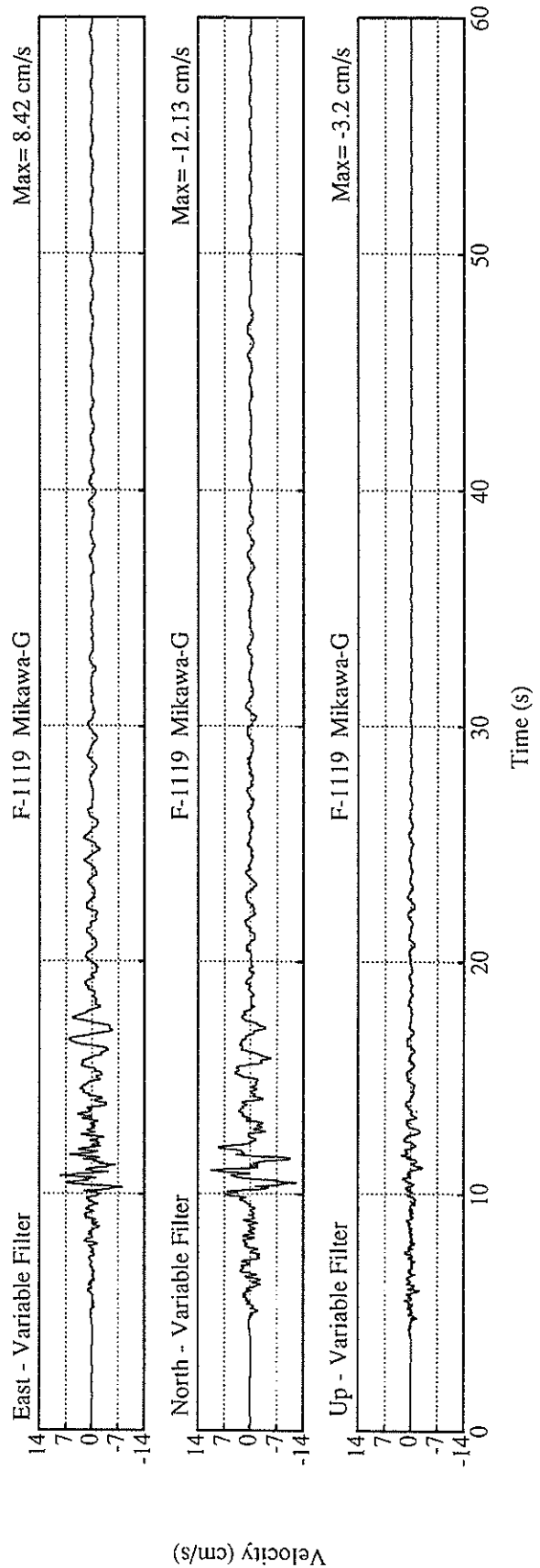
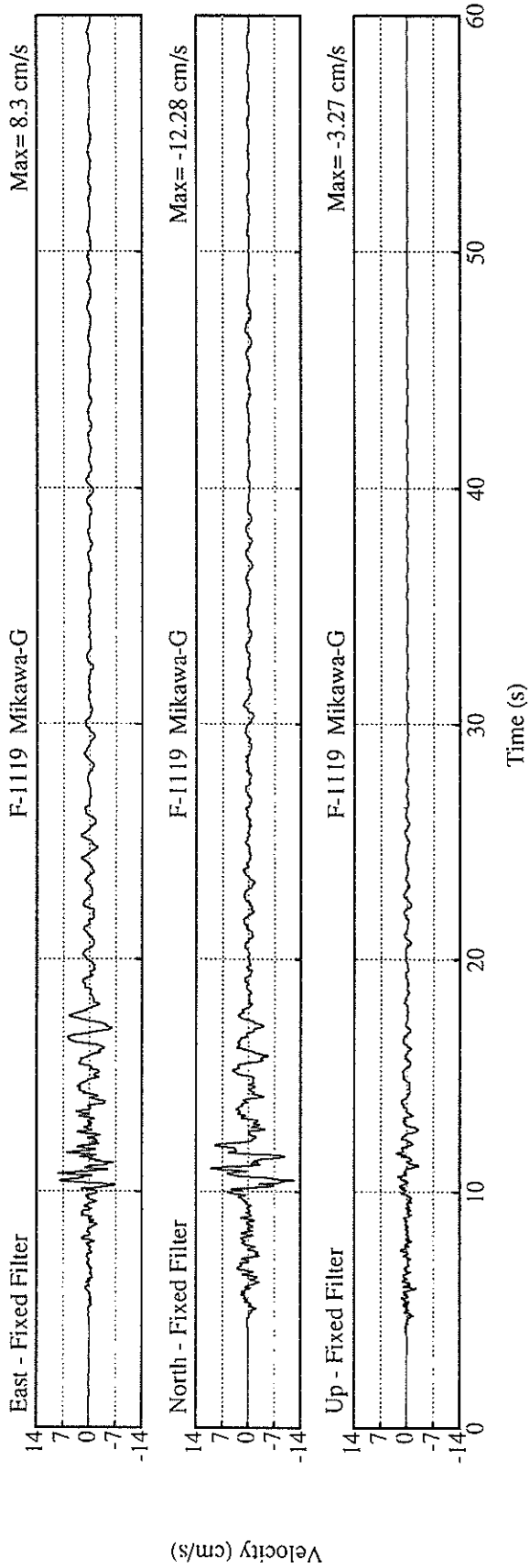
MAXIMUM DISPLACEMENT (CM)

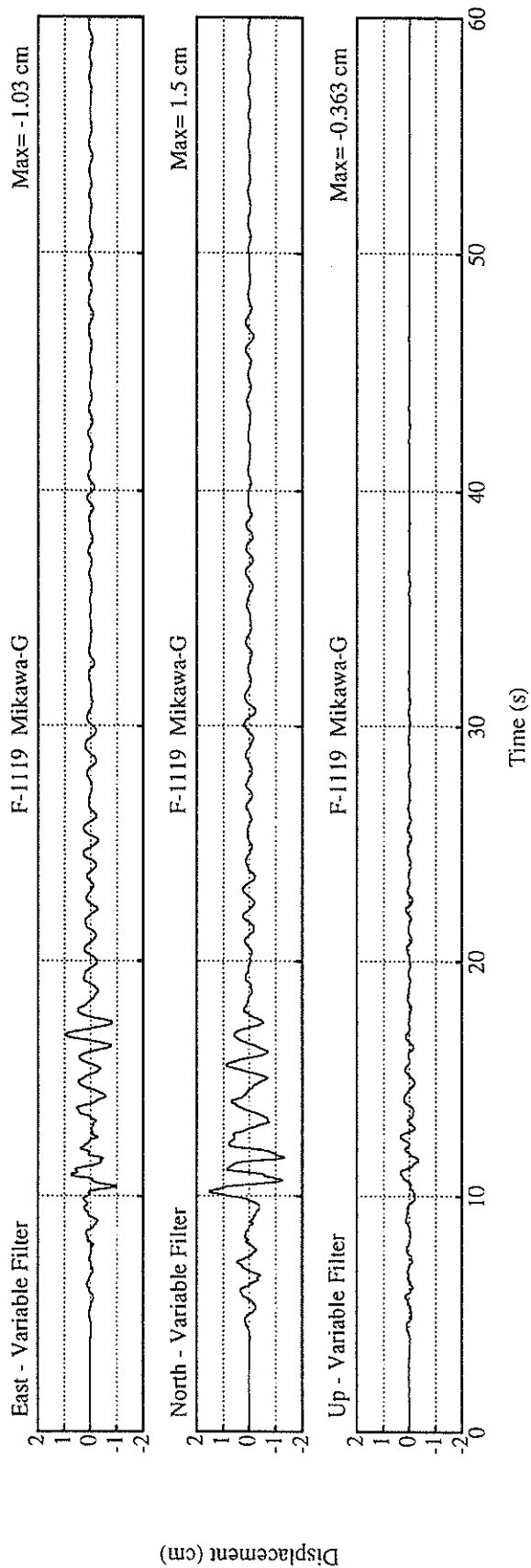
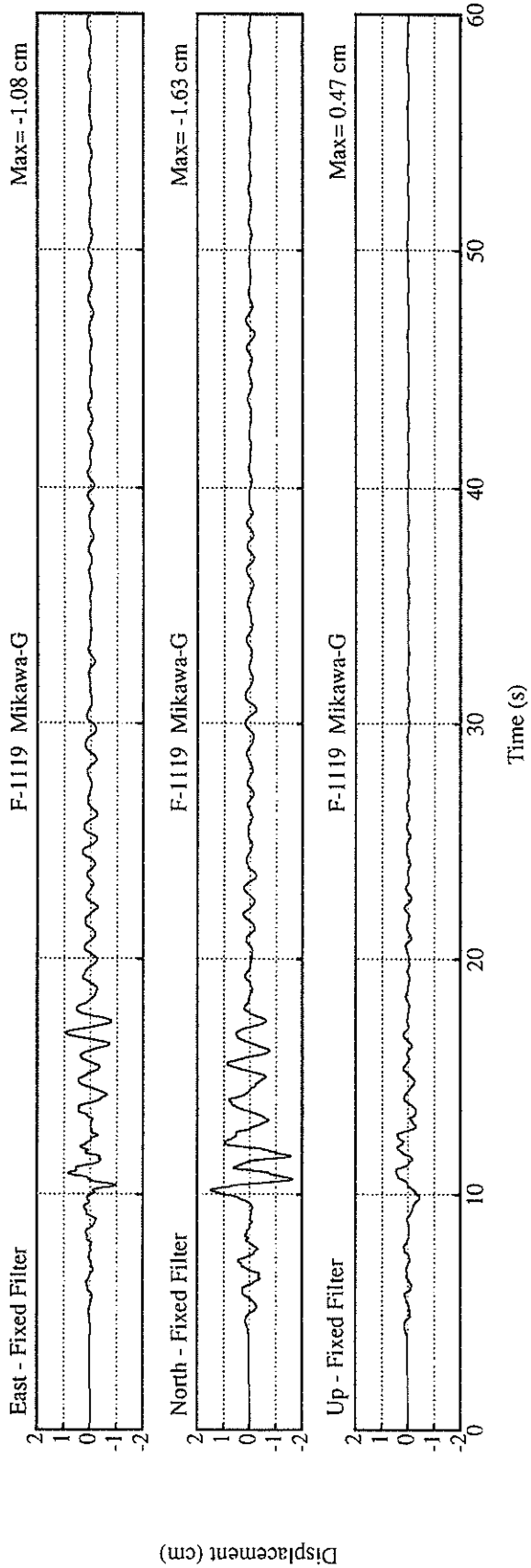
FIXED FILTER 1.63 1.08 0.47 1.63
 VARIABLE FILTER 1.50 1.03 0.36 1.50

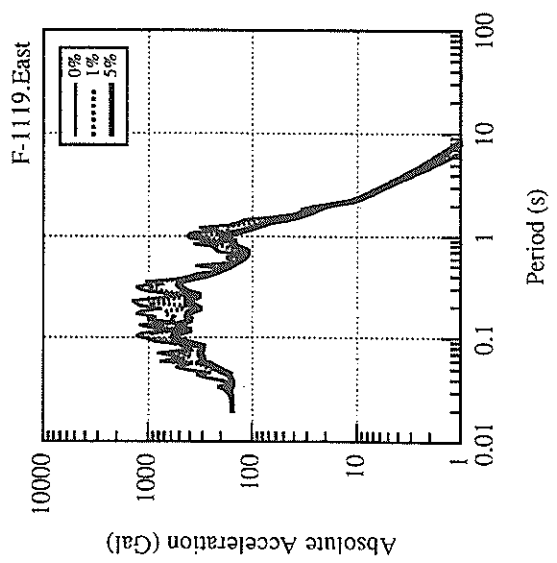
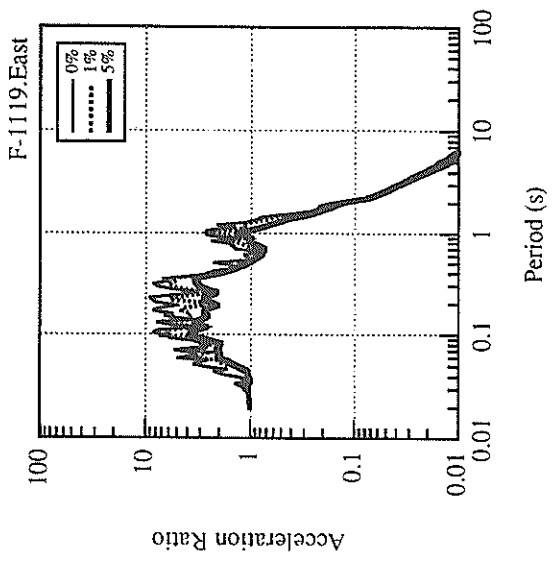
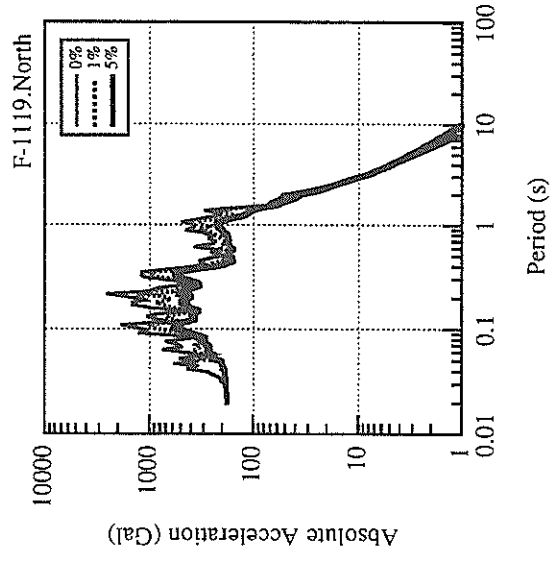
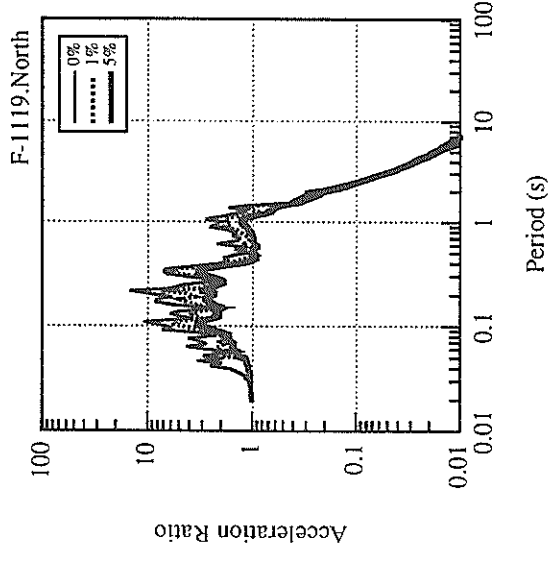
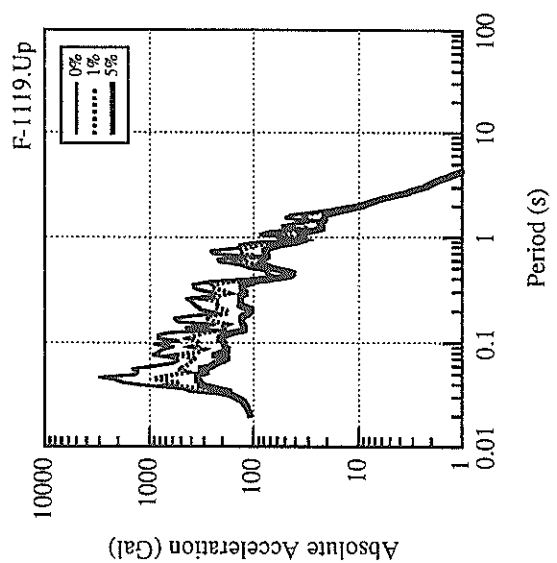
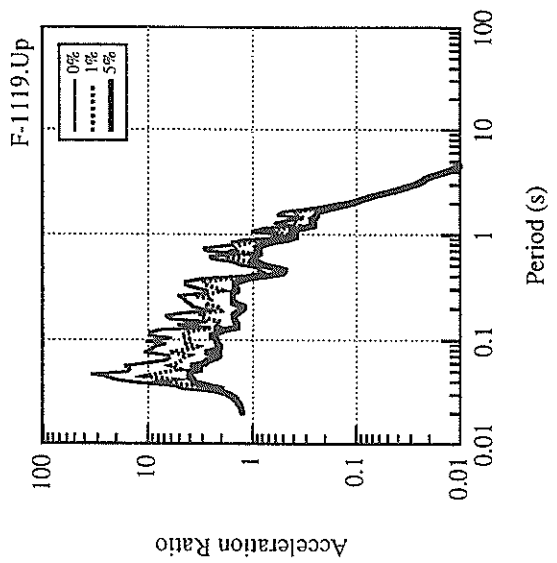
* RESULTANT OF HORIZONTAL COMPONENTS

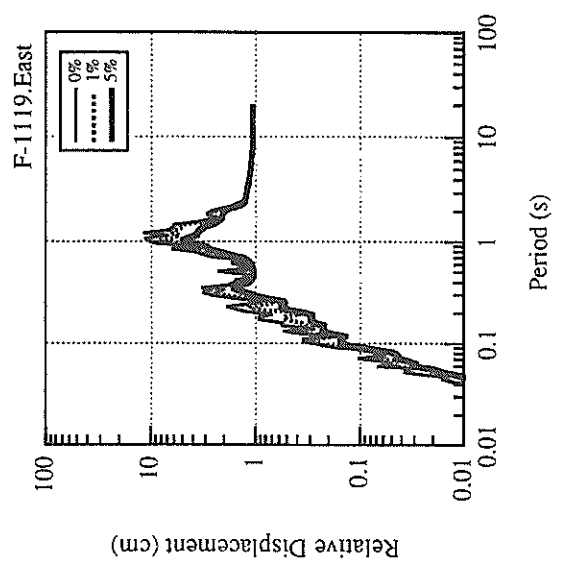
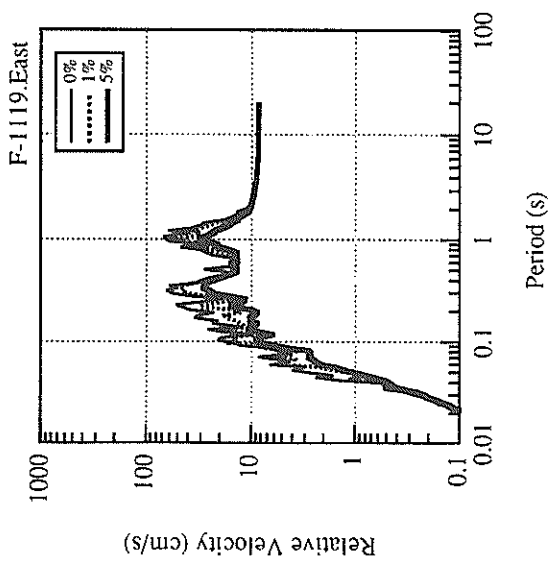
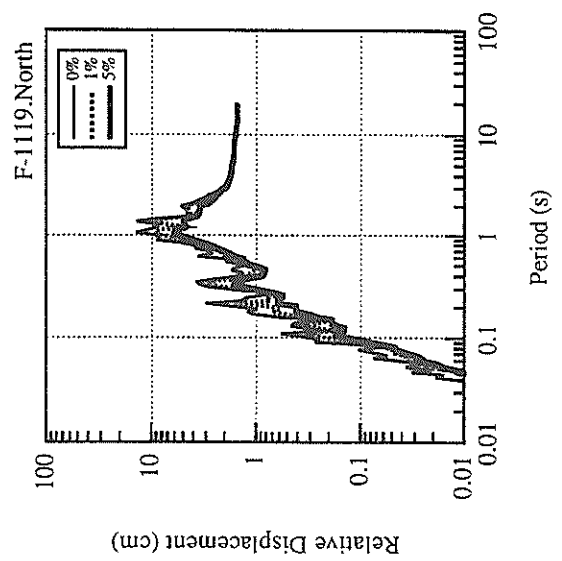
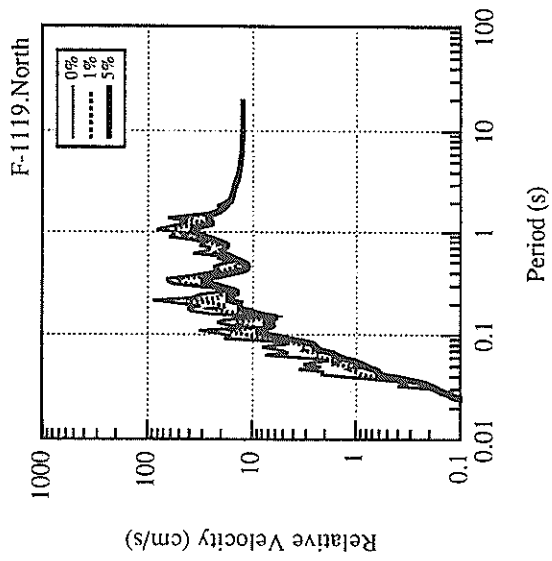
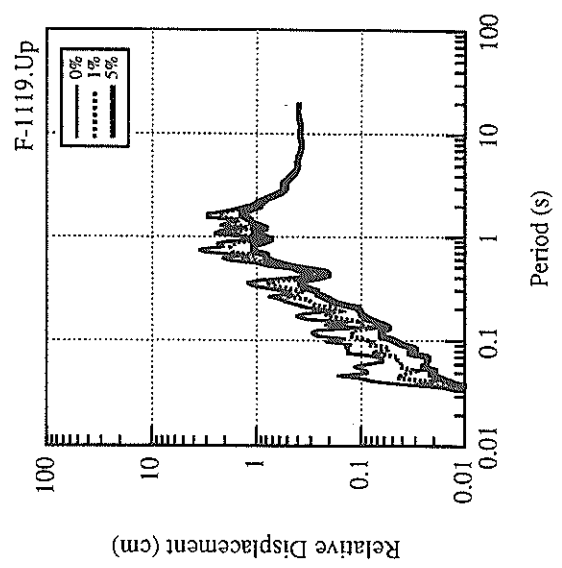
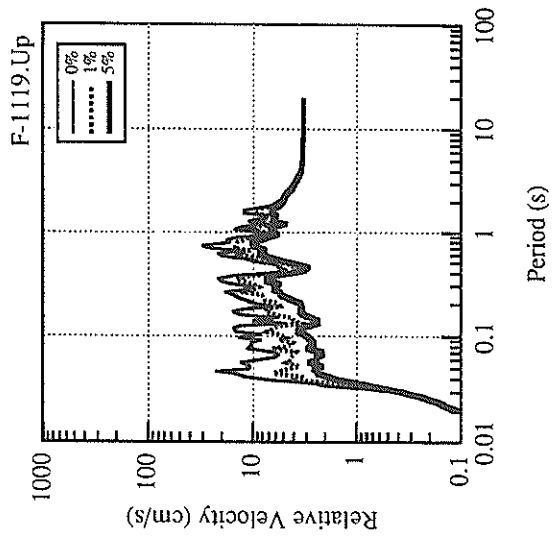


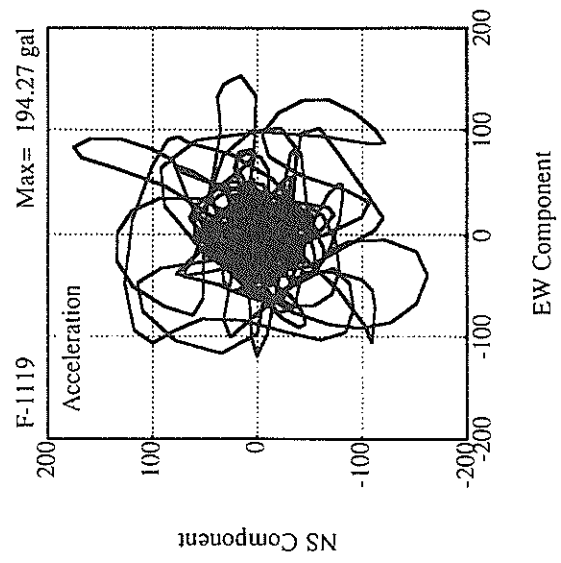
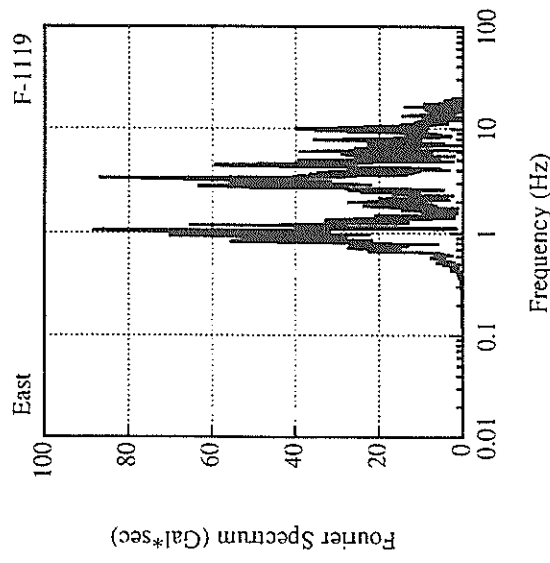
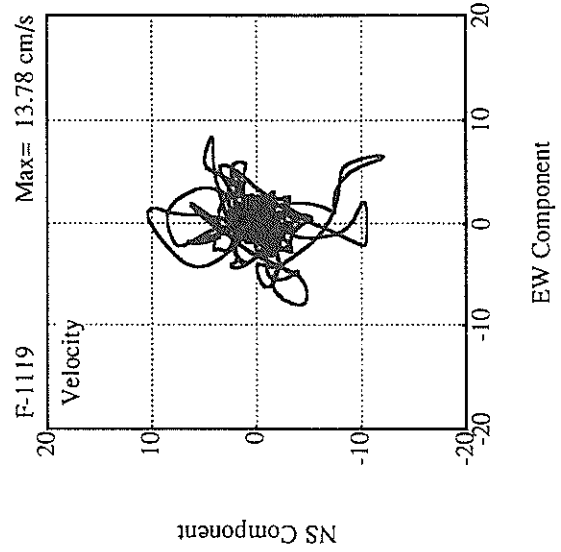
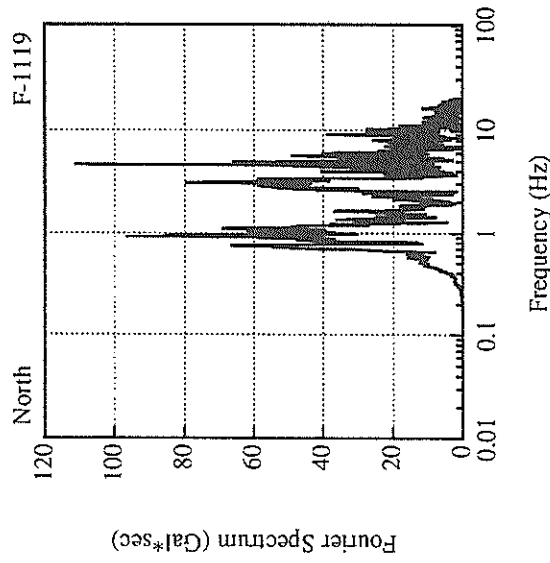
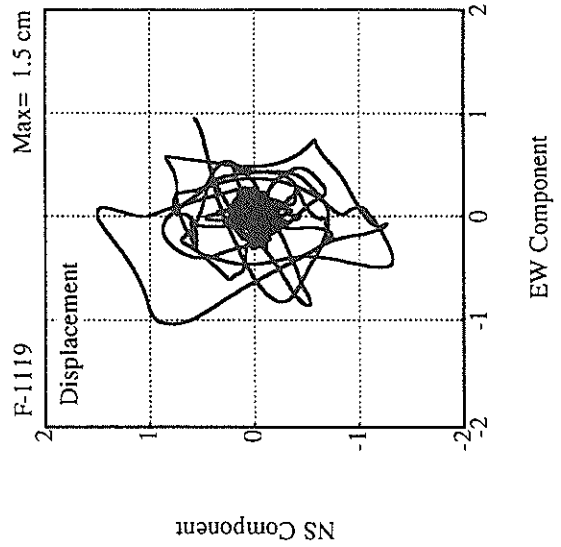
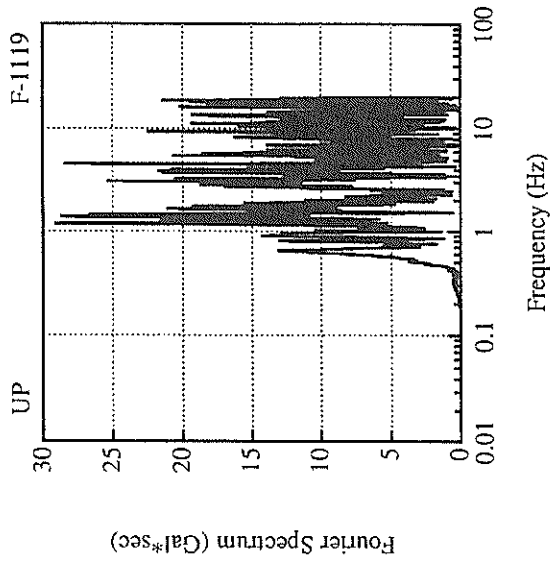












RECORD NUMBER : F-1120

STATION : NAGOYA-SORAMI-GB

EARTHQUAKE DATA

DATE AND TIME 14:51 MAR.16,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION NE AICHI PREF

LATITUDE 34°55.5' N

LONGITUDE 137°31.7' E

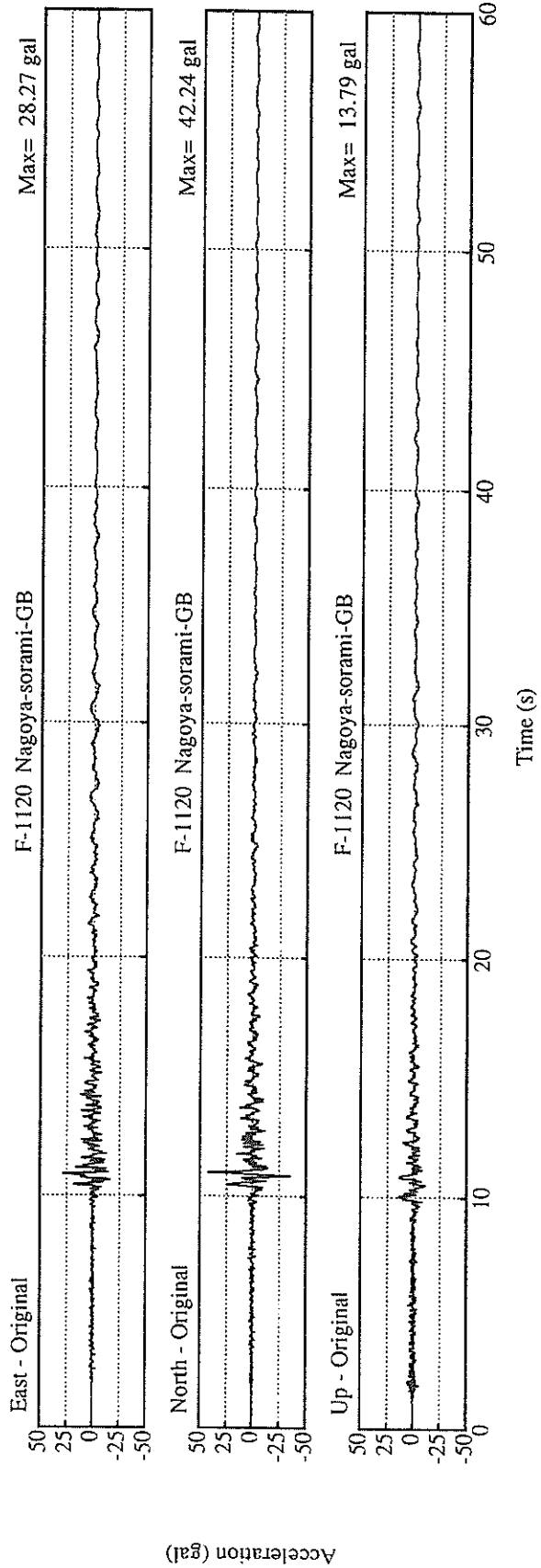
DEPTH 39.1KM

JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	42.2	28.3	13.8	44.0

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1121

STATION : NAGOYA-SORAMI-G

EARTHQUAKE DATA

 DATE AND TIME 14:51 MAR.16.1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NE AICHI PREF
 LATITUDE 34° 55.5' N
 LONGITUDE 137° 31.7' E
 DEPTH 39.1KM
 JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.298	0.292	0.317	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.298 0.292 0.317

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	71.3	83.6	17.2	97.6
ORIGINAL	88.7	101.4	31.6	127.4
CORRECTED	88.3	101.6	33.8	126.7

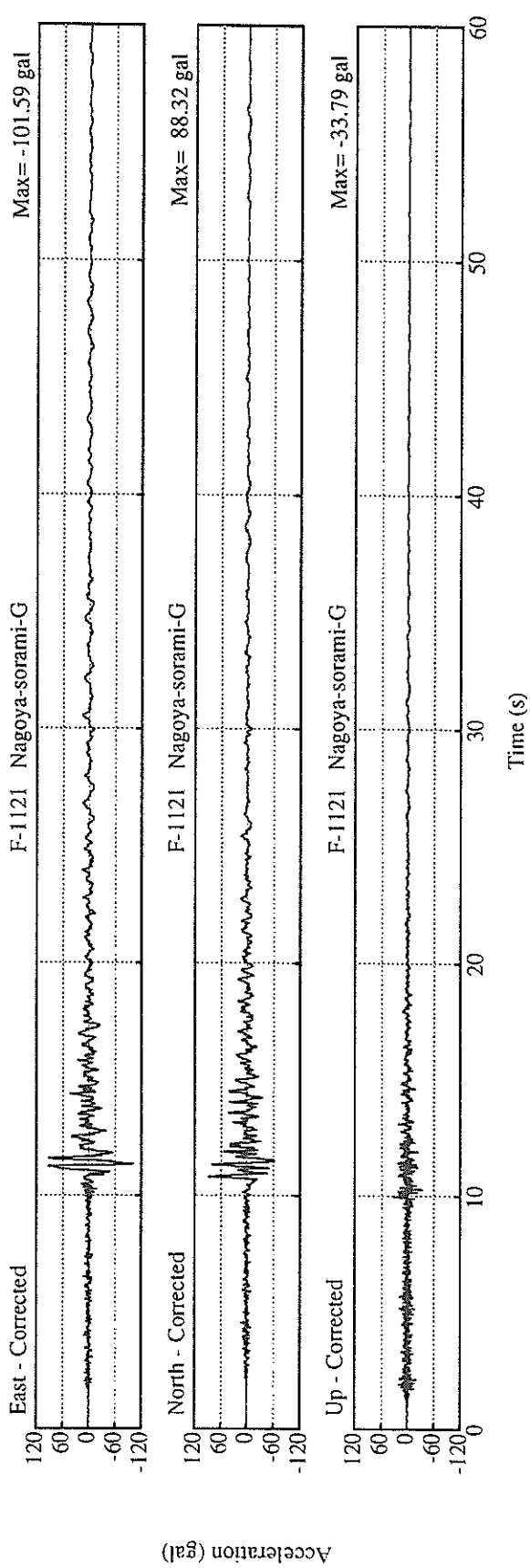
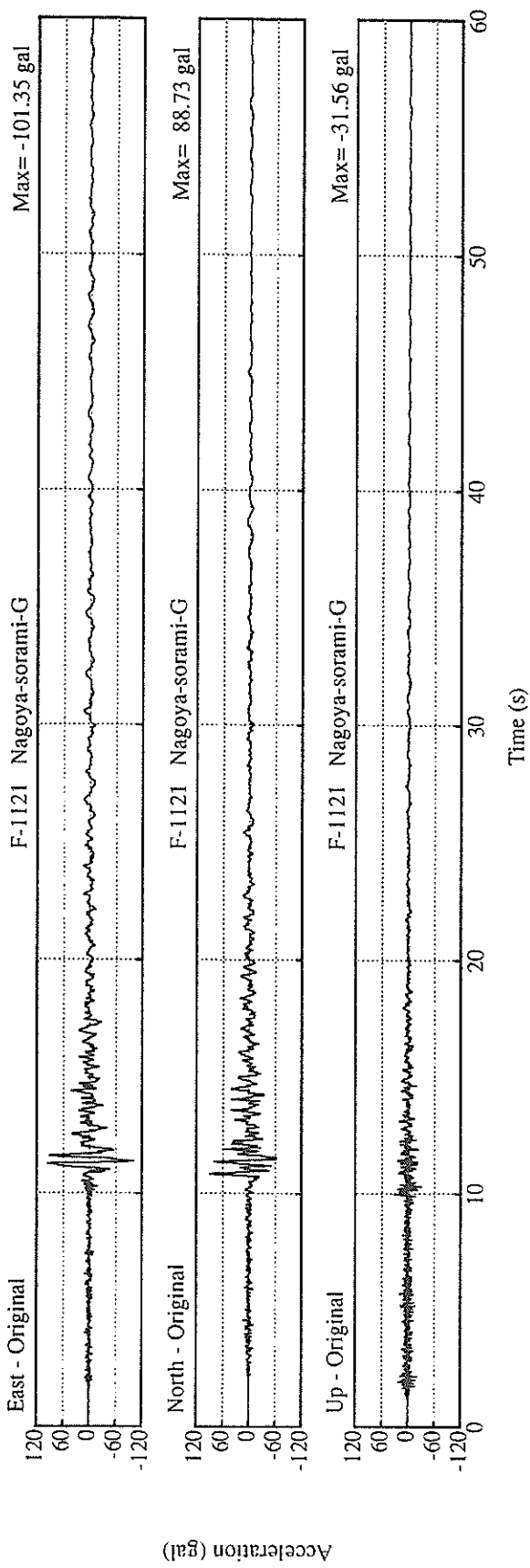
MAXIMUM VELOCITY (CM/SEC)

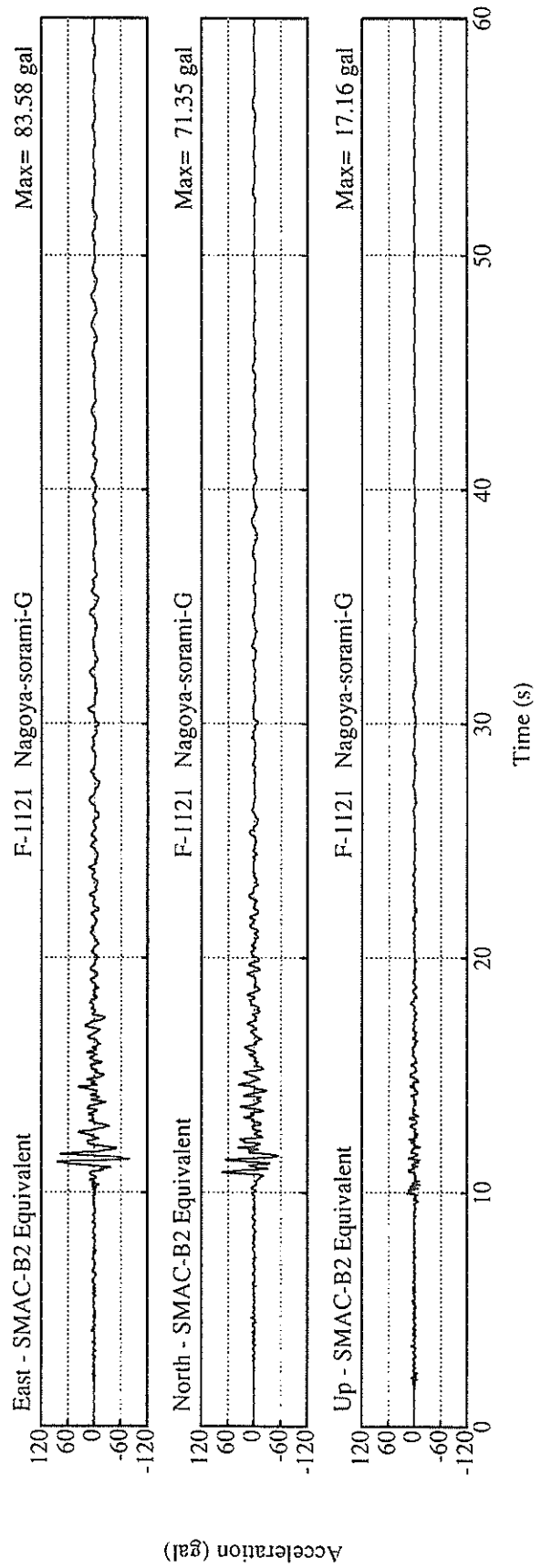
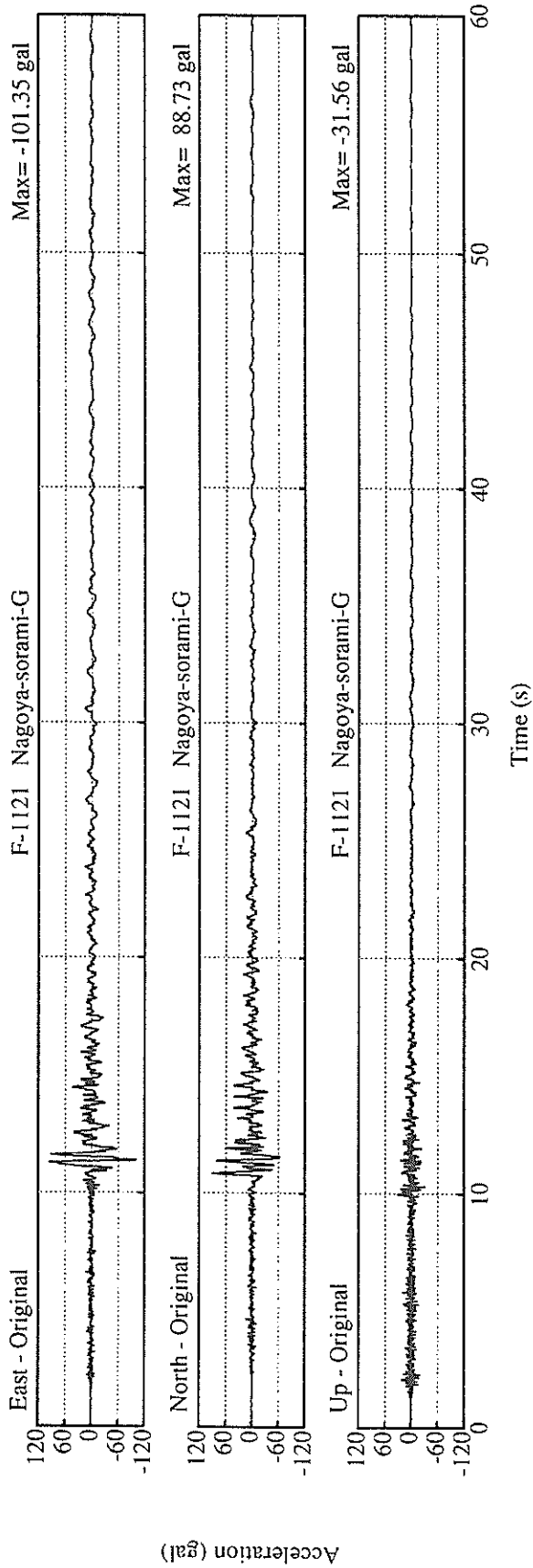
FIXED FILTER	5.67	9.10	1.50	9.10
VARIABLE FILTER	5.75	8.82	1.48	8.82

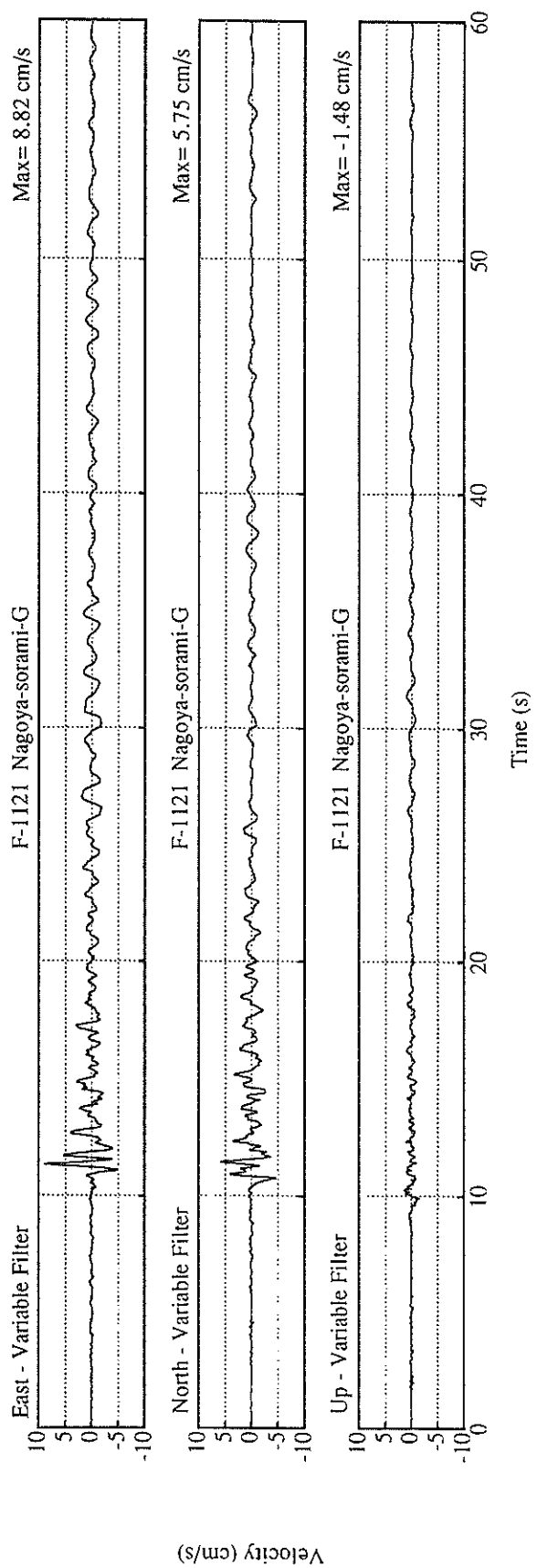
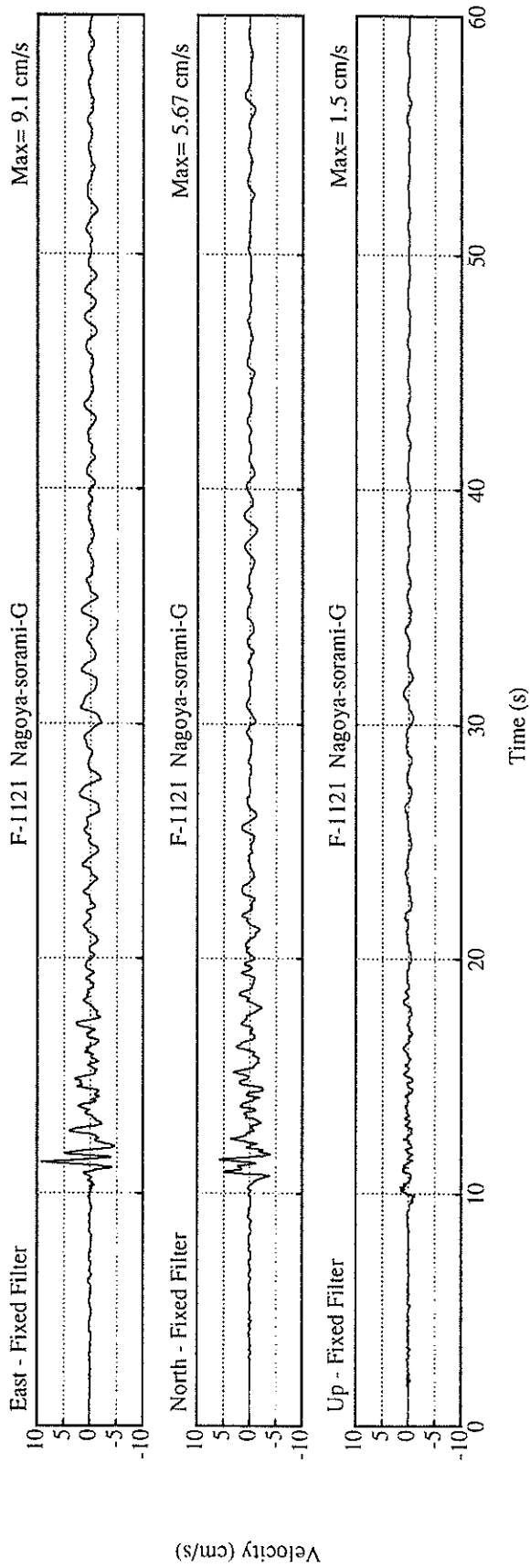
MAXIMUM DISPLACEMENT (CM)

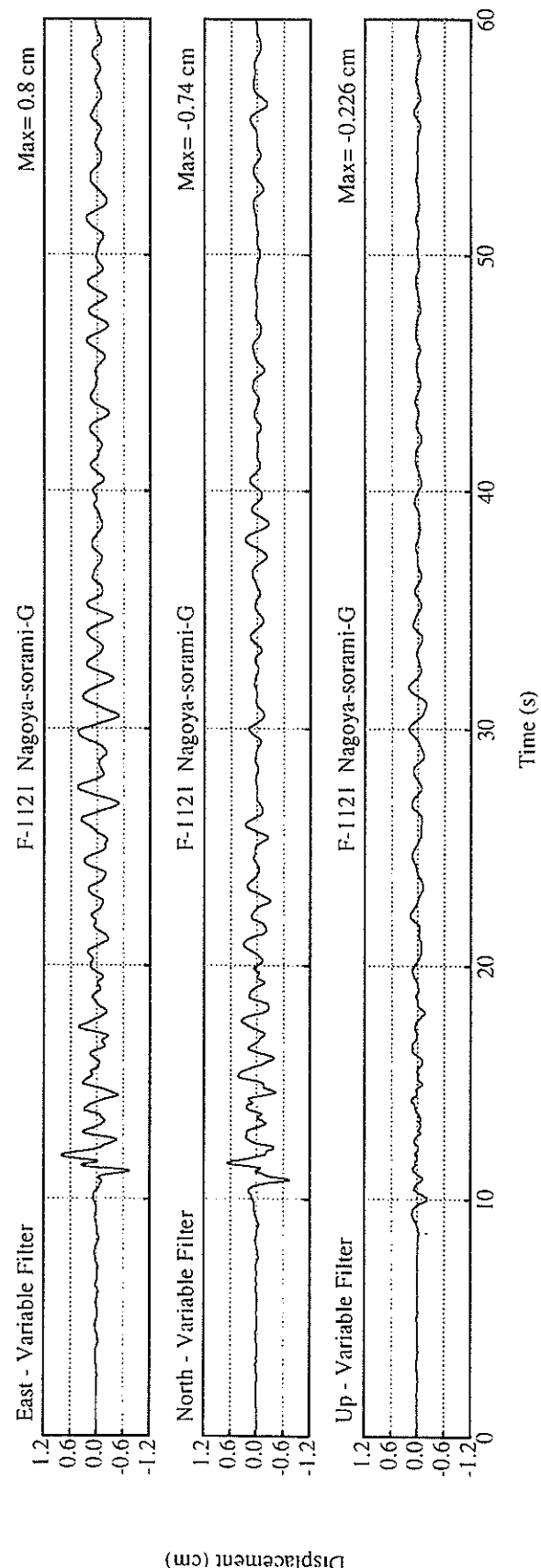
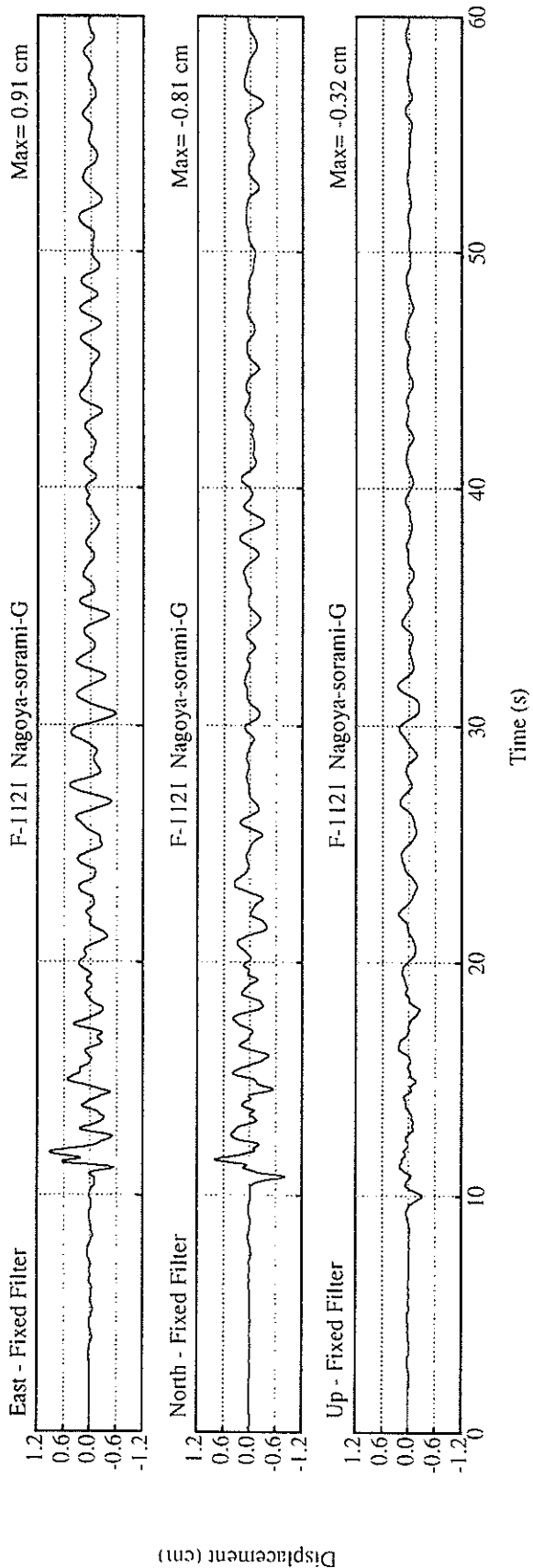
FIXED FILTER	0.81	0.91	0.32	0.91
VARIABLE FILTER	0.74	0.80	0.23	0.81

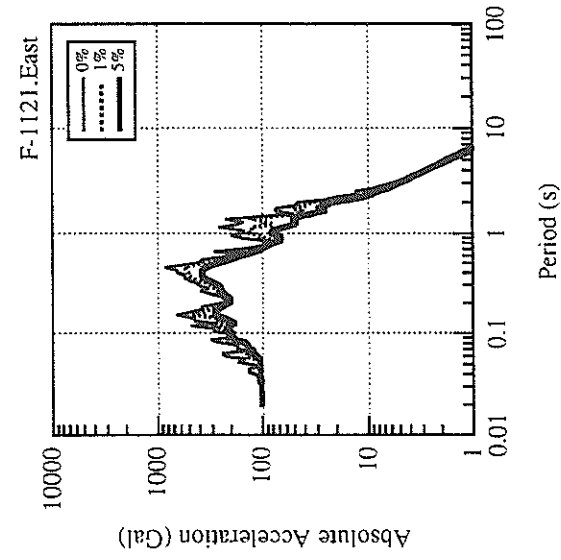
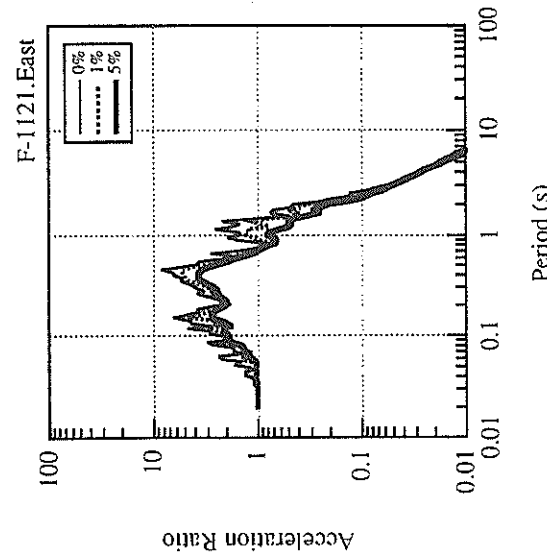
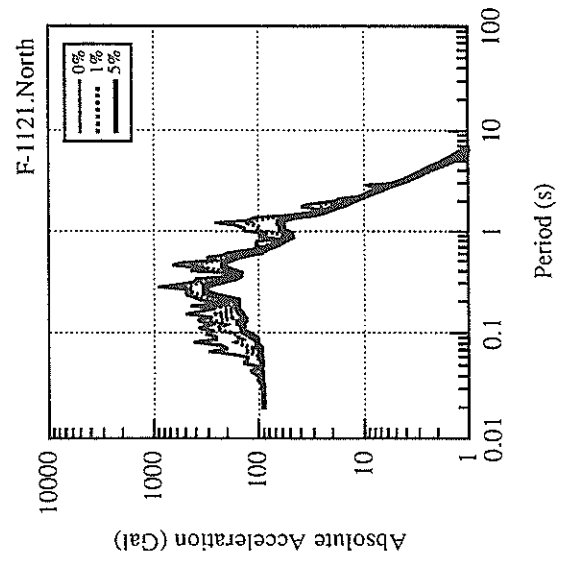
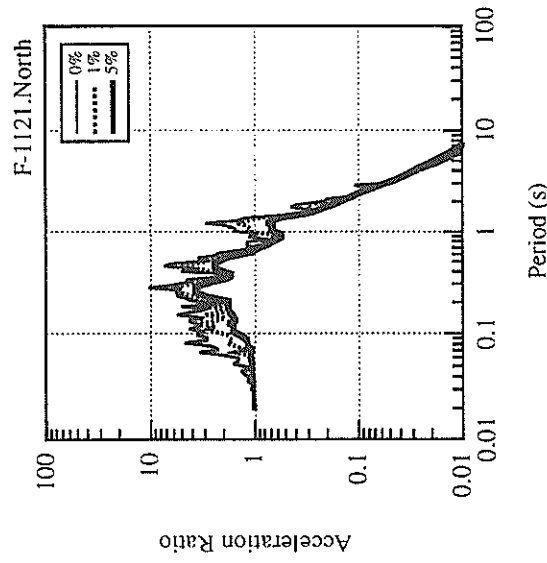
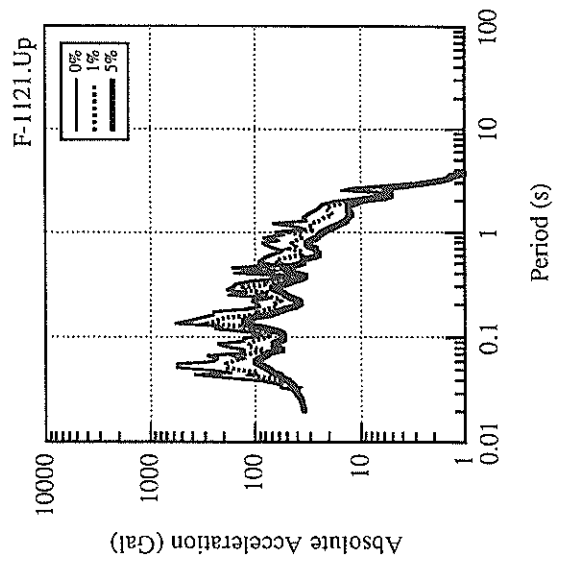
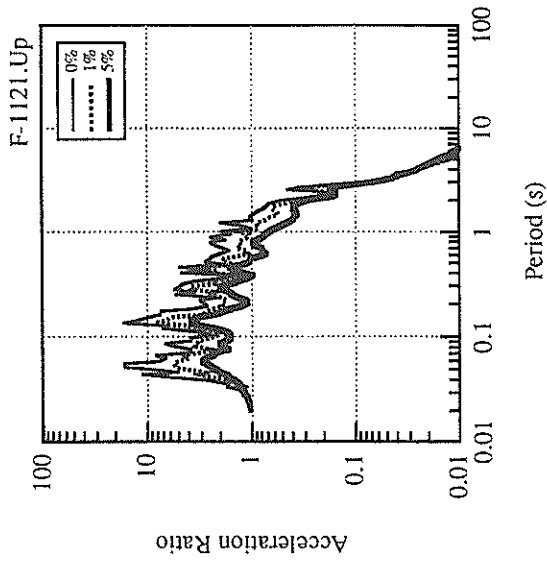
* RESULTANT OF HORIZONTAL COMPONENTS

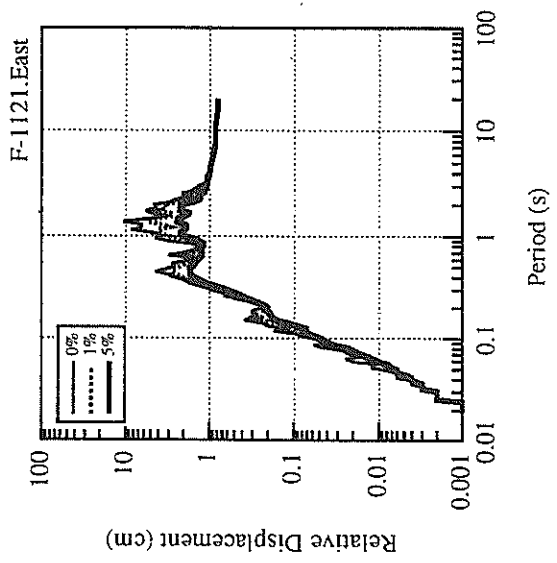
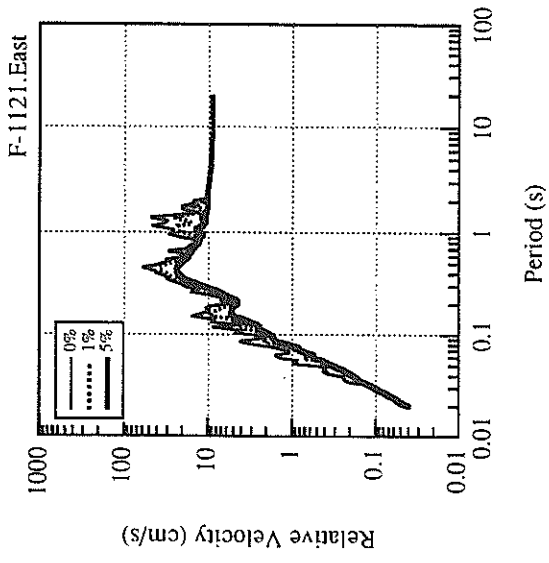
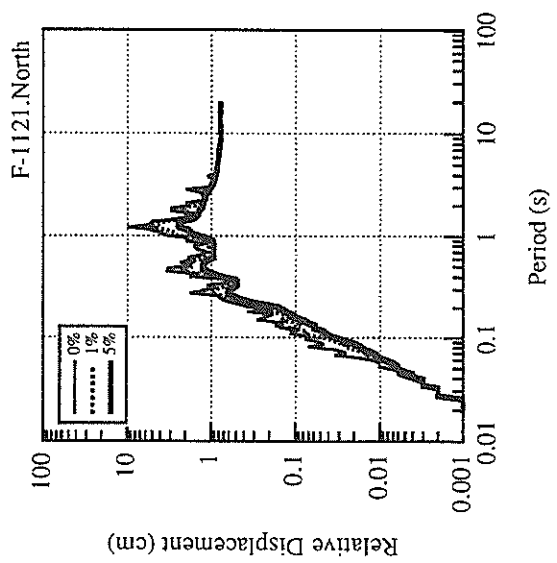
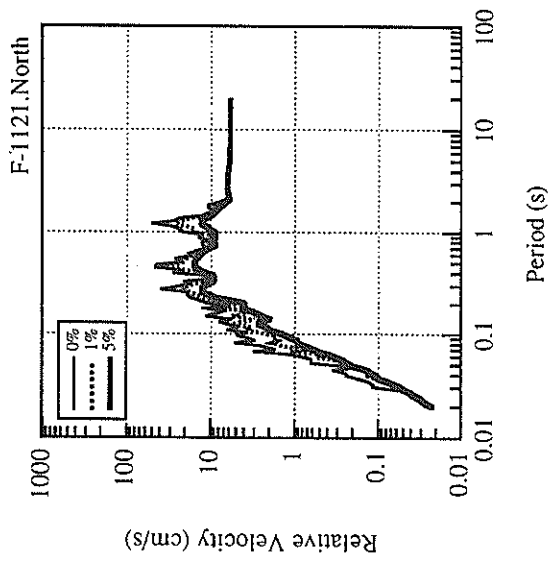
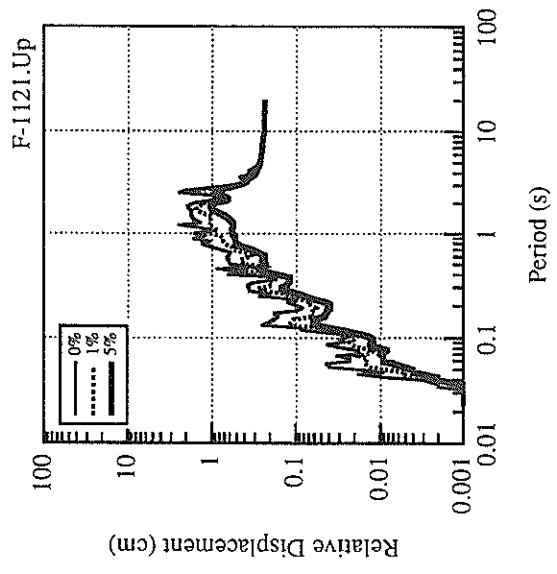
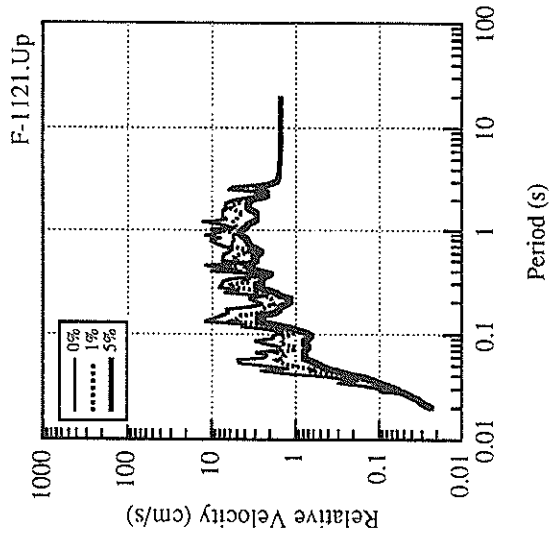


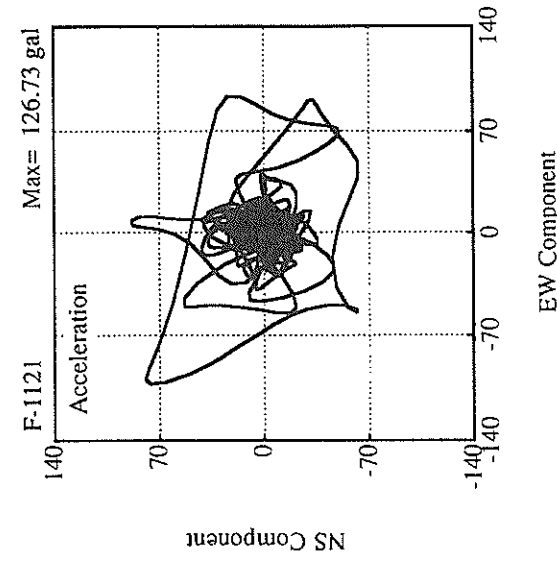
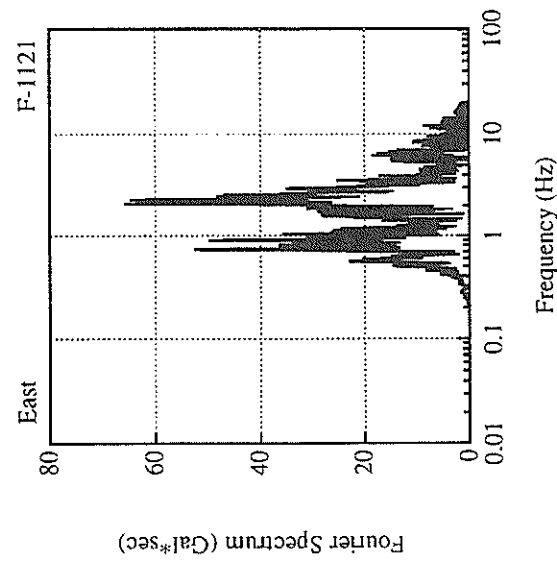
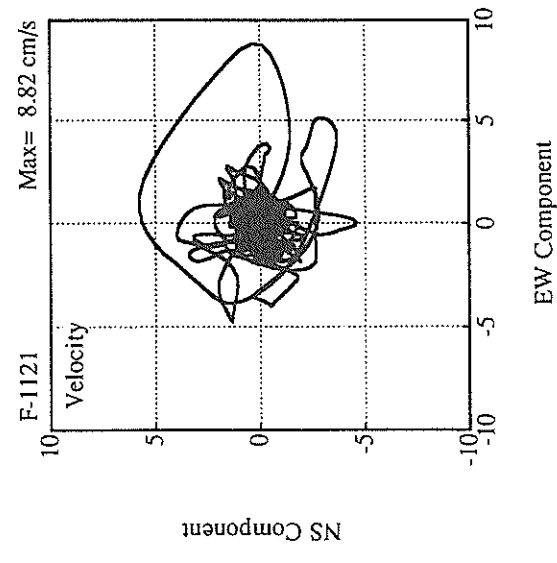
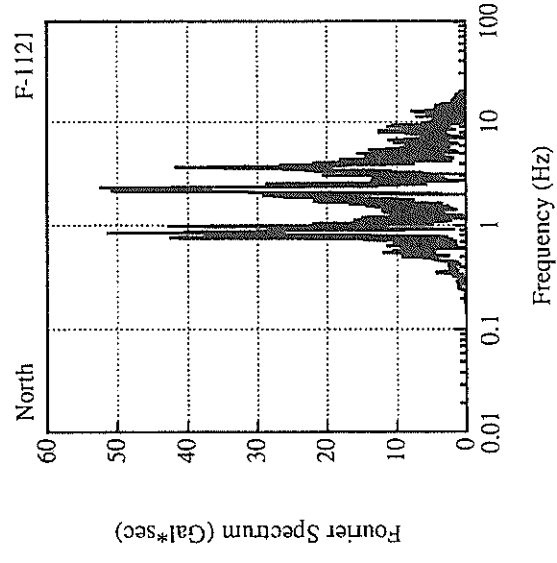
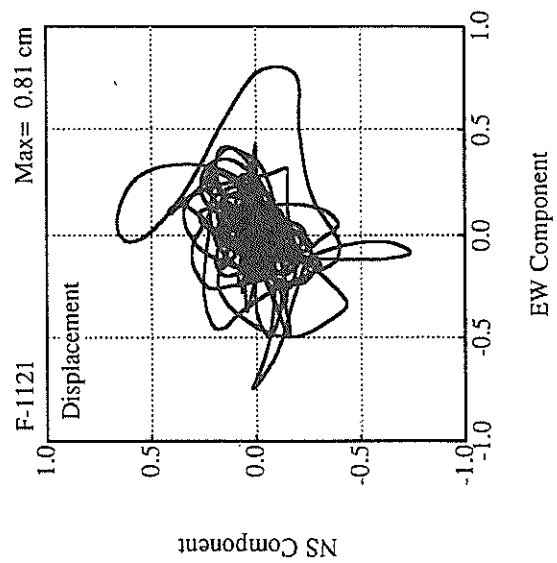
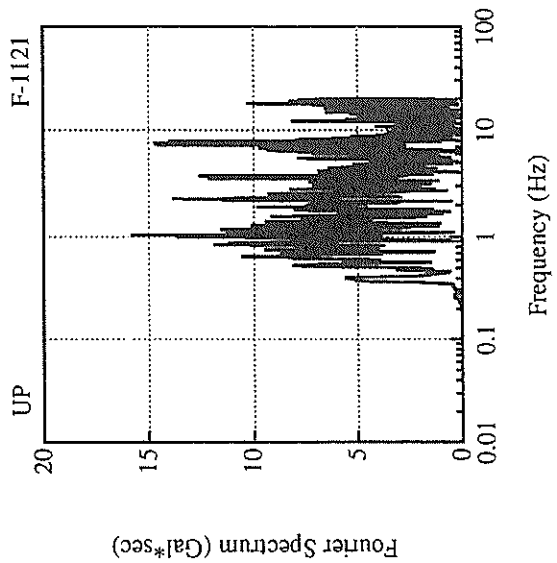












RECORD NUMBER : F-1122

STATION : NAGOYA-INAE-G

EARTHQUAKE DATA

DATE AND TIME 14:51 MAR.16,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION NE AICHI PREF

LATITUDE 34° 55.5' N

LONGITUDE 137° 31.7' E

DEPTH 39.1KM

JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

	N	S	E	W	U	D	HORIZONTAL*
FC (HZ)	0.299	0.299	0.299	0.299	0.354		

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.299 0.299 0.299 0.354

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	37.1	61.7	30.5	63.3
ORIGINAL	49.1	98.4	52.1	101.8
CORRECTED	48.7	93.5	52.9	96.4

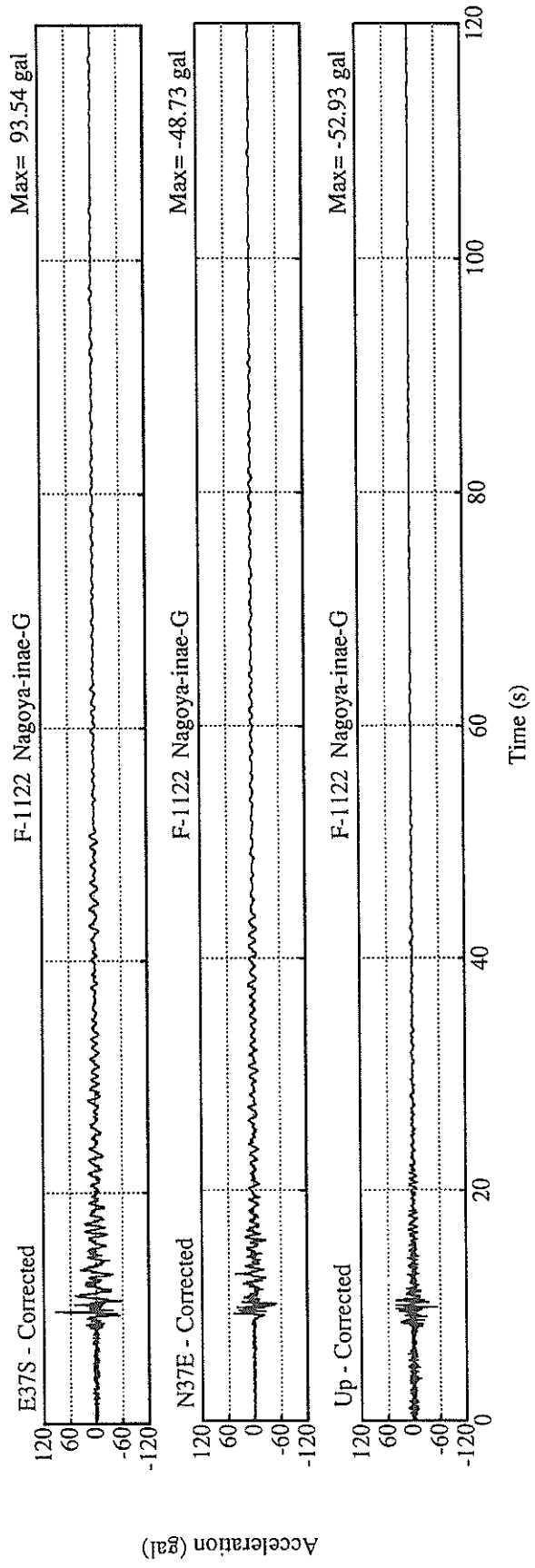
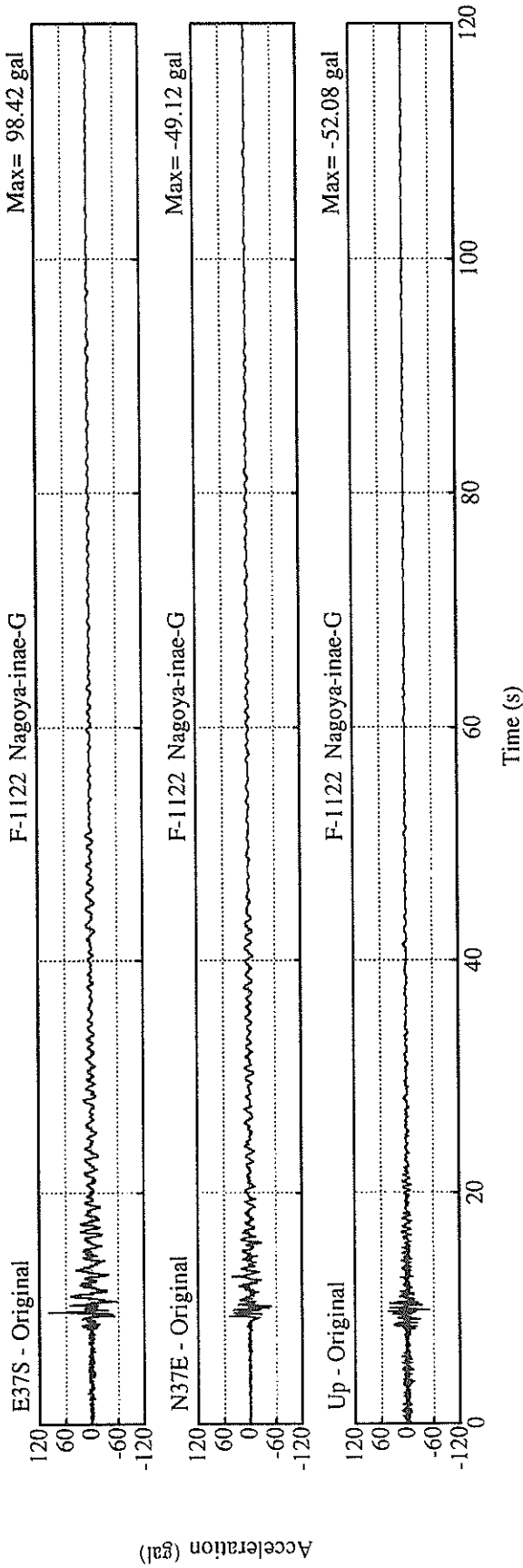
MAXIMUM VELOCITY (CM/SEC)

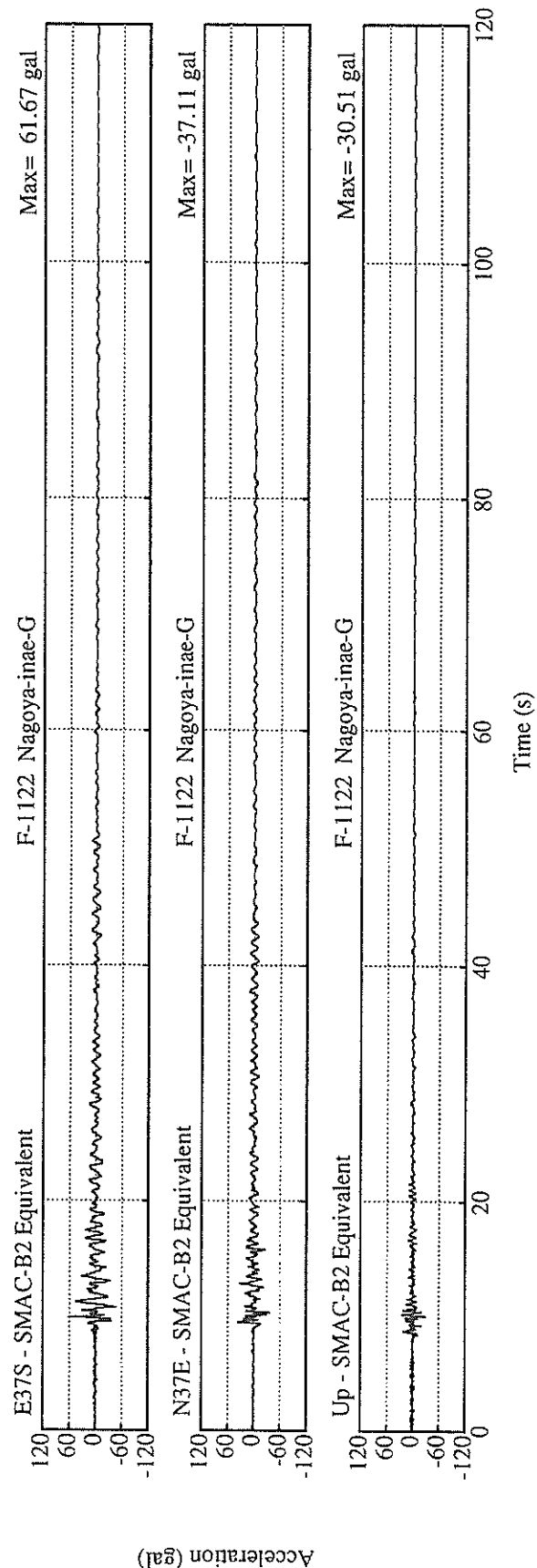
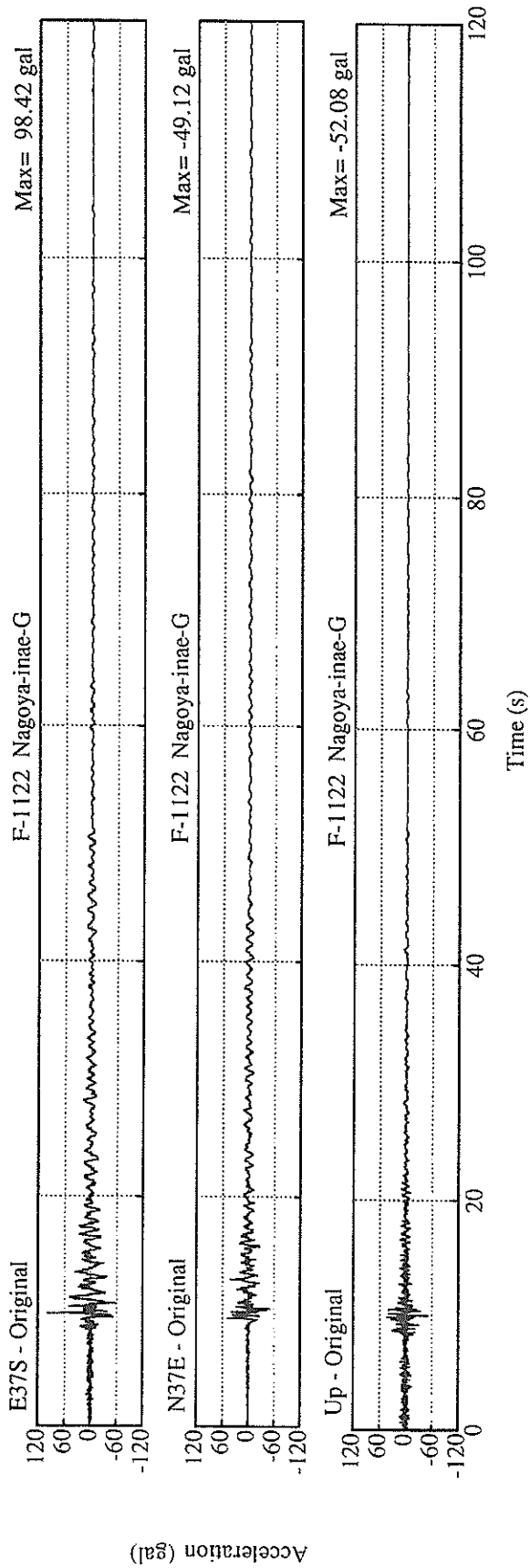
FIXED FILTER	4.23	6.36	1.76	6.40
VARIABLE FILTER	4.31	6.06	1.95	6.12

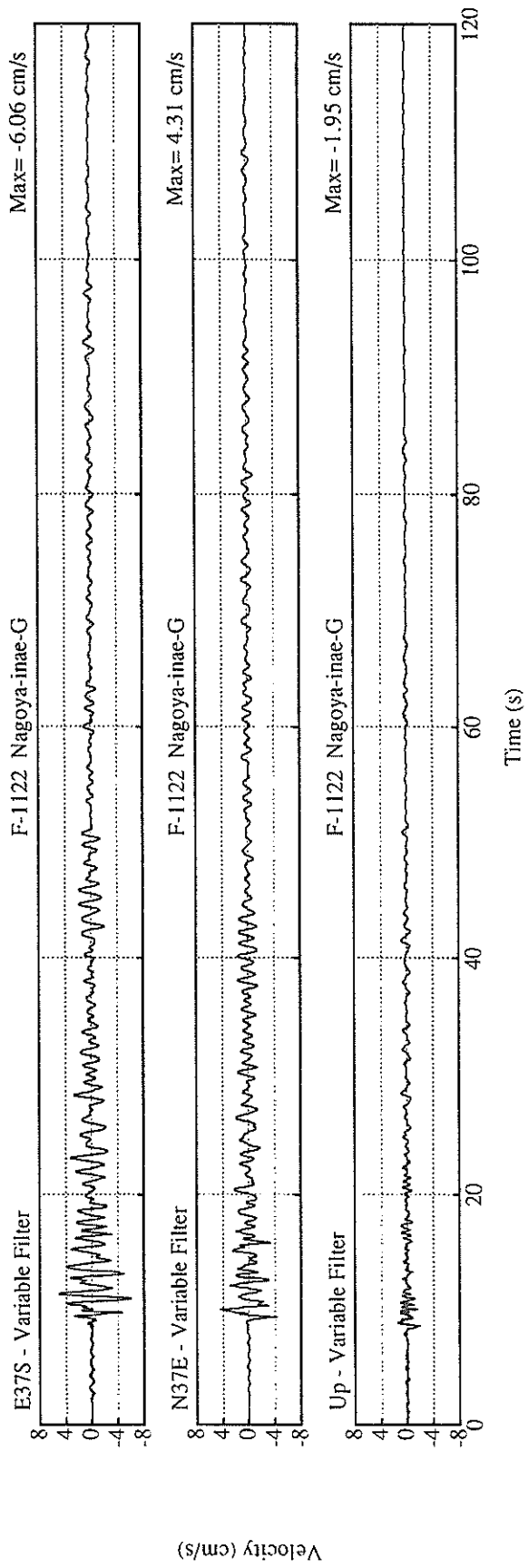
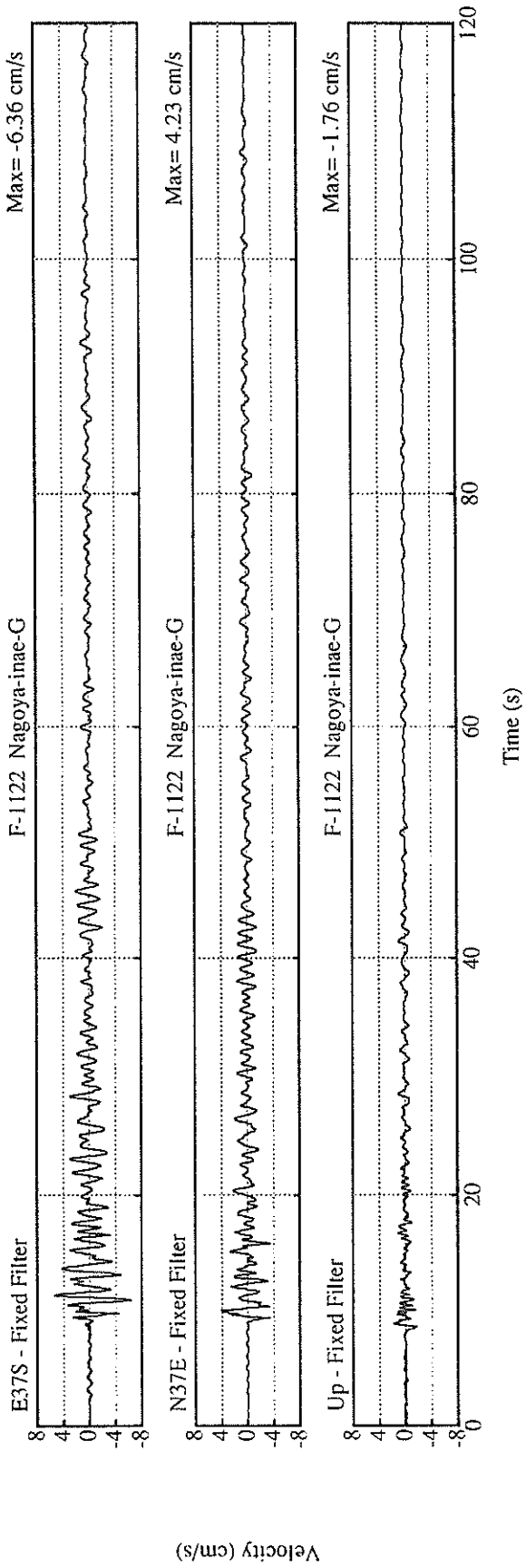
MAXIMUM DISPLACEMENT (CM)

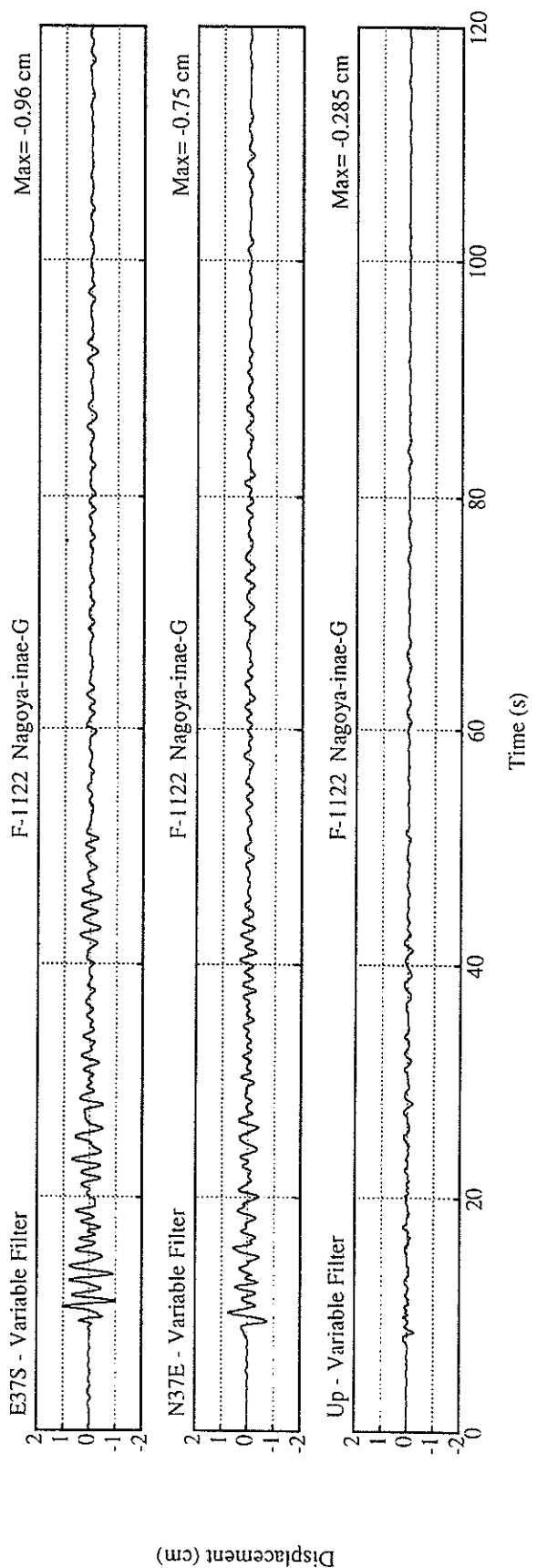
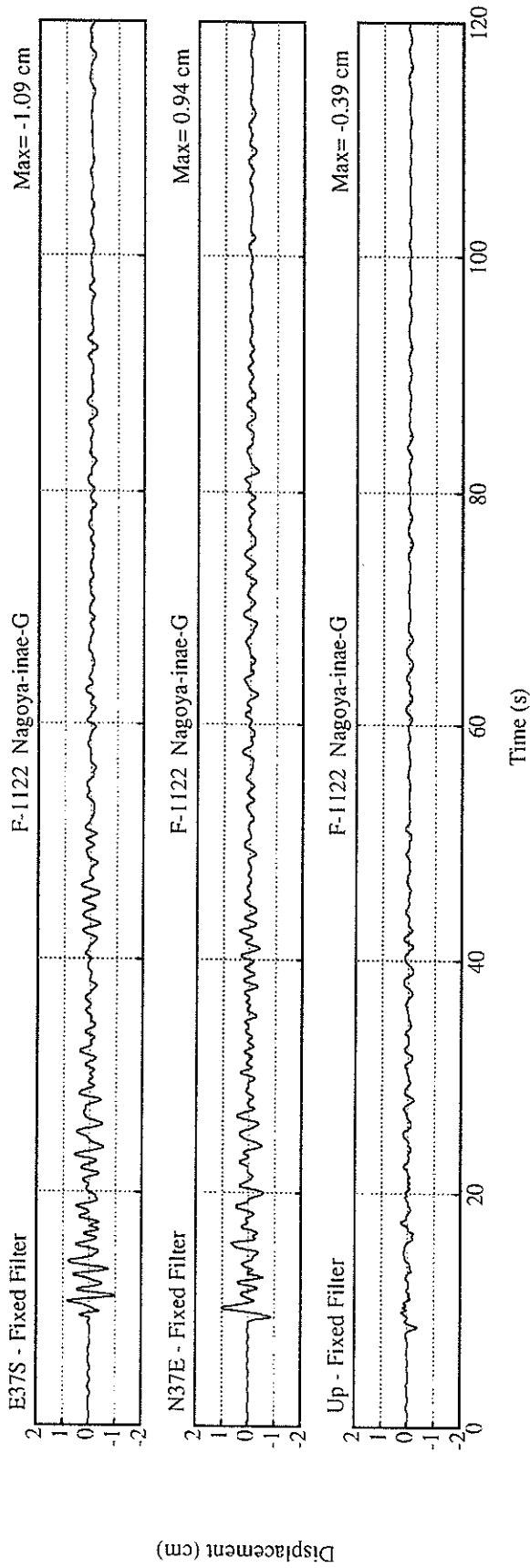
FIXED FILTER	0.94	1.09	0.39	1.10
VARIABLE FILTER	0.75	0.96	0.28	0.97

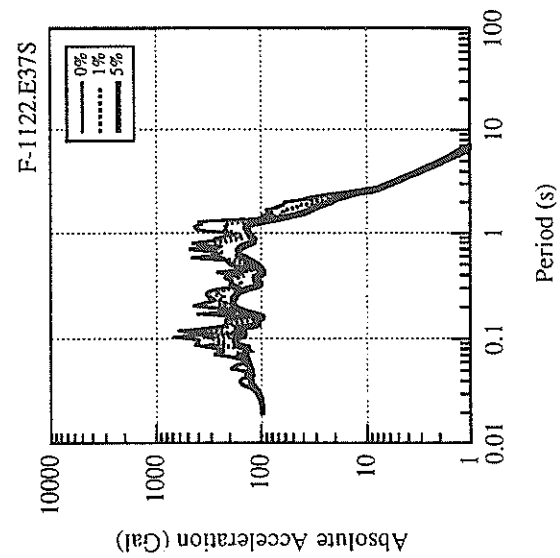
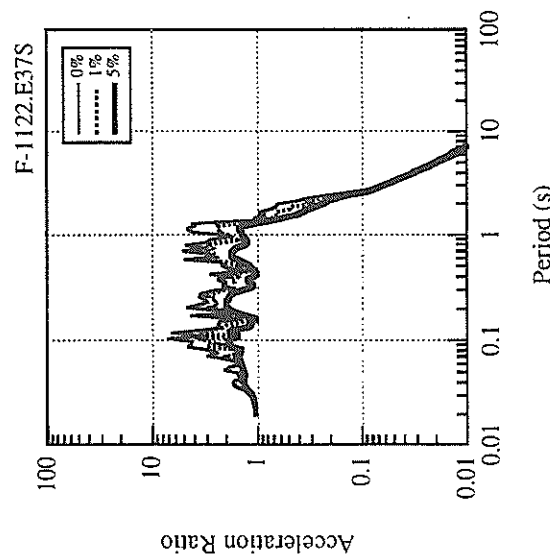
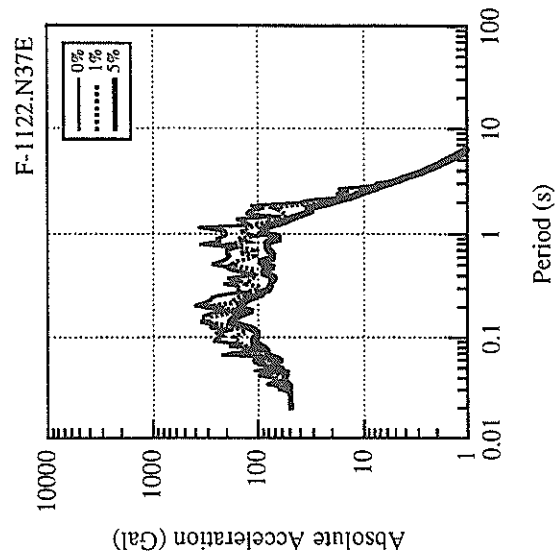
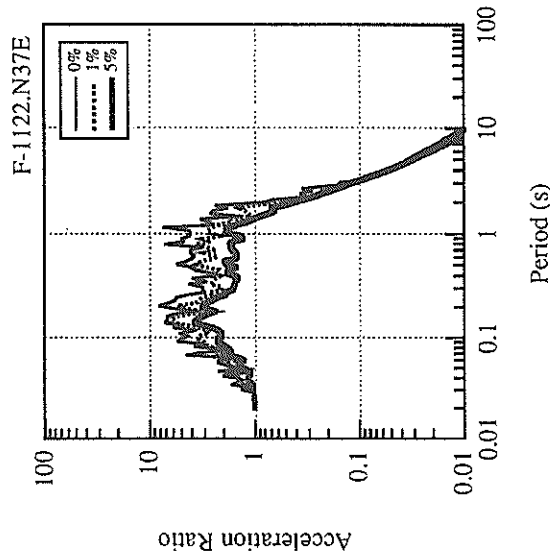
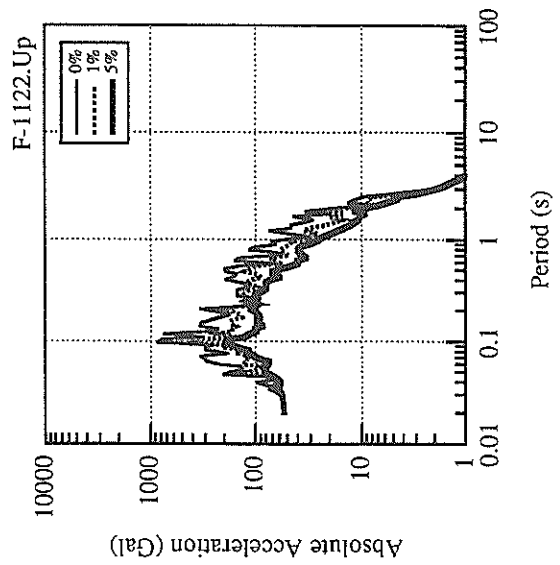
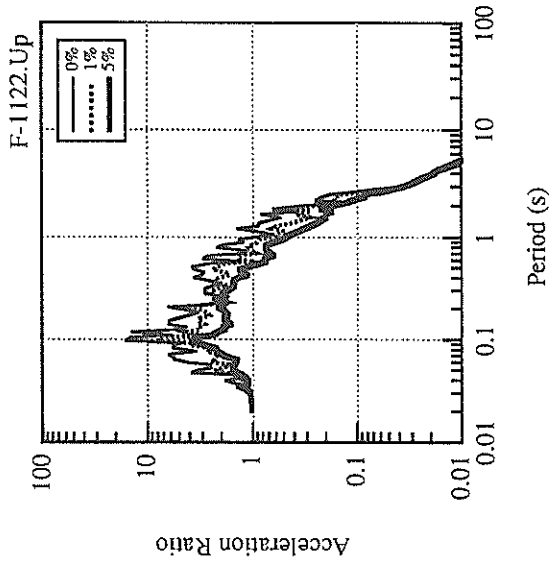
* RESULTANT OF HORIZONTAL COMPONENTS

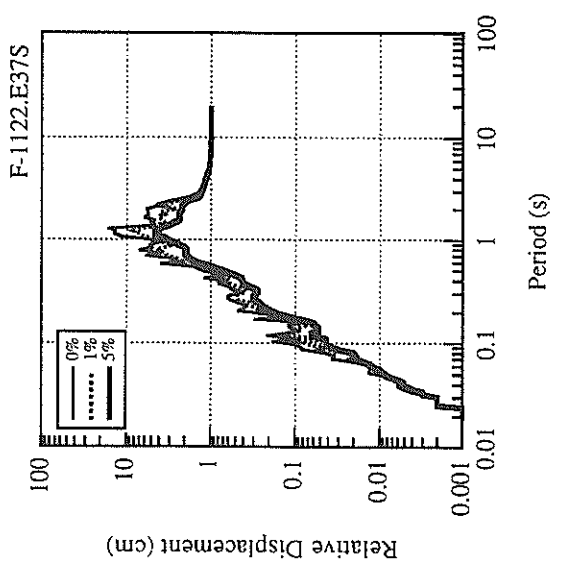
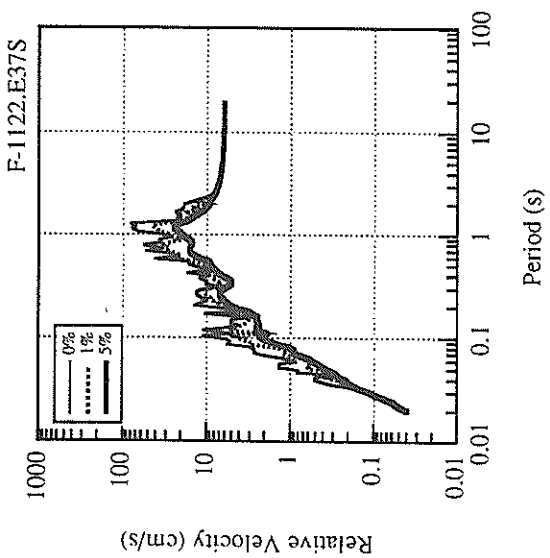
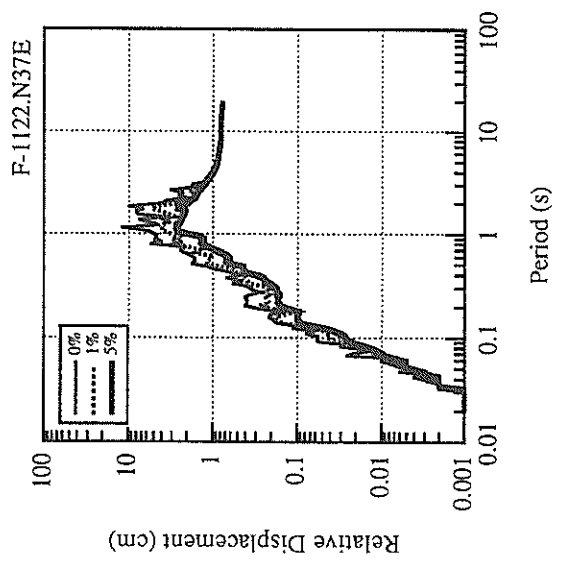
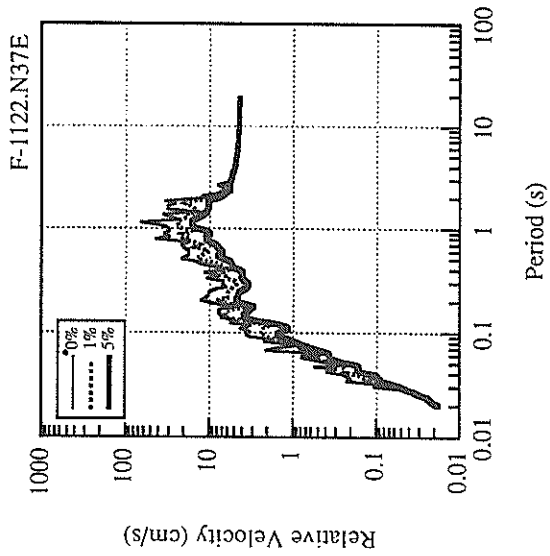
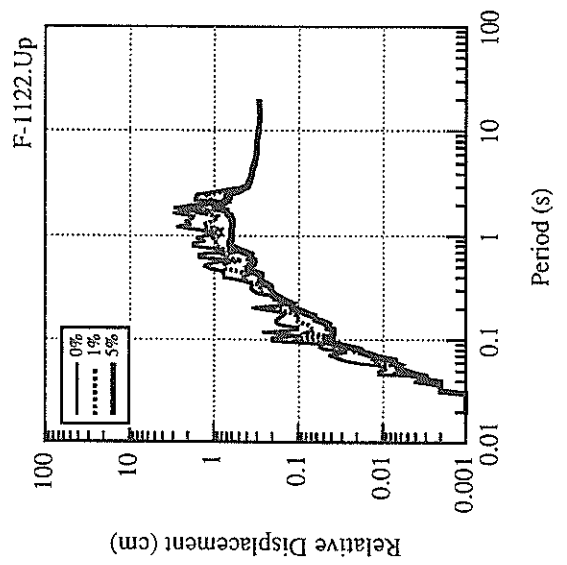
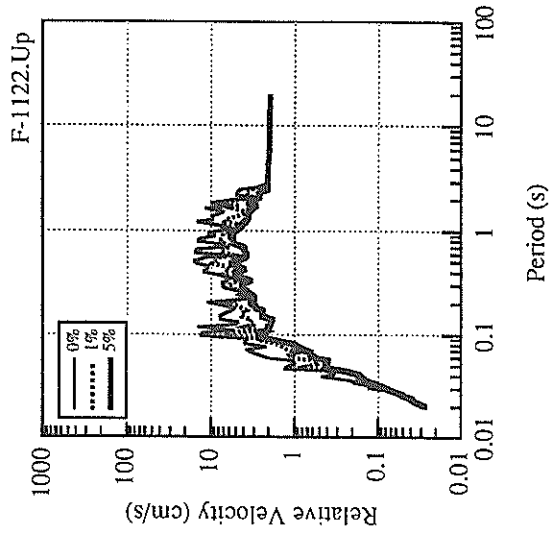


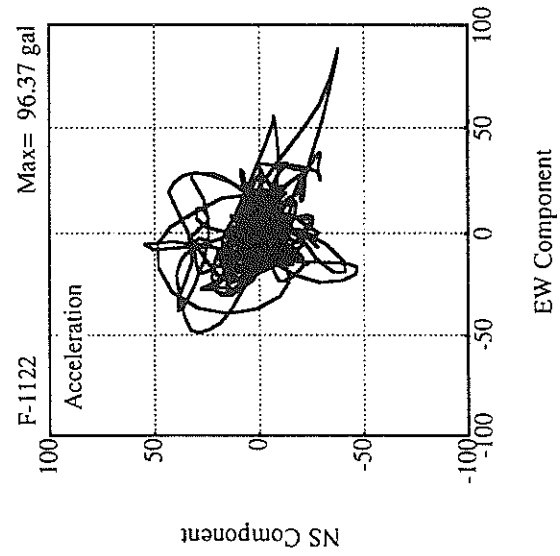
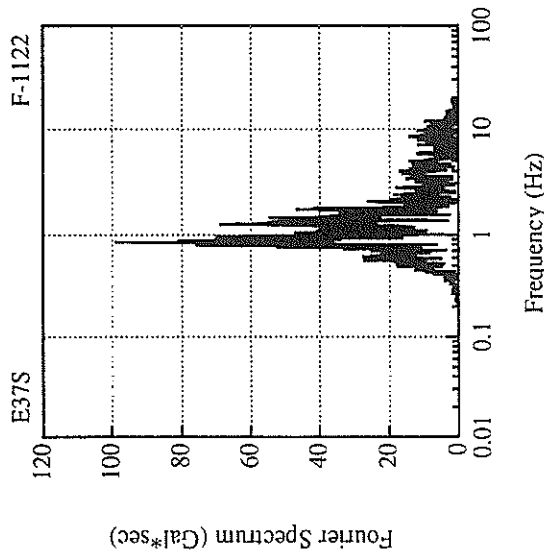
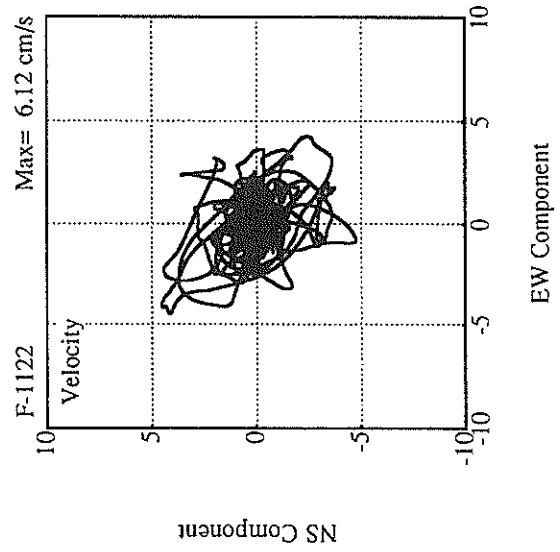
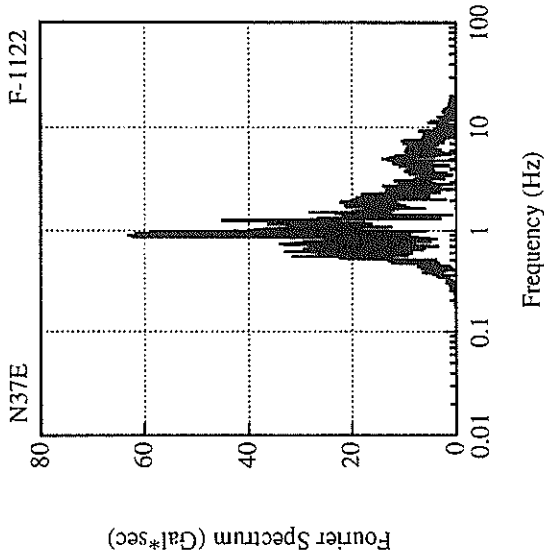
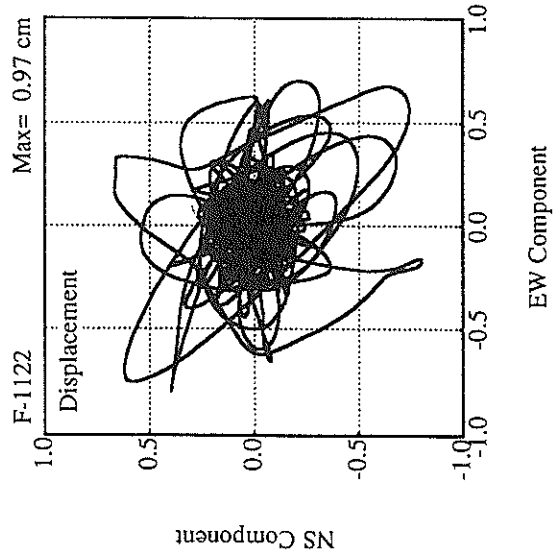
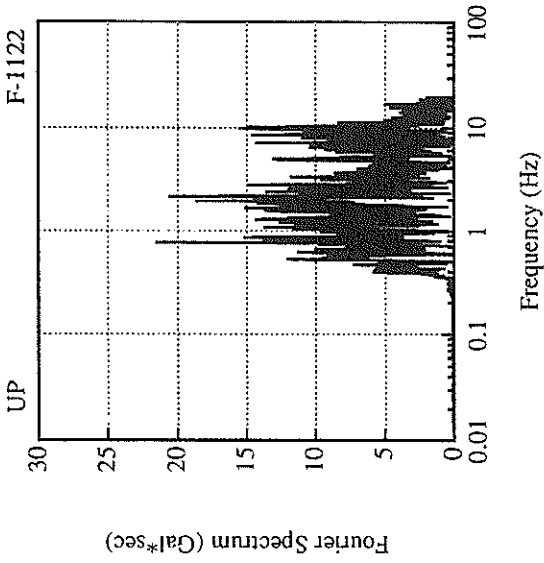












RECORD NUMBER : S-2671

STATION : YOKKA.-CHITOSE-S

EARTHQUAKE DATA

DATE AND TIME 14:51 MAR.16,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION NE AICHI PREF

LATITUDE 34°55.5' N

LONGITUDE 137°31.7' E

DEPTH 39.1KM

JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
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PARAMETER OF THE VARIABLE FILTER

FC (HZ)	0.377	0.475	0.756	
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MAXIMUM ACCELERATION (GAL)

ORIGINAL	57.1	29.6	8.3	63.8
CORRECTED	68.5	39.4	10.2	76.9

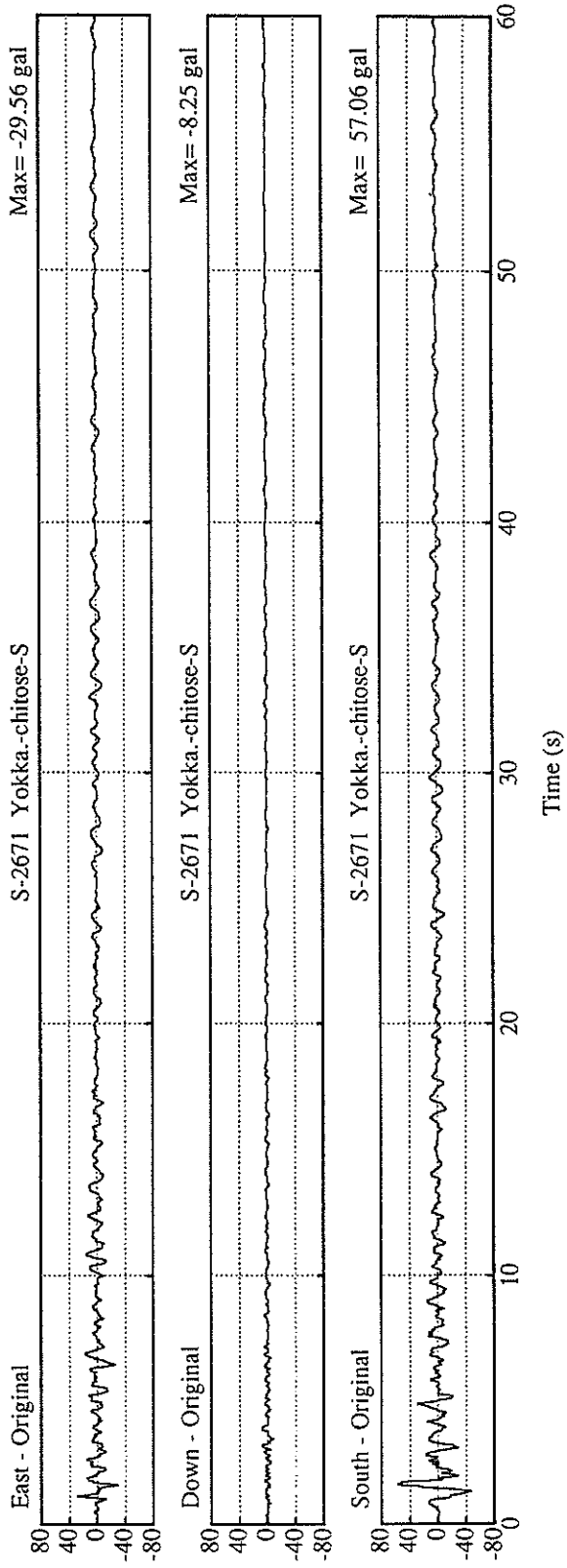
MAXIMUM VELOCITY (CM/SEC)

FIXED FILTER	8.76	2.65	0.78	8.89
VARIABLE FILTER	7.50	2.34	0.82	7.61

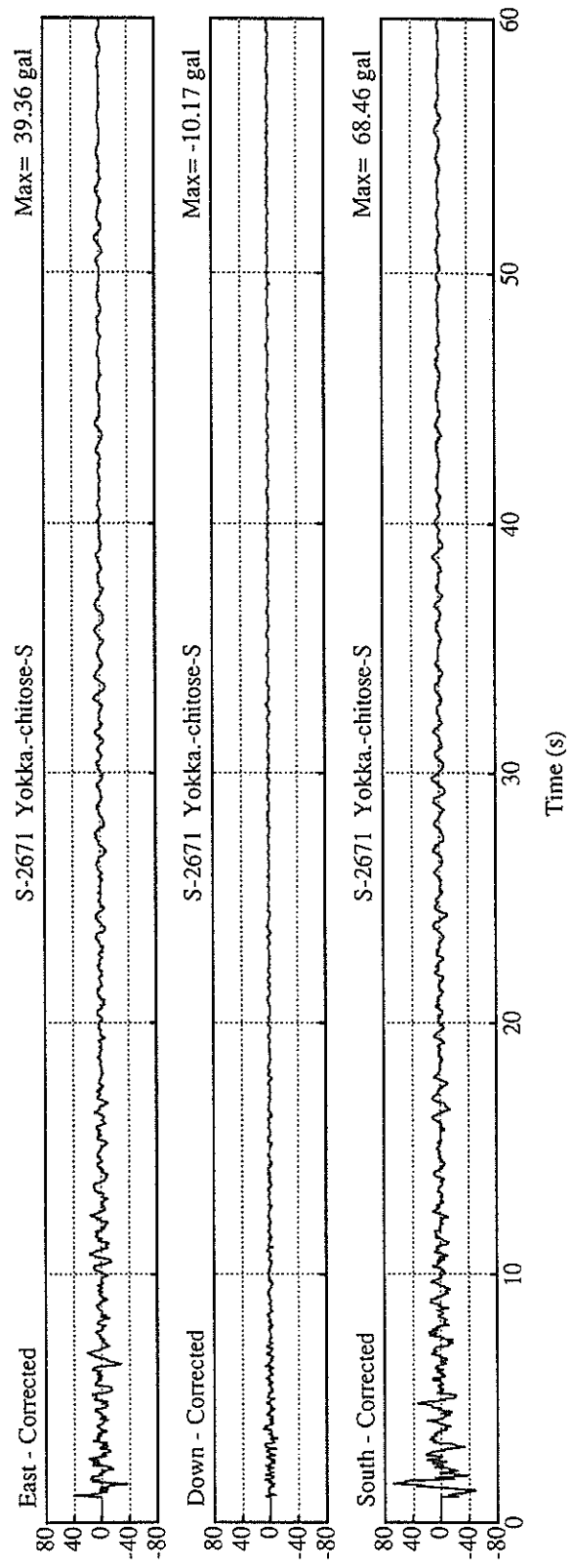
MAXIMUM DISPLACEMENT (CM)

FIXED FILTER	2.18	0.65	0.42	2.25
VARIABLE FILTER	1.02	0.37	0.09	1.05

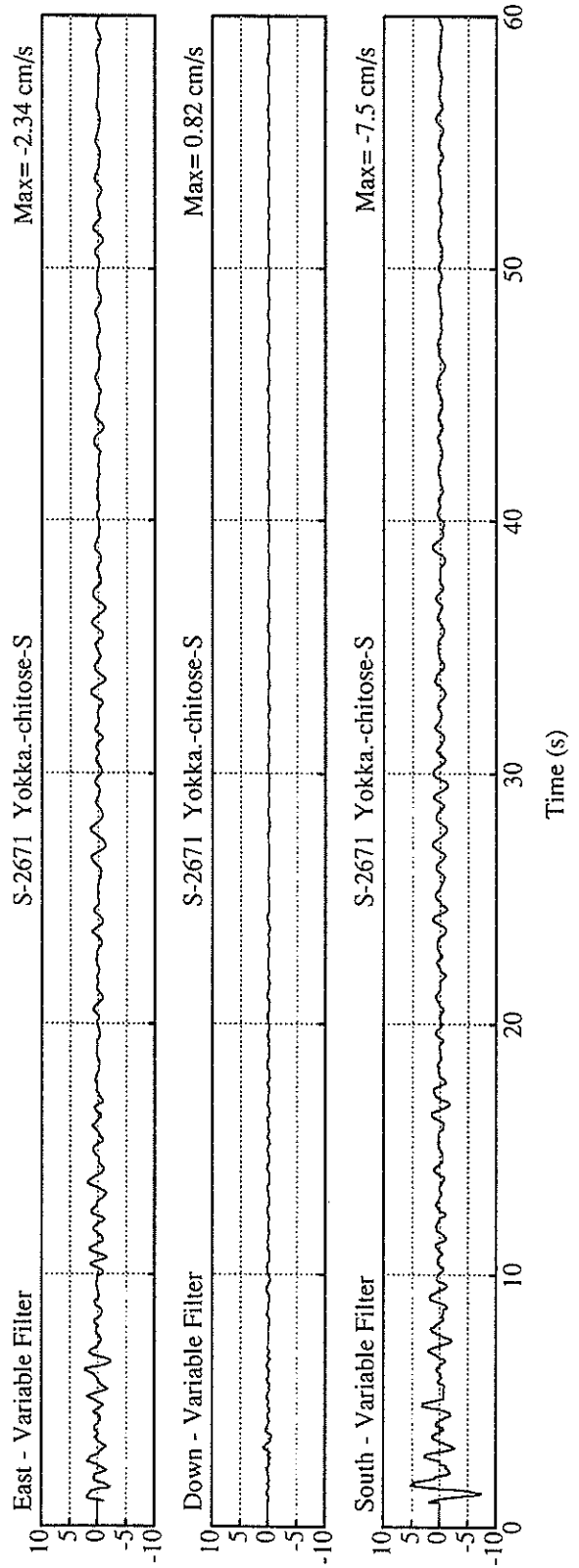
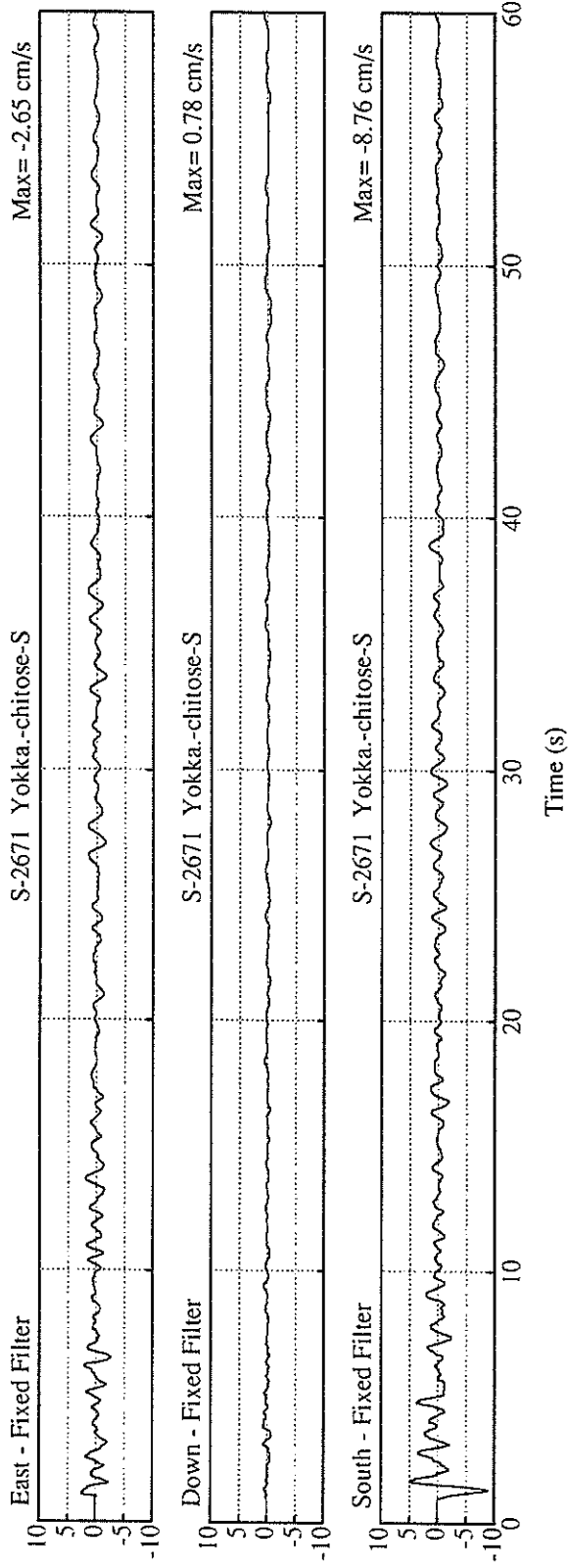
* RESULTANT OF HORIZONTAL COMPONENTS

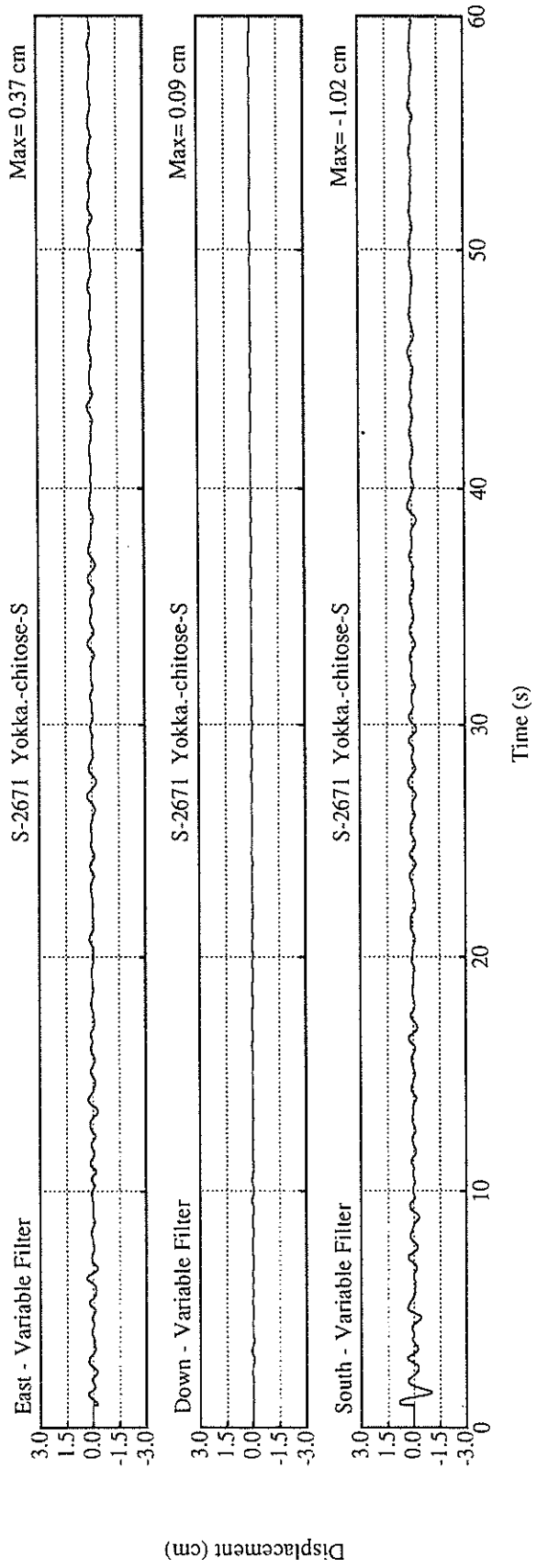
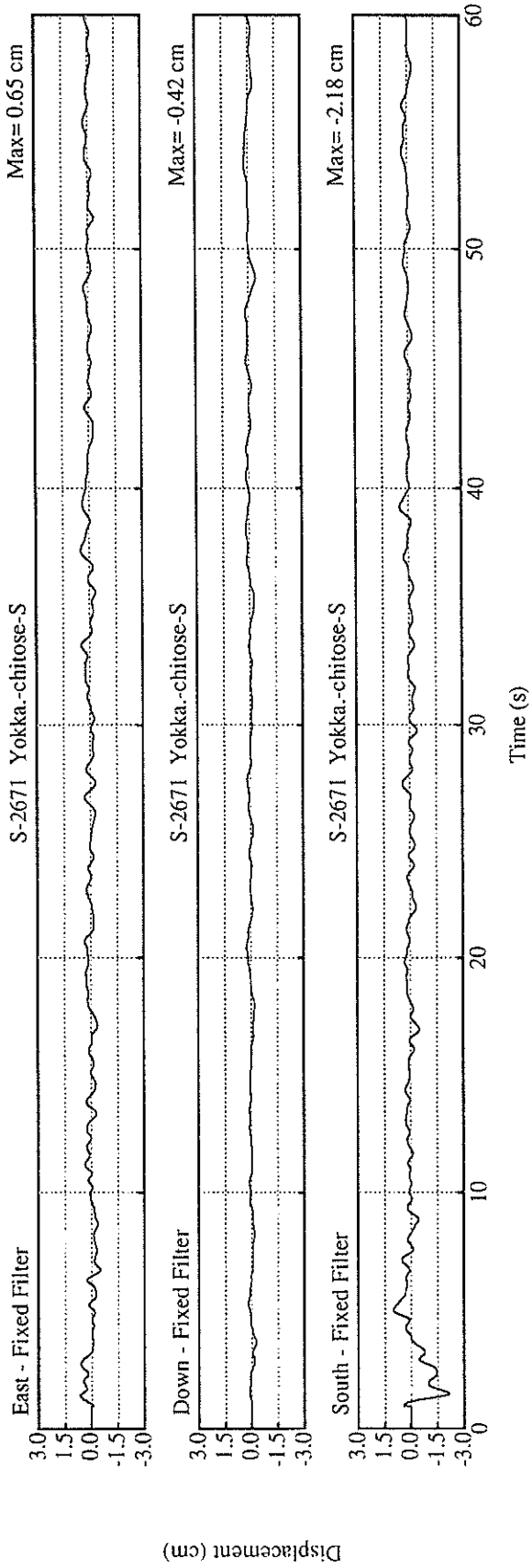


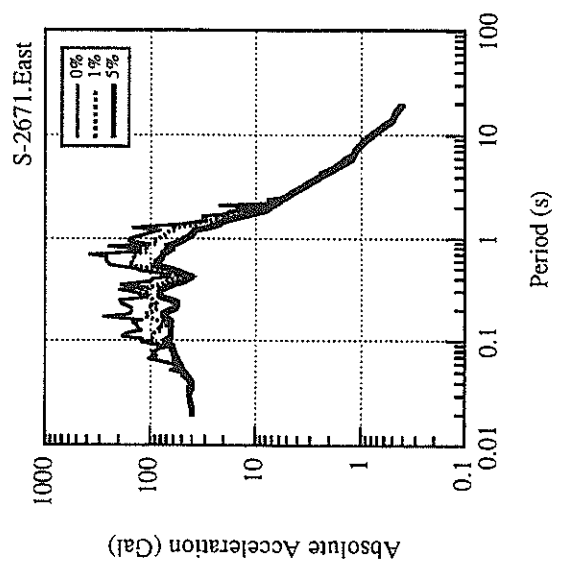
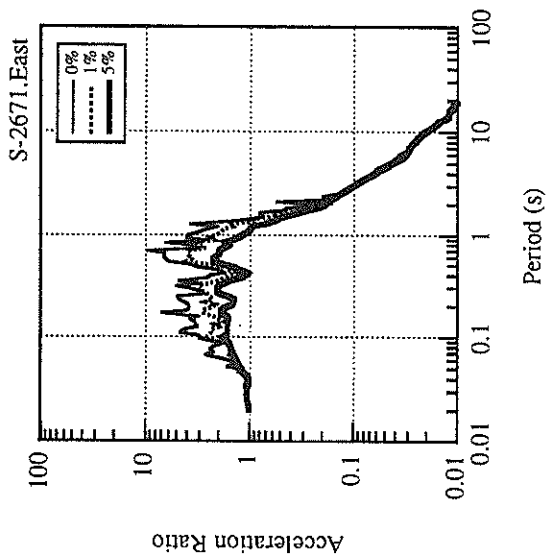
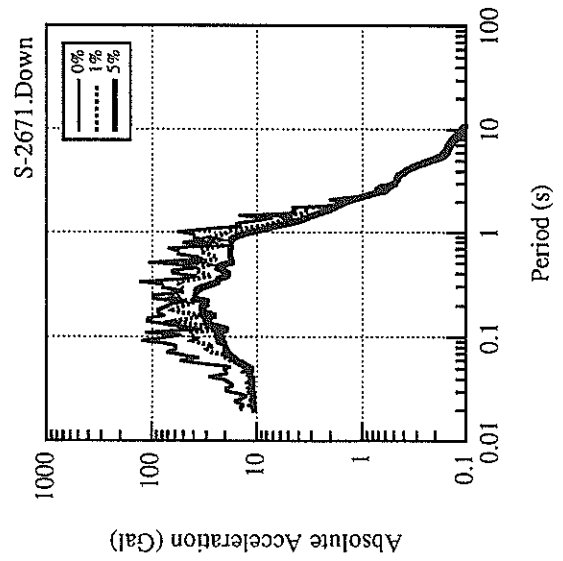
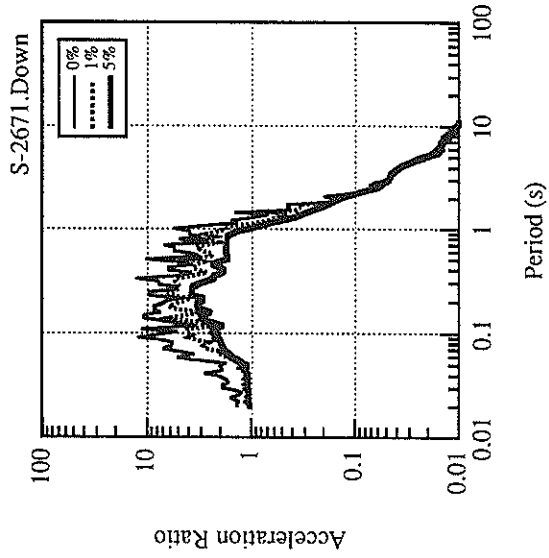
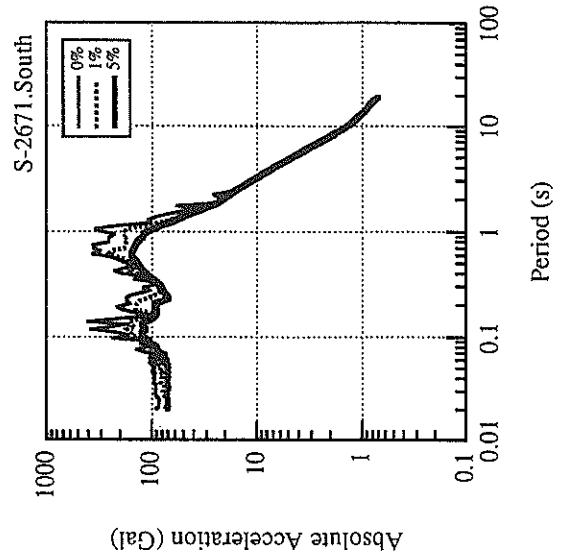
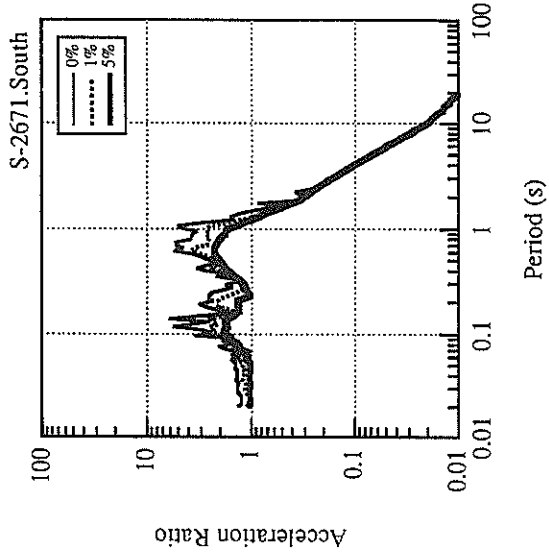
Acceleration (gal)

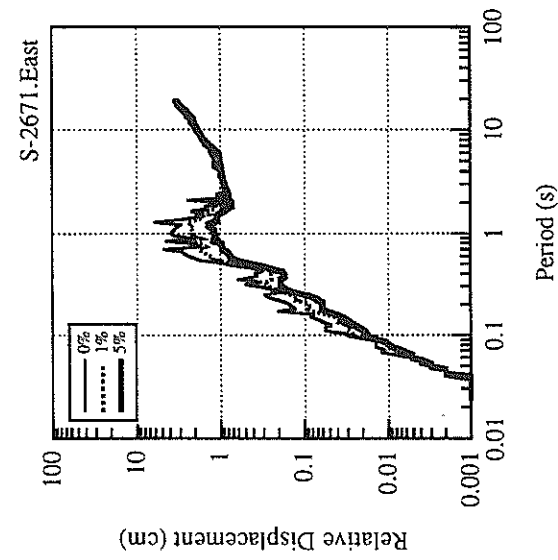
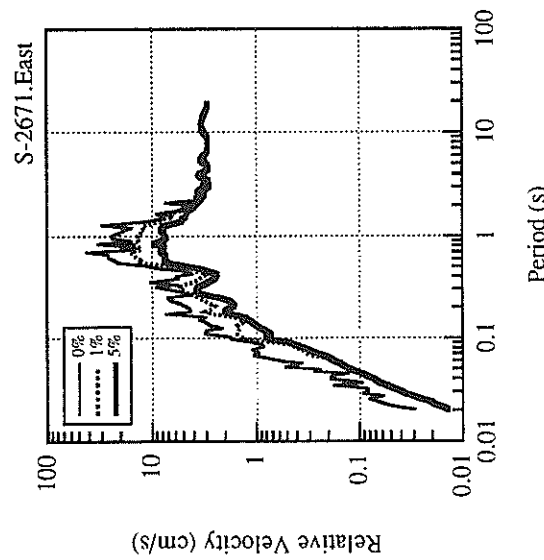
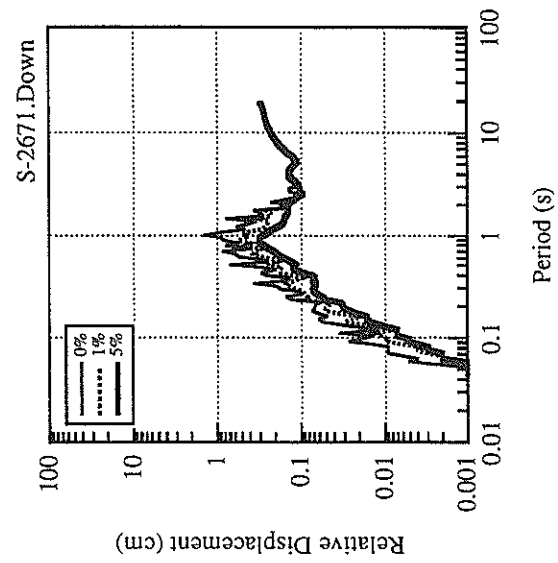
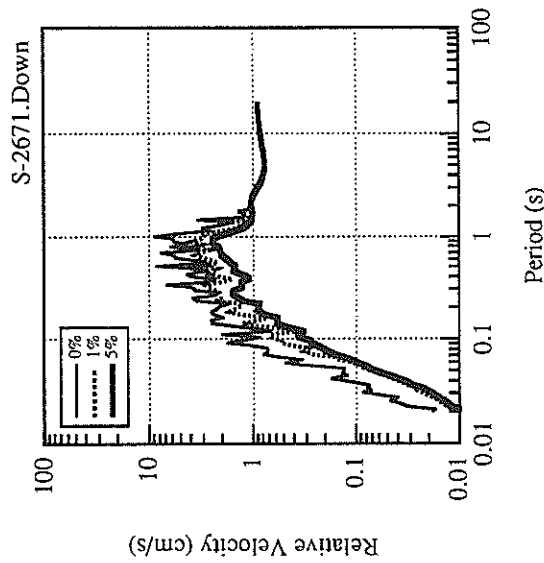
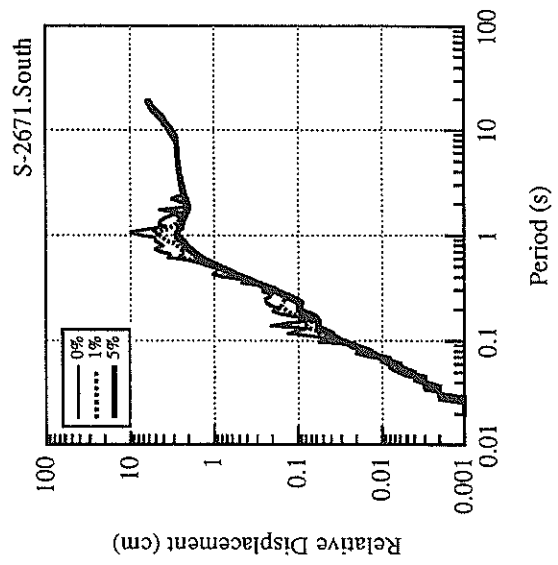
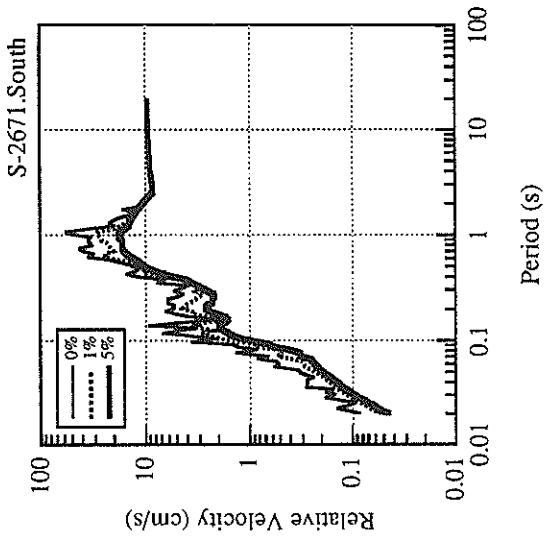


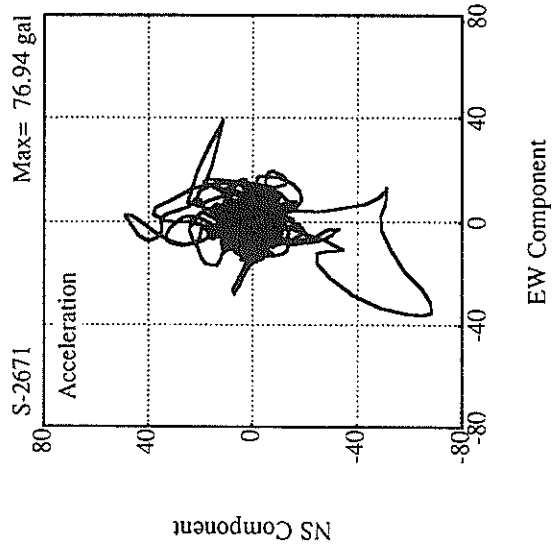
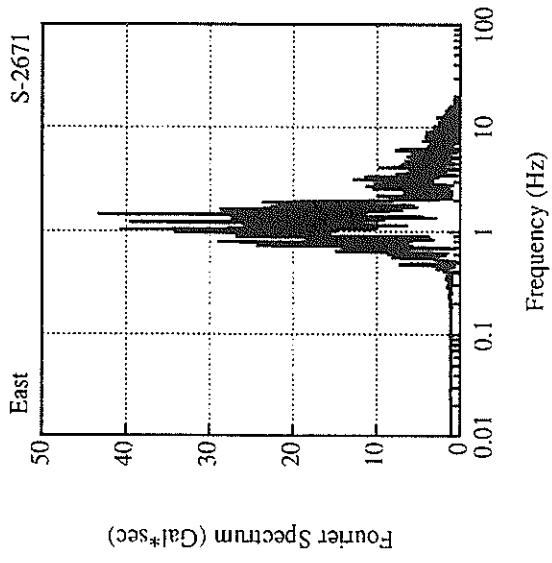
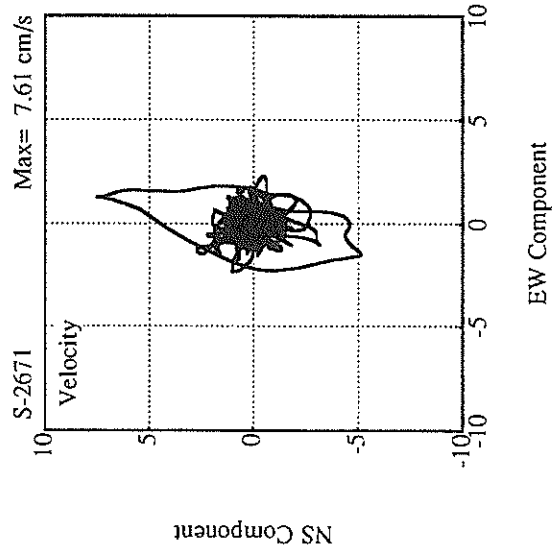
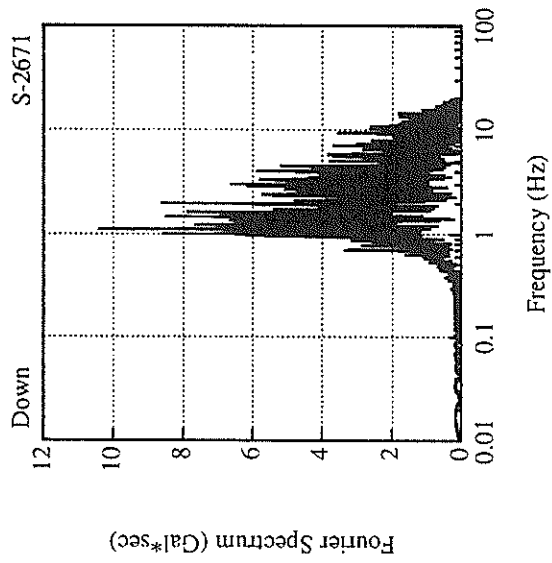
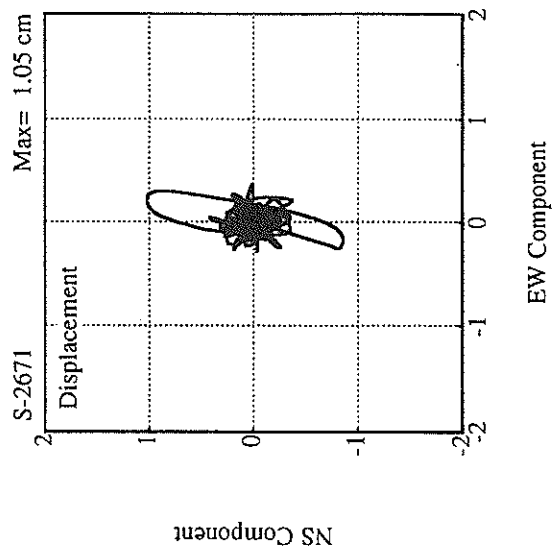
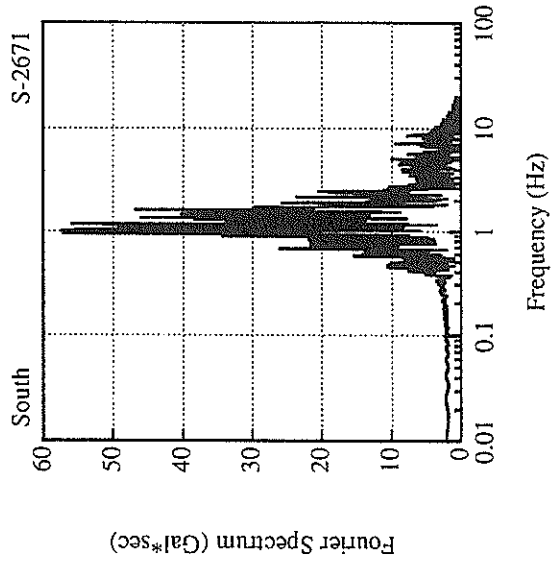
Acceleration (gal)











RECORD NUMBER : S-2672

STATION : KINUURA-JI-S

EARTHQUAKE DATA

 DATE AND TIME 14:51 MAR.16,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NE AICHI PREF
 LATITUDE 34°55.5' N
 LONGITUDE 137°31.7' E
 DEPTH 39.1KM
 JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
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PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.353 0.280 0.463

MAXIMUM ACCELERATION (GAL)

ORIGINAL	79.1	140.0	32.6	140.0
CORRECTED	102.6	204.9	45.7	205.1

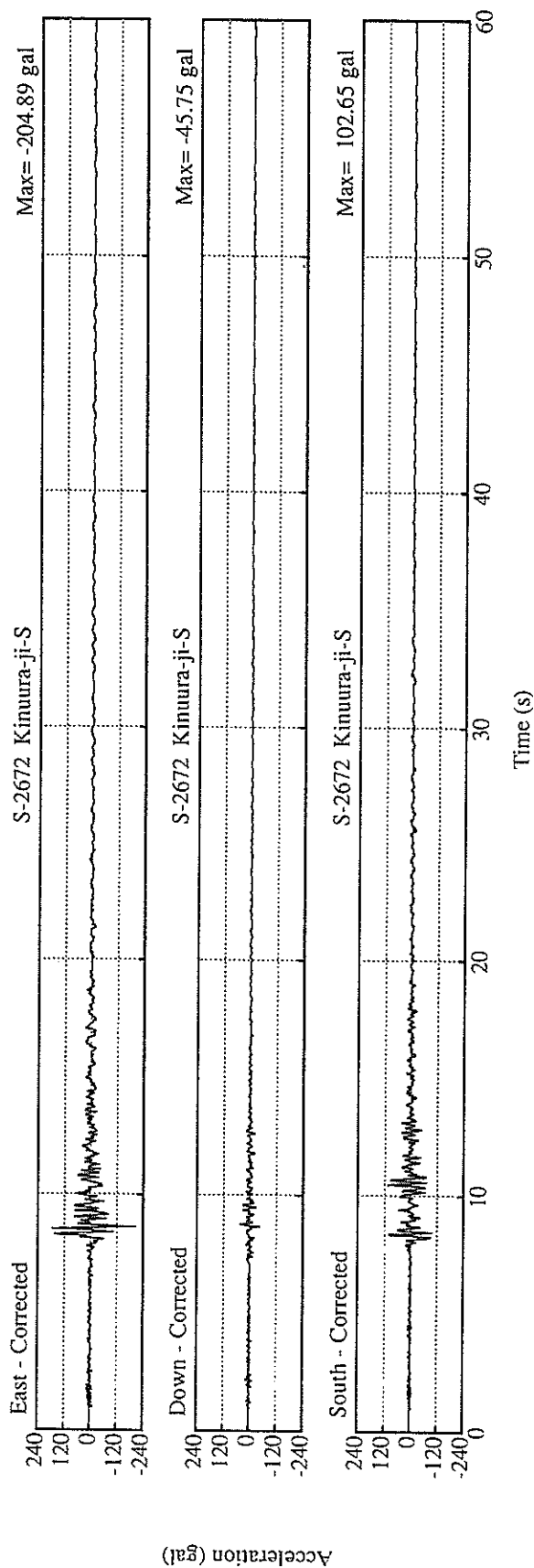
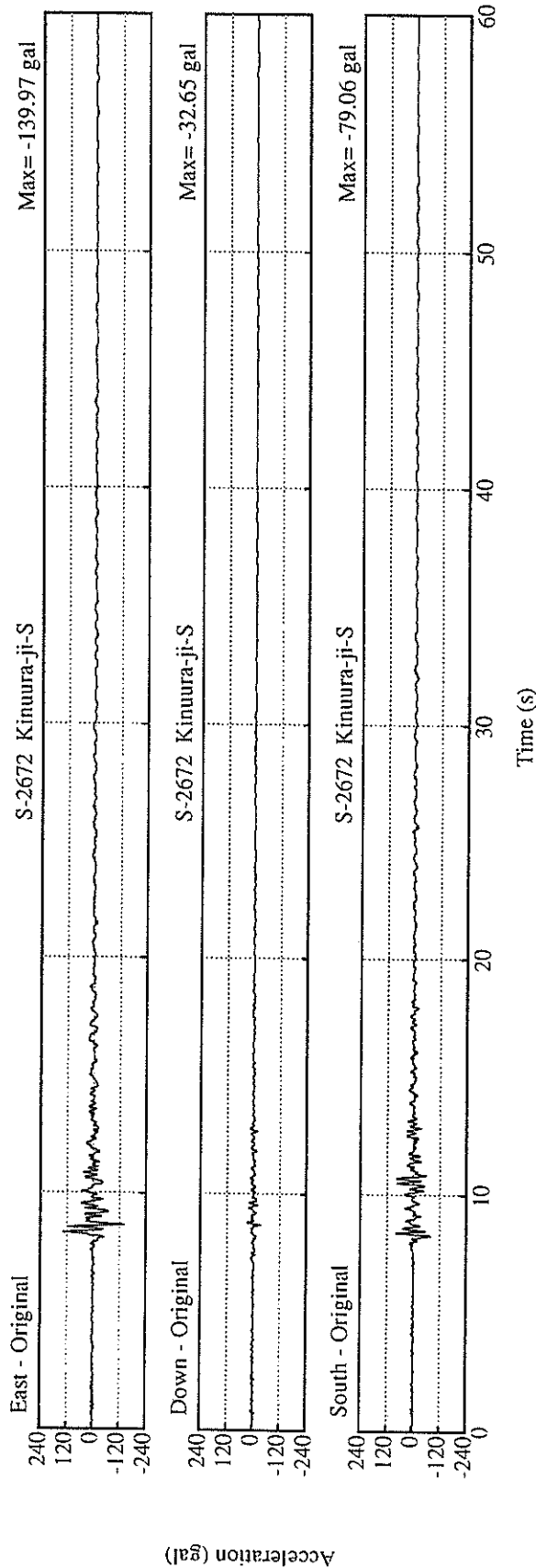
MAXIMUM VELOCITY (CM/SEC)

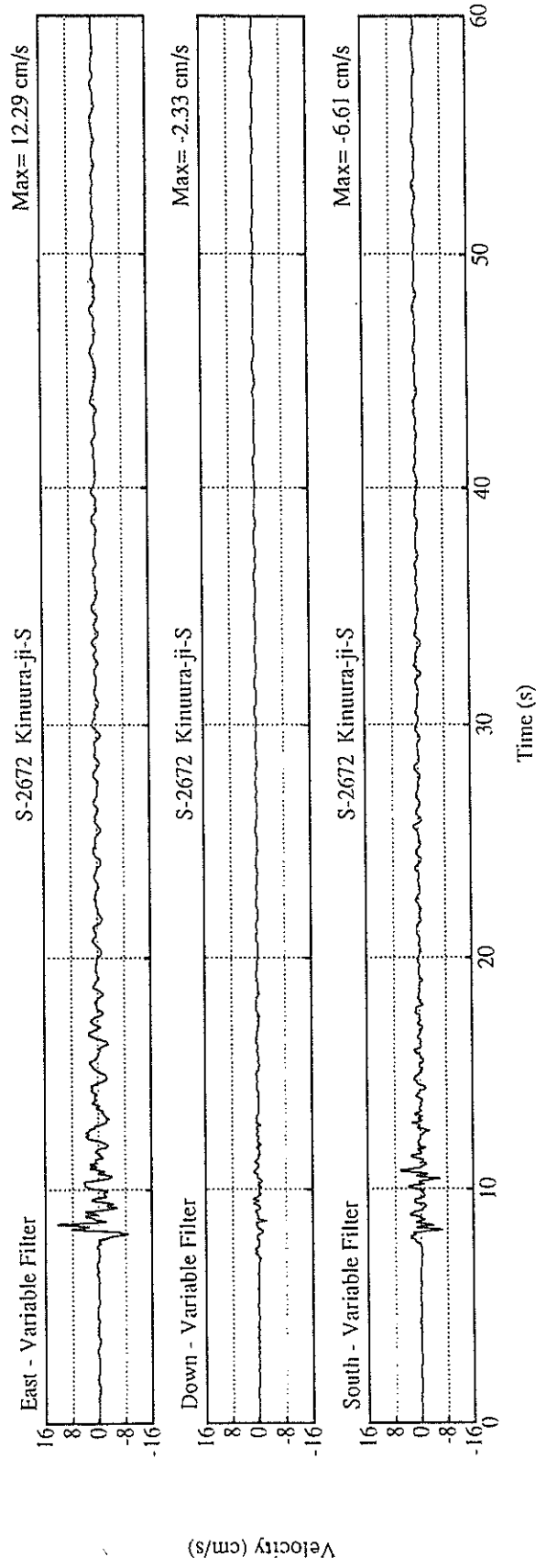
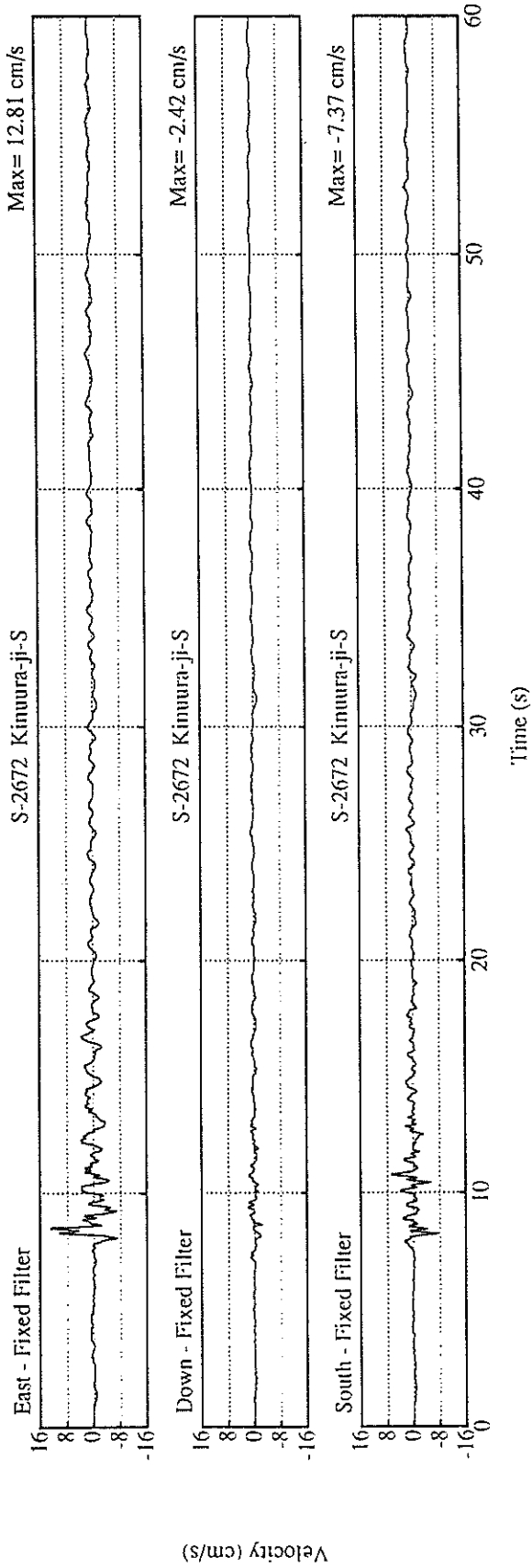
FIXED FILTER	7.37	12.81	2.42	12.82
VARIABLE FILTER	6.61	12.29	2.33	12.30

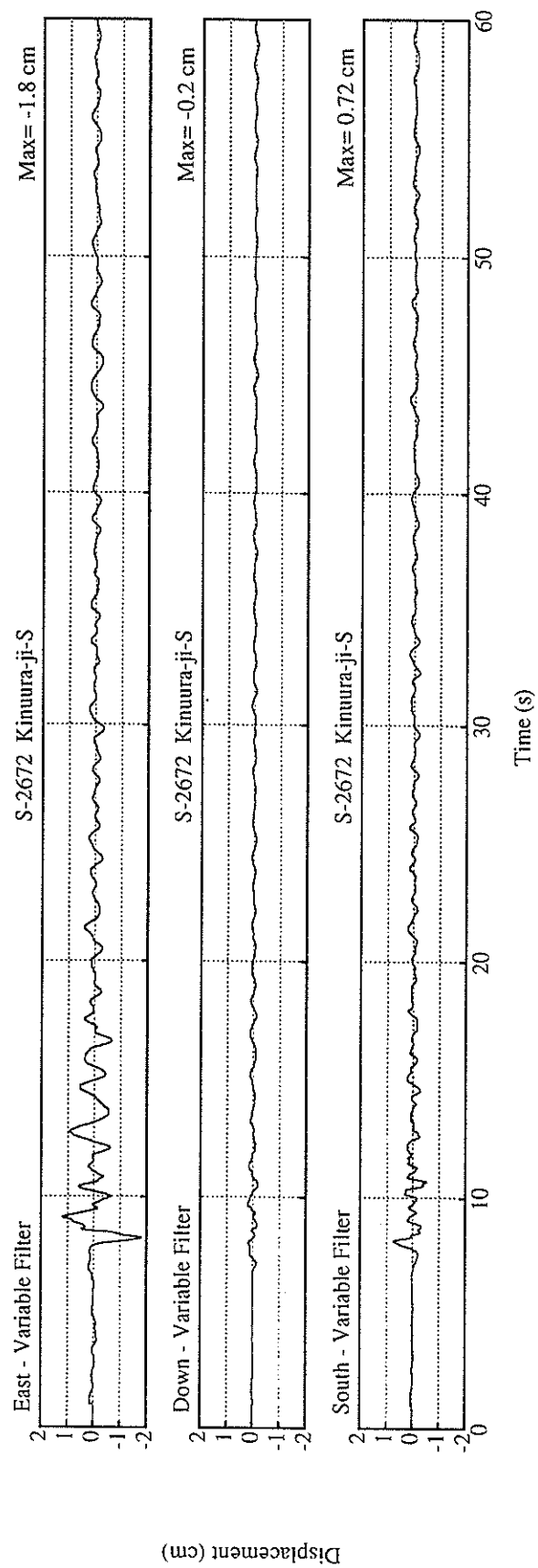
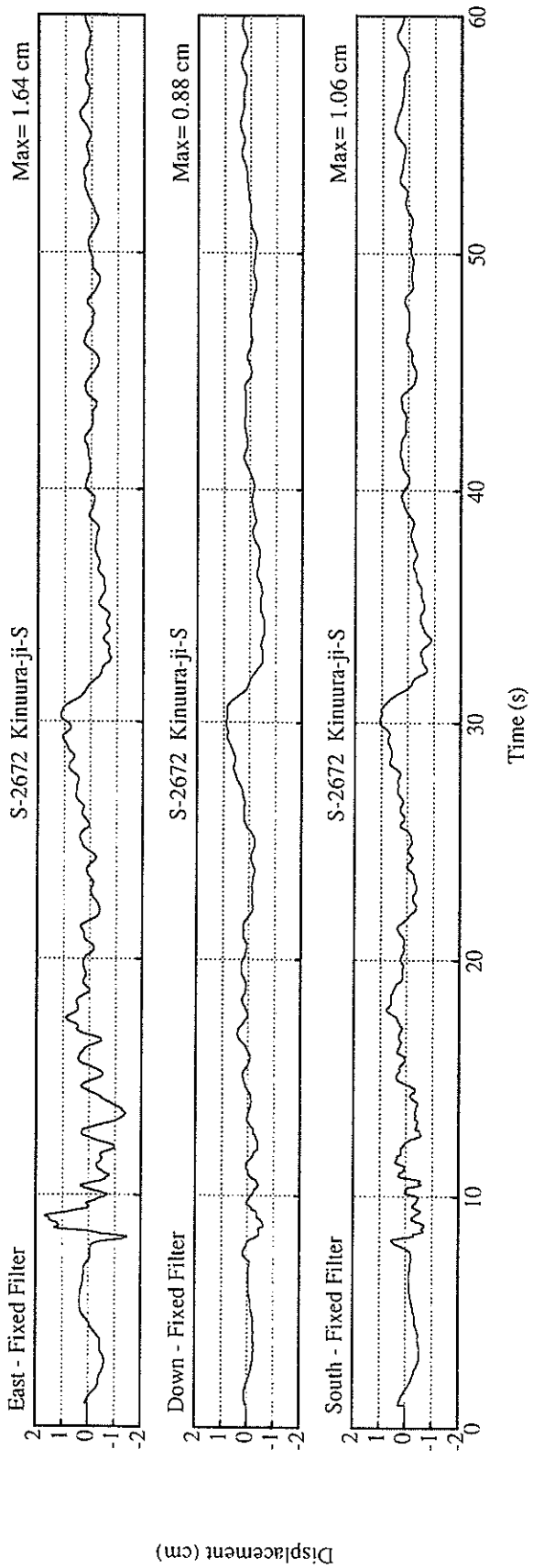
MAXIMUM DISPLACEMENT (CM)

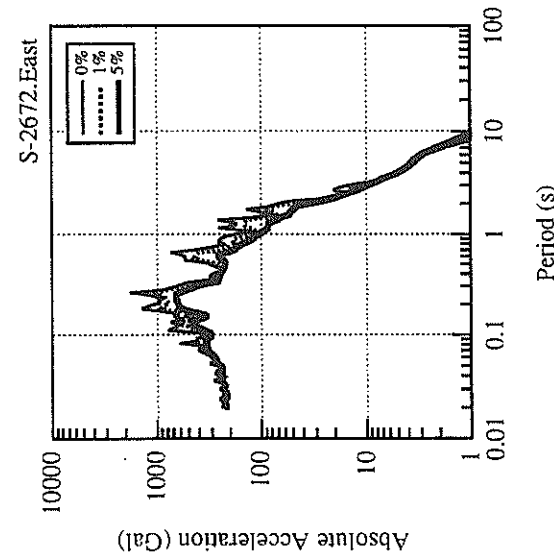
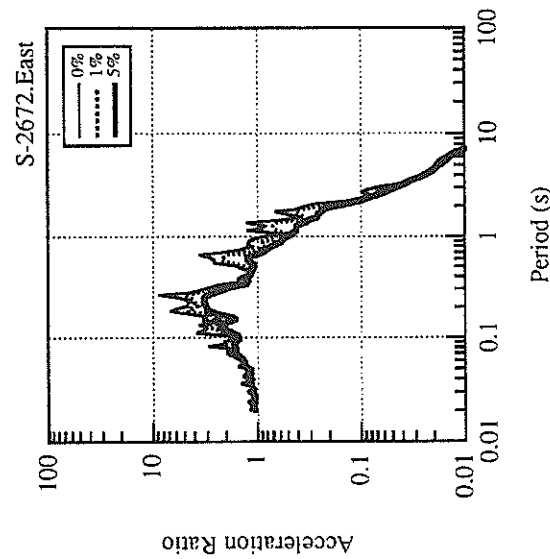
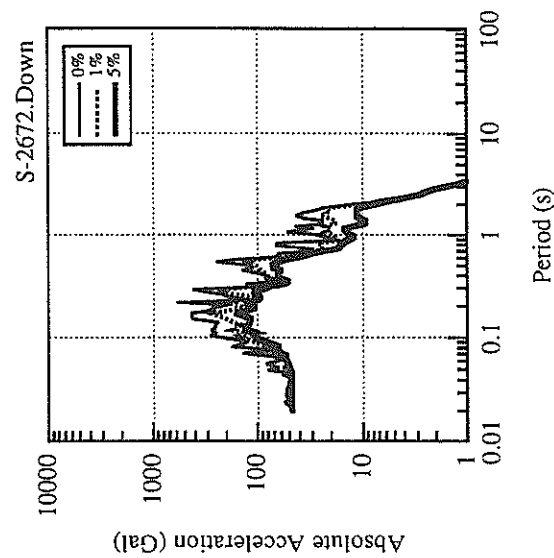
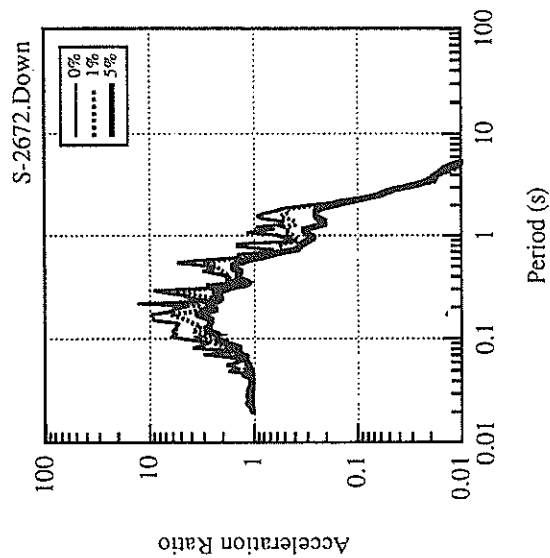
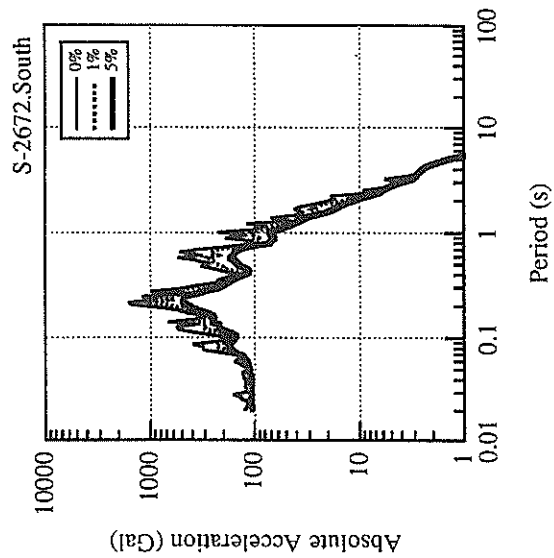
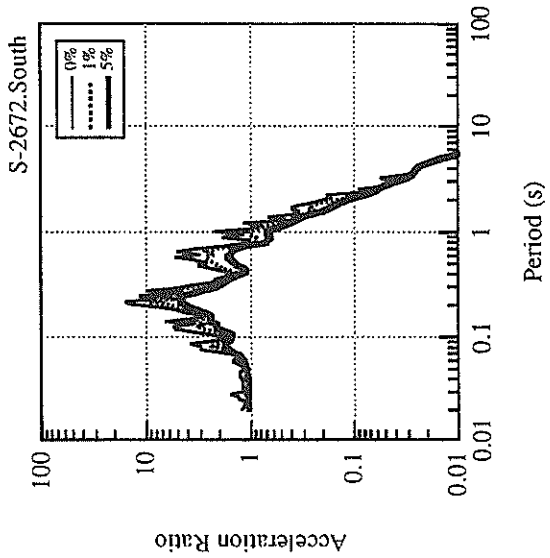
FIXED FILTER	1.06	1.64	0.88	1.66
VARIABLE FILTER	0.72	1.80	0.20	1.86

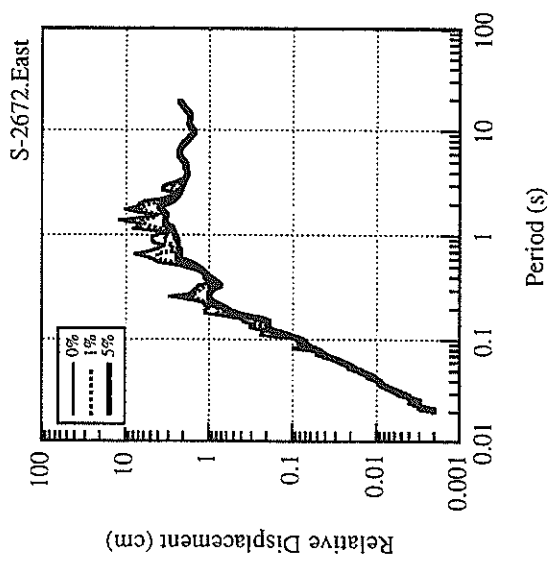
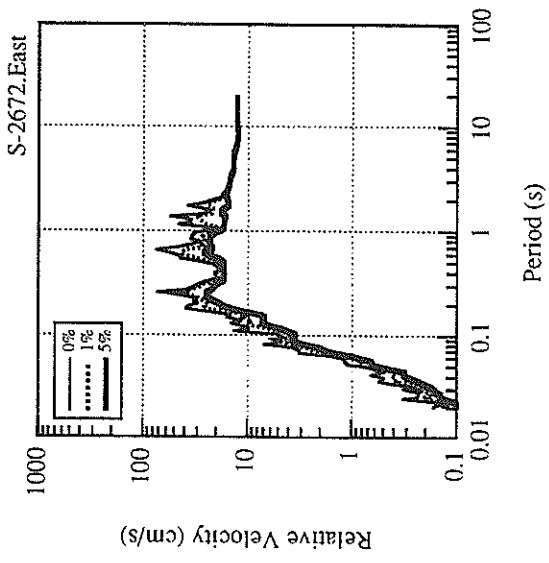
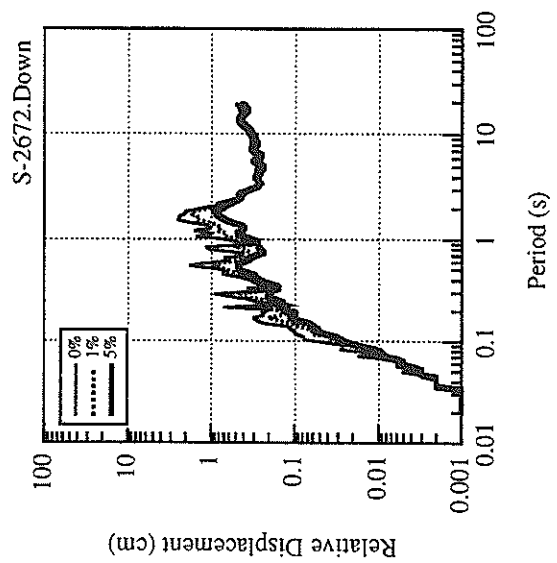
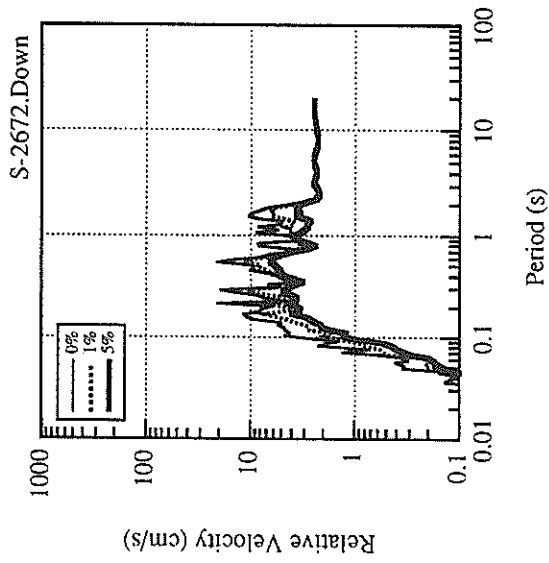
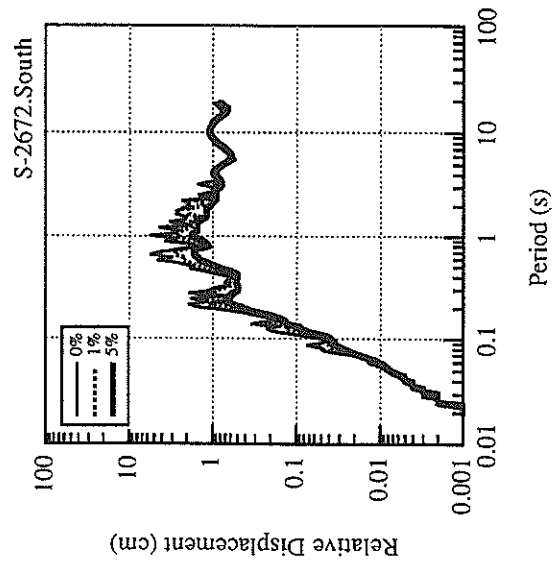
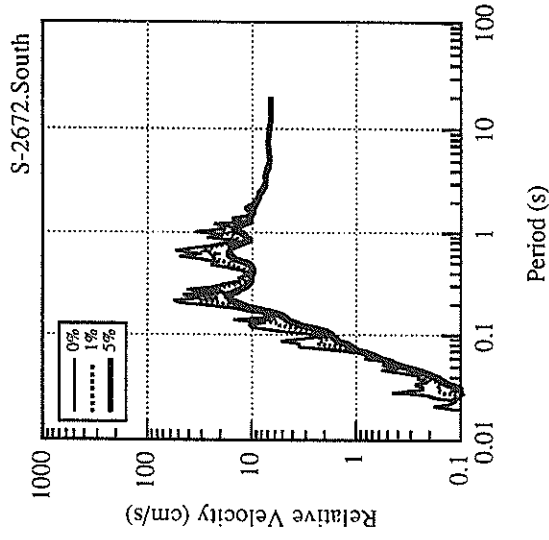
* RESULTANT OF HORIZONTAL COMPONENTS

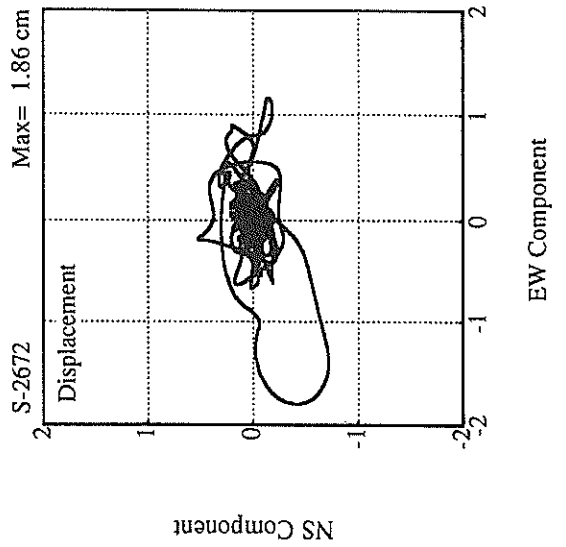
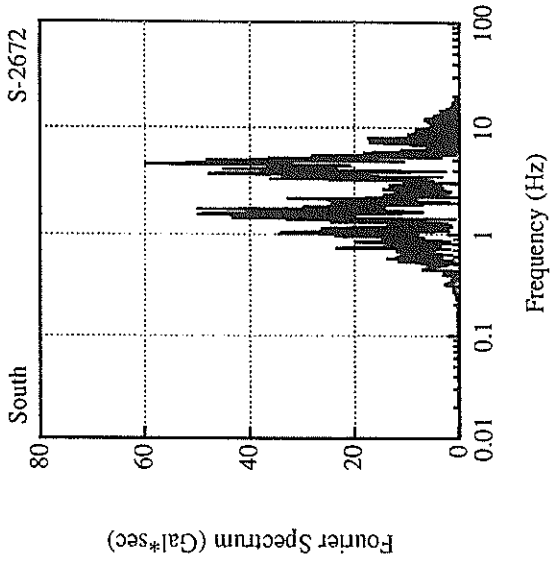
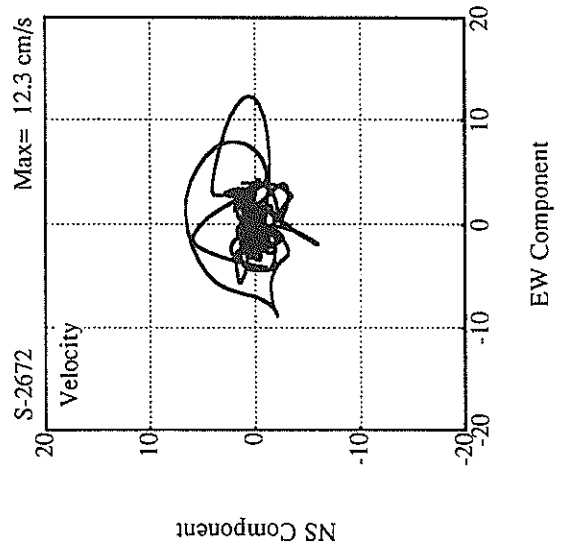
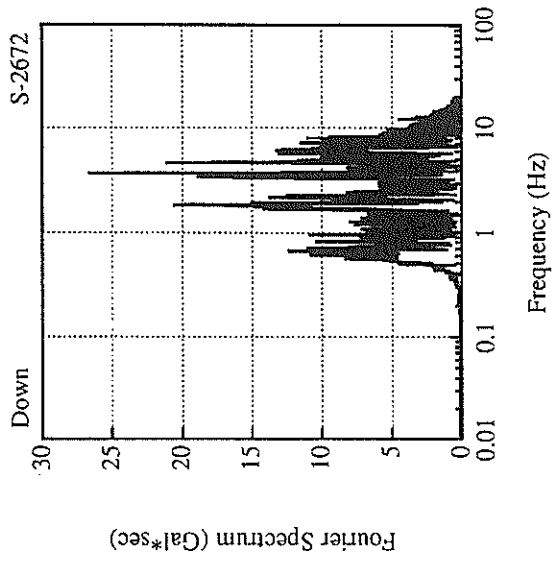
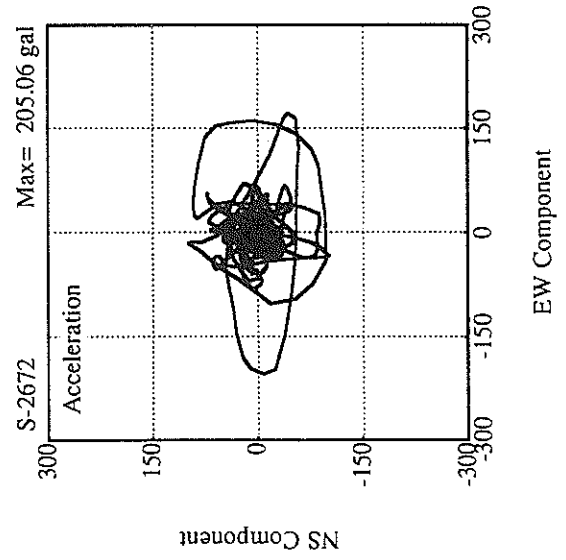
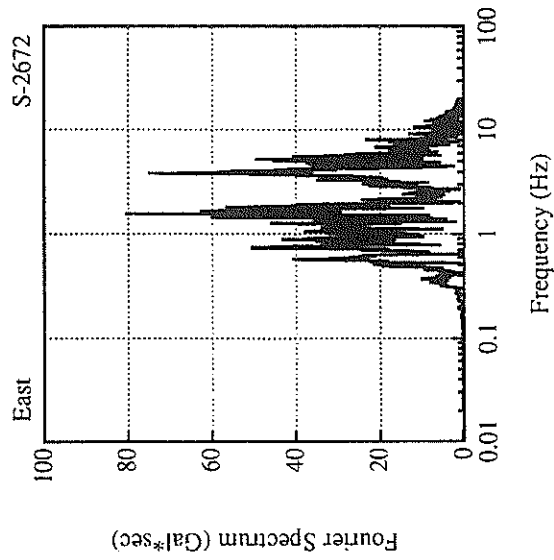












RECORD NUMBER : M-1582

STATION : YOKKA.-SEKITAN-M

EARTHQUAKE DATA

 DATE AND TIME 14:51 MAR.16,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NE AICHI PREF
 LATITUDE 34°55.5' N
 LONGITUDE 137°31.7' E
 DEPTH 39.1KM
 JMA MAGNITUDE 5.8

PEAK VALUES OF COMPONENTS

 N S E W U D HORIZONTAL*

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.427 0.318

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT 105.3 68.1 120.6
 ORIGINAL 128.2 99.6 150.0
 CORRECTED 124.5 100.2 148.8

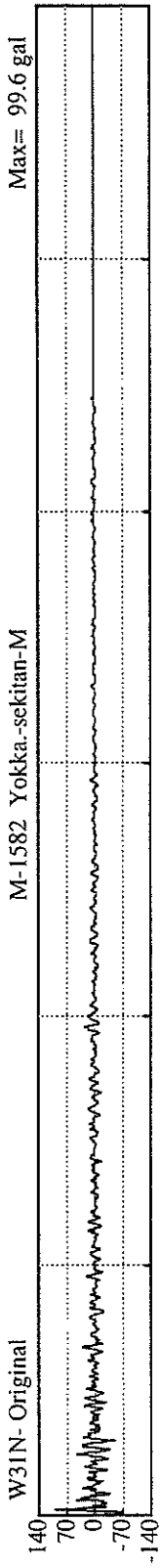
MAXIMUM VELOCITY (CM/SEC)

FIXED FILTER 6.81 6.38 8.93
 VARIABLE FILTER 7.04 5.15 8.40

MAXIMUM DISPLACEMENT (CM)

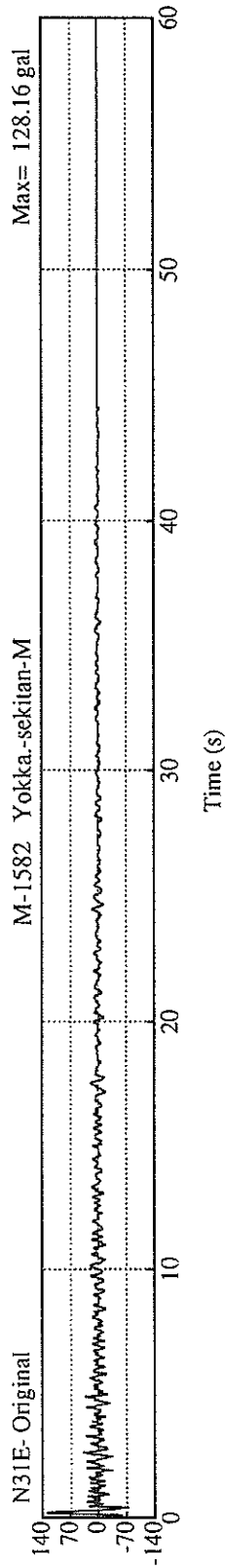
FIXED FILTER 1.722 1.967 1.986
 VARIABLE FILTER 0.648 0.589 0.654

* RESULTANT OF HORIZONTAL COMPONENTS

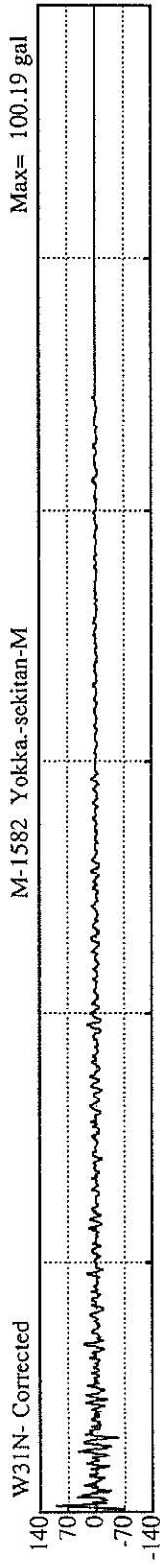


Acceleration(gal)

UP-DOWN component is not under observation.

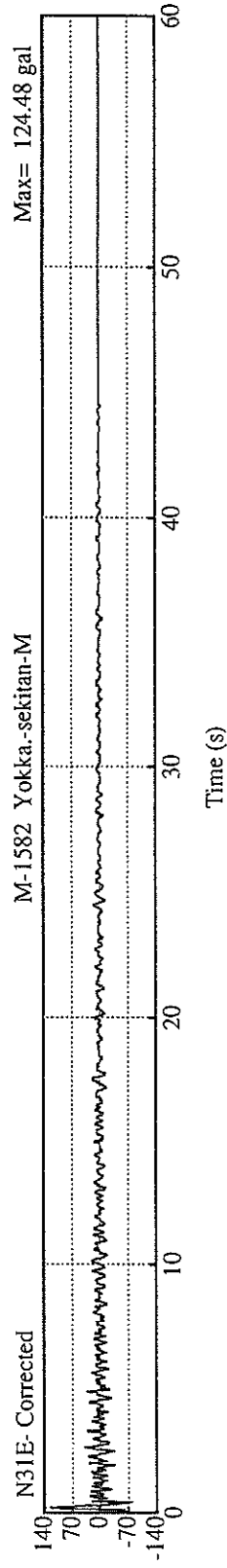


Time (s)

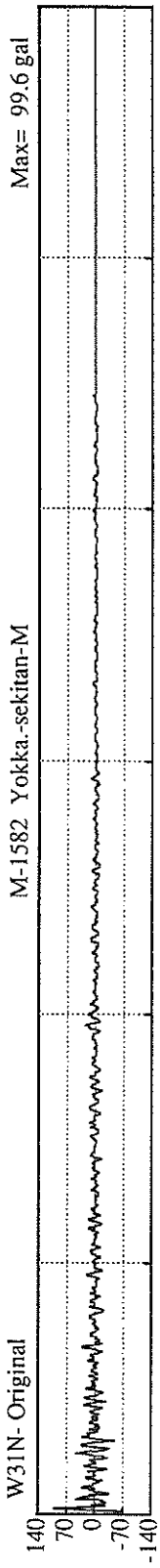


Acceleration(gal)

UP-DOWN component is not under observation.

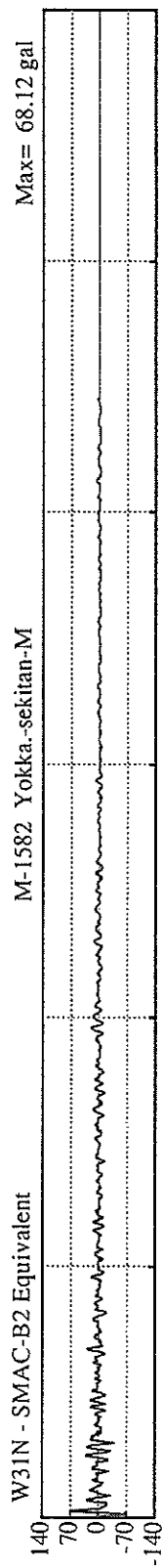
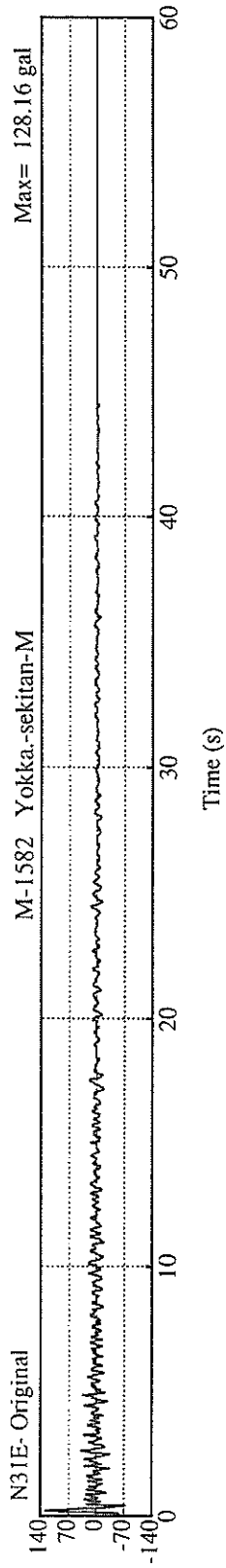


Time (s)



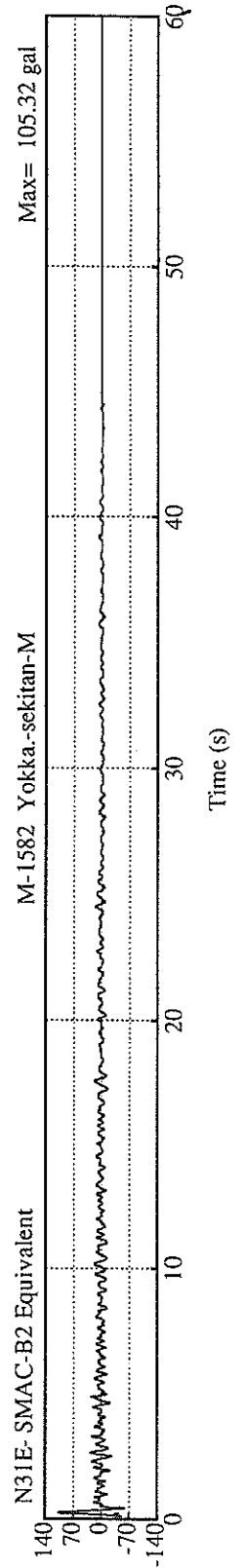
Acceleration (gal)

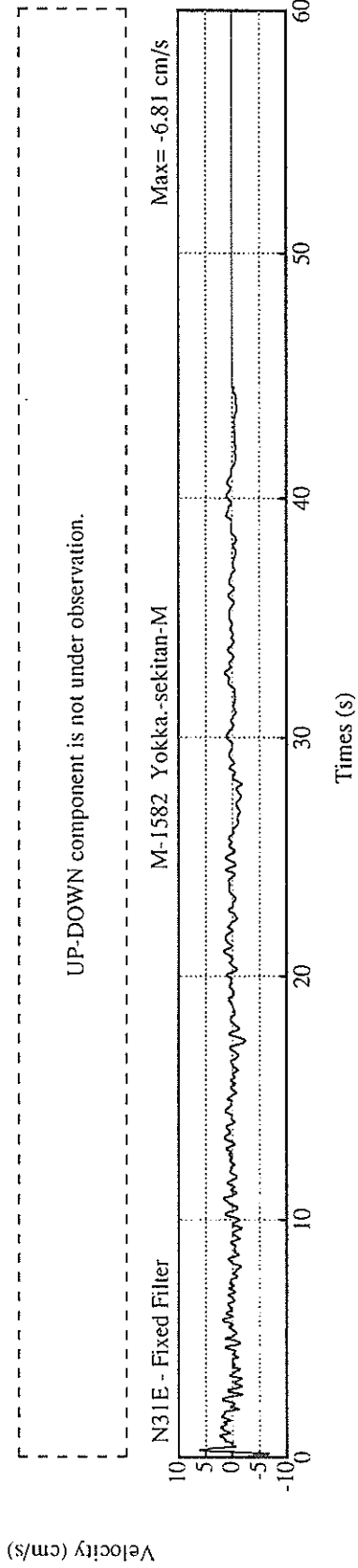
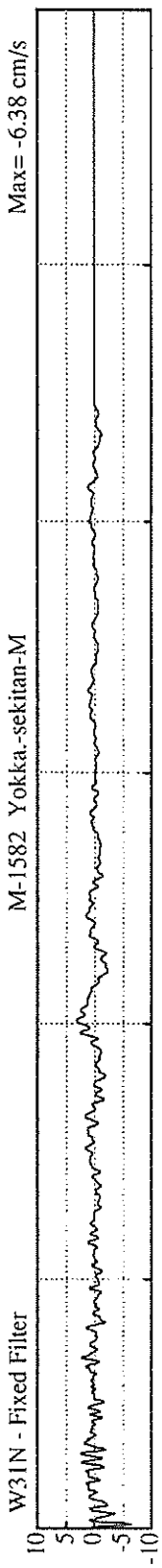
UP-DOWN component is not under observation.



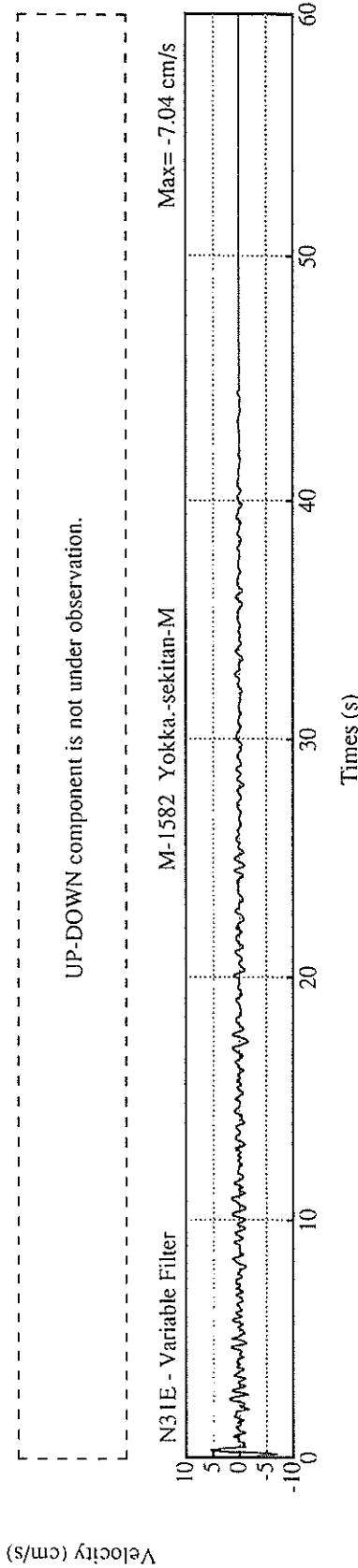
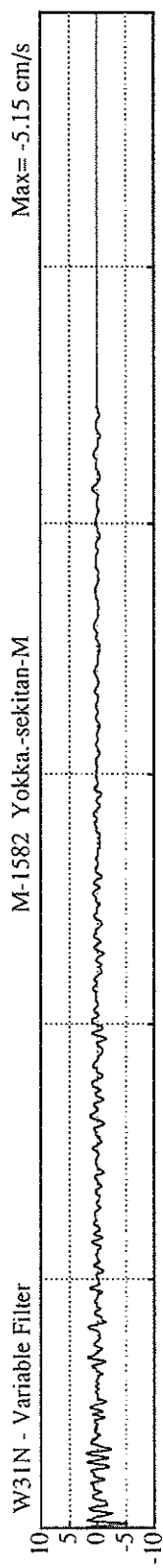
Acceleration (gal)

UP-DOWN component is not under observation.

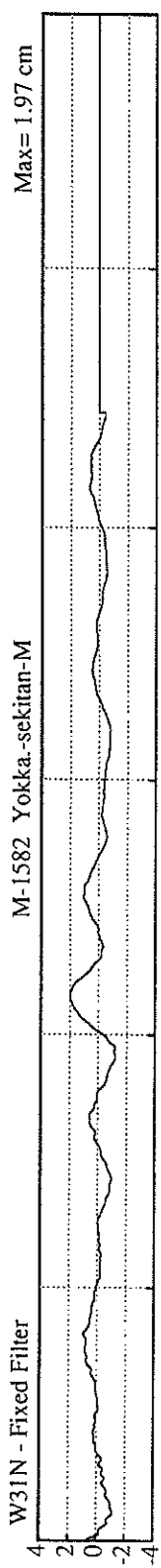




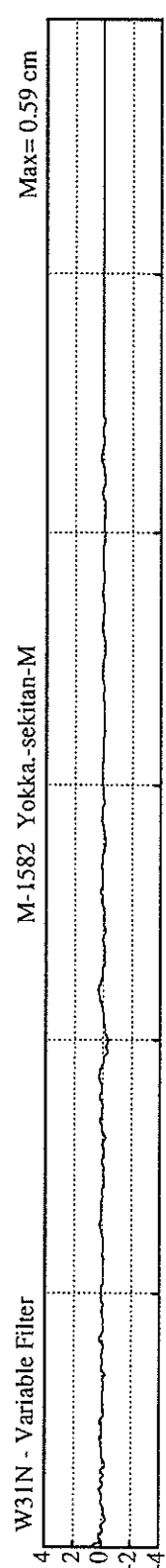
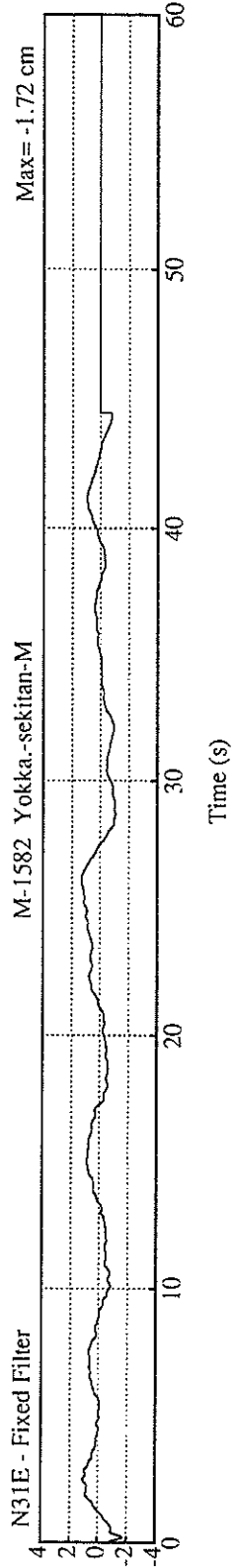
UP-DOWN component is not under observation.



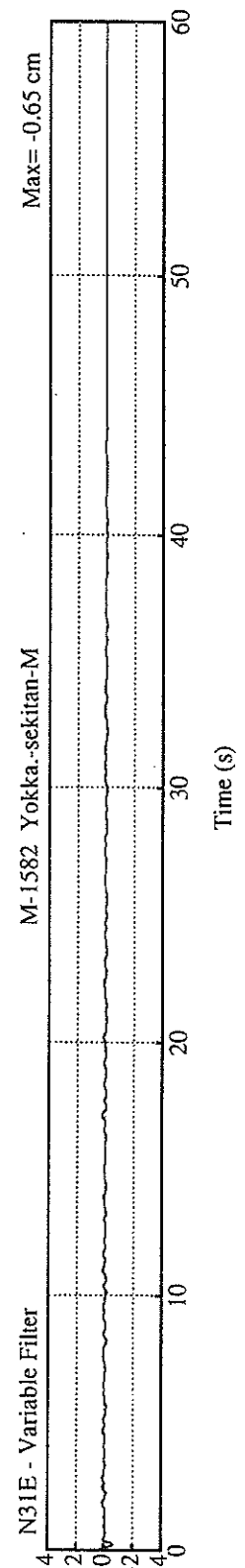
UP-DOWN component is not under observation.

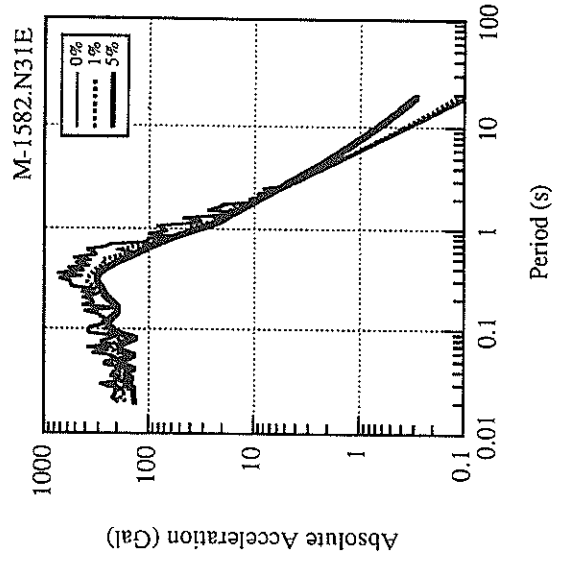
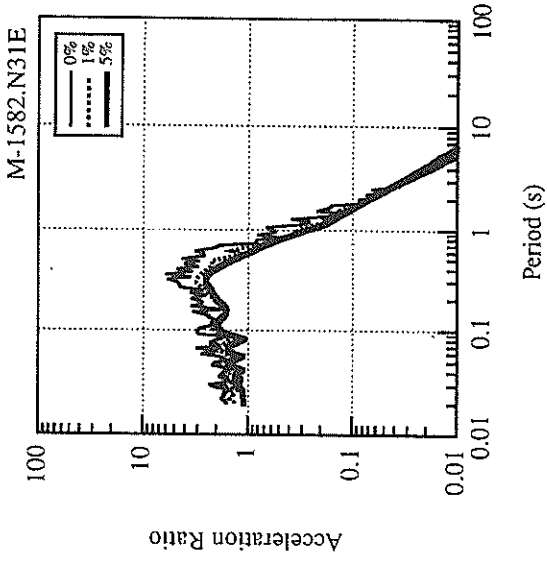


Displacement(cm)



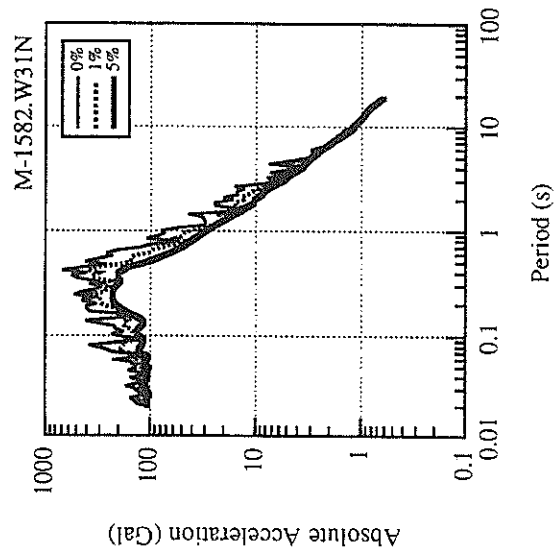
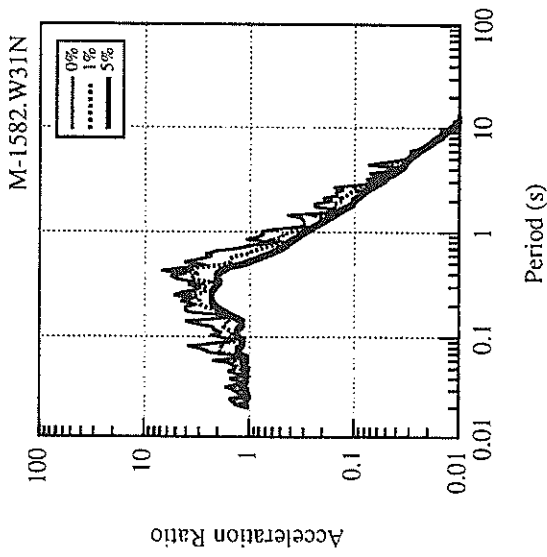
Displacement(cm)

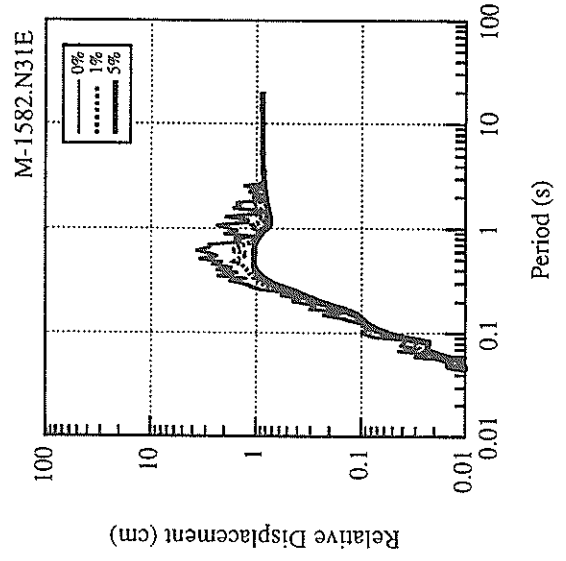
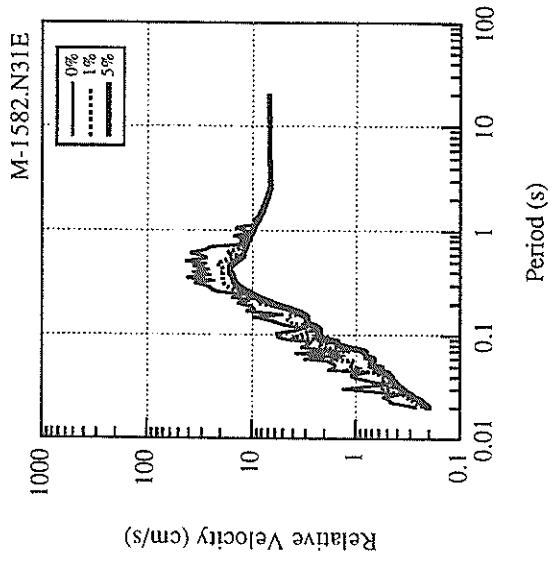




UP-DOWN component is
not under observation.

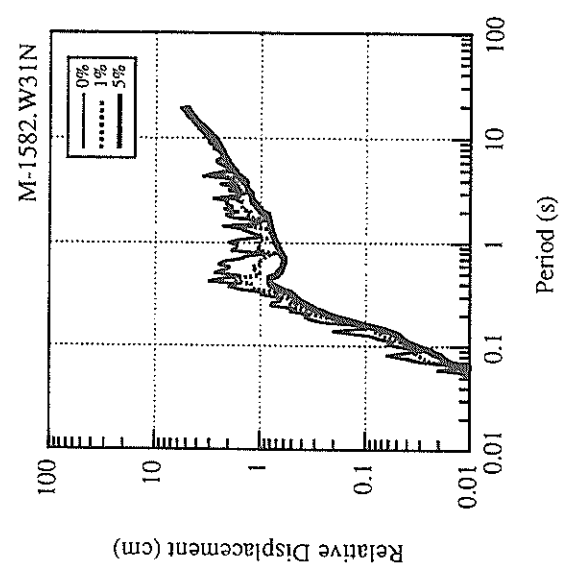
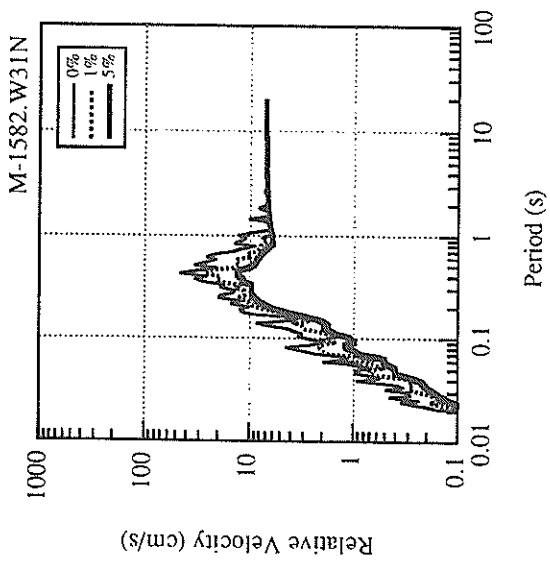
UP-DOWN component is
not under observation.

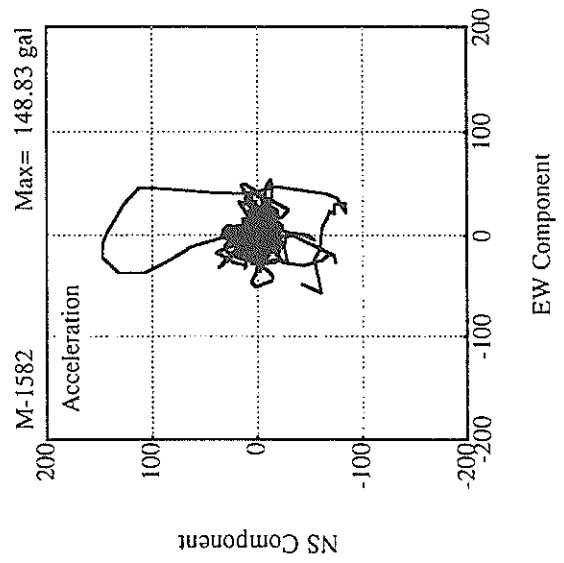
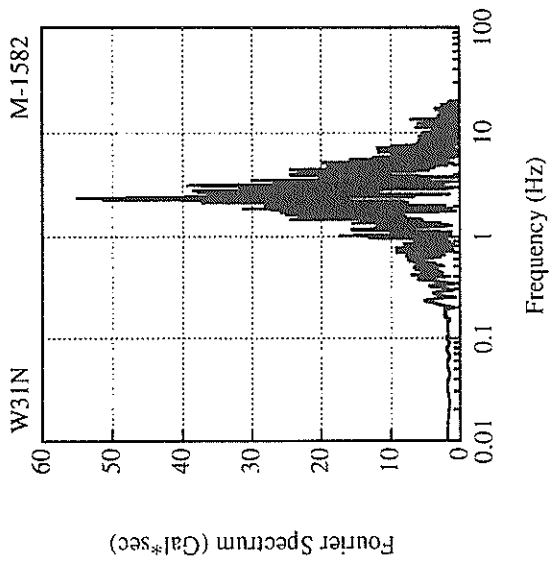




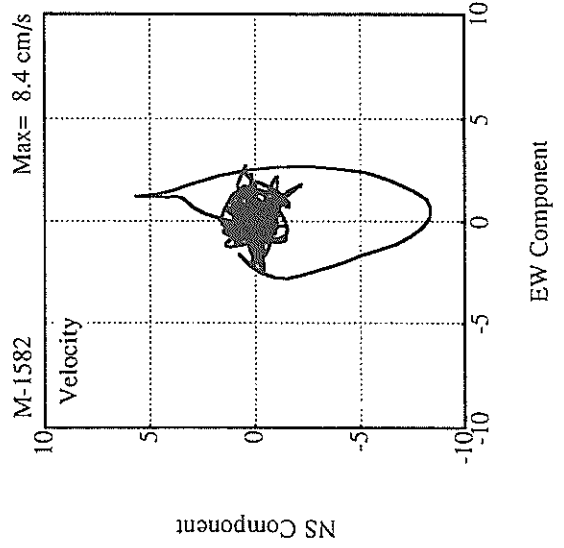
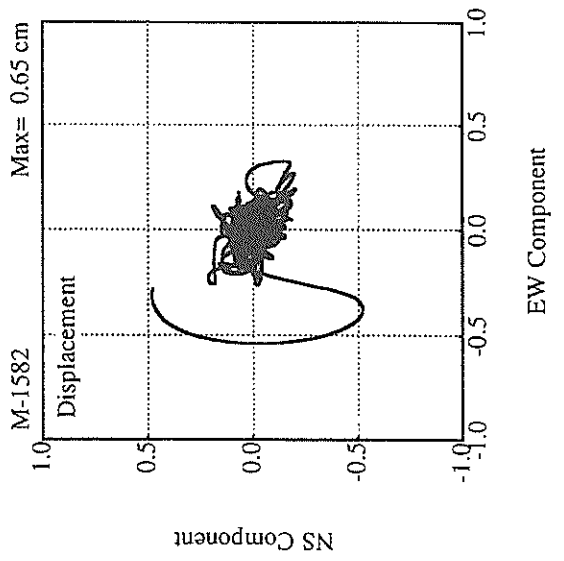
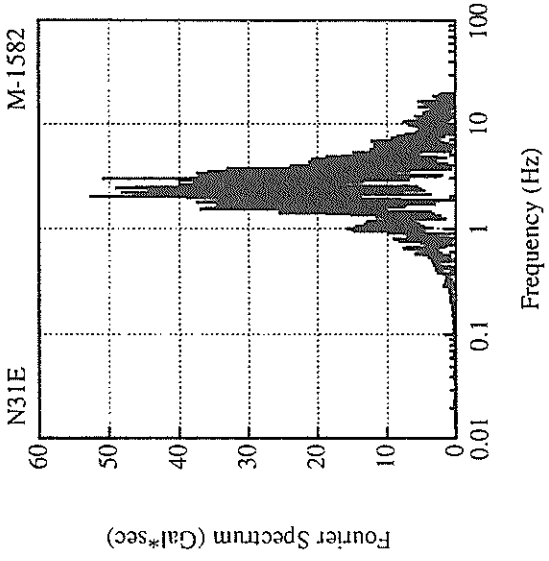
UP-DOWN component is
not under observation.

UP-DOWN component is
not under observation.





UP-DOWN component is
not under observation.



RECORD NUMBER : F-1123

STATION : KAGOSHIMA-G

EARTHQUAKE DATA

DATE AND TIME 17:31 MAR.26,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION NW KAGOSHIMA PREF

LATITUDE 31°58.2' N

LONGITUDE 130°21.7' E

DEPTH 11.9KM

JMA MAGNITUDE 6.5

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.189	0.183	0.323	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.189 0.183 0.323

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	46.1	38.5	13.6	56.7
ORIGINAL	59.5	50.2	22.6	68.5
CORRECTED	60.3	51.0	21.8	69.1

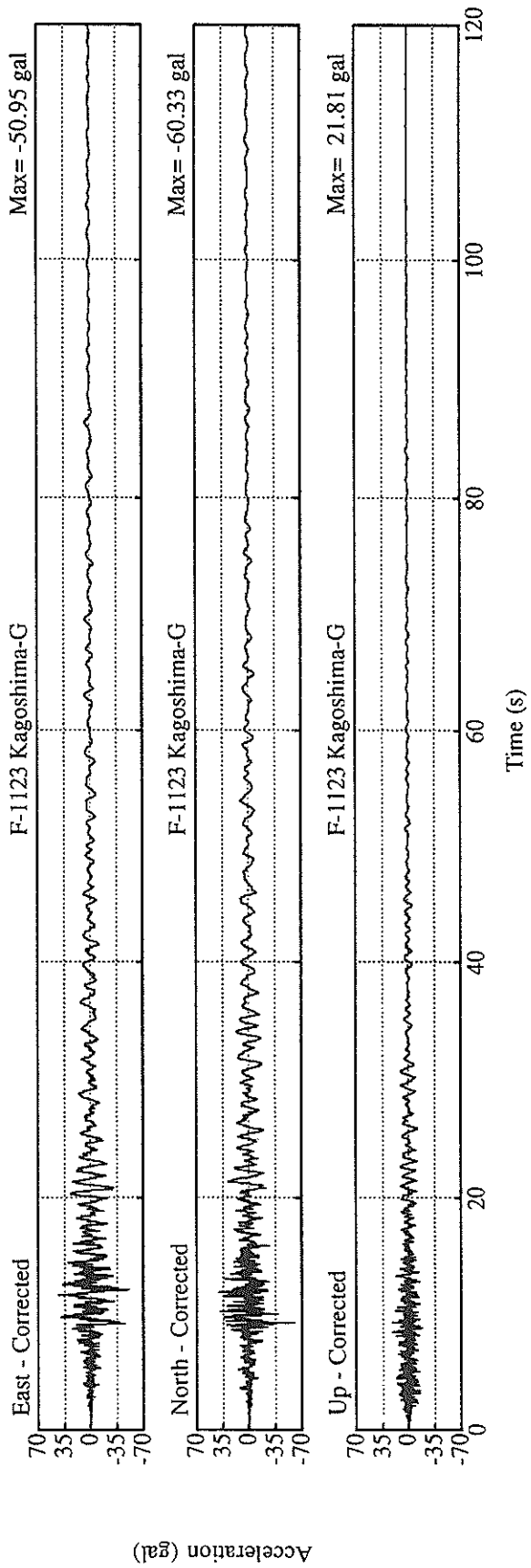
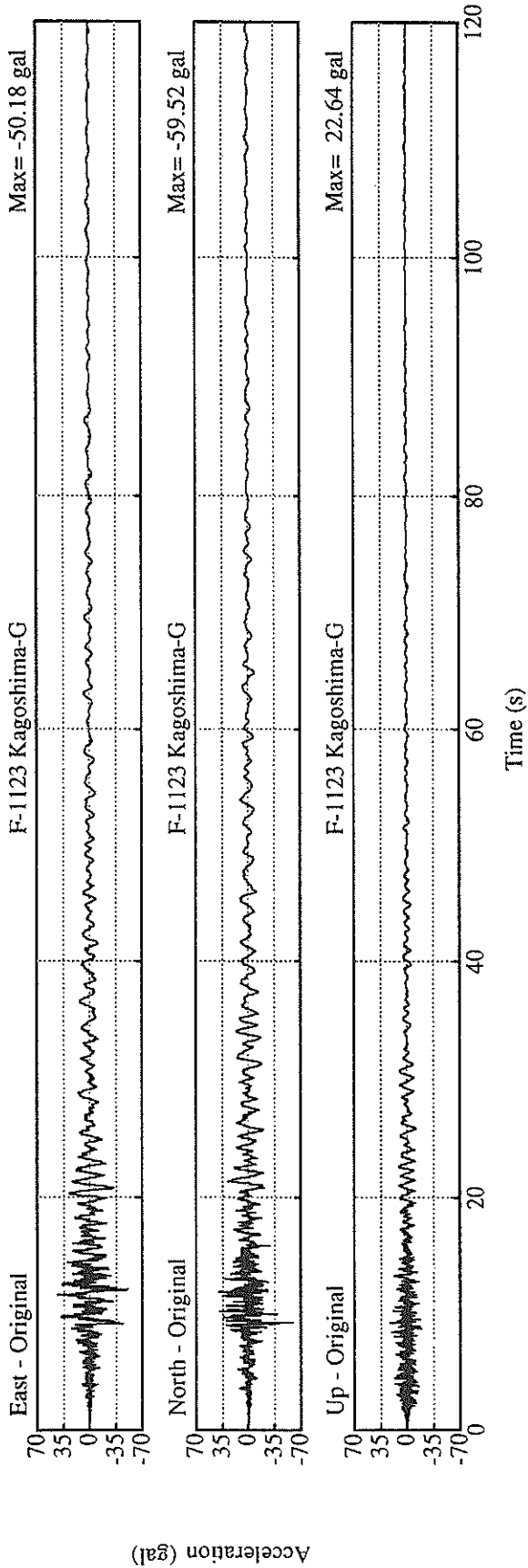
MAXIMUM VELOCITY (CM/SEC)

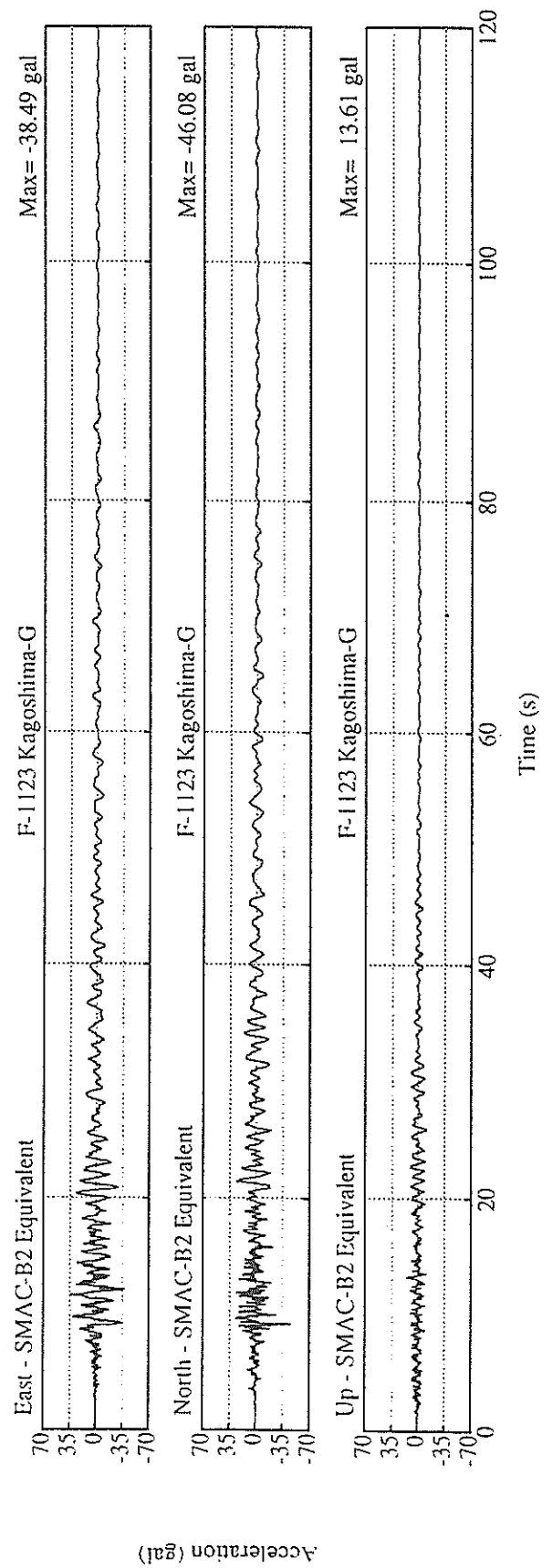
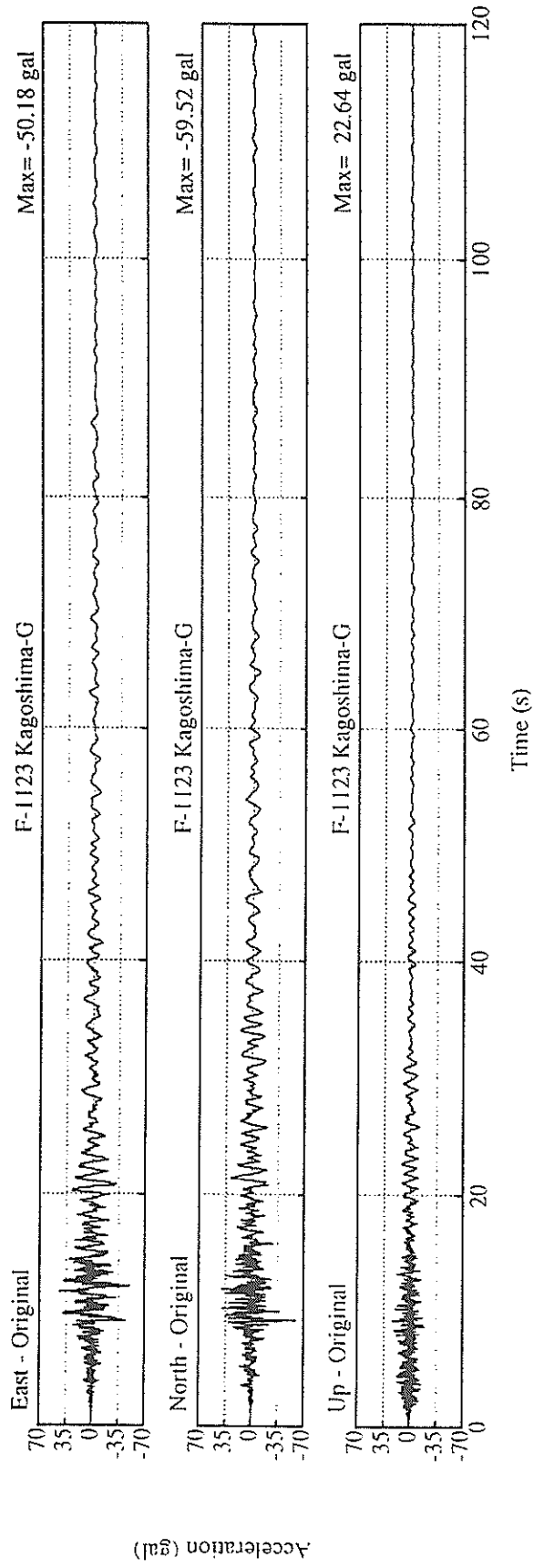
FIXED FILTER	5.06	5.82	2.05	6.43
VARIABLE FILTER	4.95	5.13	1.90	6.05

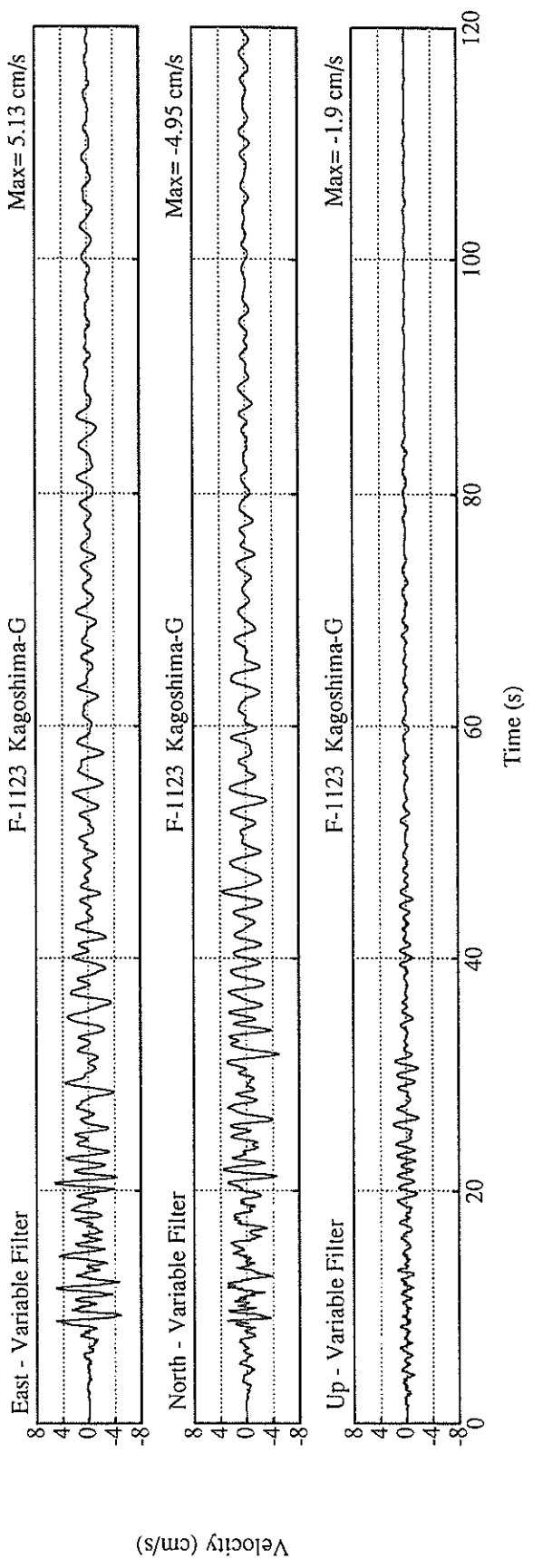
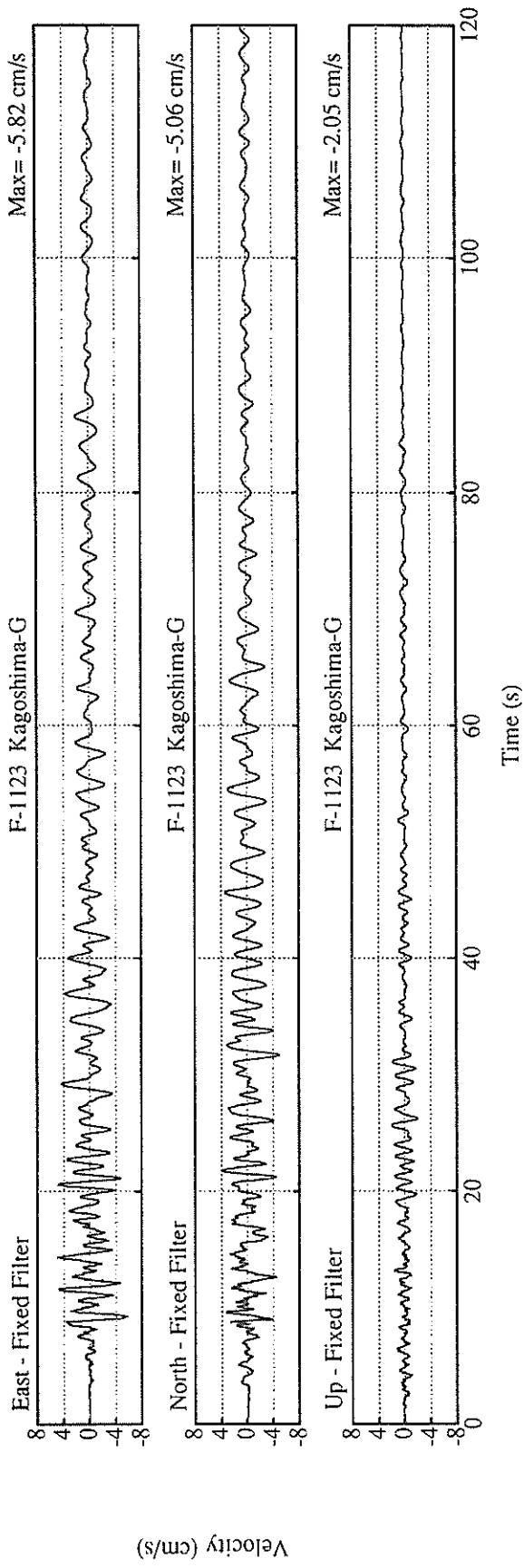
MAXIMUM DISPLACEMENT (CM)

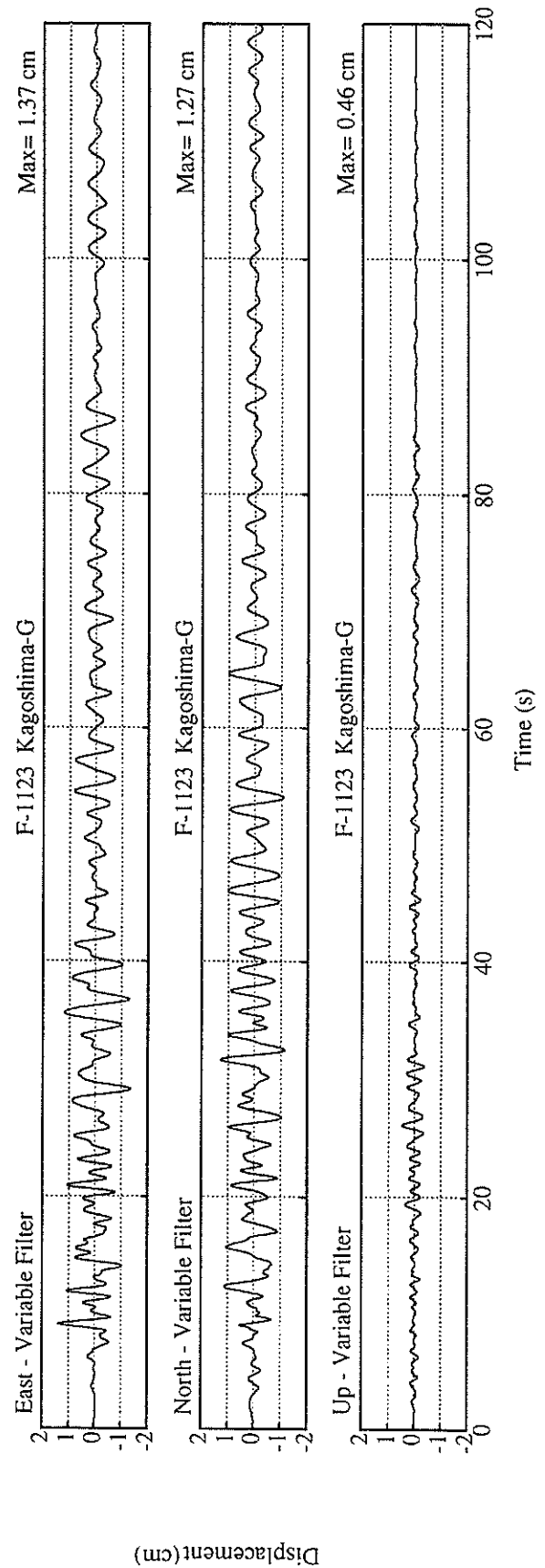
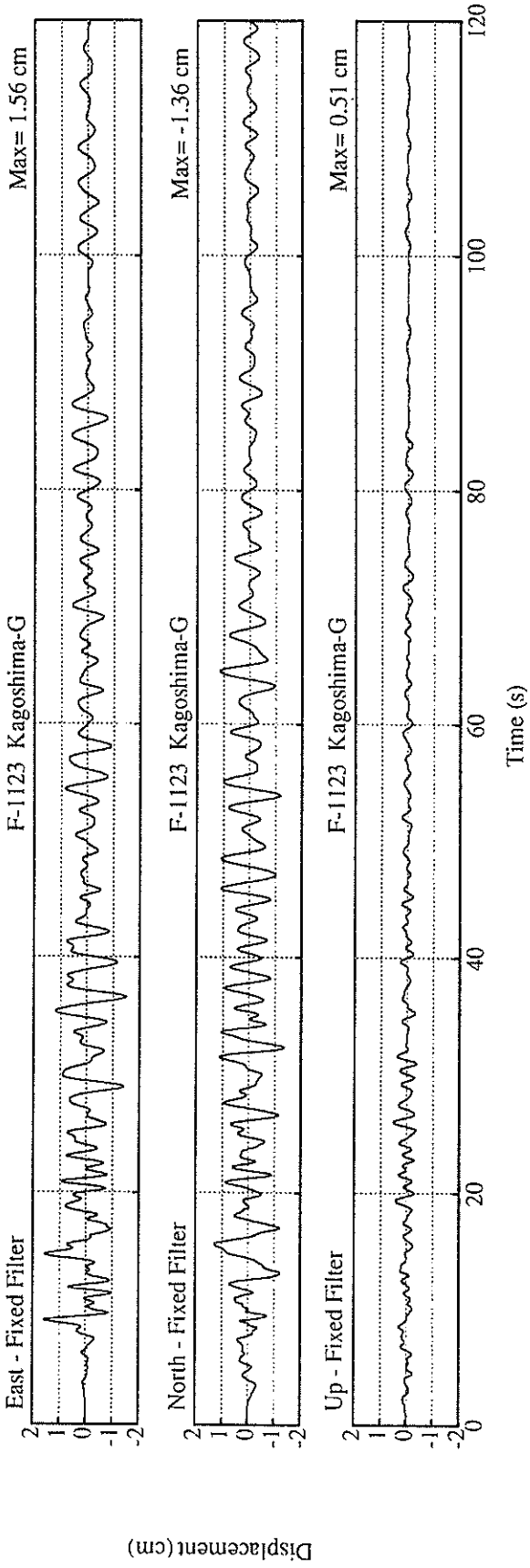
FIXED FILTER	1.36	1.56	0.51	1.63
VARIABLE FILTER	1.27	1.37	0.46	1.44

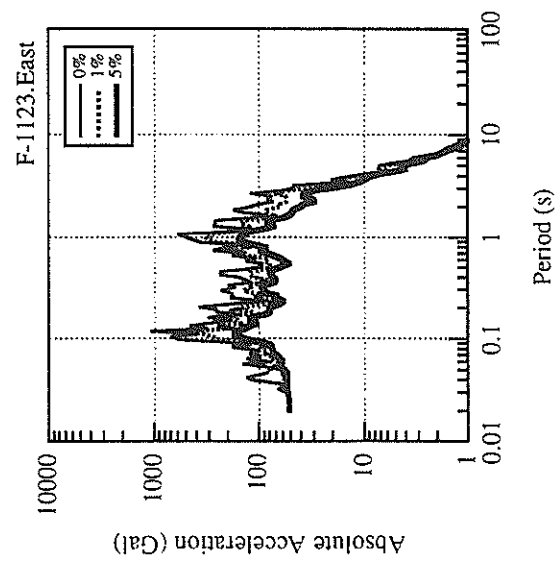
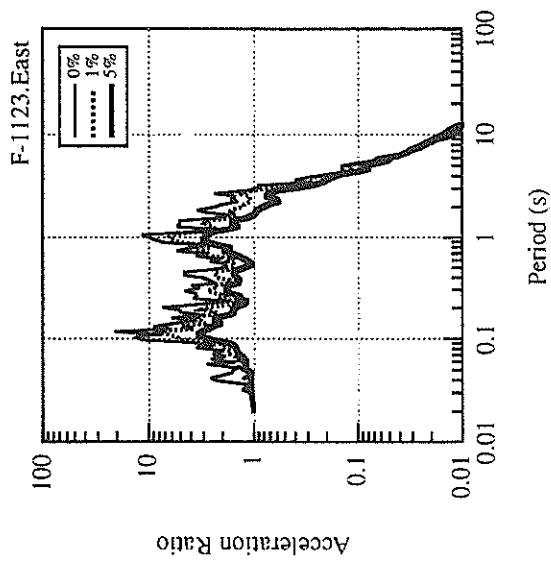
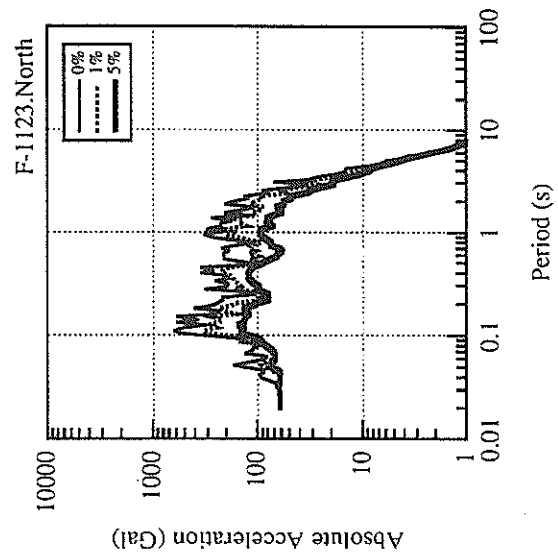
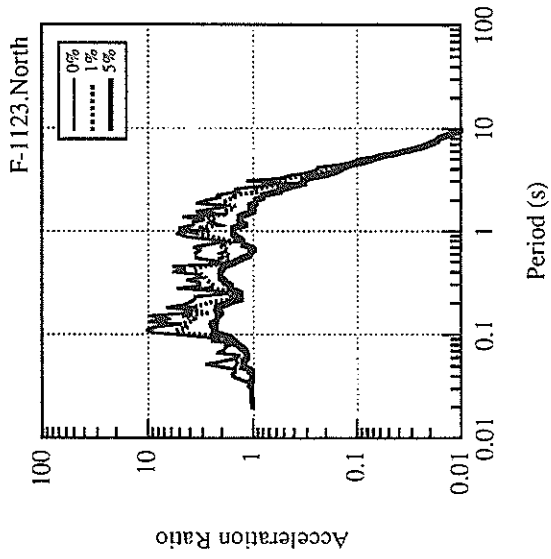
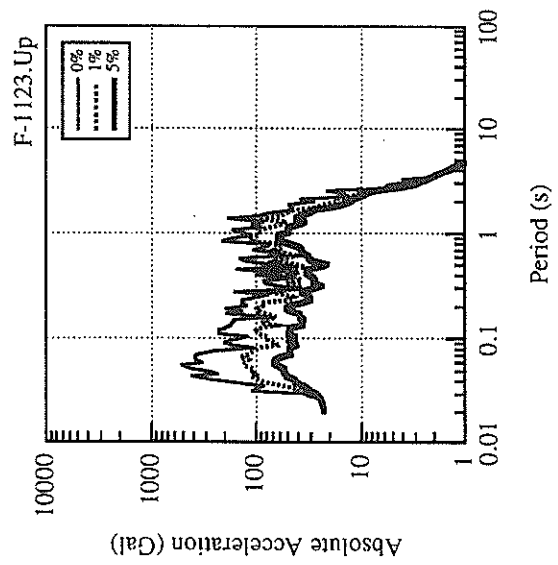
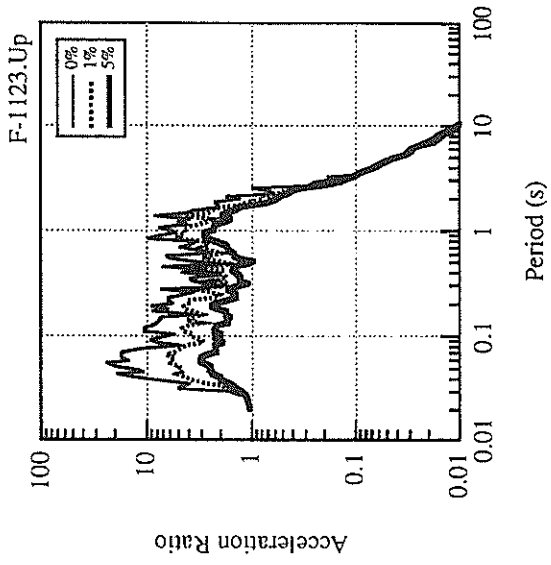
* RESULTANT OF HORIZONTAL COMPONENTS

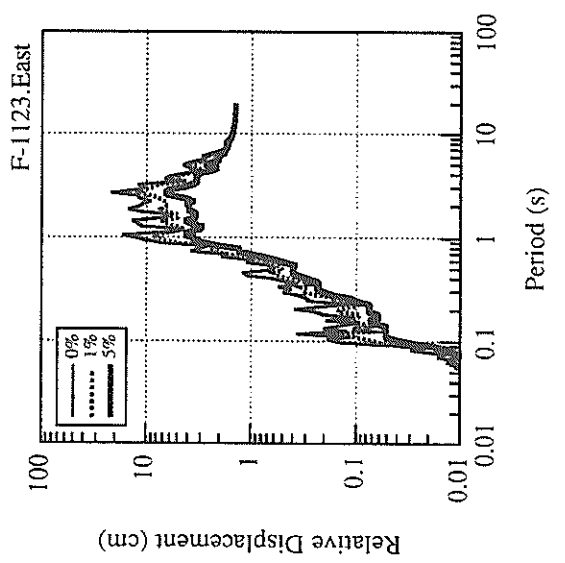
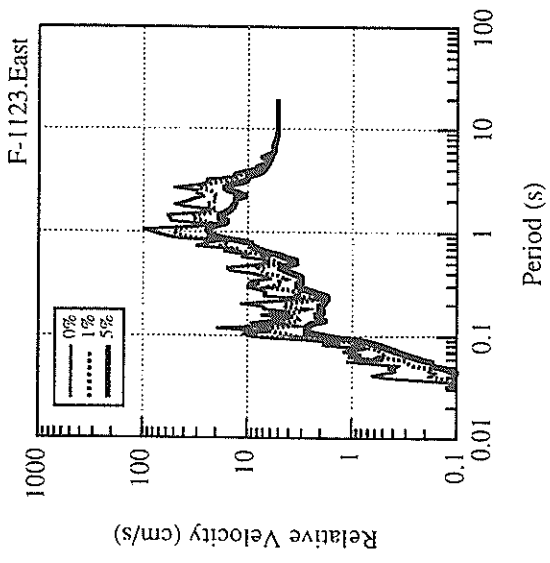
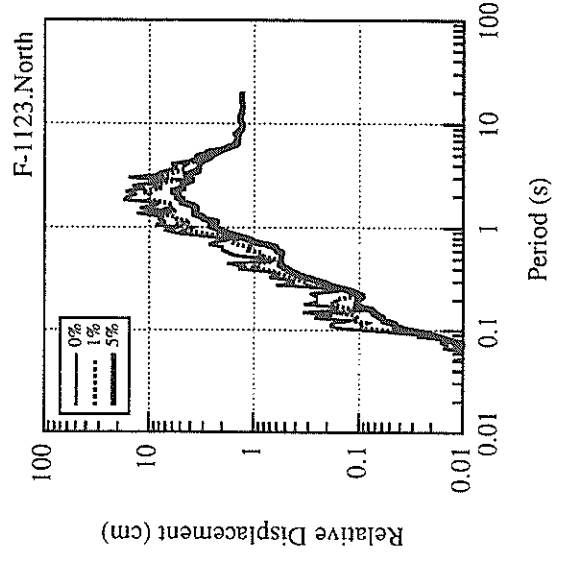
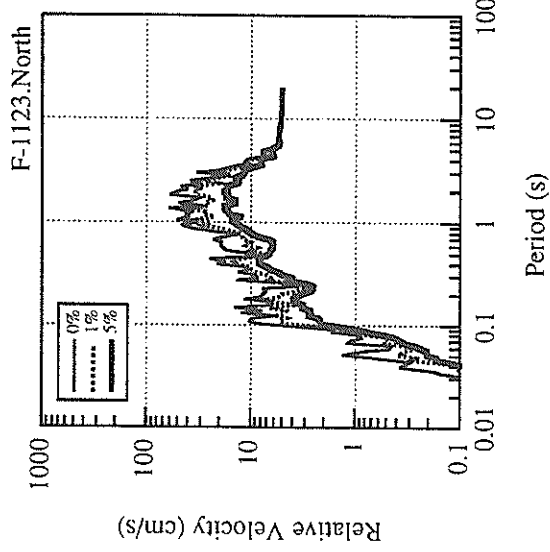
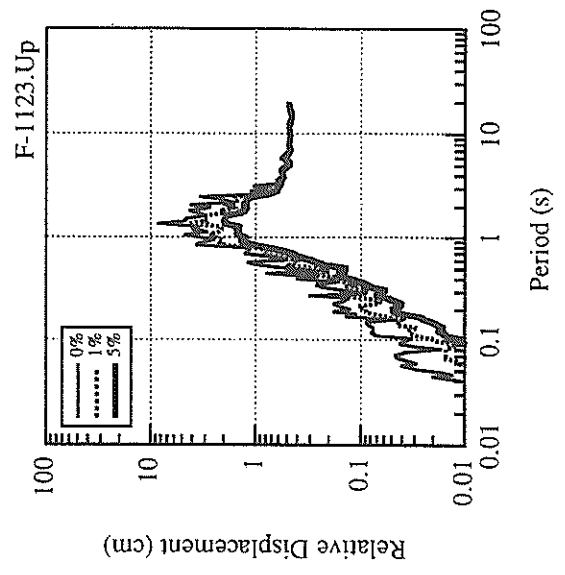
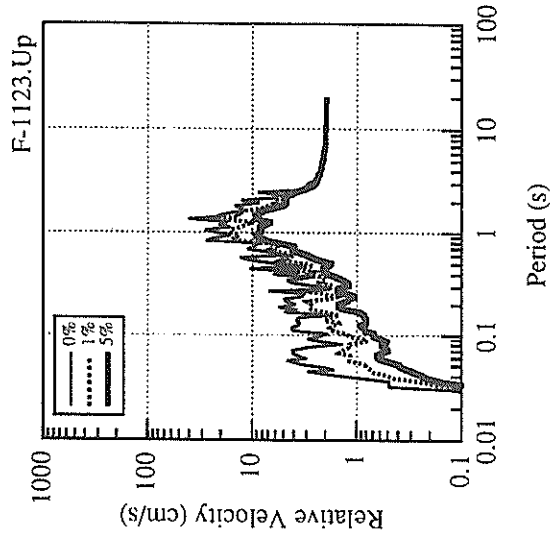


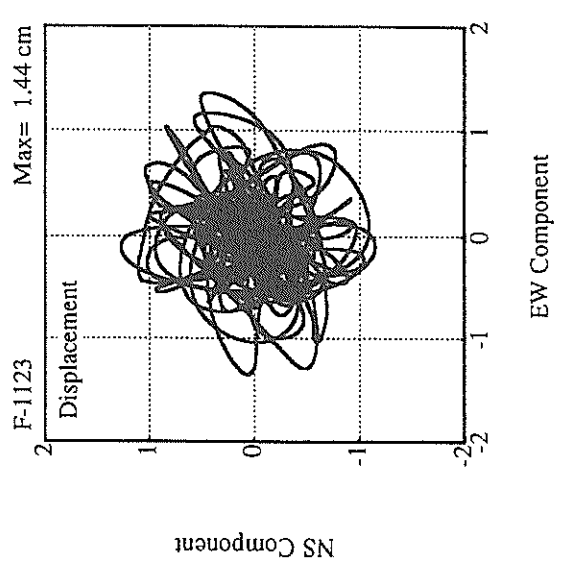
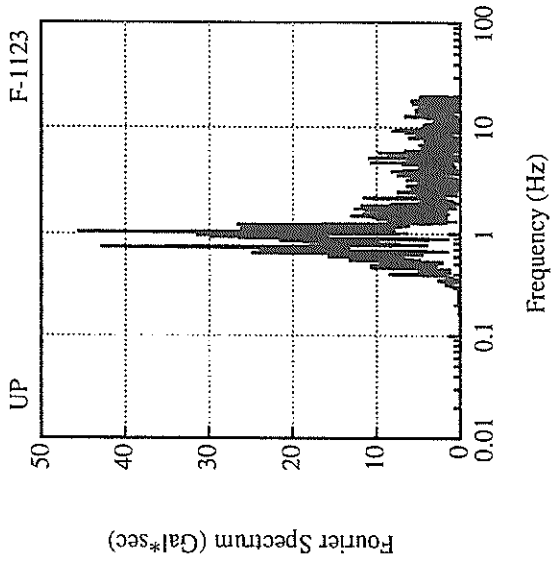
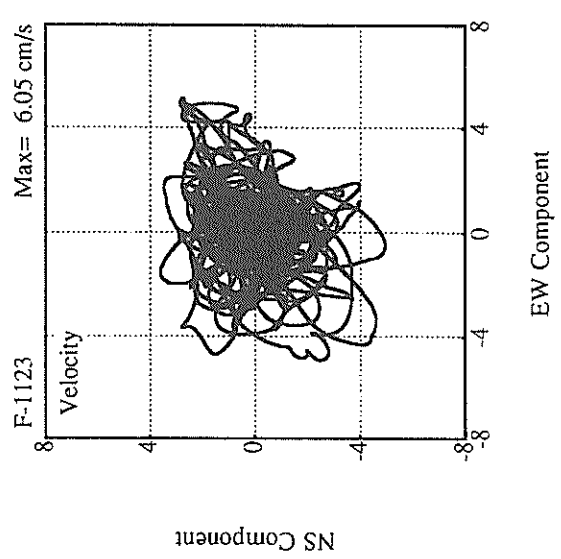
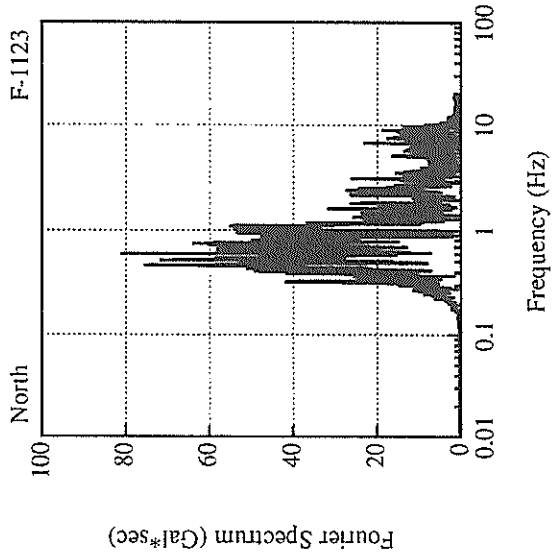
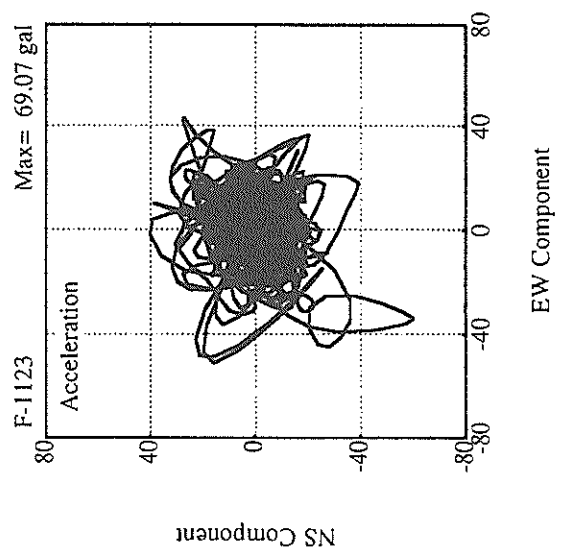
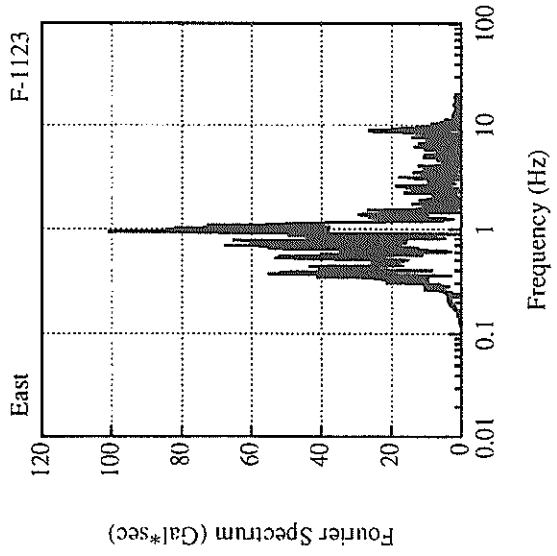












RECORD NUMBER : F-1178

STATION : ONAHAMA-JI-G

EARTHQUAKE DATA

DATE AND TIME : 20: 7 APR. 28, 1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : E OFF FUKUSHIMA PREF

LATITUDE : 37° 18.5' N

LONGITUDE : 141° 23.6' E

DEPTH : 53.9KM

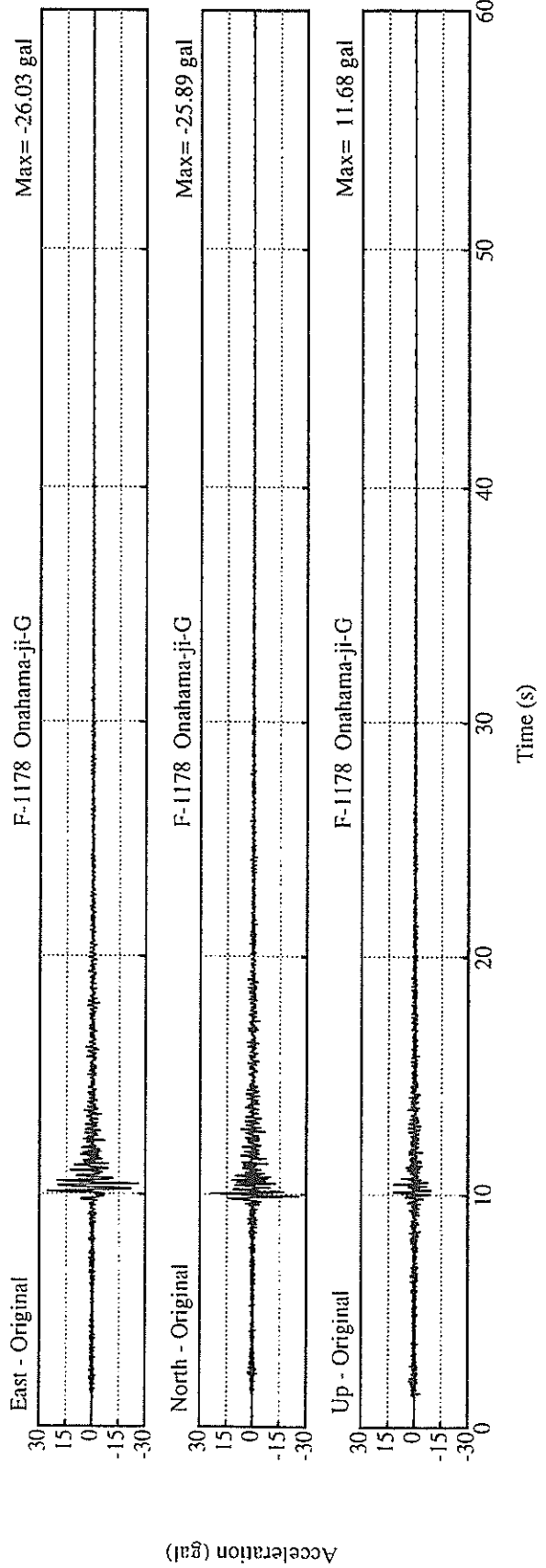
JMA MAGNITUDE : 4.4

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
25.9	26.0	11.7	29.7

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : S-2675
 STATION : SOMA-S

EARTHQUAKE DATA

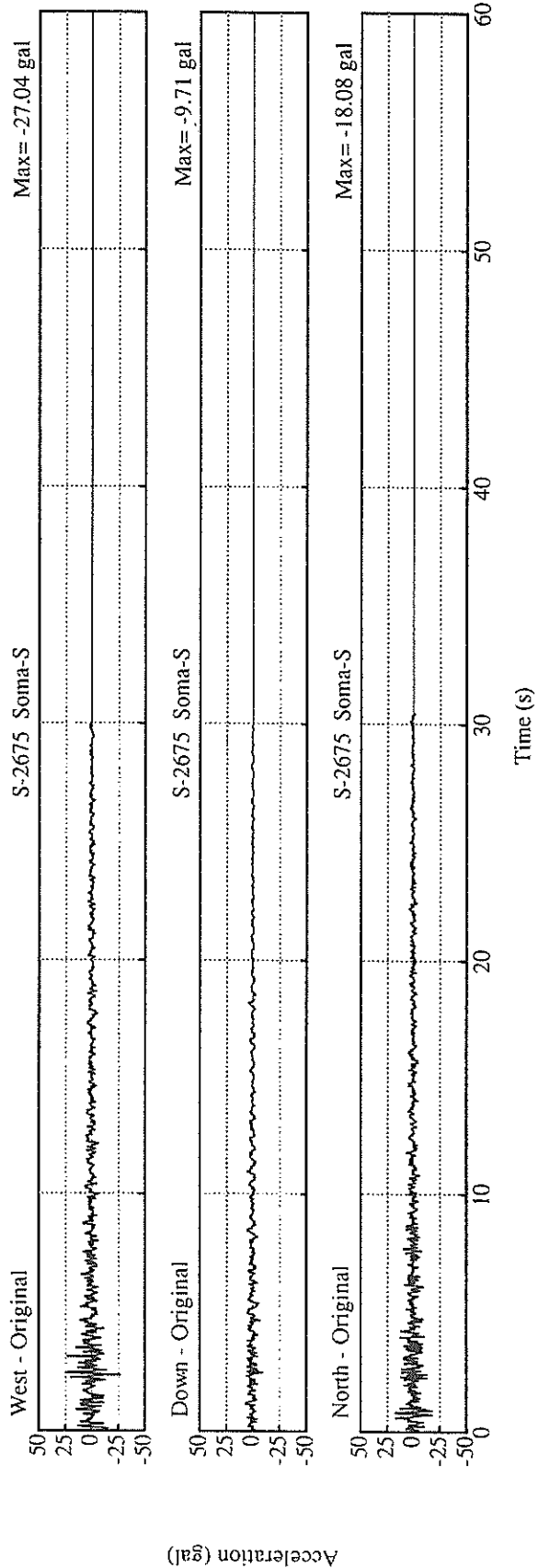
 DATE AND TIME 7:59 MAY 12, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF FUKUSHIMA PREF
 LATITUDE 37° 3.5' N
 LONGITUDE 141° 15.0' E
 DEPTH 54.1KM
 JMA MAGNITUDE 5.5

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
18.1	27.0	9.7	27.6

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1179

STATION : ONAHAMA-JI-GB

EARTHQUAKE DATA

DATE AND TIME : 7:59 MAY 12, 1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : E OFF FUKUSHIMA PREF

LATITUDE : 37° 3.5' N

LONGITUDE : 141° 15.0' E

DEPTH : 54.1KM

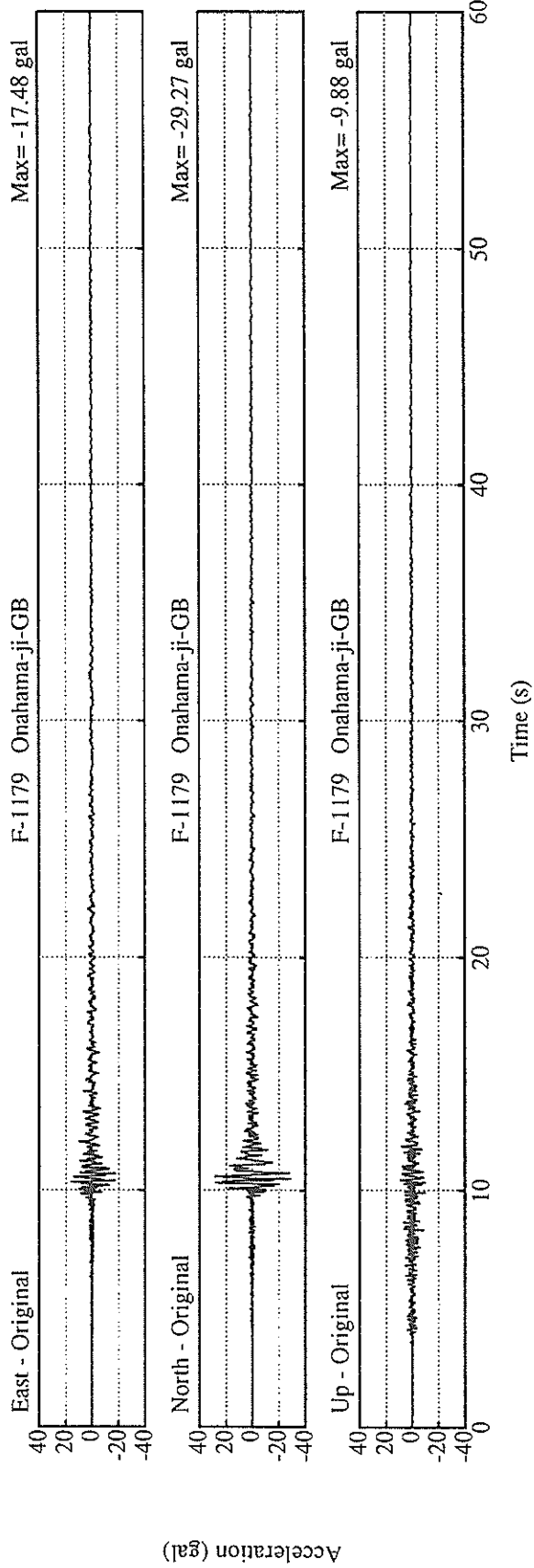
JMA MAGNITUDE : 5.5

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
29.3	17.5	9.9	30.1

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1180

STATION : ONAHAMA-JI-G

EARTHQUAKE DATA

 DATE AND TIME 7:59 MAY 12, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF FUKUSHIMA PREF
 LATITUDE 37° 3.5' N
 LONGITUDE 141° 15.0' E
 DEPTH 54.1KM
 JMA MAGNITUDE 5.5

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.829	0.384	1.373	

PARAMETER OF THE VARIABLE FILTER

FC (HZ)	0.829	0.384	1.373
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MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	56.5	42.0	16.9	63.6
ORIGINAL	87.2	86.1	37.5	93.8
CORRECTED	87.0	84.7	37.0	95.7

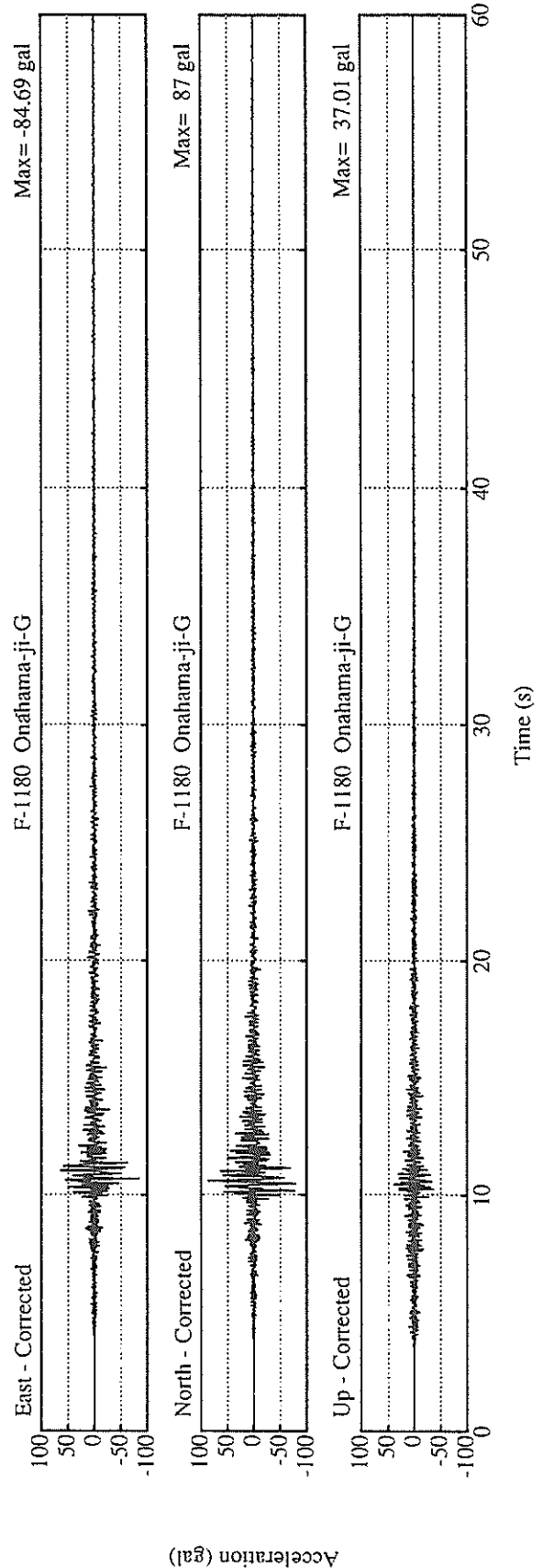
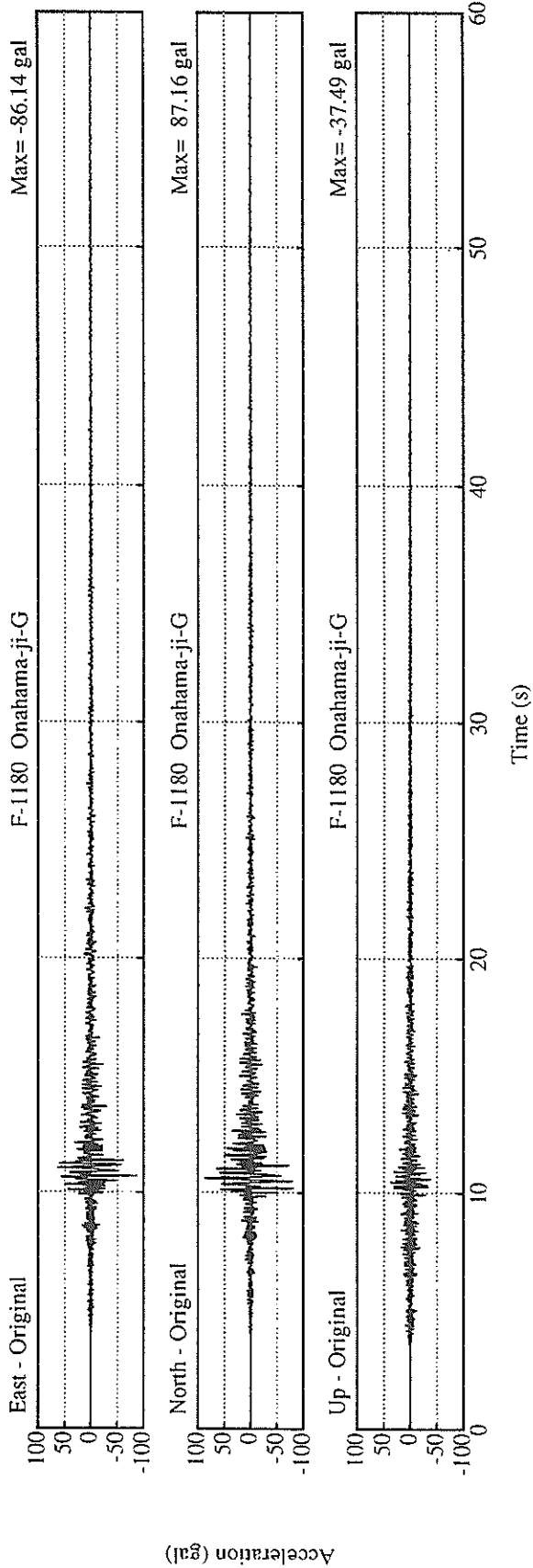
MAXIMUM VELOCITY (CM/SEC)

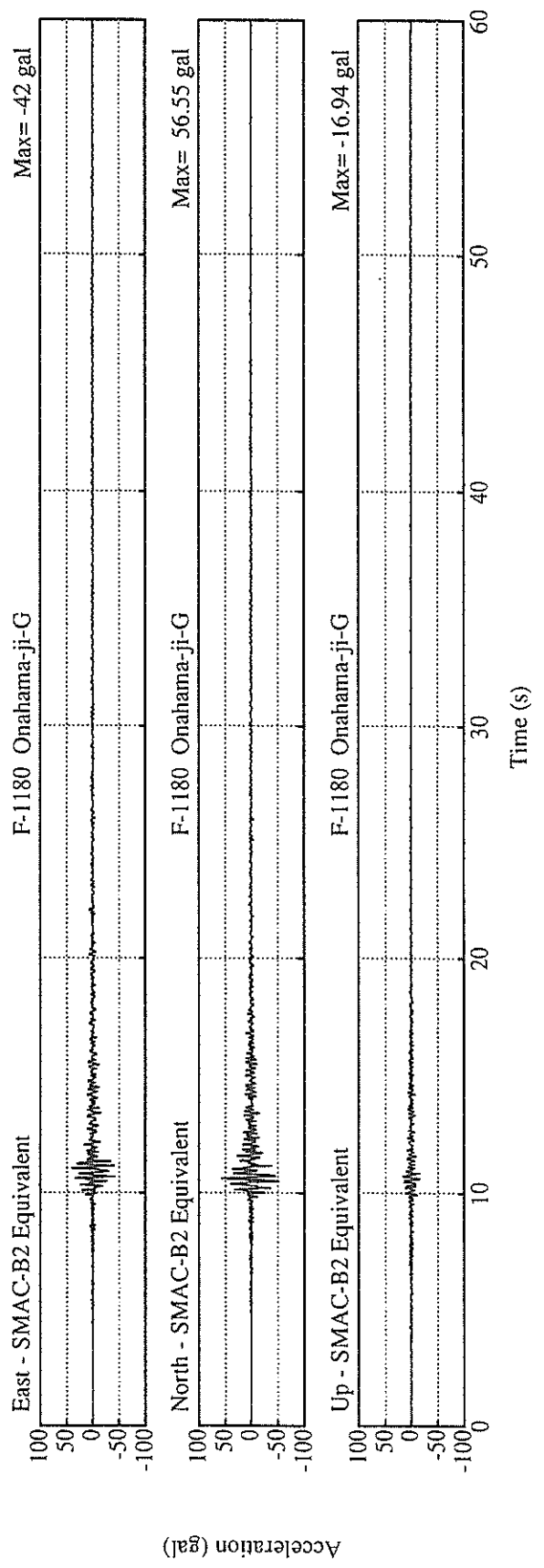
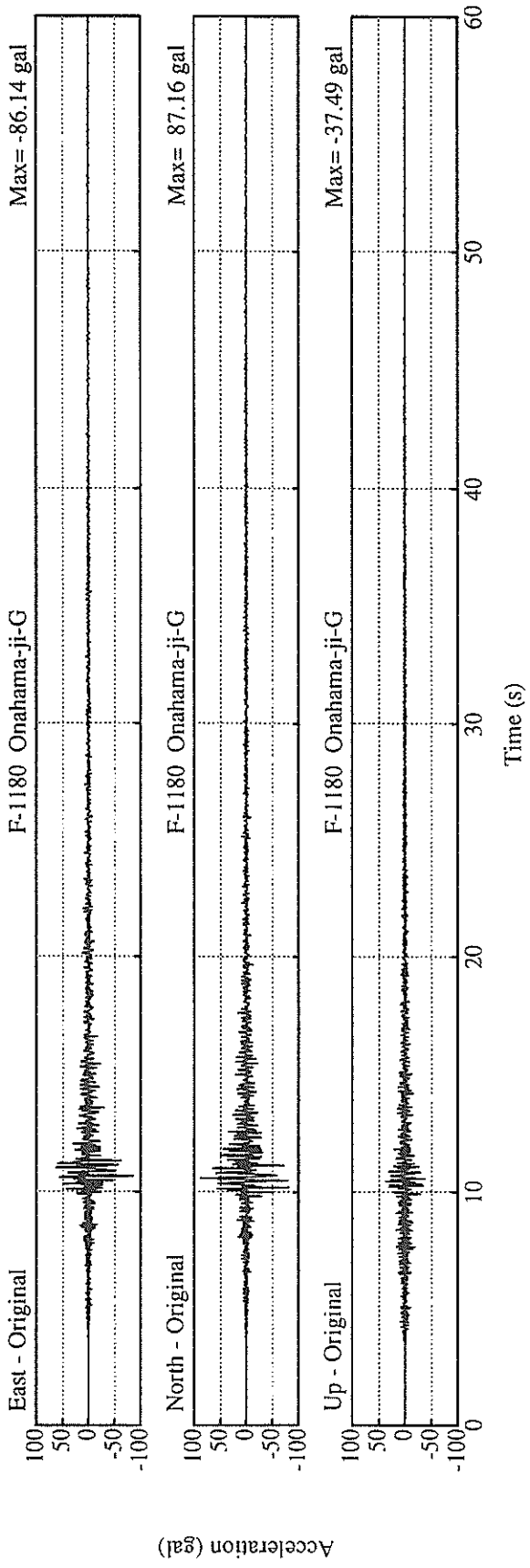
FIXED FILTER	2.64	2.73	0.88	3.31
VARIABLE FILTER	2.67	2.31	0.93	3.51

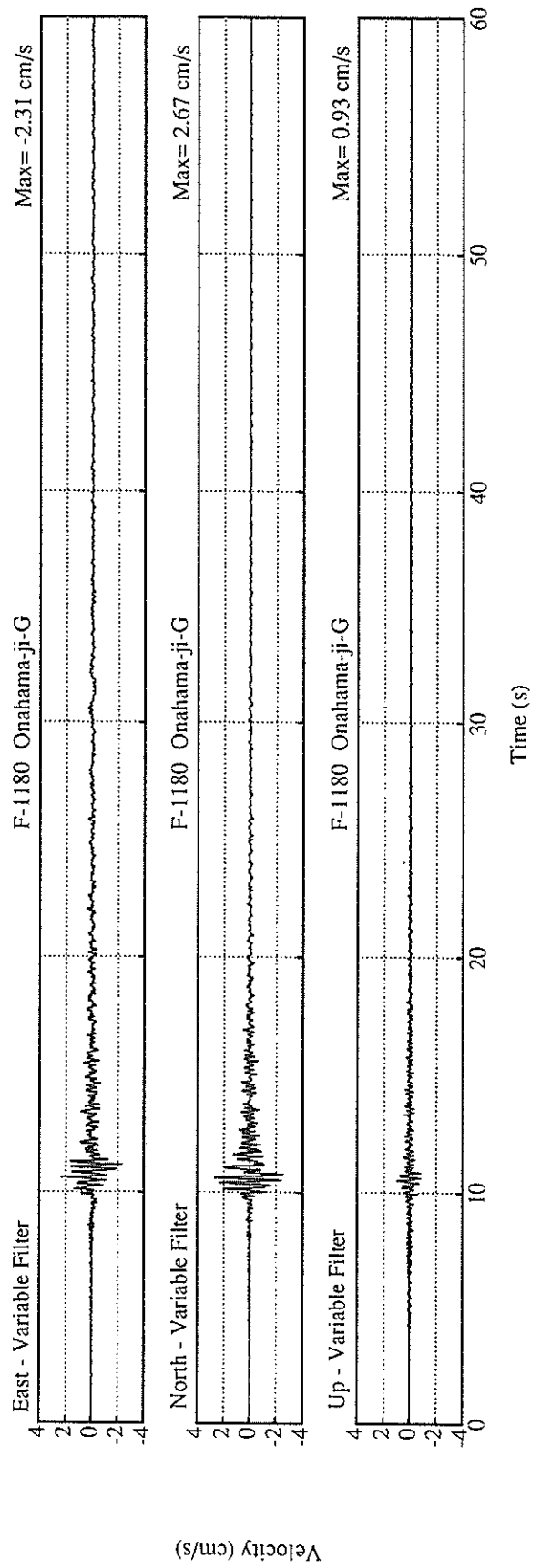
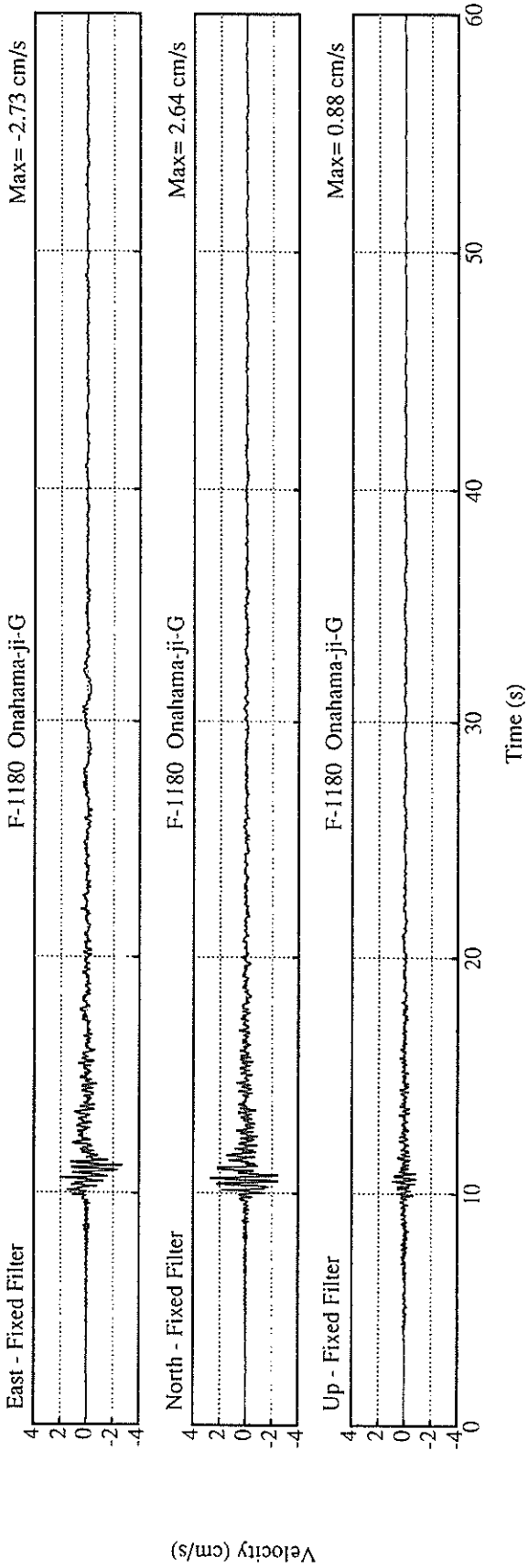
MAXIMUM DISPLACEMENT (CM)

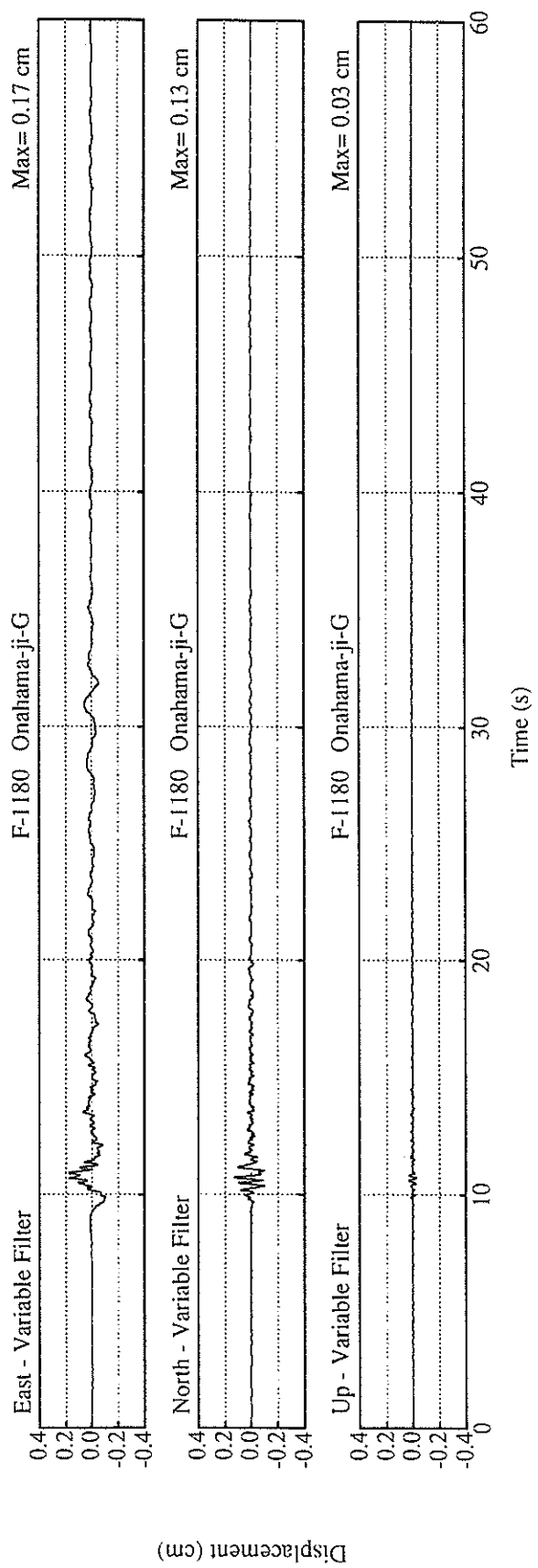
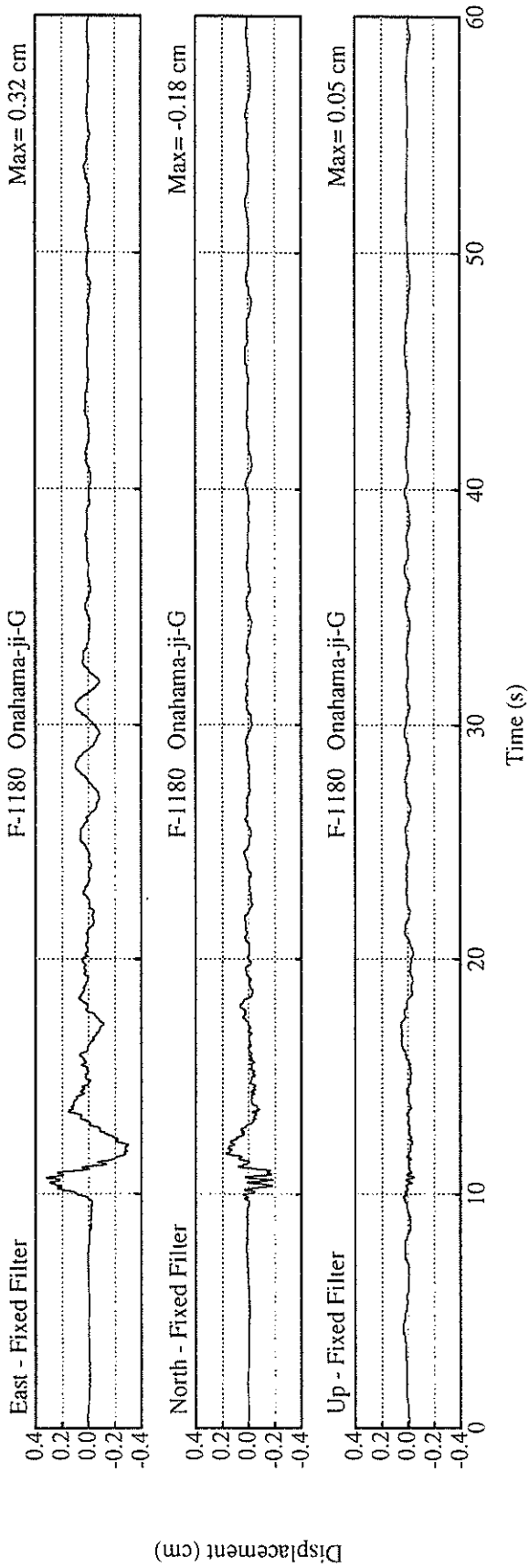
FIXED FILTER	0.18	0.32	0.05	0.33
VARIABLE FILTER	0.13	0.17	0.03	0.20

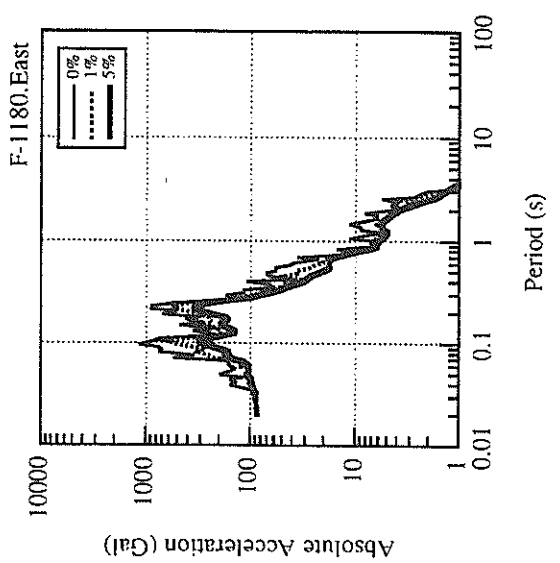
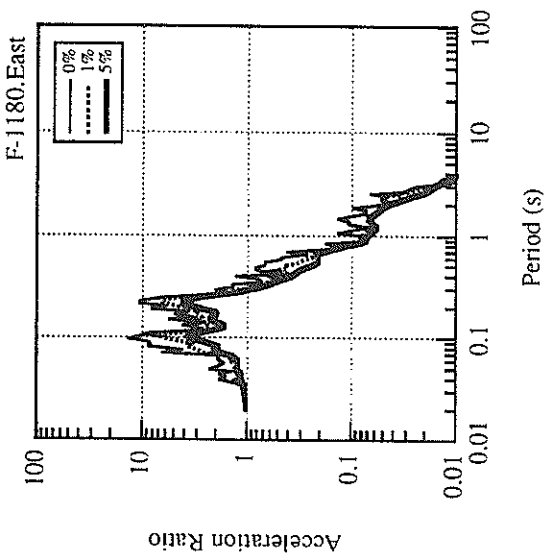
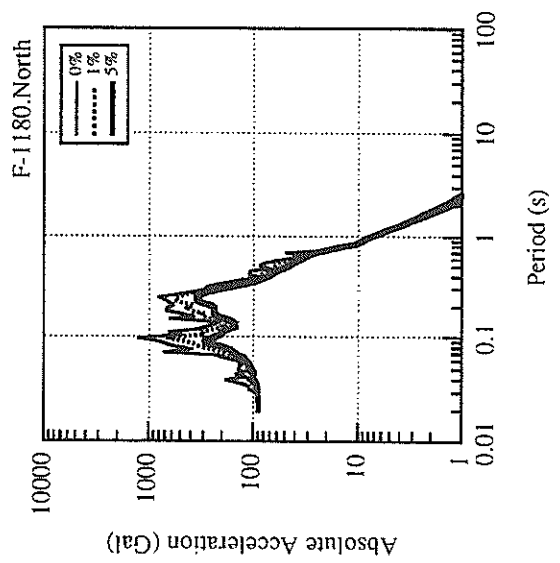
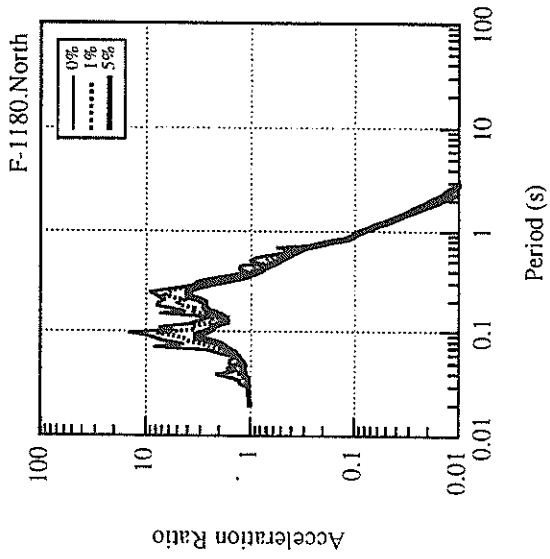
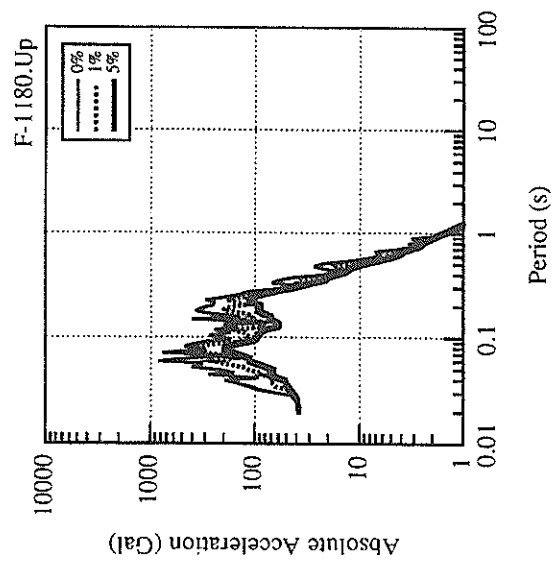
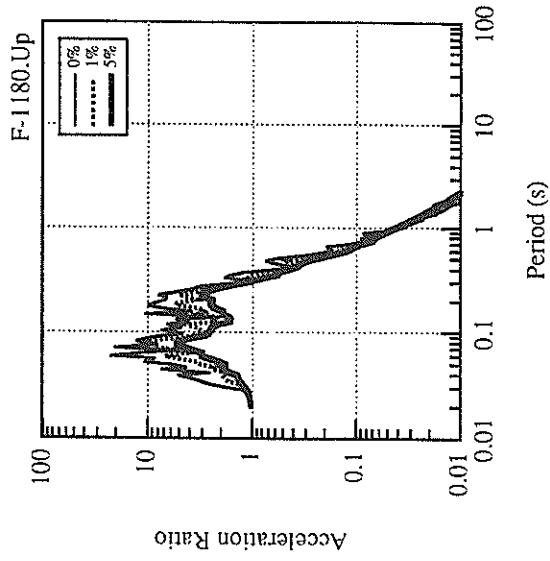
* RESULTANT OF HORIZONTAL COMPONENTS

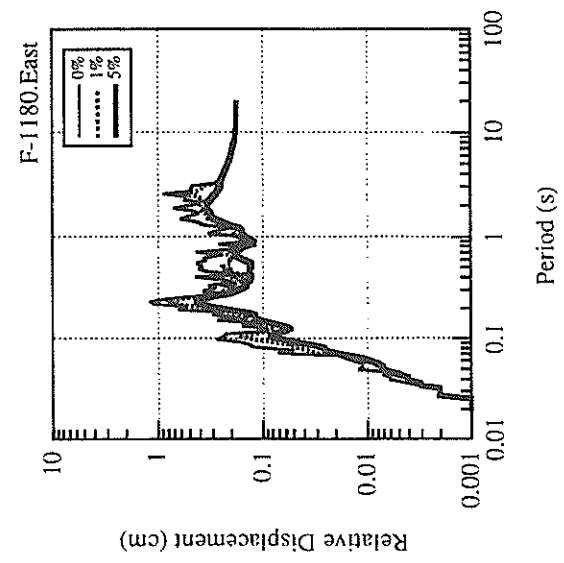
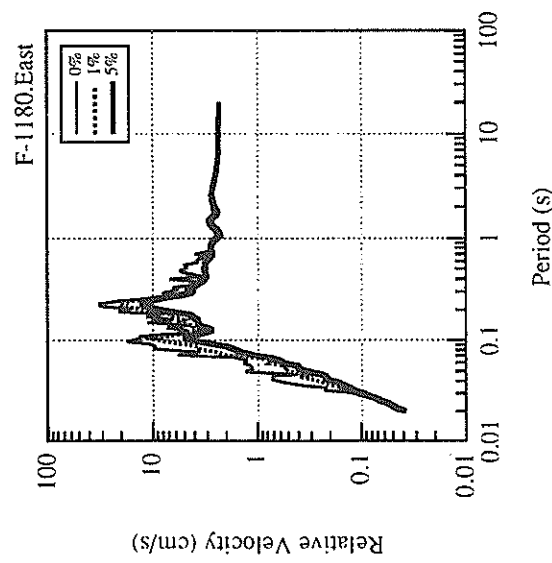
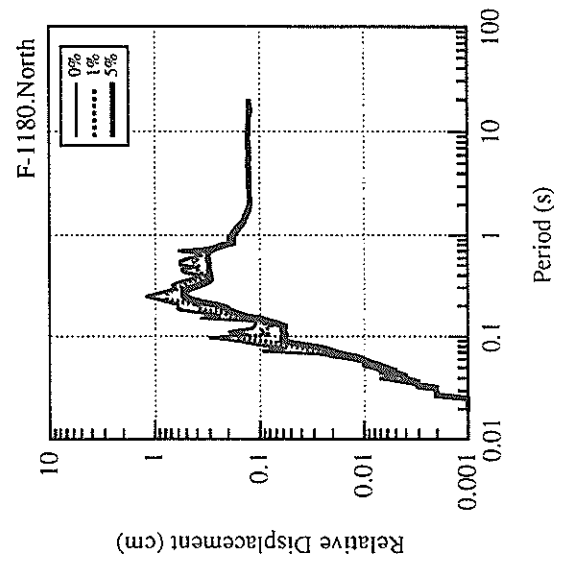
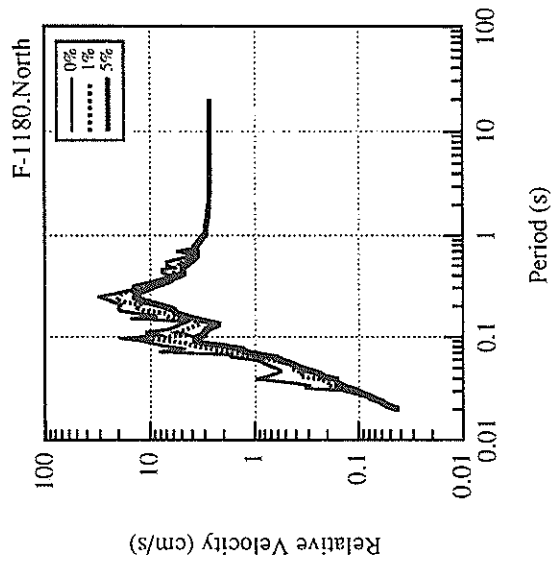
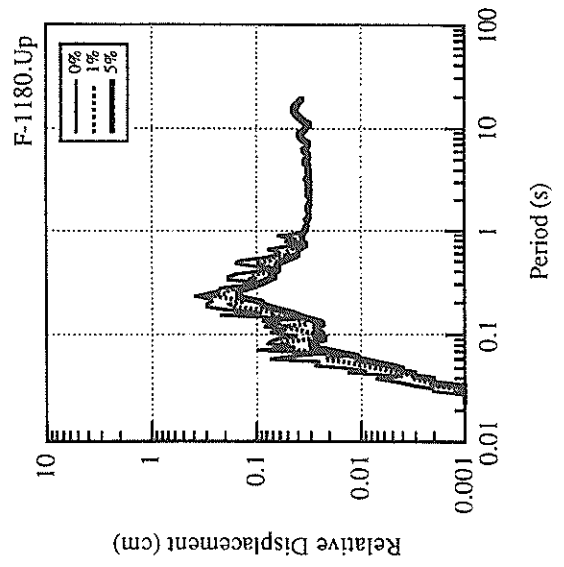
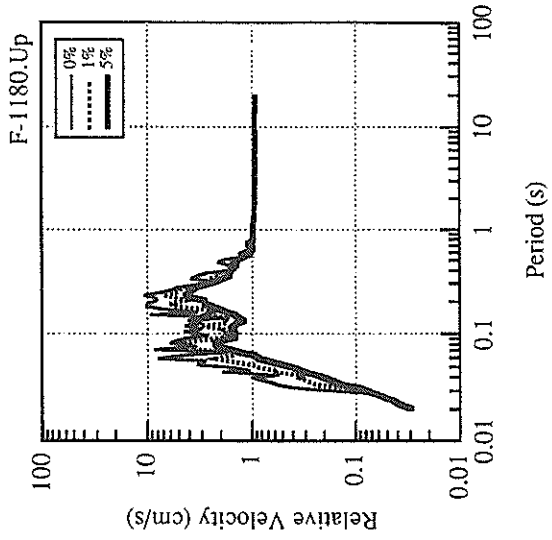


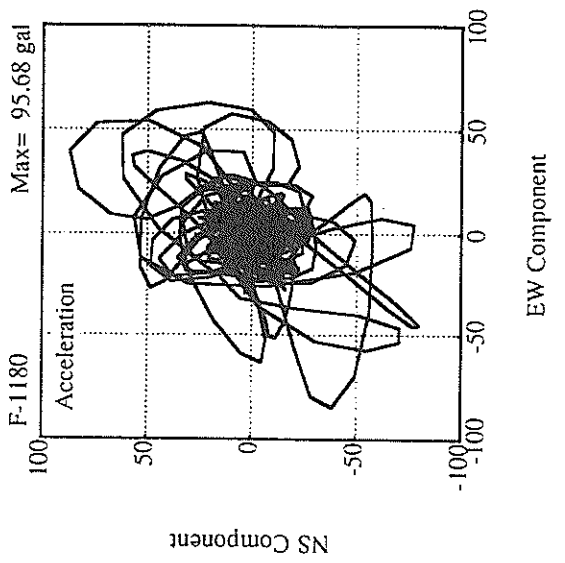
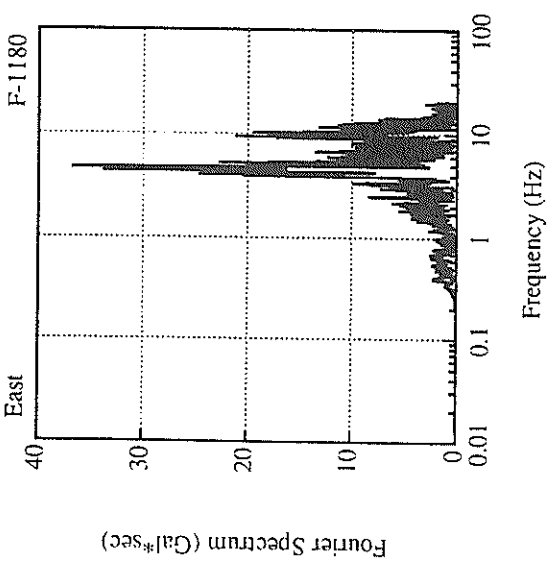
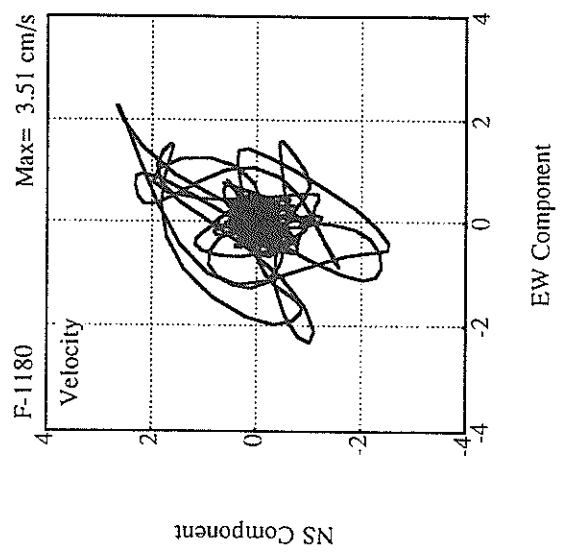
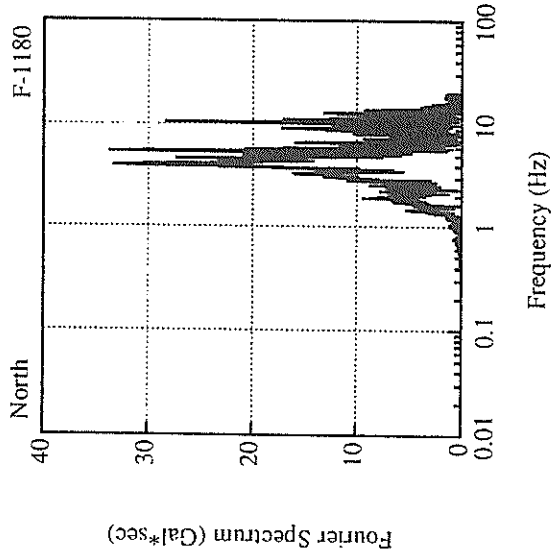
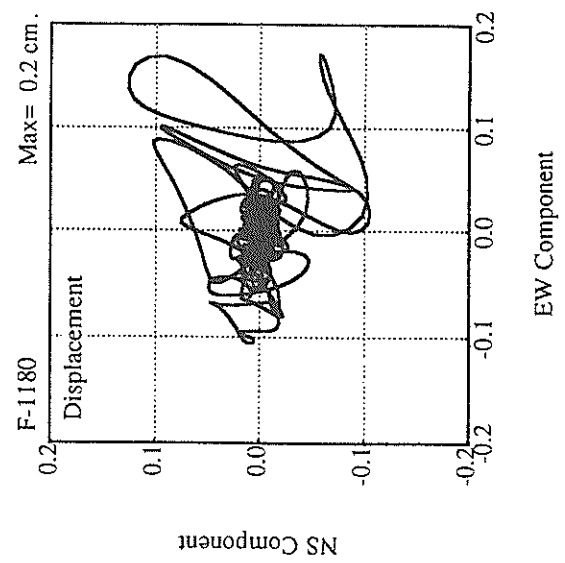
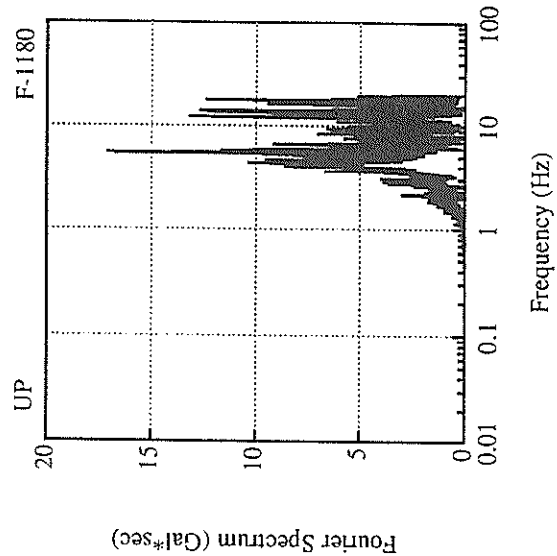












RECORD NUMBER : F-1184

STATION : KAGOSHIMA-G

EARTHQUAKE DATA

DATE AND TIME 14:38 MAY 13, 1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION NW KAGOSHIMA PREF

LATITUDE 31° 56.7' N

LONGITUDE 130° 18.3' E

DEPTH 9.2KM

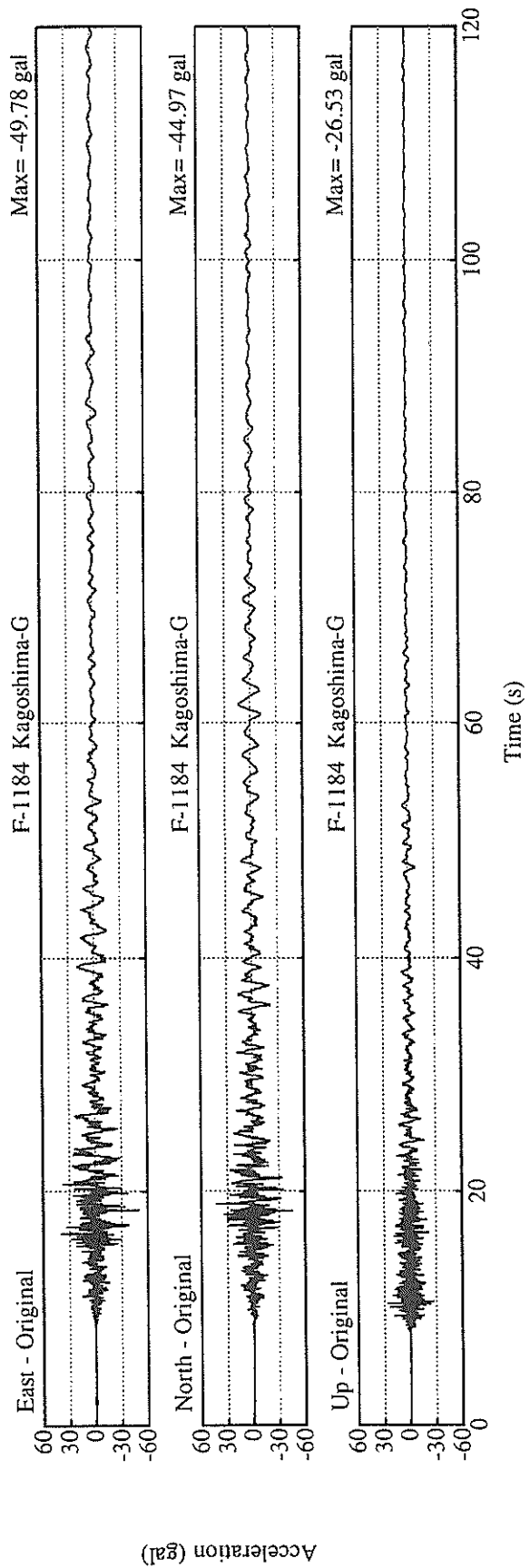
JMA MAGNITUDE 6.3

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
45.0	49.8	26.5	51.9

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1182

STATION : TOKACHI-G

EARTHQUAKE DATA

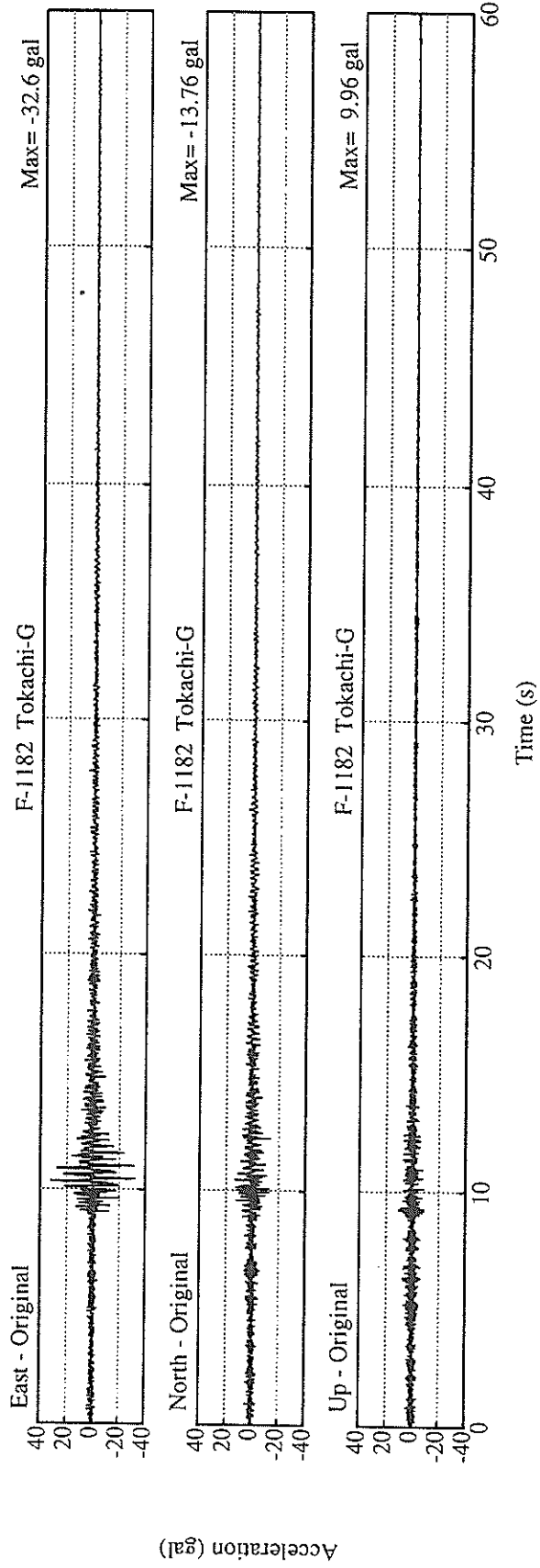
 DATE AND TIME 13:54 JUNE15,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION KUSHIRO REGION
 LATITUDE 42°58.6' N
 LONGITUDE 144°12.7' E
 DEPTH 97.6KM
 JMA MAGNITUDE 5.1

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
13.8	32.6	10.0	35.0

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1185

STATION : KUSHIRO-GB

EARTHQUAKE DATA

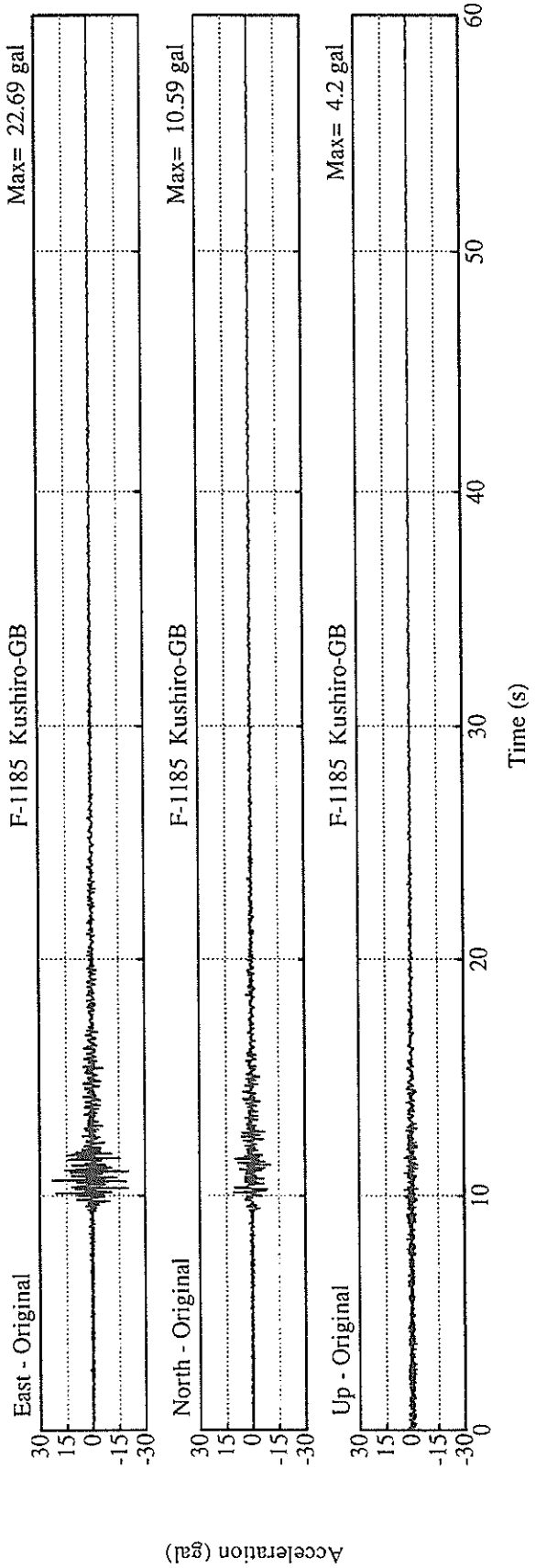
 DATE AND TIME 13:54 JUNE15,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION KUSHIRO REGION
 LATITUDE 42° 58.6' N
 LONGITUDE 144° 12.7' E
 DEPTH 97.6KM
 JMA MAGNITUDE 5.1

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
10.6	22.7	4.2	22.7

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1186

STATION : KUSHIRO-G

EARTHQUAKE DATA

 DATE AND TIME 13:54 JUNE15,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION KUSHIRO REGION
 LATITUDE 42°58.6' N
 LONGITUDE 144°12.7' E
 DEPTH 97.6KM
 JMA MAGNITUDE 5.1

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.567	0.610	1.495	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.567 0.610 1.495

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	22.6	32.4	5.4	32.6
ORIGINAL	54.0	79.0	14.0	82.6
CORRECTED	52.8	76.5	14.4	80.7

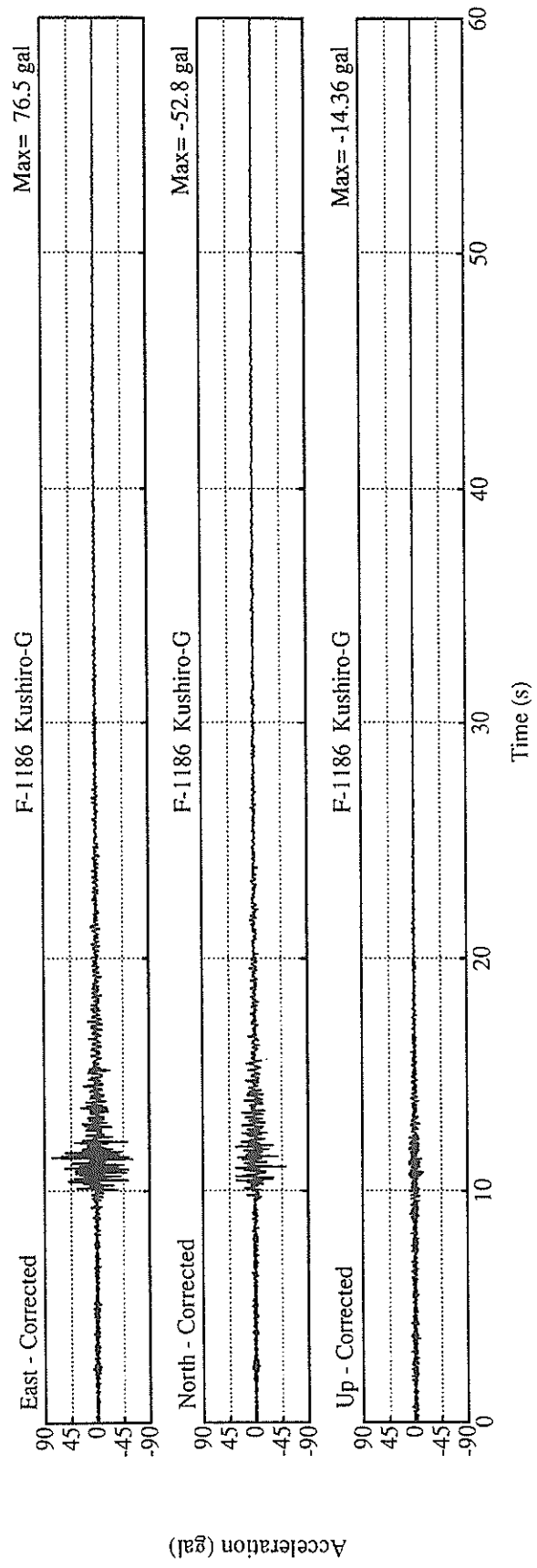
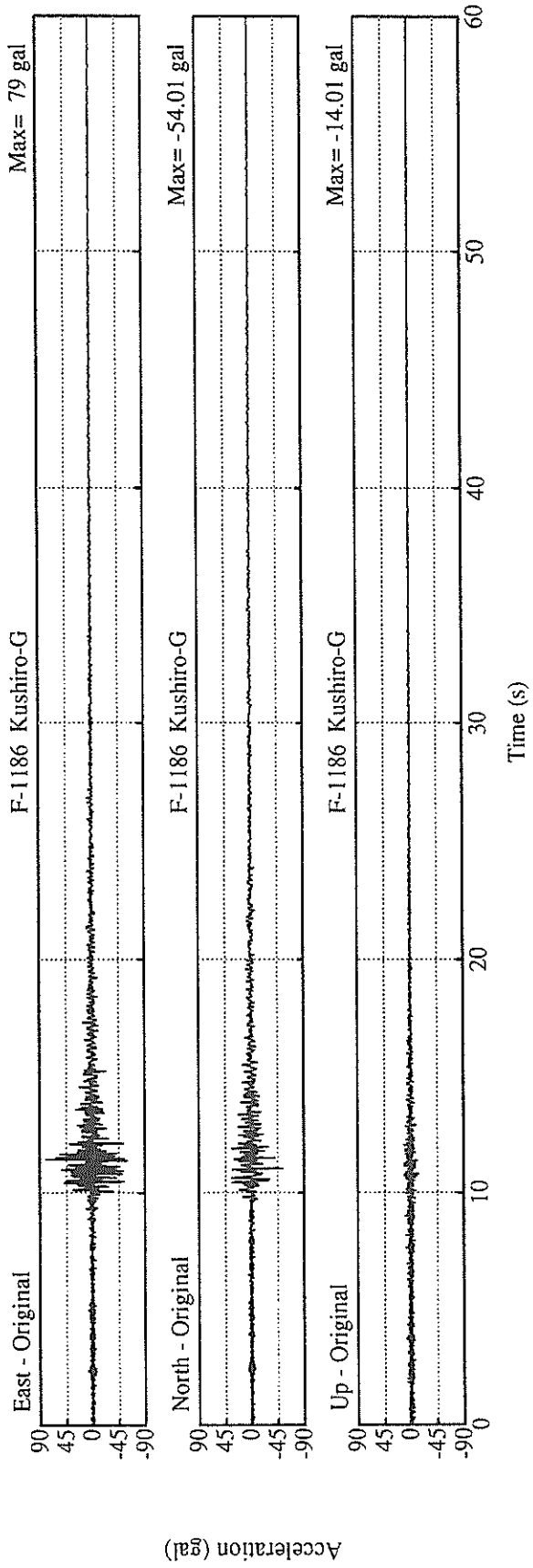
MAXIMUM VELOCITY (CM/SEC)

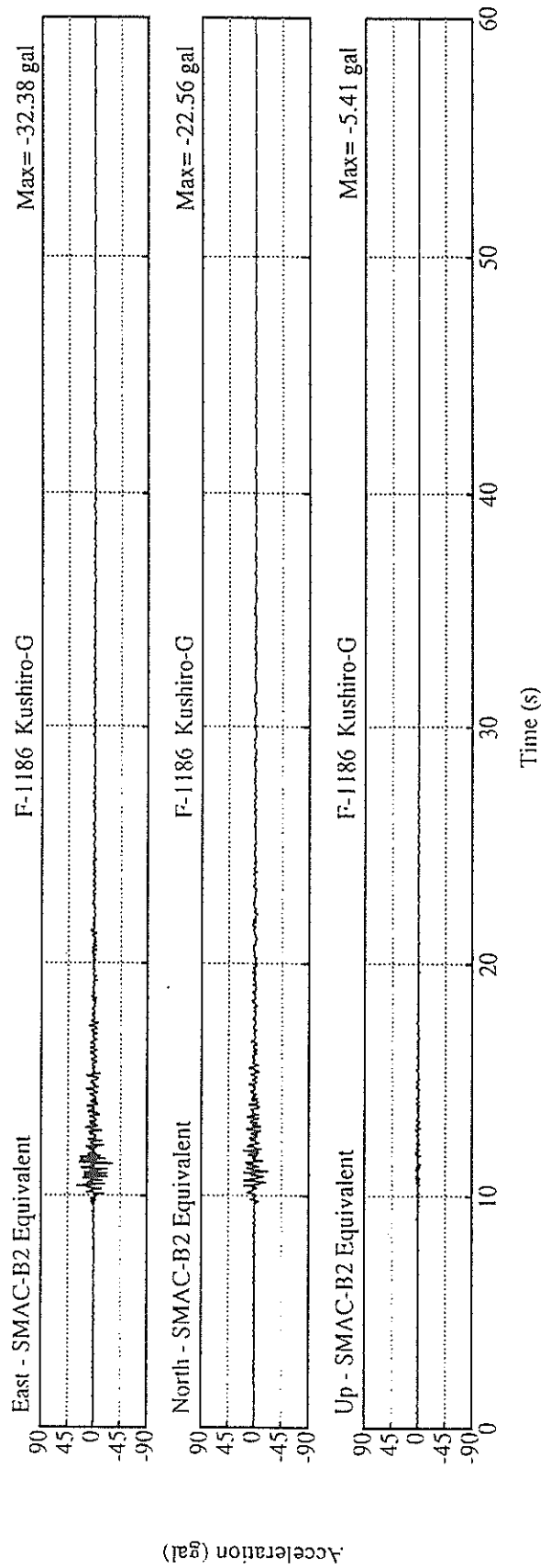
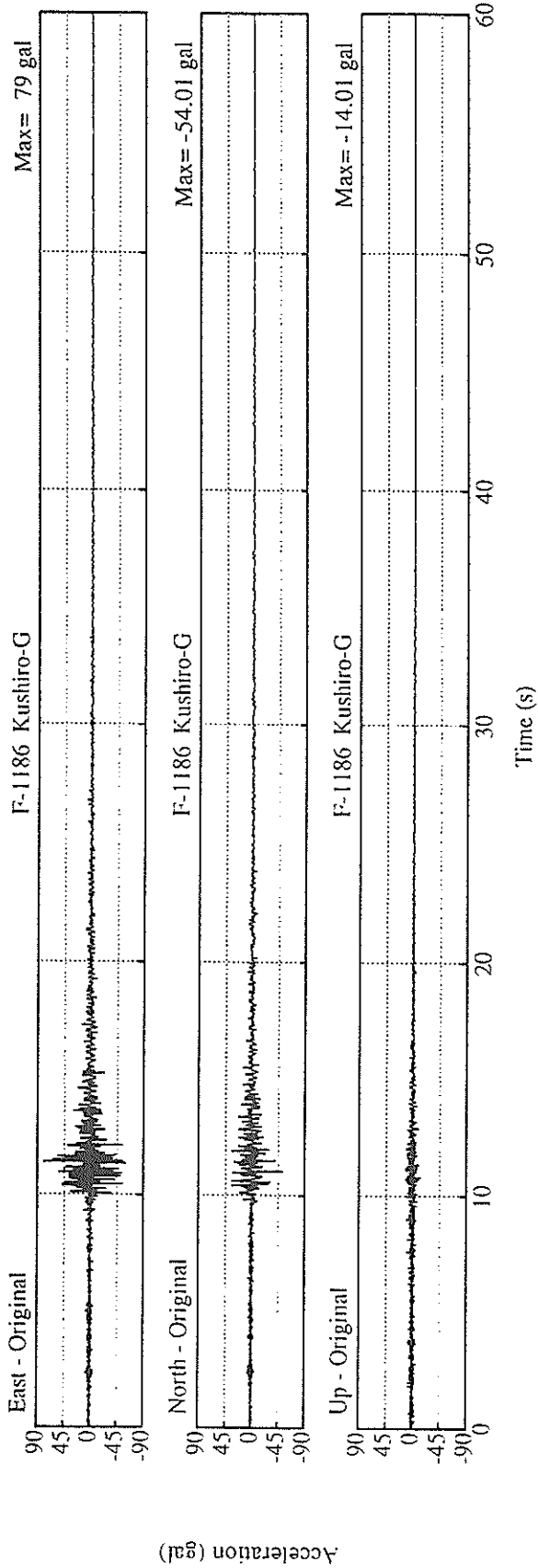
FIXED FILTER	1.56	2.12	0.28	2.12
VARIABLE FILTER	1.30	1.92	0.27	1.93

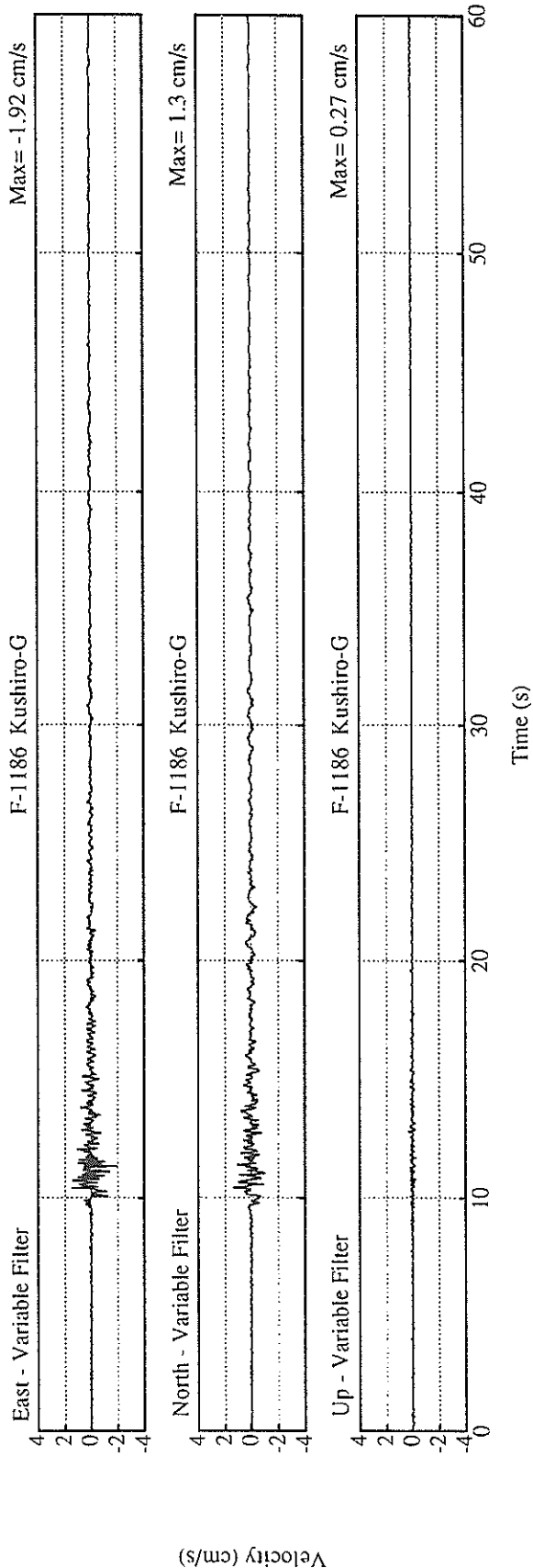
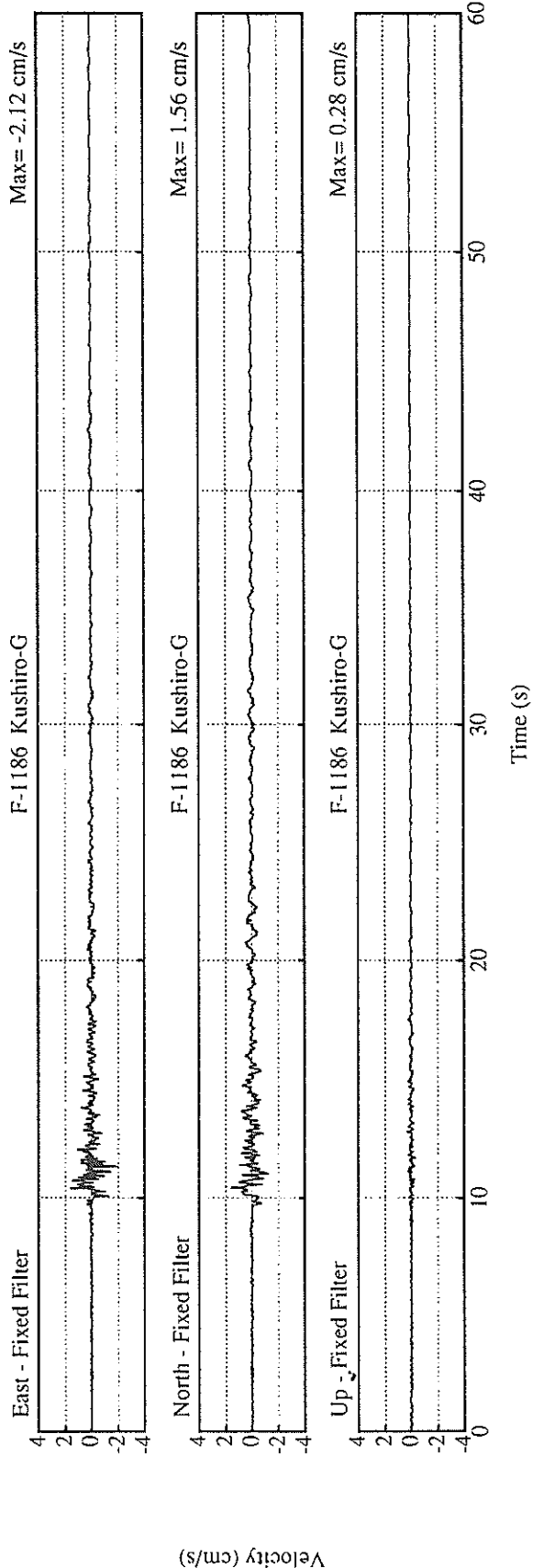
MAXIMUM DISPLACEMENT (CM)

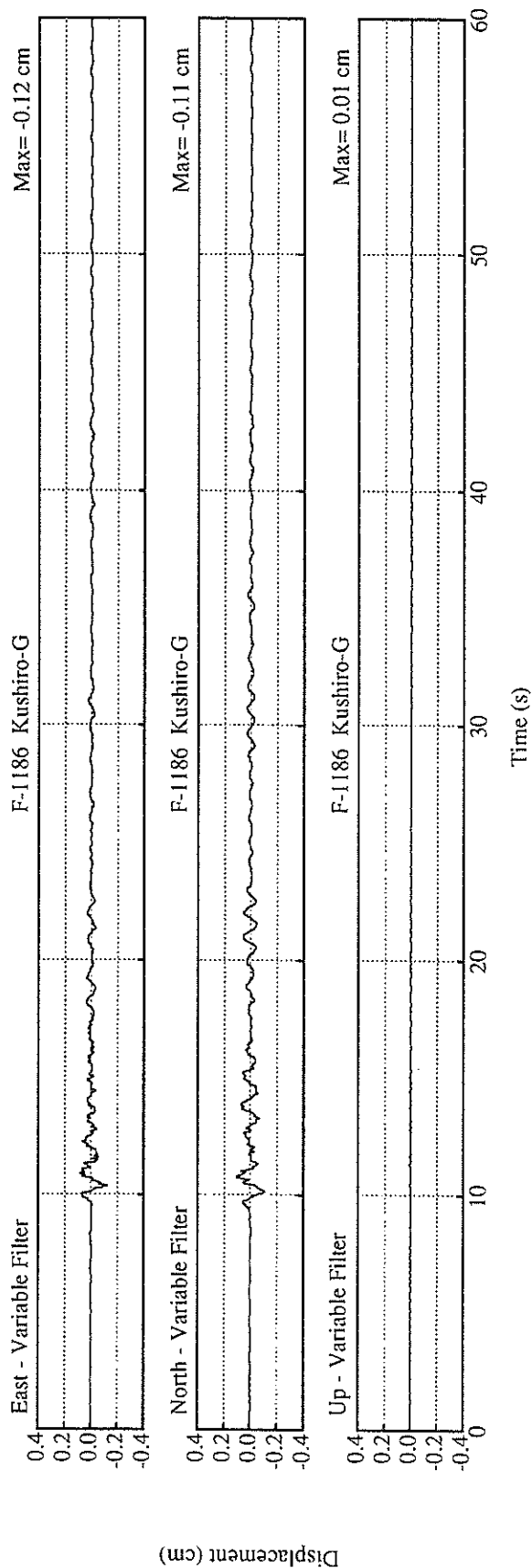
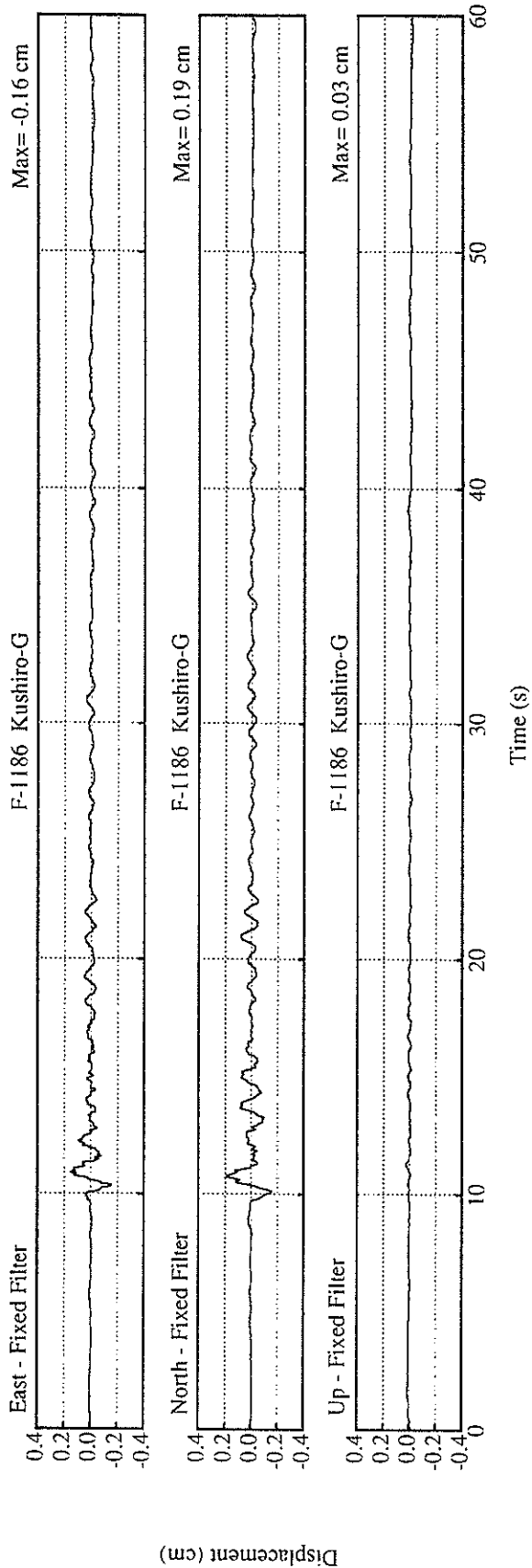
FIXED FILTER	0.19	0.16	0.03	0.22
VARIABLE FILTER	0.11	0.12	0.01	0.13

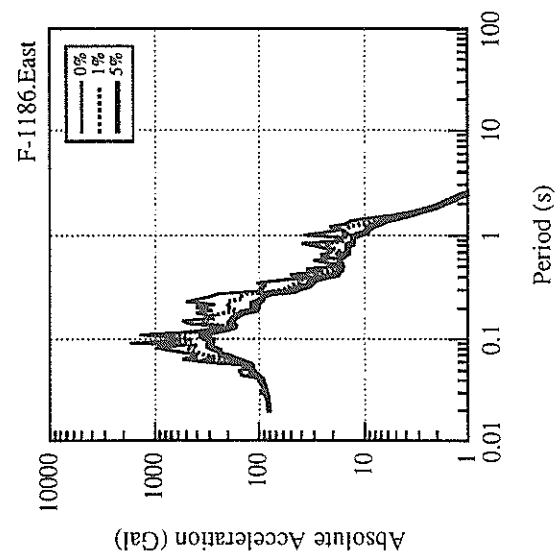
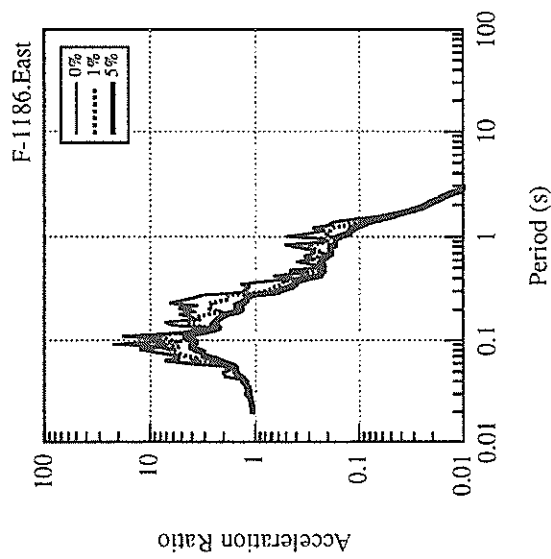
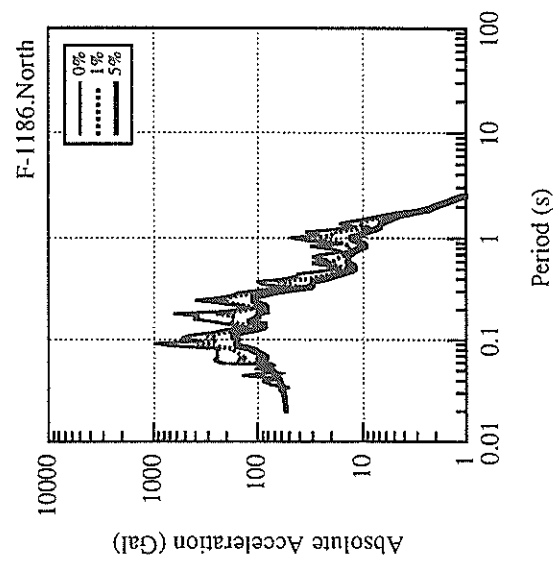
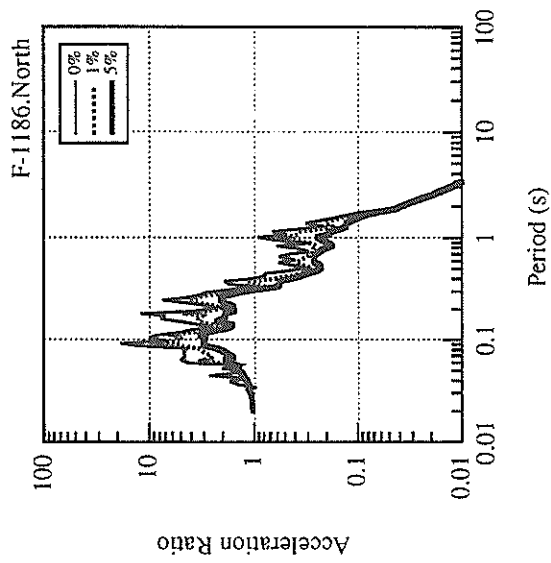
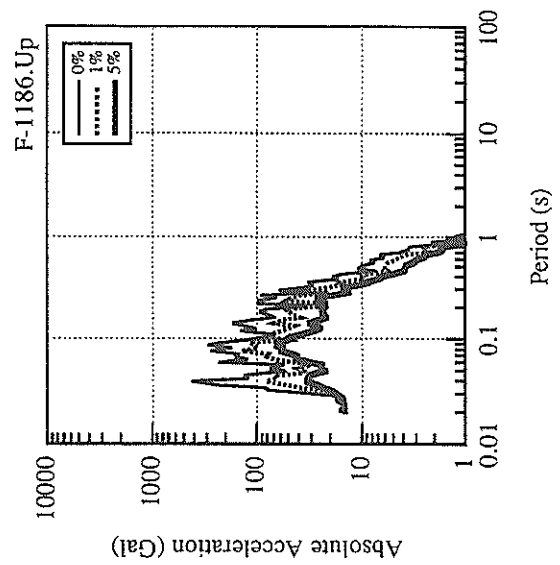
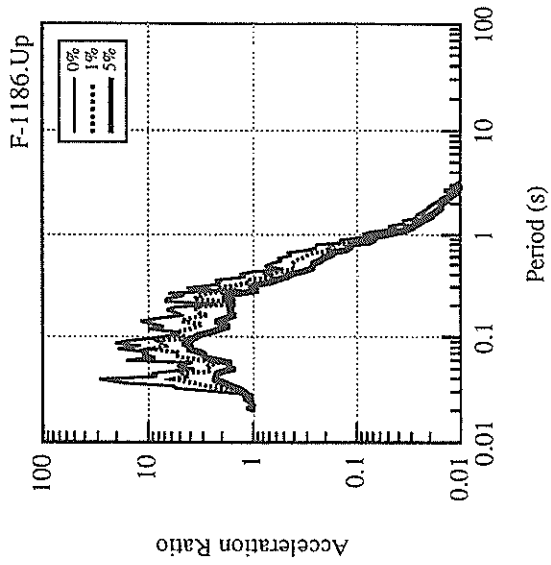
* RESULTANT OF HORIZONTAL COMPONENTS

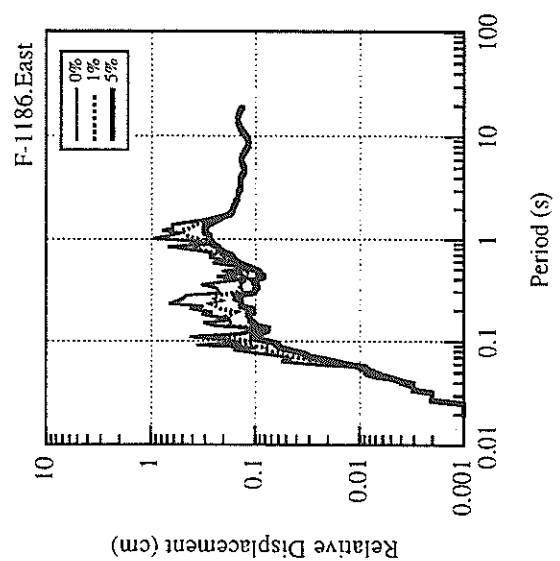
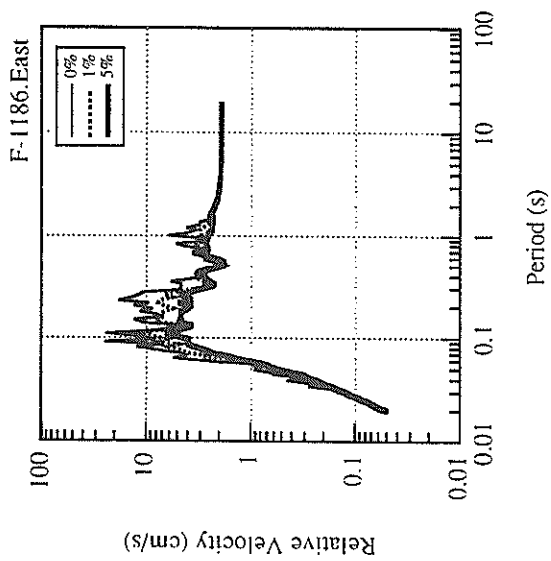
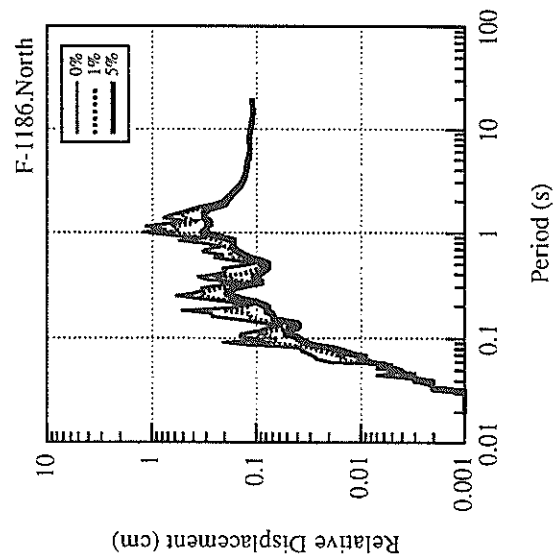
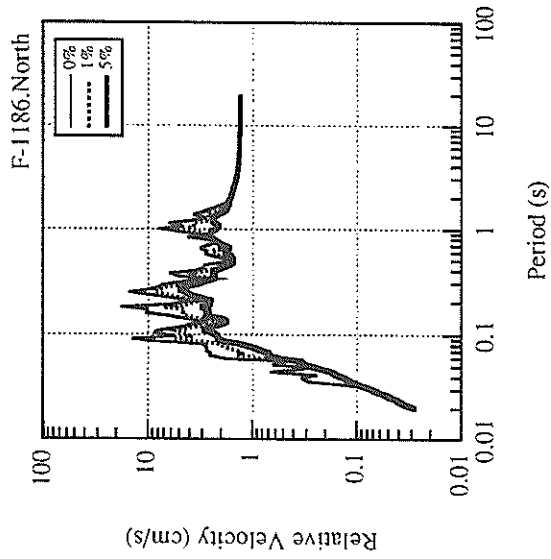
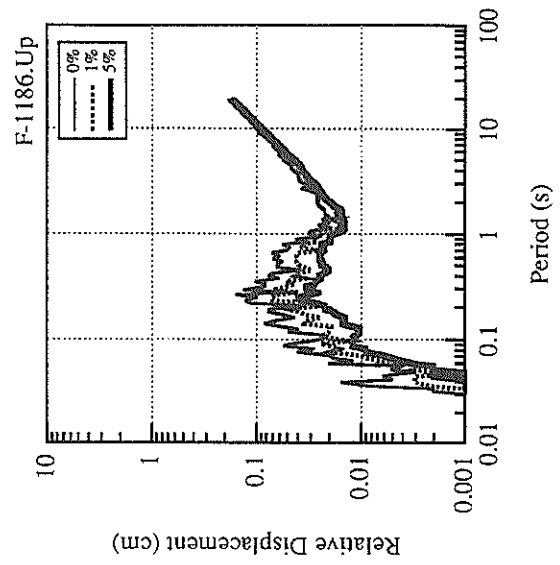
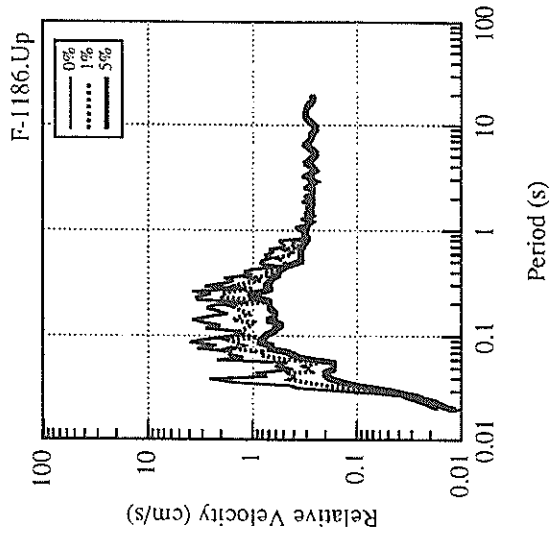


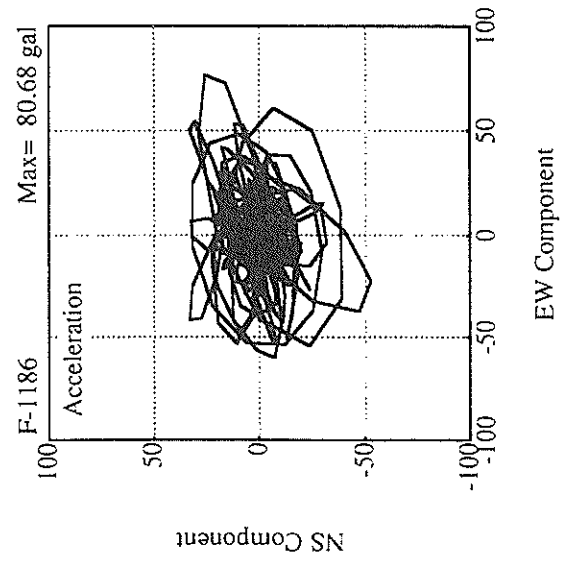
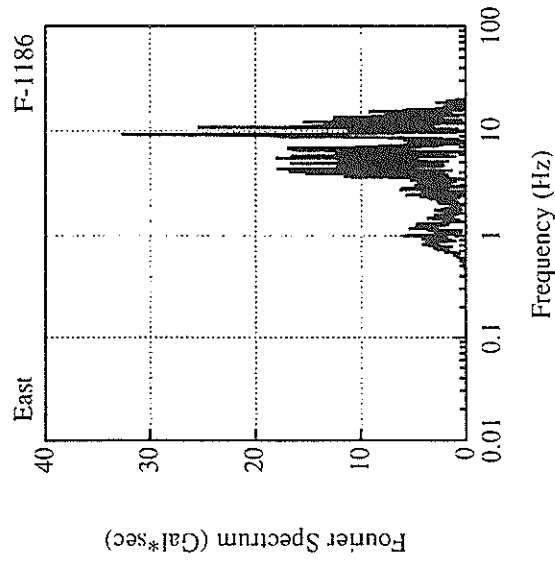
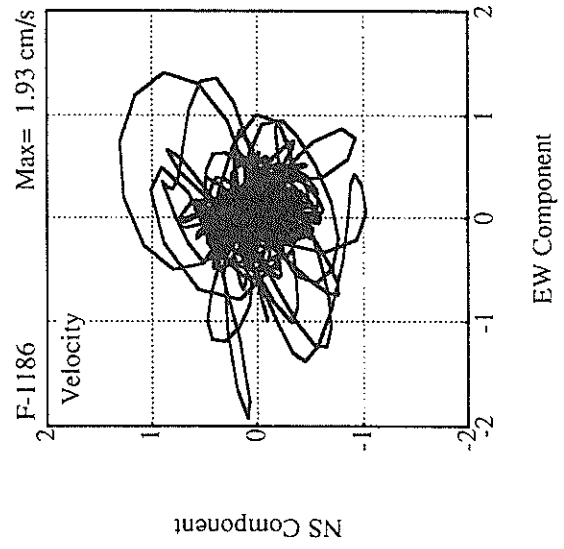
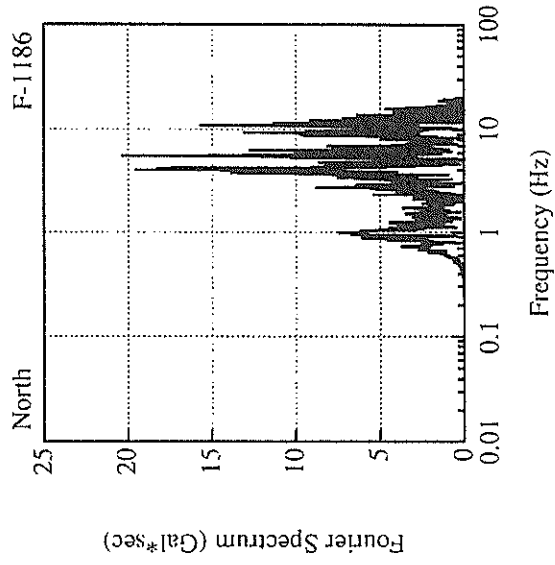
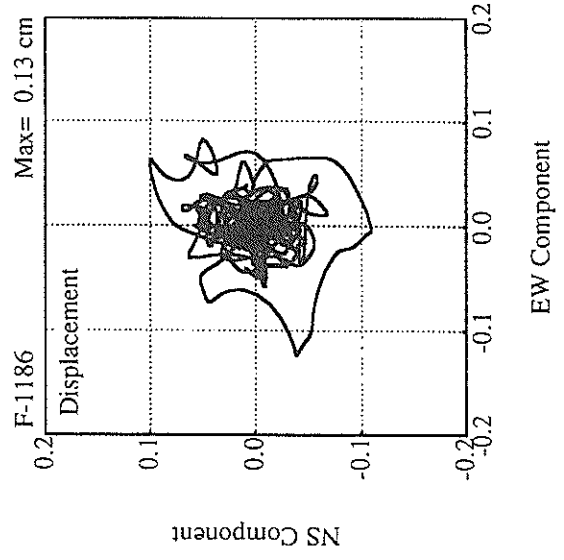
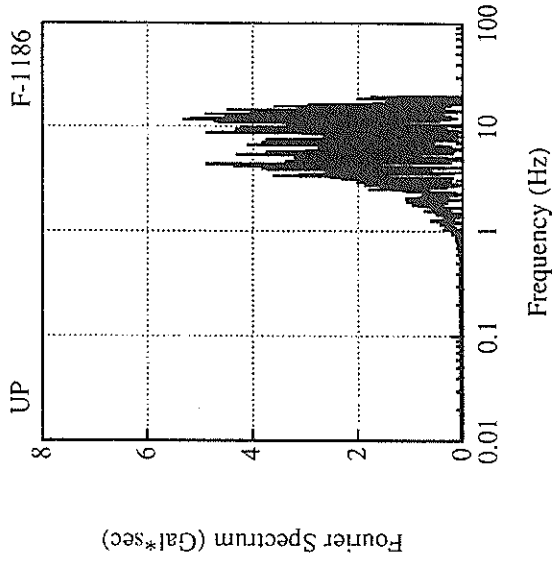












RECORD NUMBER : F-1266

STATION : MURORAN-G

EARTHQUAKE DATA

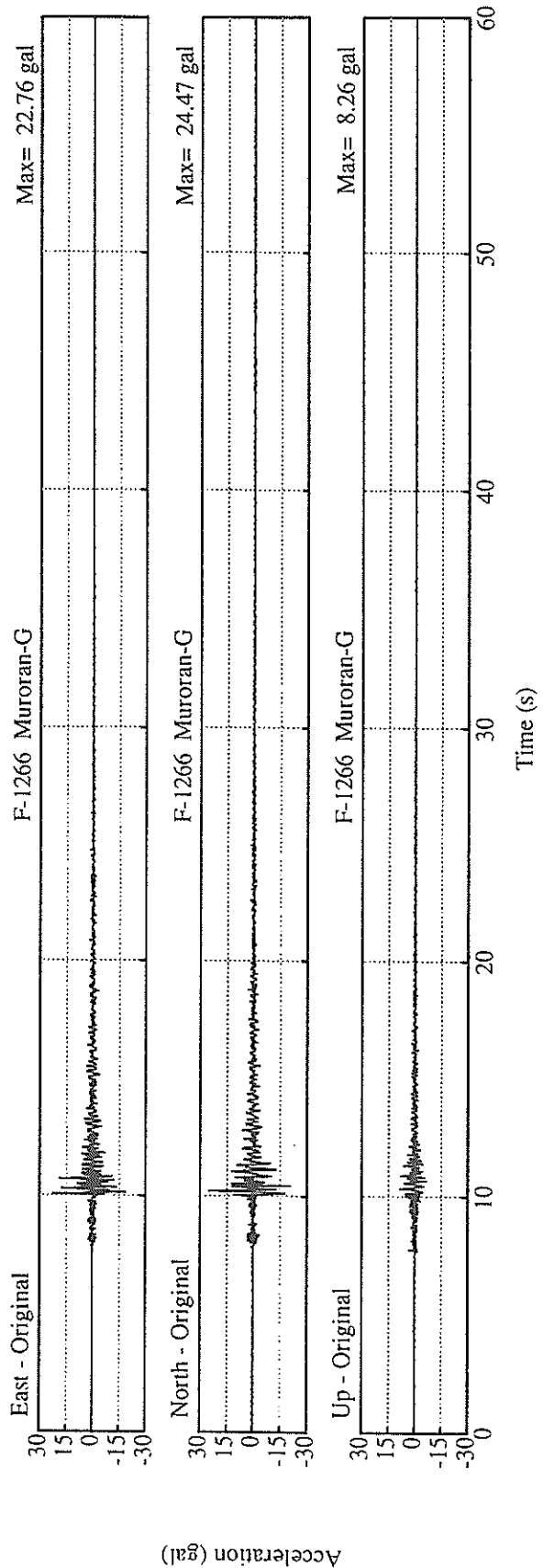
 DATE AND TIME 9:16 JUNE17,1997
 LOCATION OF HYPOCENTER UCHIURA BAY REGION
 EPICENTRAL REGION 42°16.1' N
 LATITUDE 140°49.4' E
 LONGITUDE 9.6KM
 DEPTH 3.5
 JMA MAGNITUDE 3.5

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
24.5	22.8	8.3	26.2

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1267

STATION : MURORAN-G

EARTHQUAKE DATA

DATE AND TIME : 9:18 JUNE17,1997

LOCATION OF HYPOCENTER : UCHIURA BAY REGION

EPICENTRAL REGION : 42°16.3' N

LATITUDE : 140°49.3' E

LONGITUDE : 10.3KM

DEPTH : 3.4

JMA MAGNITUDE : 3.4

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	2.020	2.557	3.973	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 2.020 2.557 3.973

MAXIMUM ACCELERATION (GAL)

	N S	E W	U D	HORIZONTAL*
SMAC-B2 EQUIVALENT	11.5	15.6	4.5	17.4
ORIGINAL	33.4	51.8	12.8	52.9
CORRECTED	34.0	52.5	12.7	54.3

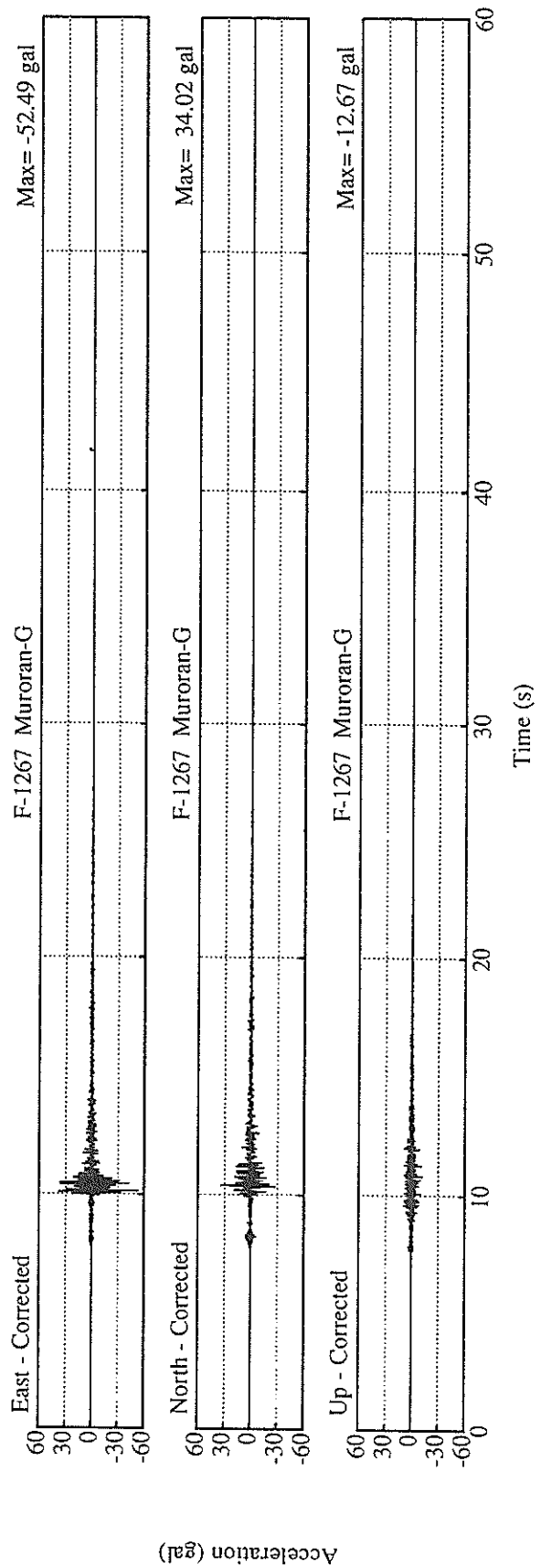
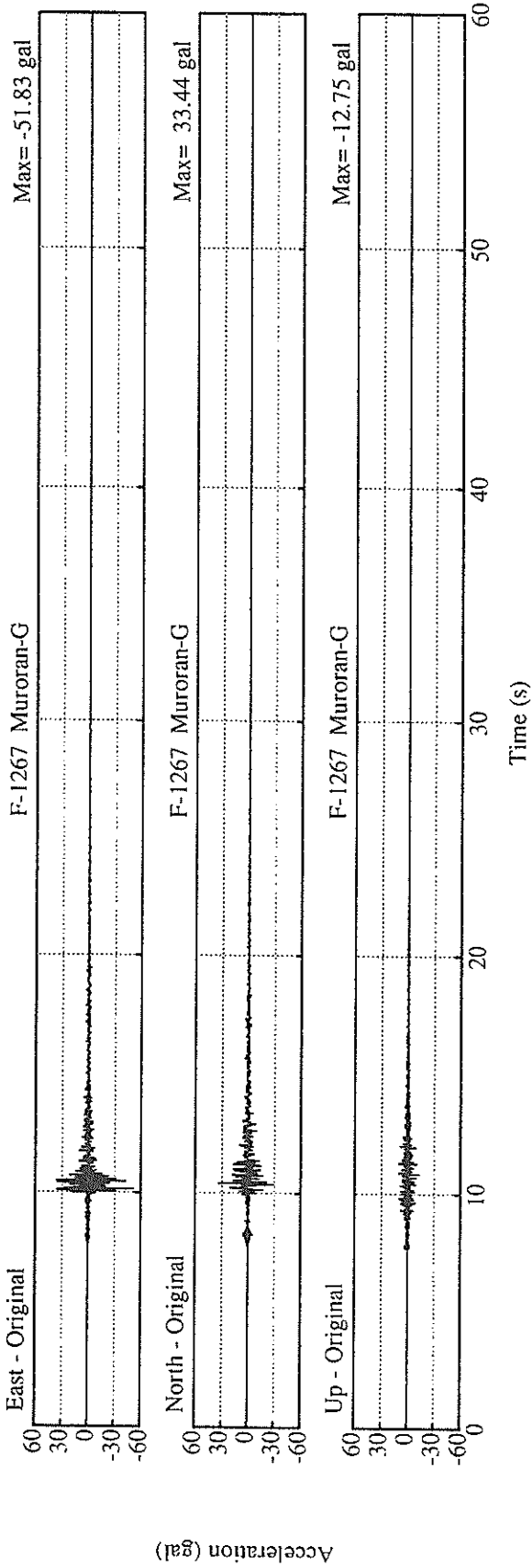
MAXIMUM VELOCITY (CM/SEC)

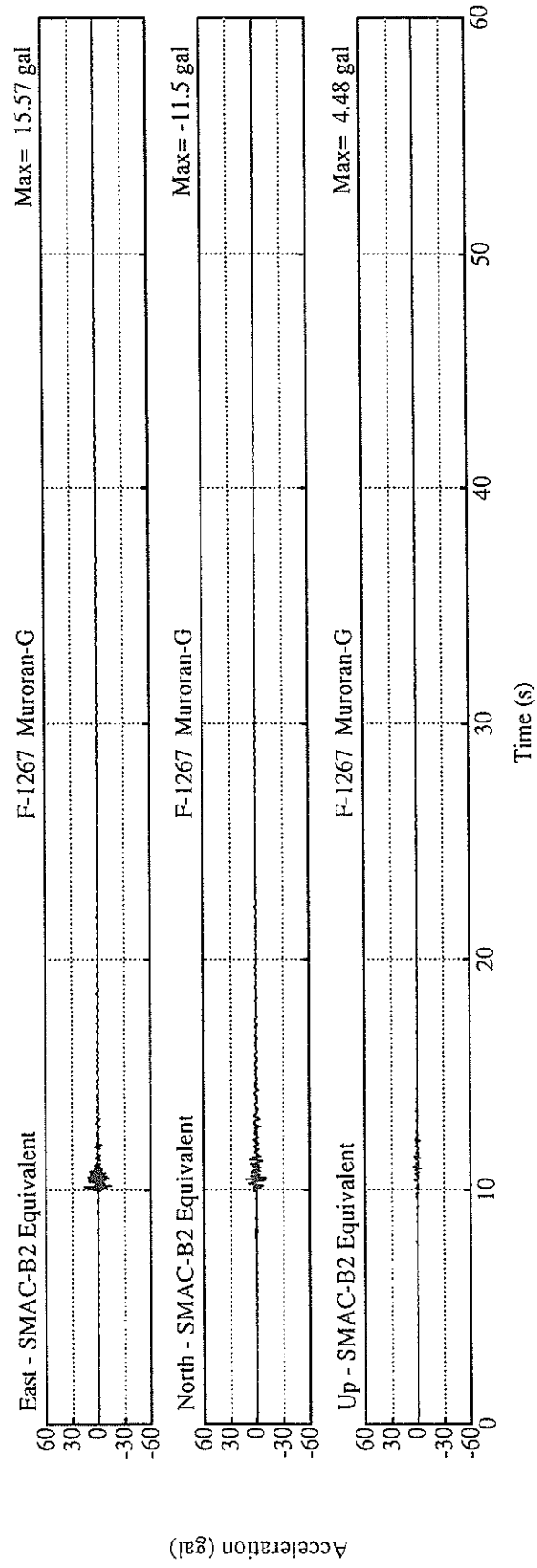
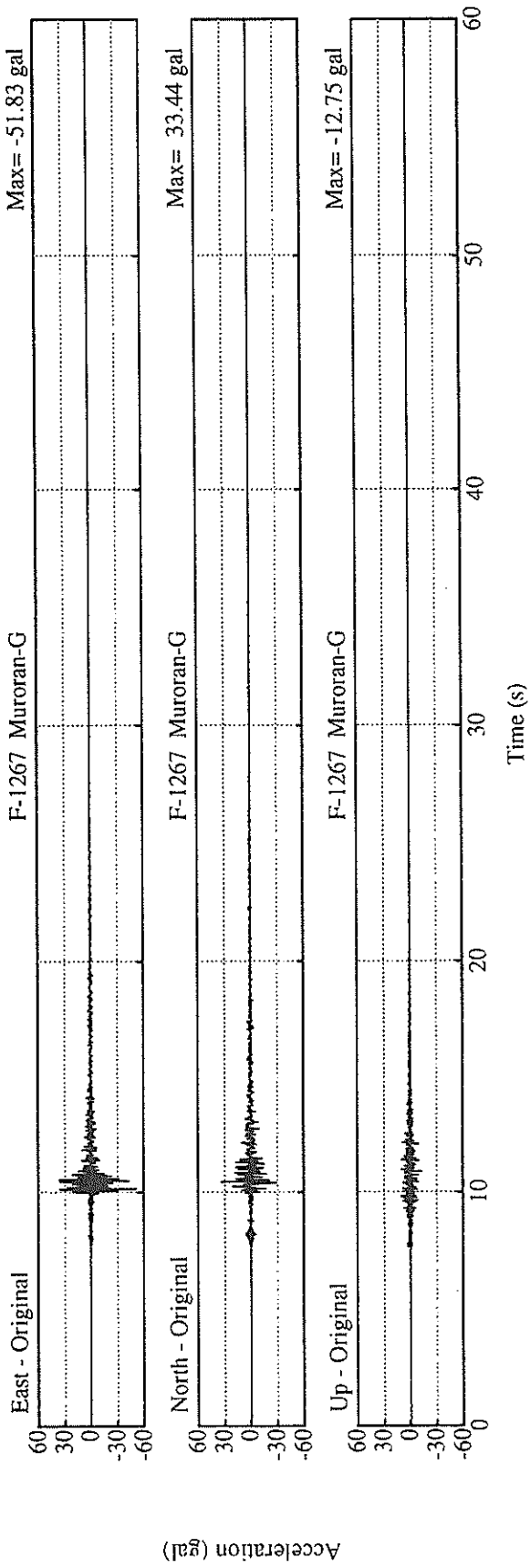
	N S	E W	U D	HORIZONTAL*
FIXED FILTER	0.56	0.88	0.22	0.88
VARIABLE FILTER	0.52	0.84	0.19	0.85

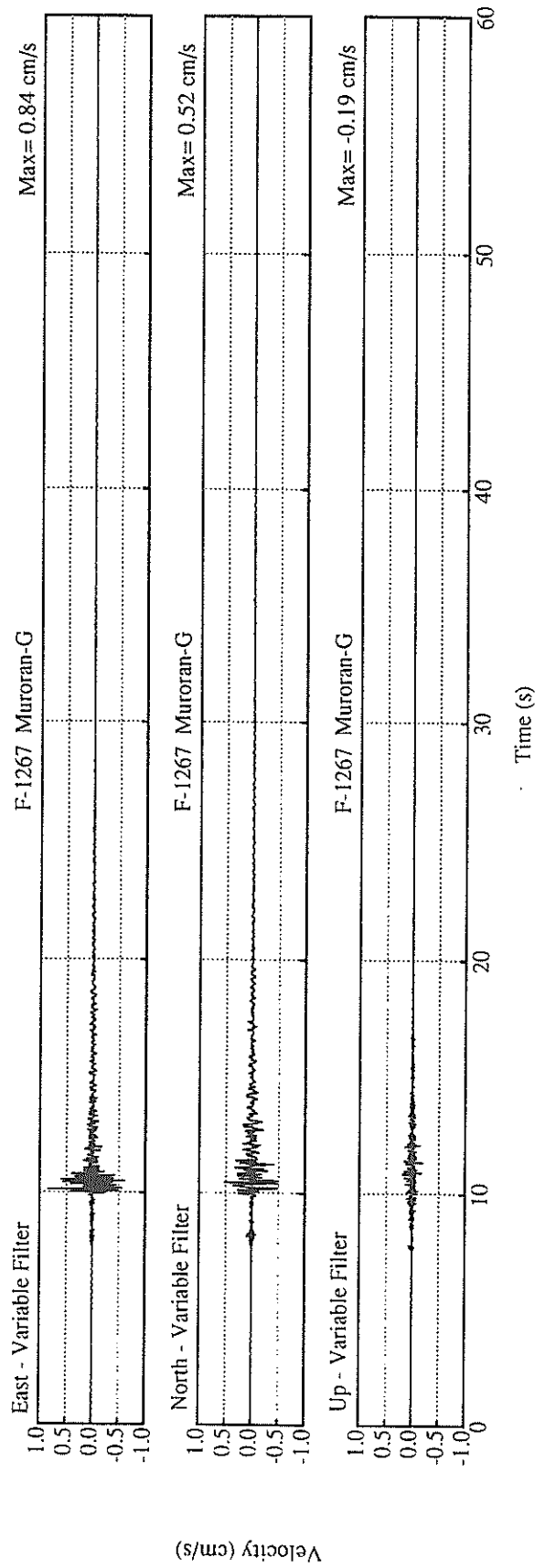
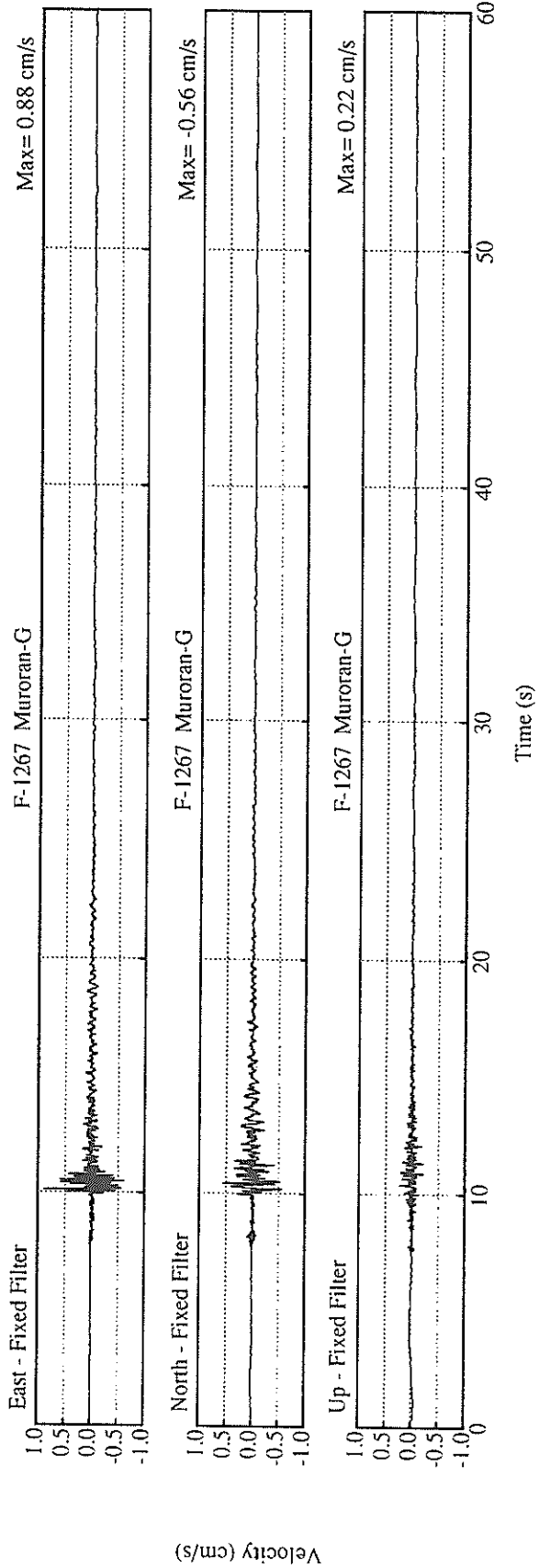
MAXIMUM DISPLACEMENT (CM)

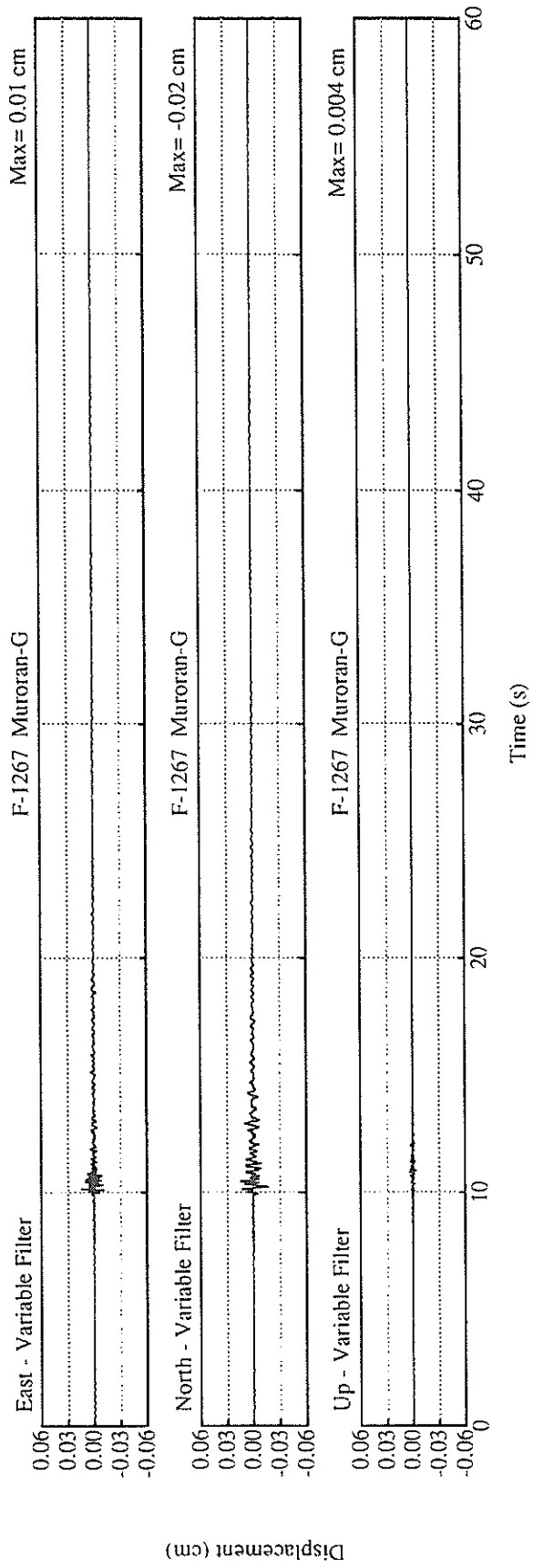
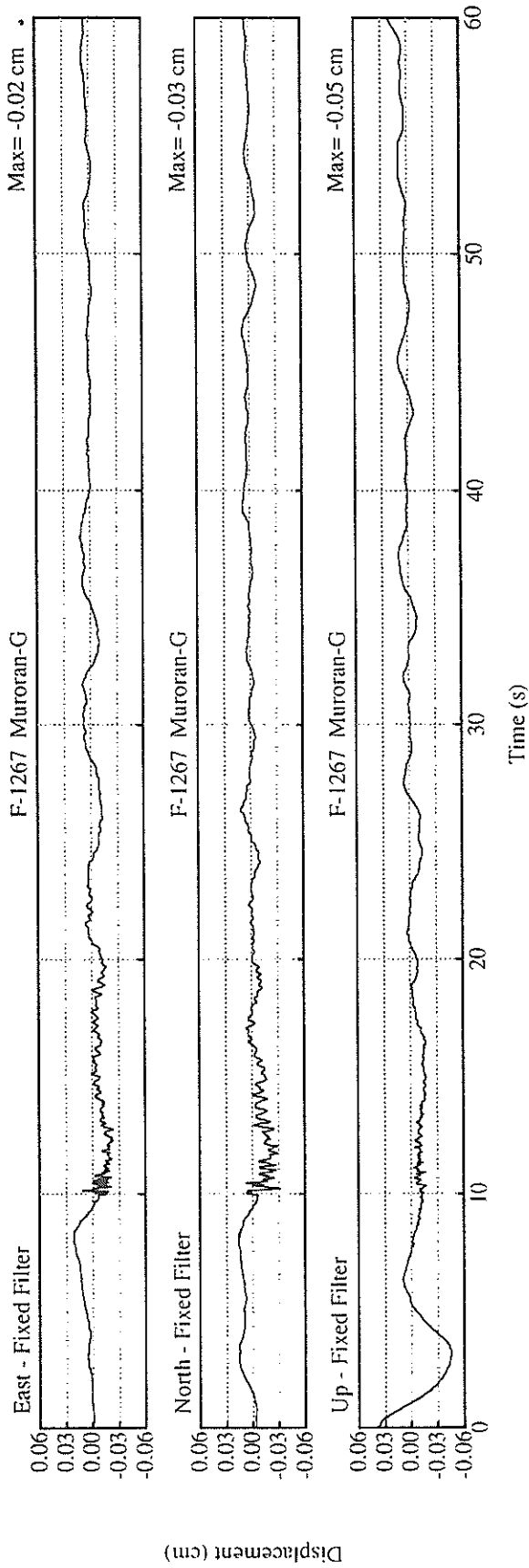
	N S	E W	U D	HORIZONTAL*
FIXED FILTER	0.03	0.02	0.05	0.03
VARIABLE FILTER	0.02	0.01	0.00	0.02

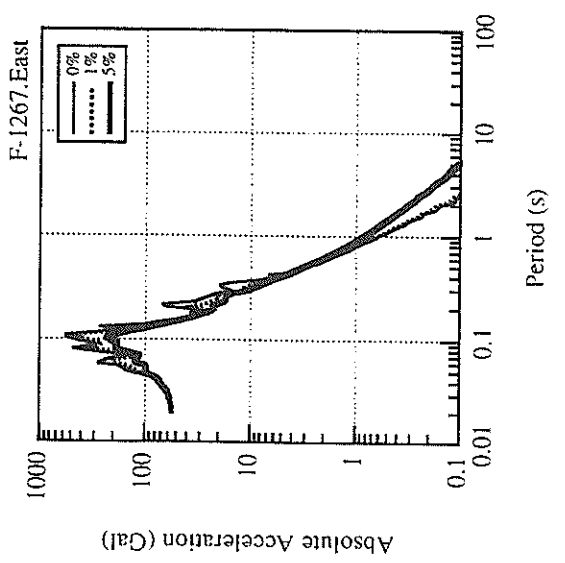
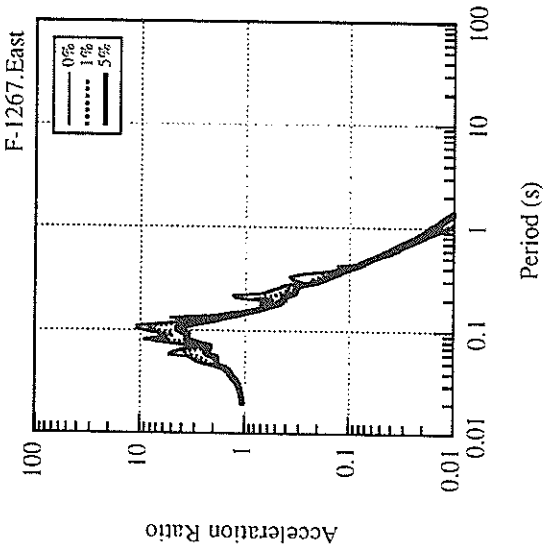
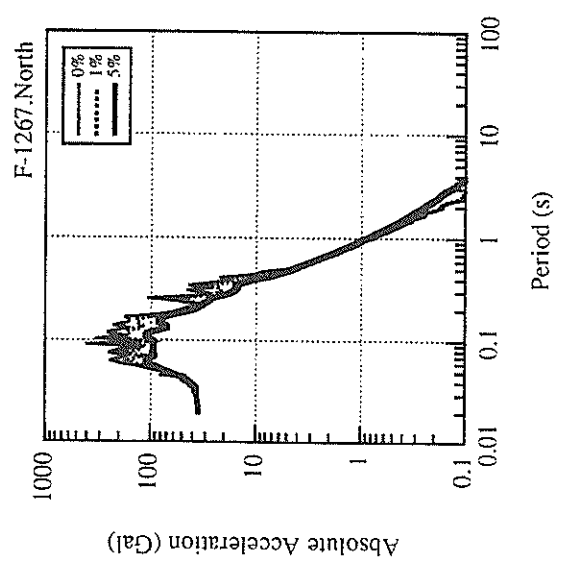
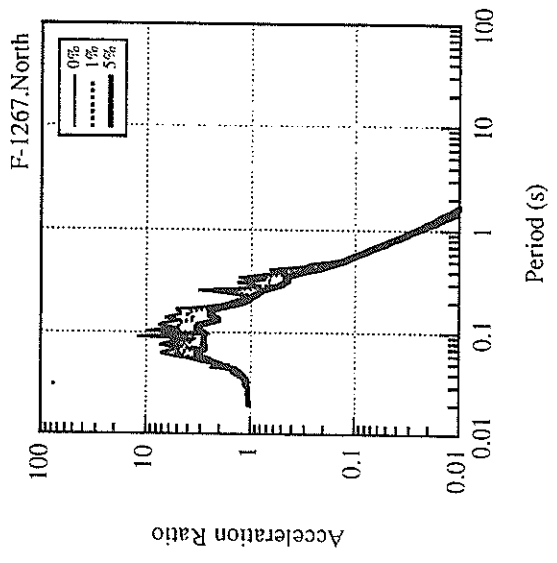
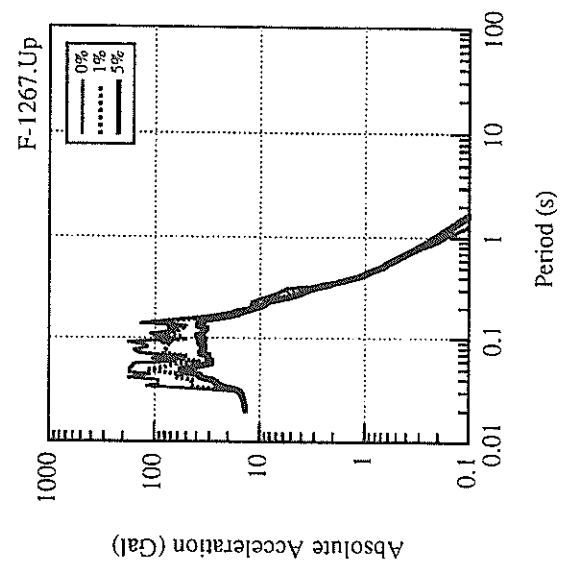
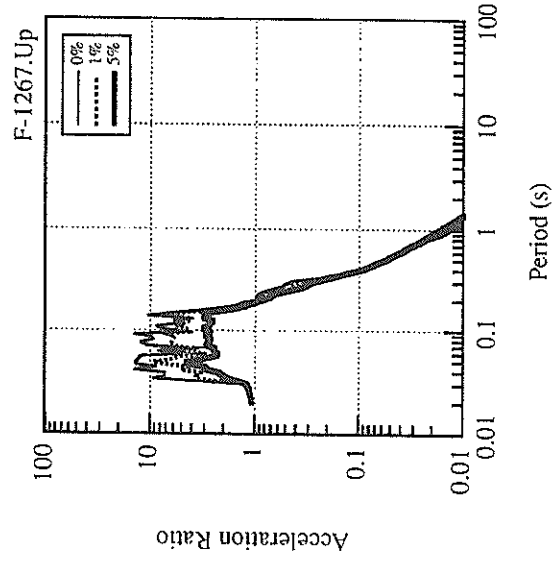
* RESULTANT OF HORIZONTAL COMPONENTS

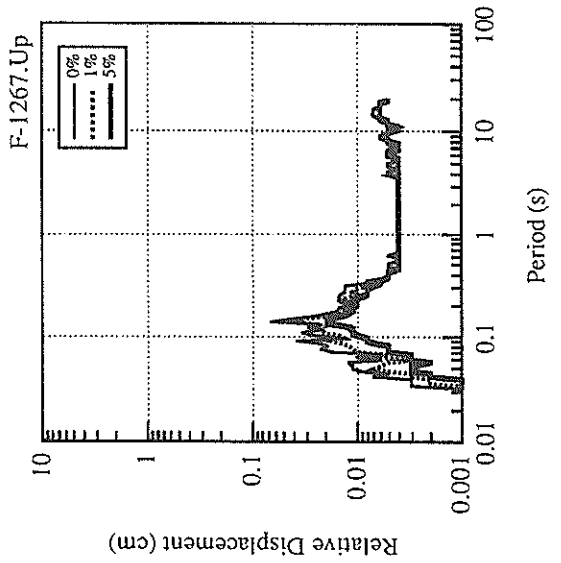
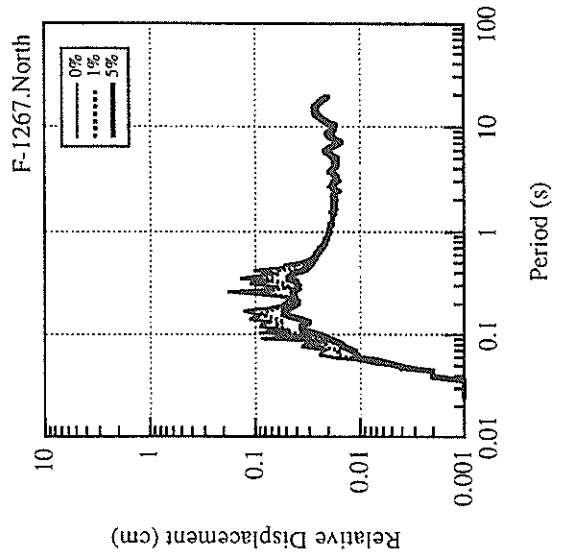
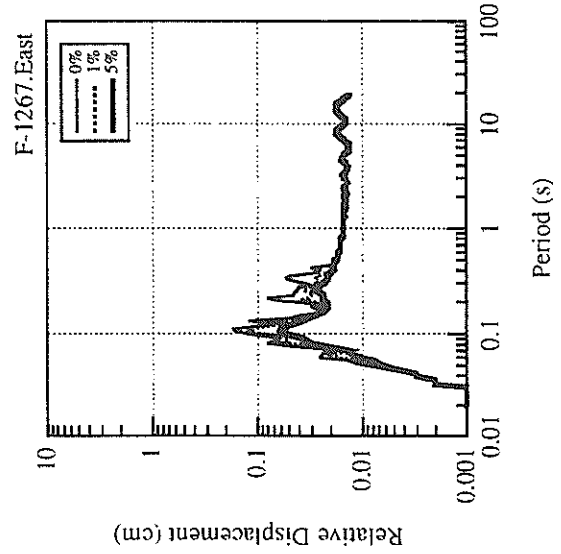
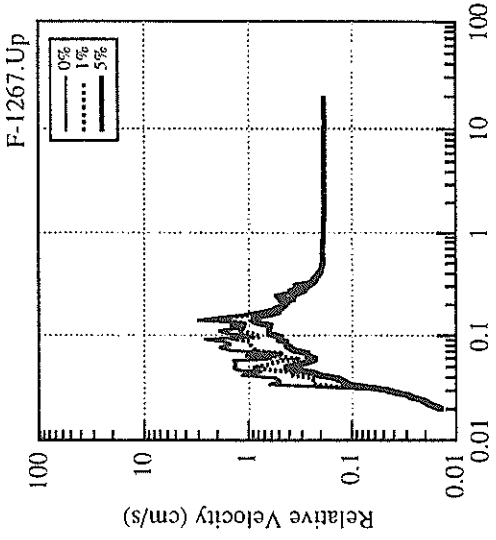
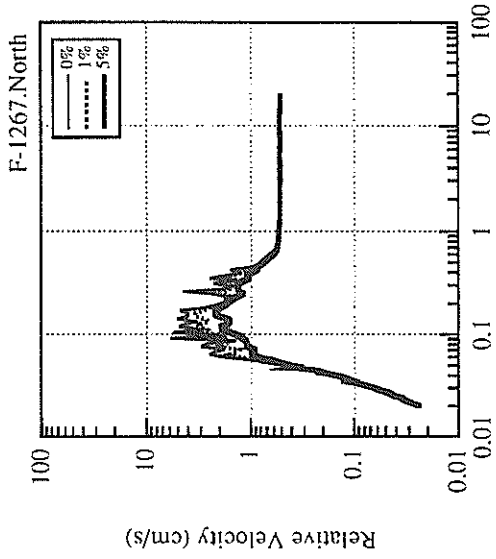
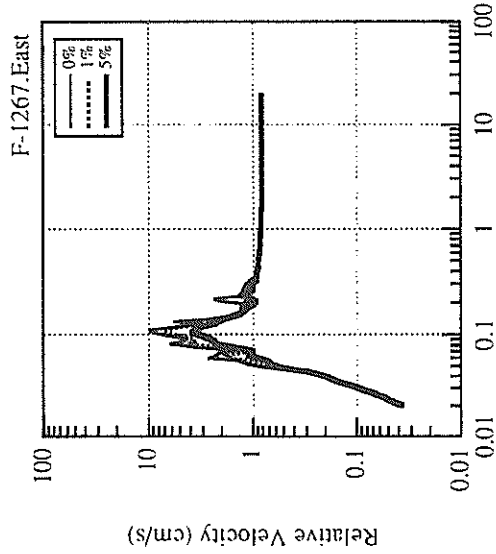


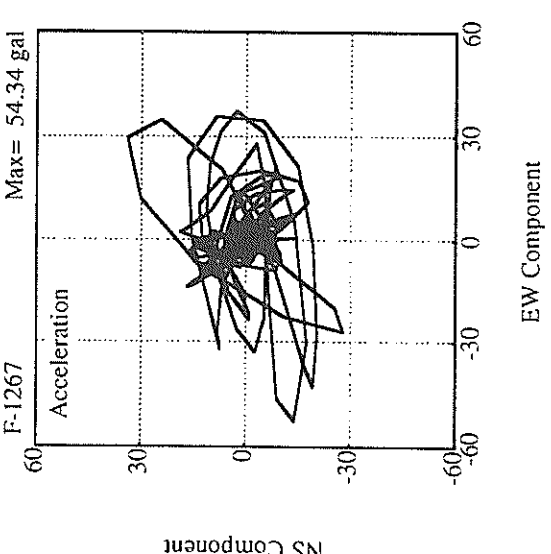
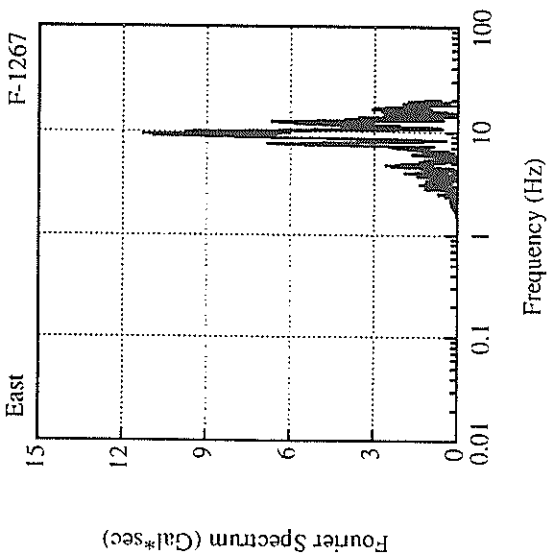
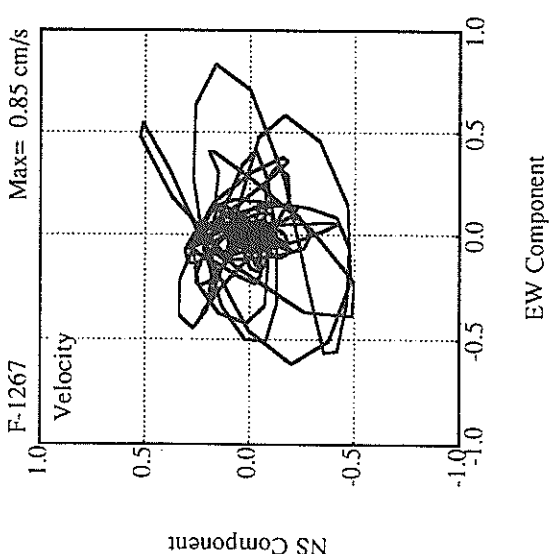
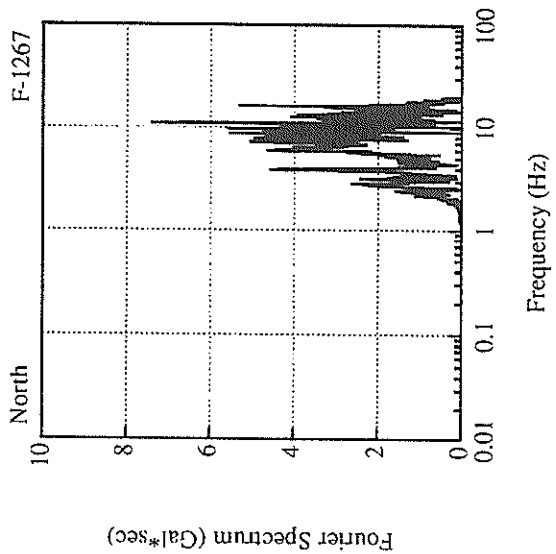
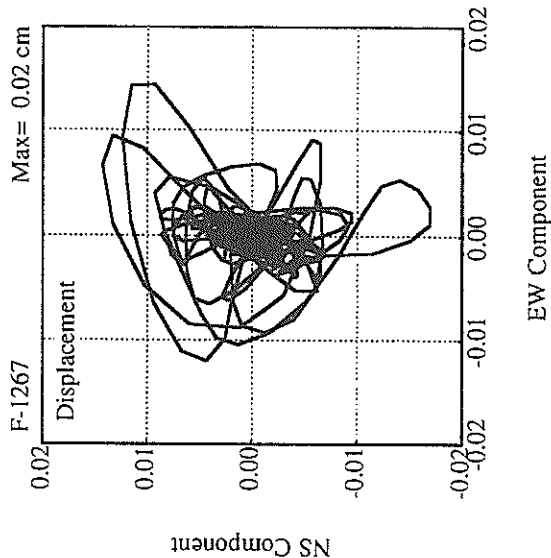
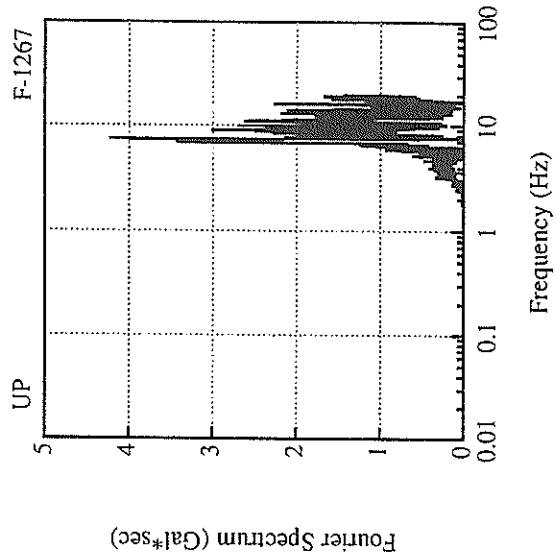












RECORD NUMBER : F-1181

STATION : HIROSHIMA-G

EARTHQUAKE DATA

DATE AND TIME 18:50 JUNE25,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION

LATITUDE

LONGITUDE

DEPTH

JMA MAGNITUDE

YAMAGUCHI PEF

34°26.3' N

131°40.1' E

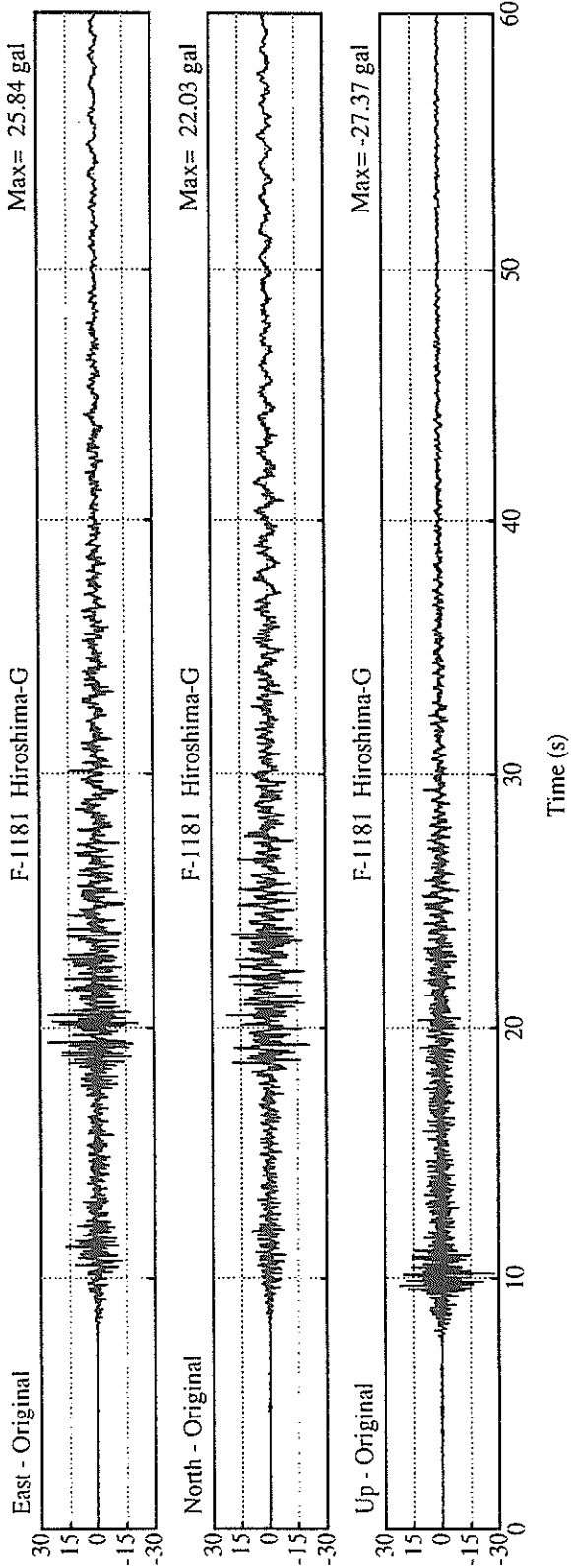
8.3KM

6.3

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	22.0	25.8	27.4	30.8

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1183

STATION : SAKAIMINATO-G

EARTHQUAKE DATA

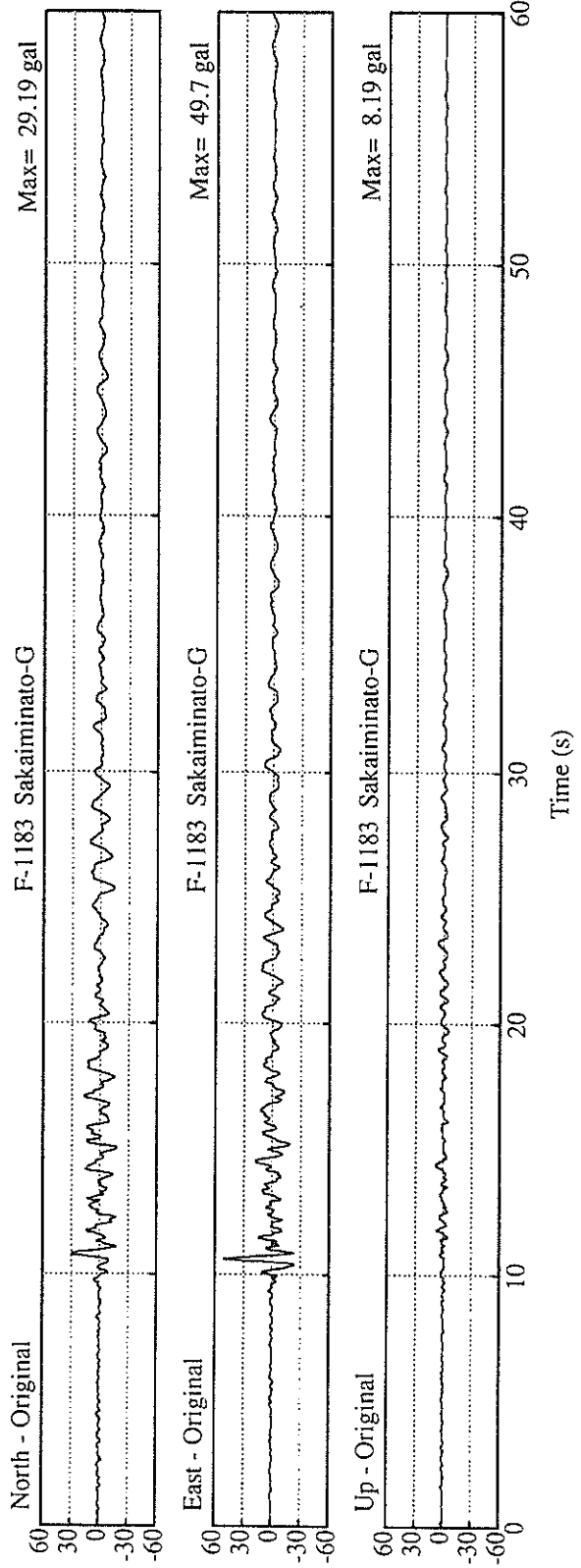
 DATE AND TIME 18:50 JUNE25,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION YAMAGUCHI PREF
 LATITUDE 34°26.3' N
 LONGITUDE 131°40.1' E
 DEPTH 8.3KM
 JMA MAGNITUDE 6.3

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
29.2	49.7	8.2	49.9

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1187

STATION : MATSUYAMA-G

EARTHQUAKE DATA

DATE AND TIME : 18:50 JUNE25,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : YAMAGUCHI PREF

LATITUDE : 34°26.3' N

LONGITUDE : 131°40.1' E

DEPTH : 8.3KM

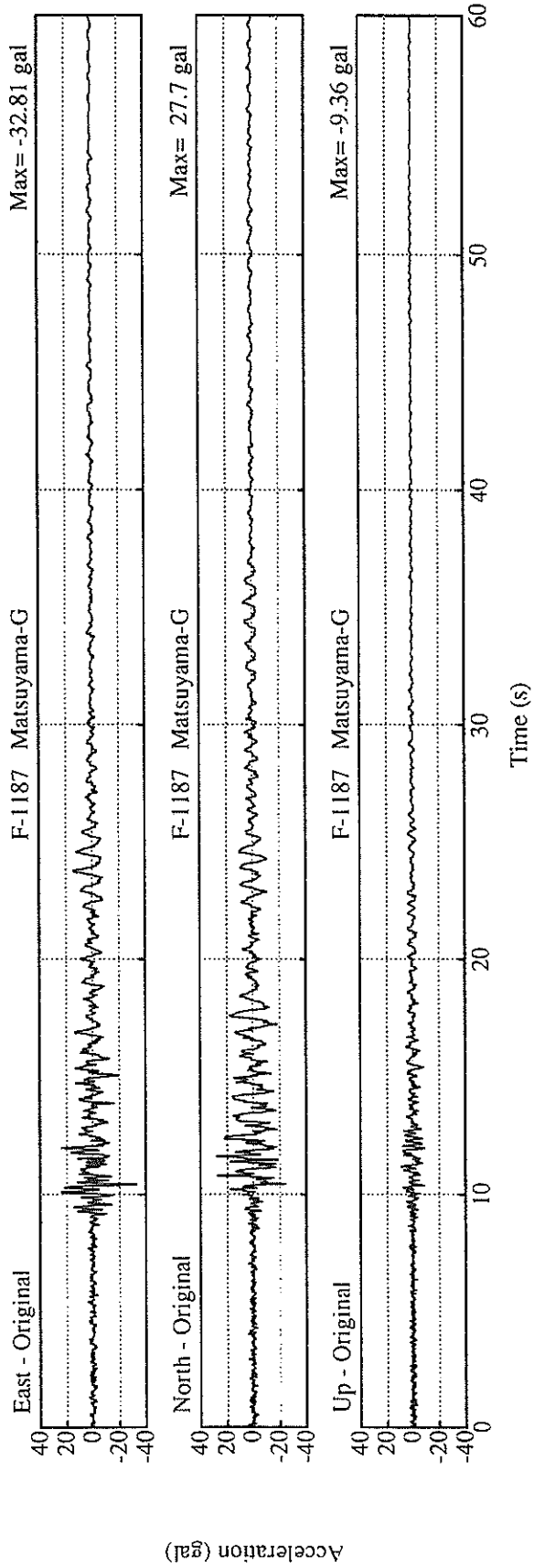
JMA MAGNITUDE : 6.3

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
27.7	32.8	9.4	41.0

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1213

STATION : KUSHIRO-G

EARTHQUAKE DATA

 DATE AND TIME 12:40 JULY 1,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION SE OFF TOKACHI
 LATITUDE 42°38.6' N
 LONGITUDE 144°39.3' E
 DEPTH 72.5KM
 JMA MAGNITUDE 5.1

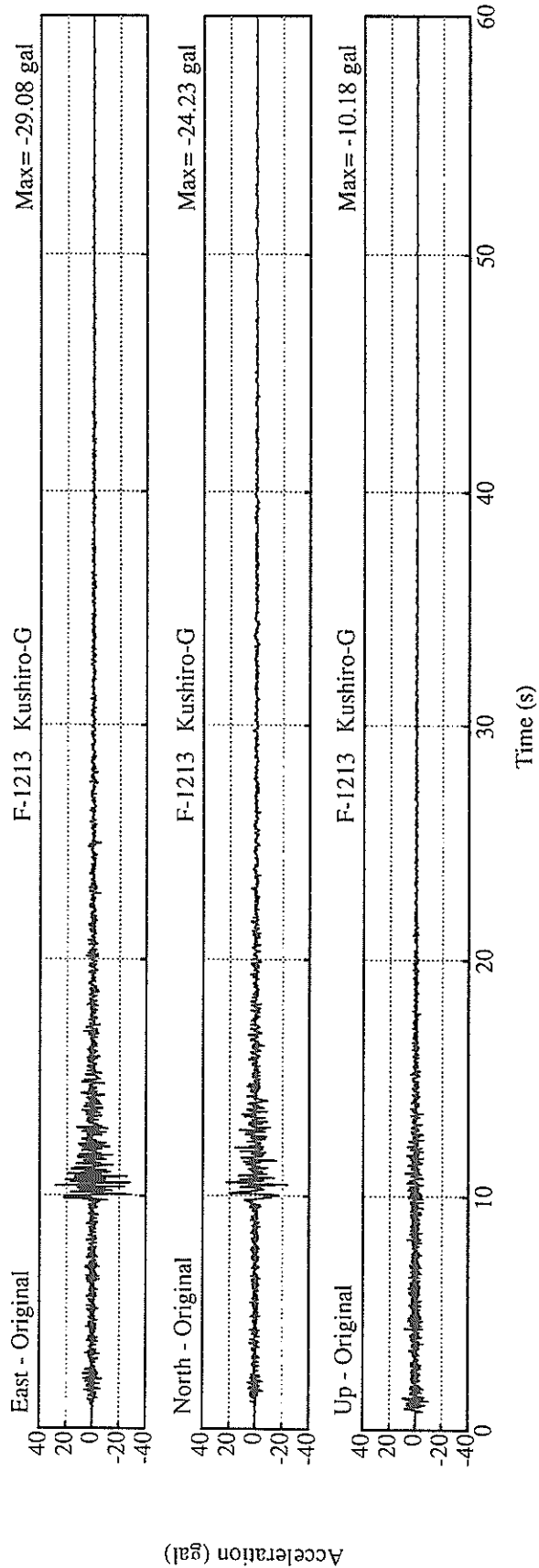
PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*

24.2	29.1	10.2	32.8

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1246

STATION : YAMASHITA-F

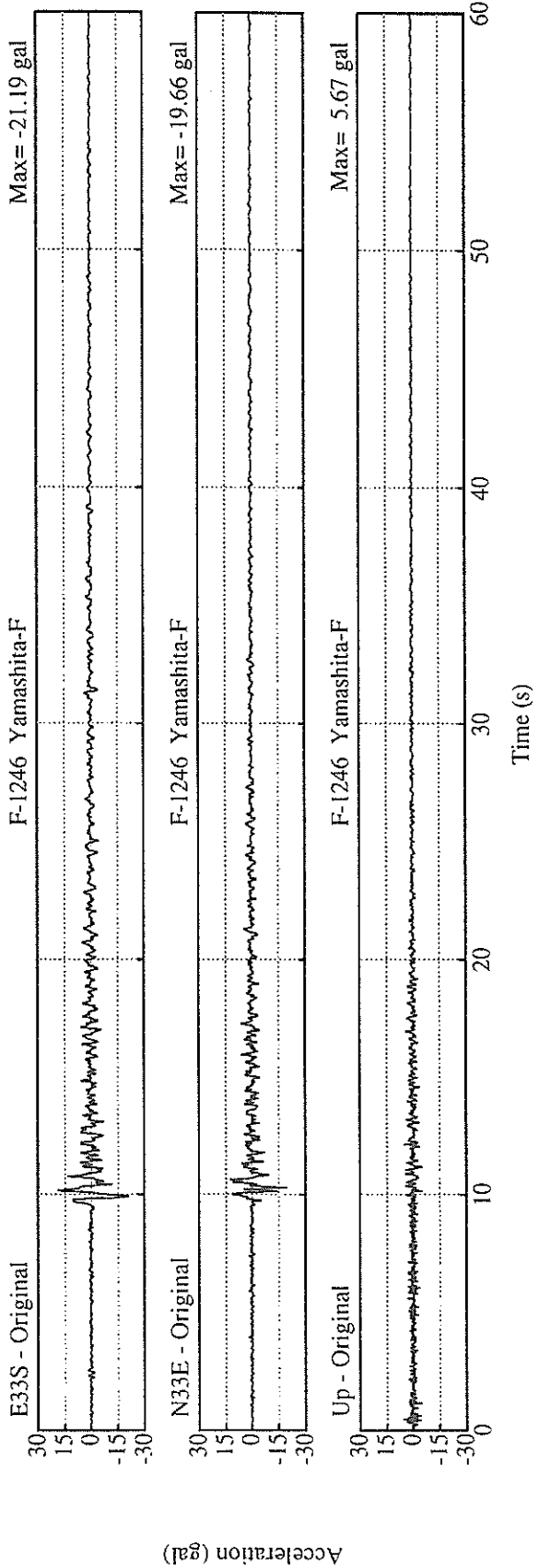
EARTHQUAKE DATA

 DATE AND TIME 18:36 JULY 9, 1997
 LOCATION OF HYPOCENTER CENTRAL CHIBA PREF
 EPICENTRAL REGION 35° 33.1' N
 LATITUDE 140° 7.7' E
 LONGITUDE 77.3KM
 DEPTH 4.6
 JMA MAGNITUDE

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	19.7	21.2	5.7	22.0

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1201

STATION : HANASAKI-F

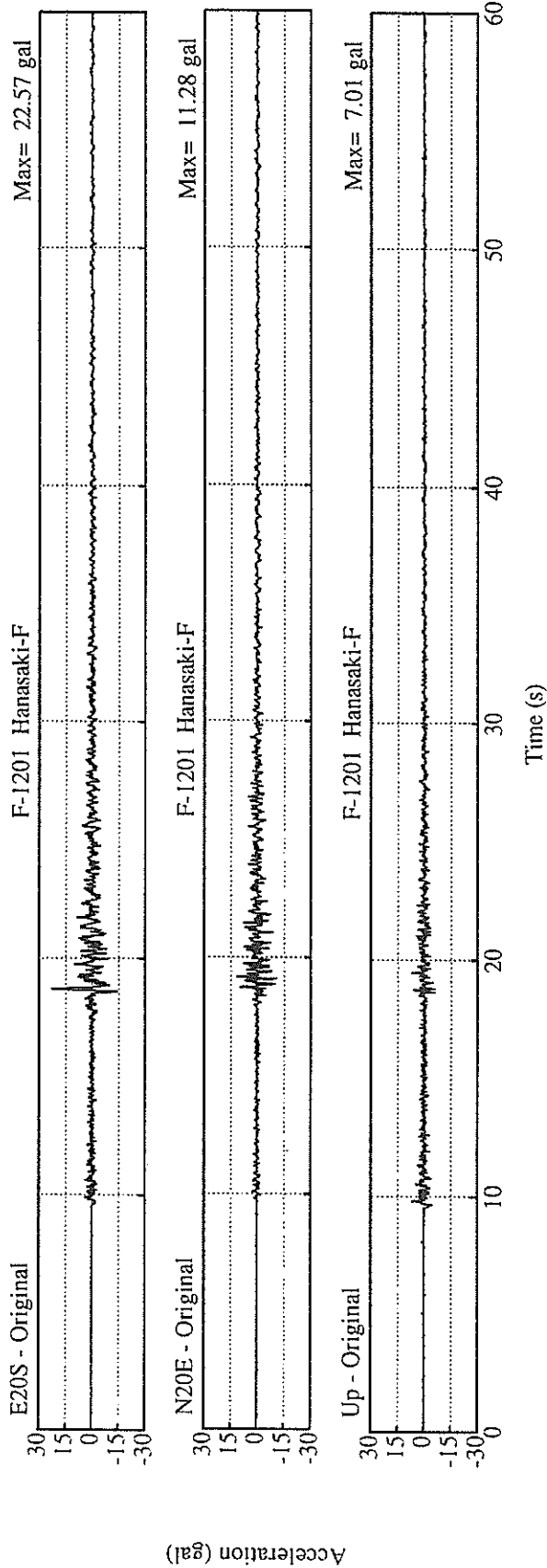
EARTHQUAKE DATA

 DATE AND TIME : 1: 9 JULY15,1997
 LOCATION OF HYPOCENTER : OFF NEMURO PENINSULA
 EPICENTRAL REGION : 43° 7.0' N
 LONGITUDE : 146° 17.5' E
 DEPTH : 36.9KM
 JMA MAGNITUDE : 5.9

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	11.3	22.6	7.0	23.8

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1224

STATION : HIRARA-G

EARTHQUAKE DATA

 DATE AND TIME 13:45 AUG.13,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NEAR MIYAKOJIMA ISLAND
 LATITUDE 25°11.2' N
 LONGITUDE 125°49.0' E
 DEPTH 94.4KM
 JMA MAGNITUDE 6.2

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
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PARAMETER OF THE VARIABLE FILTER

FC (HZ)	0.427	0.372	0.415	
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MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	34.2	30.5	16.1	41.7
ORIGINAL	52.9	47.4	24.1	61.1
CORRECTED	51.8	46.6	23.0	60.2

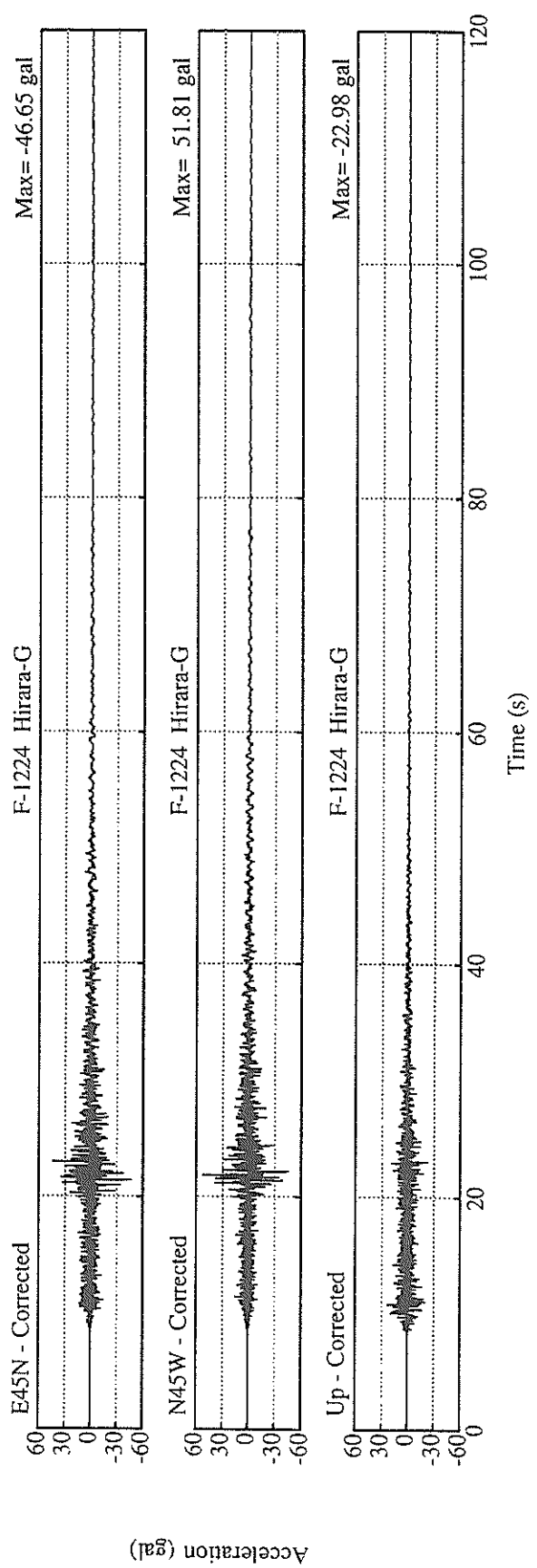
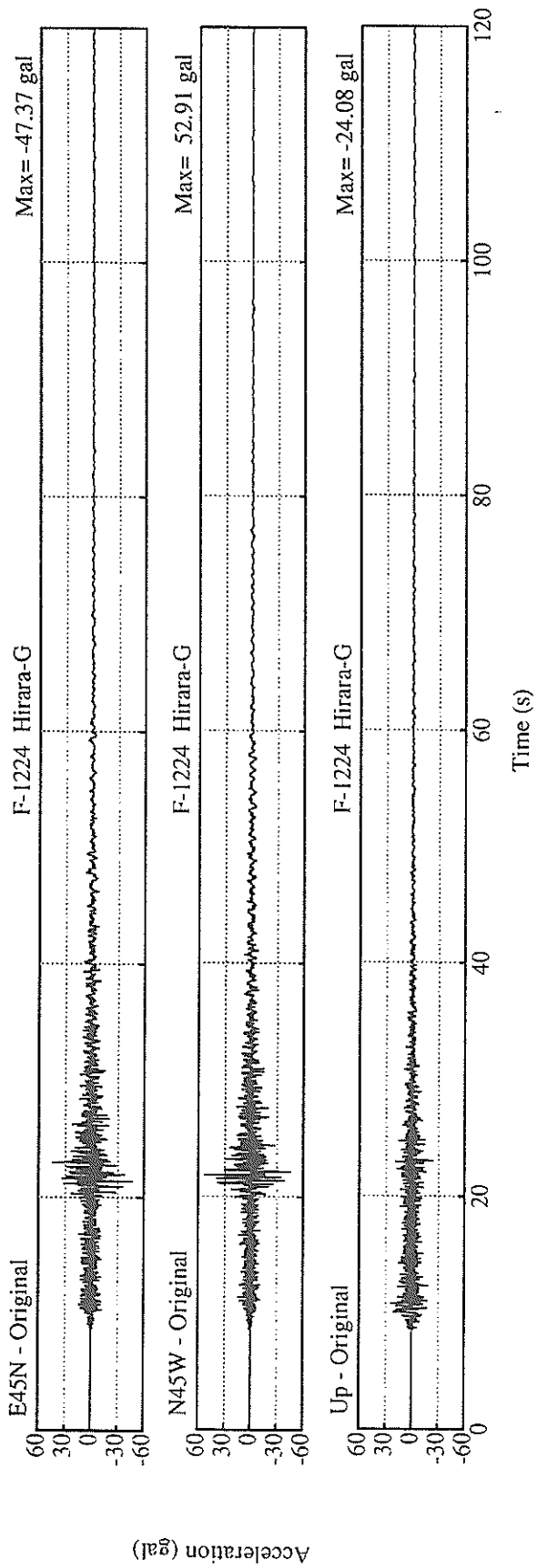
MAXIMUM VELOCITY (CM/SEC)

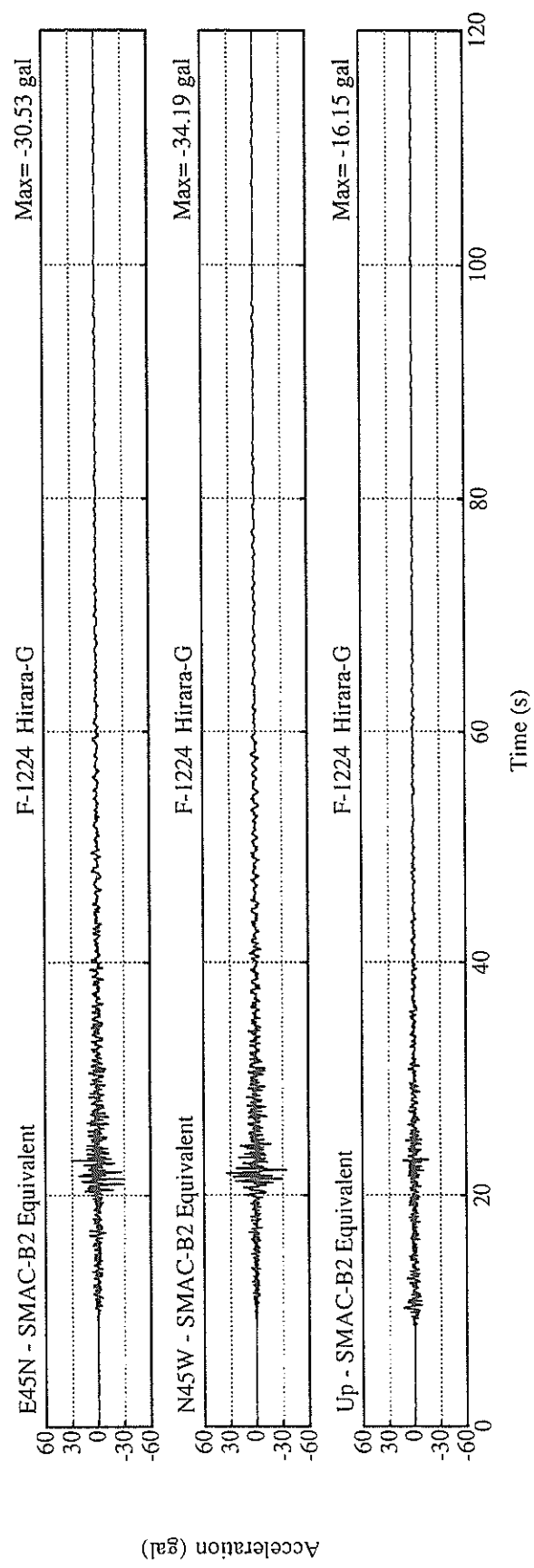
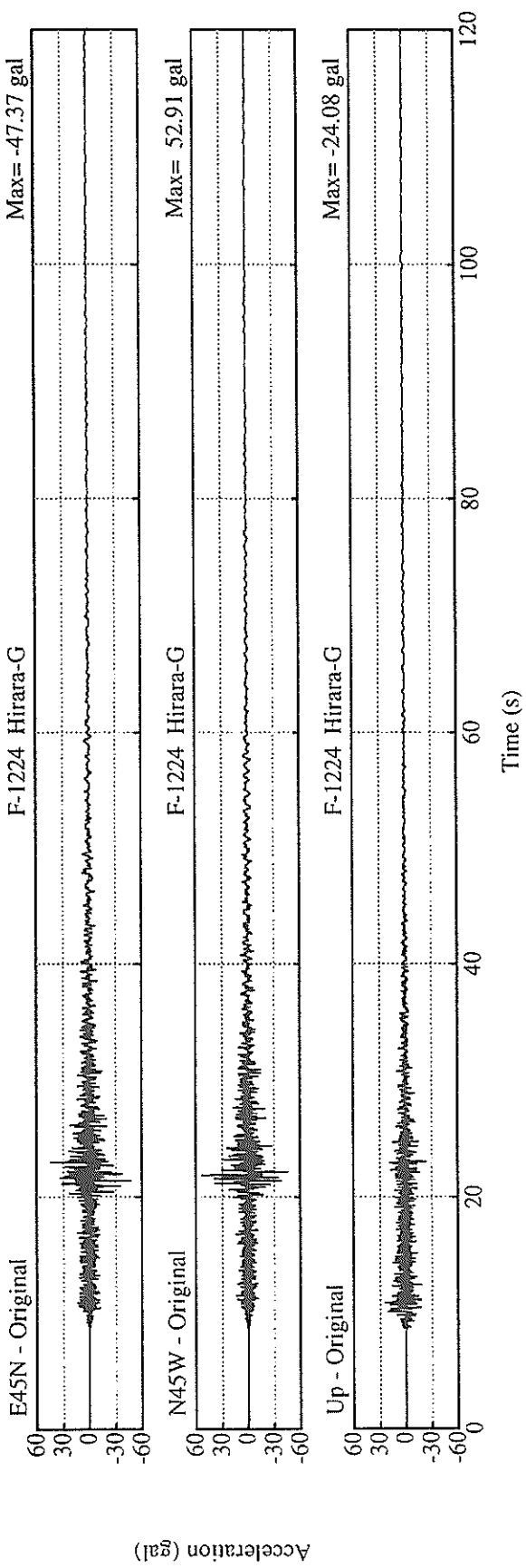
FIXED FILTER	2.63	2.12	1.19	2.63
VARIABLE FILTER	2.60	1.75	1.33	2.62

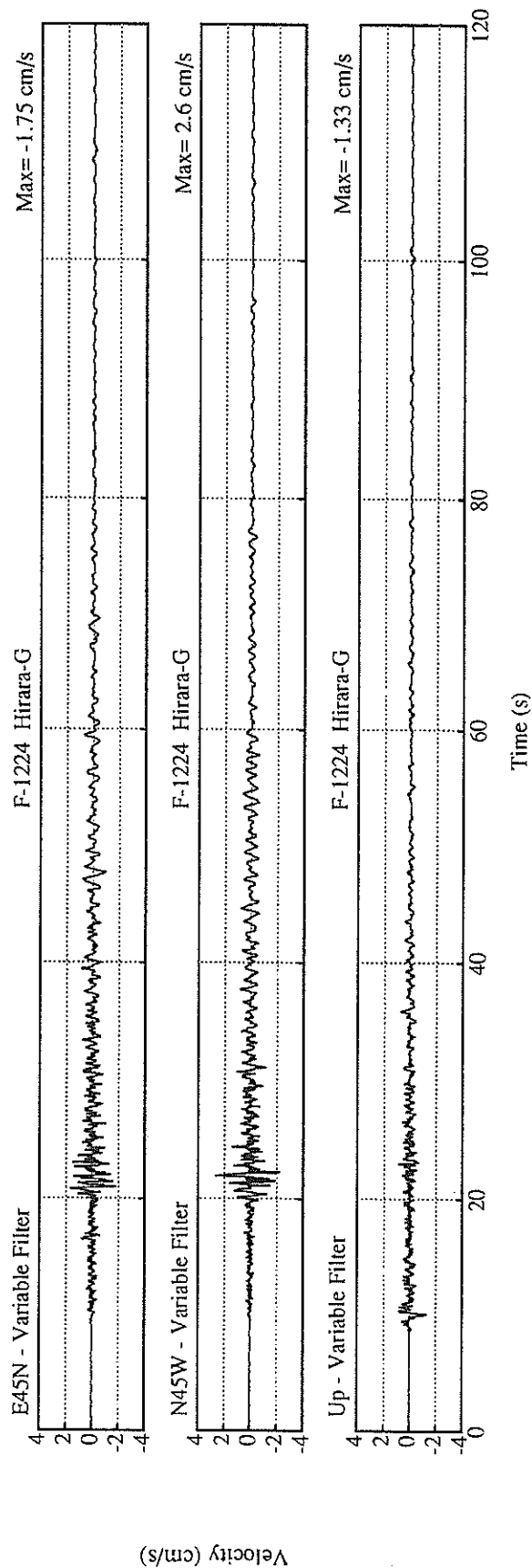
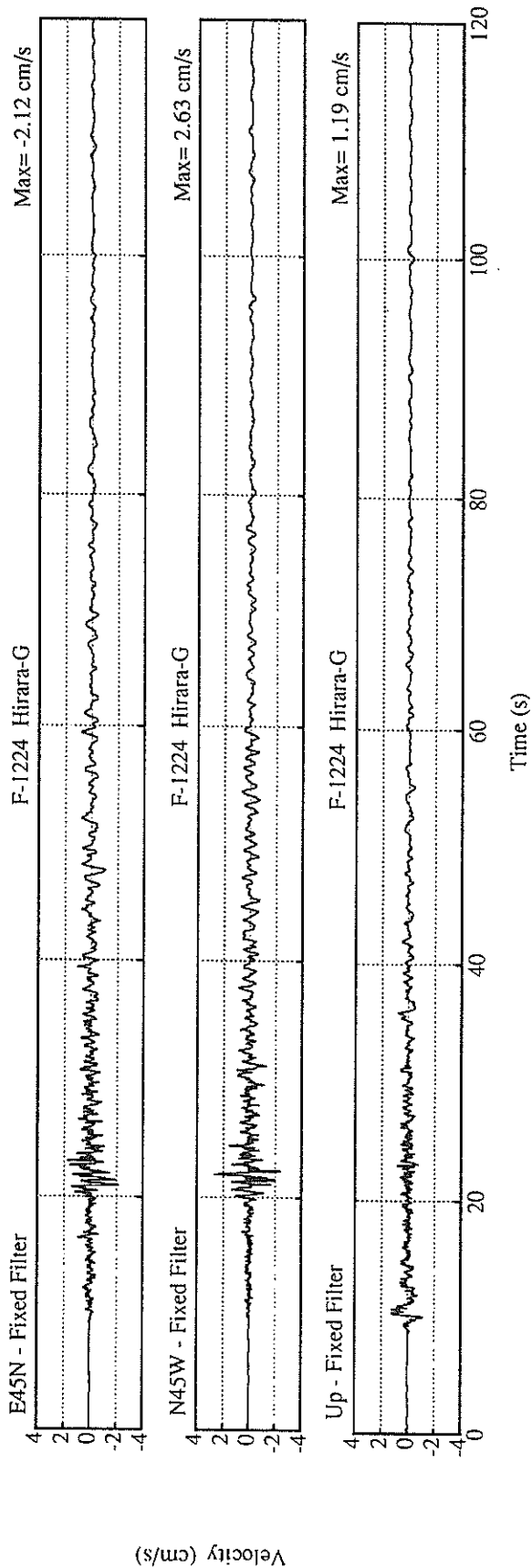
MAXIMUM DISPLACEMENT (CM)

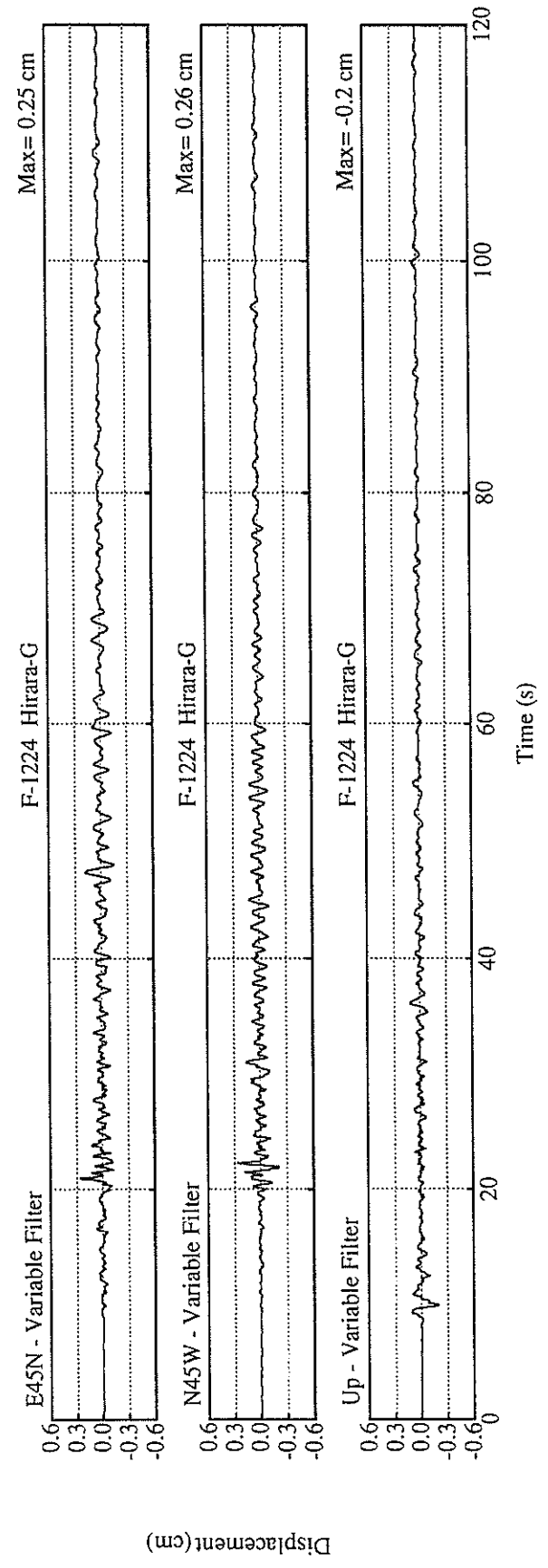
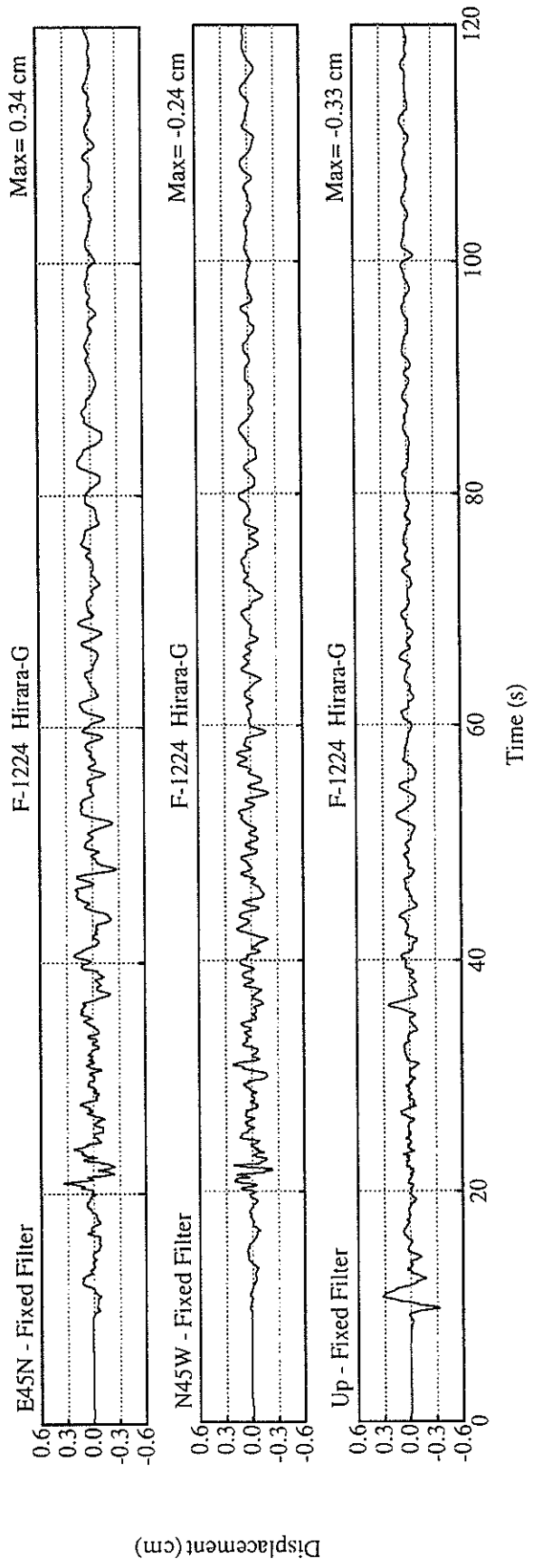
FIXED FILTER	0.24	0.34	0.33	0.39
VARIABLE FILTER	0.26	0.25	0.20	0.27

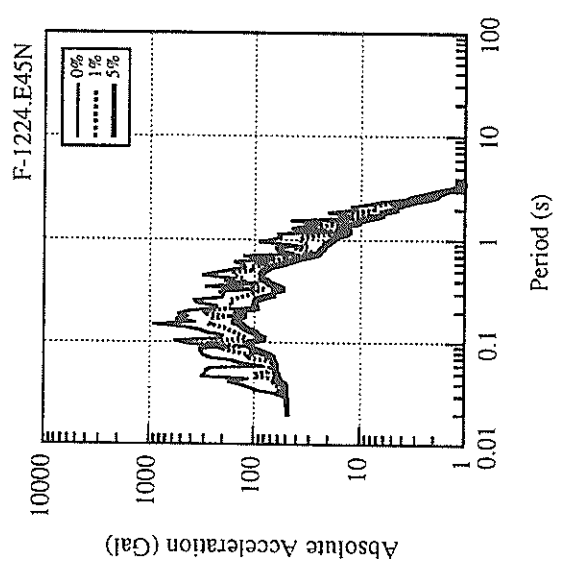
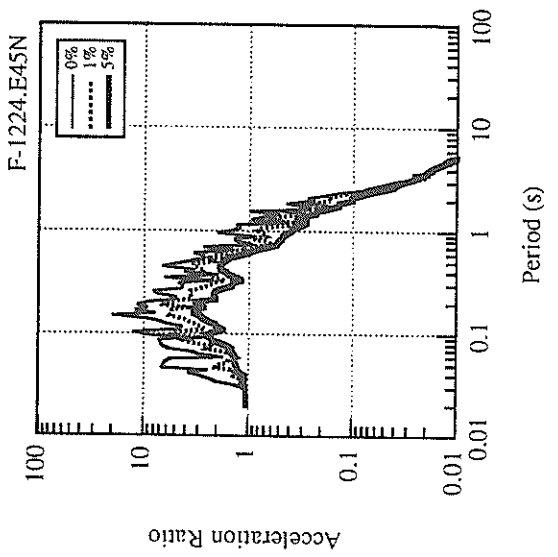
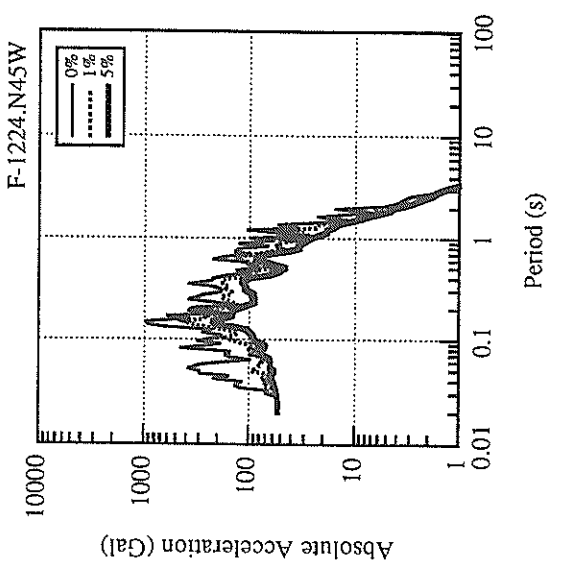
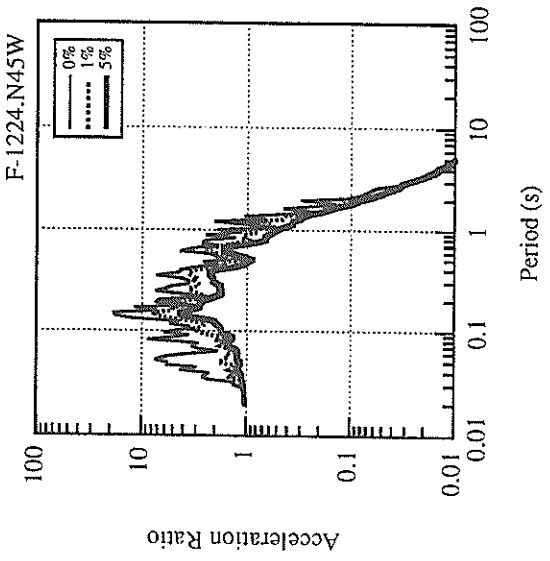
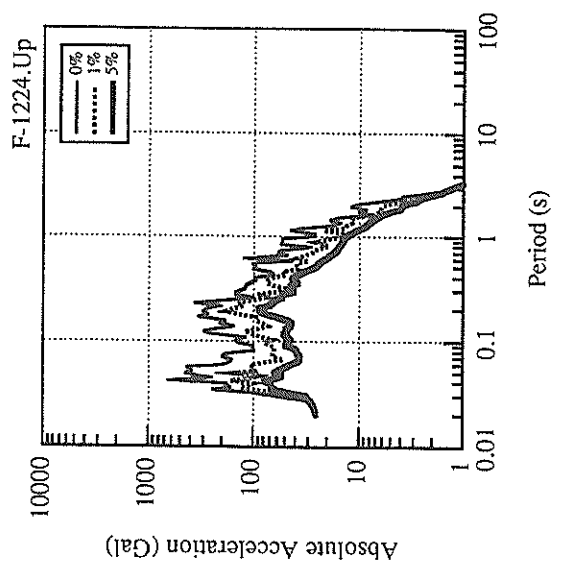
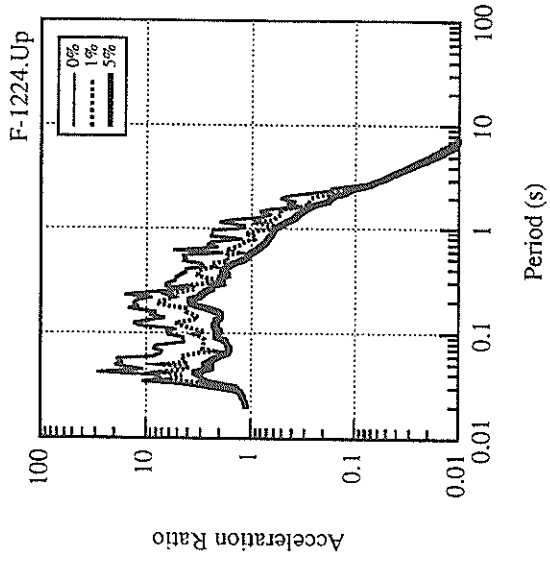
* RESULTANT OF HORIZONTAL COMPONENTS

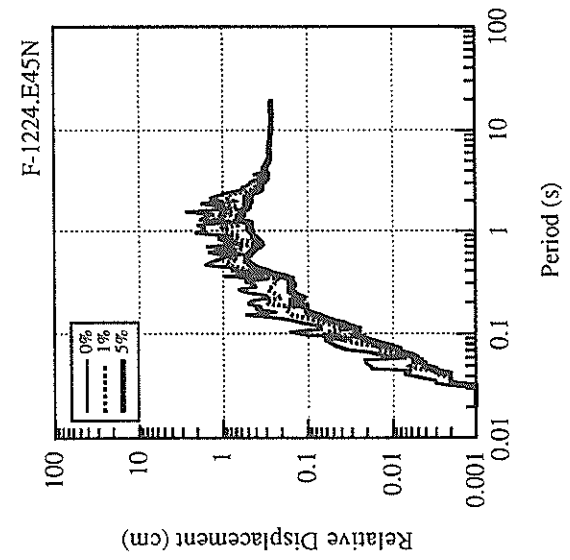
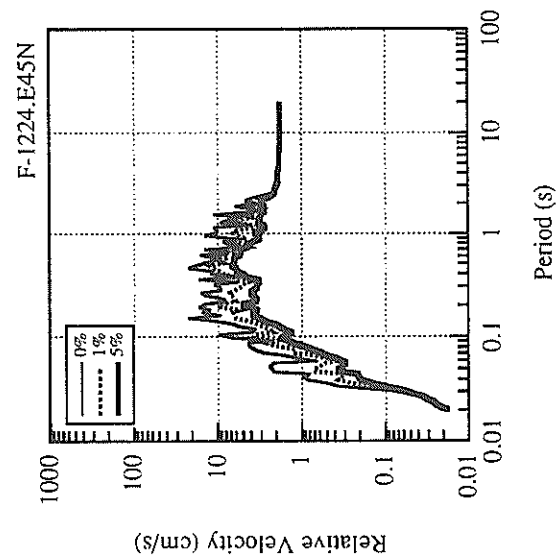
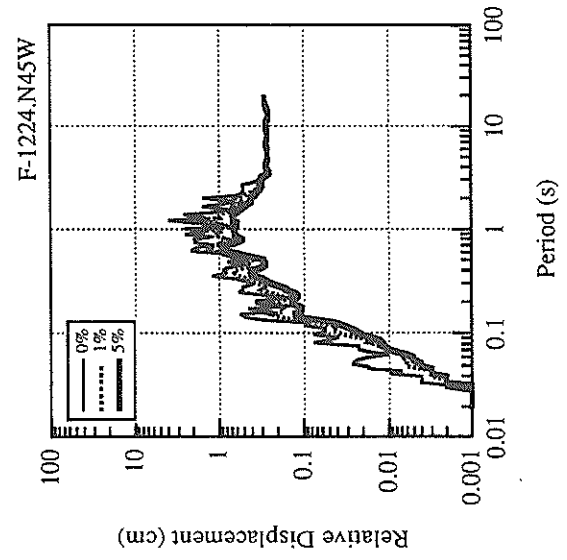
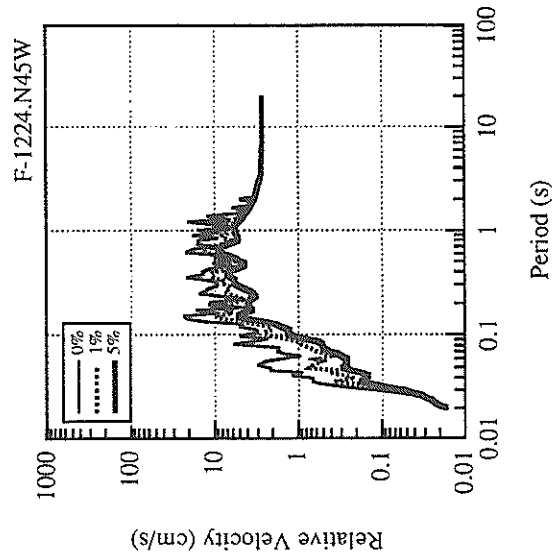
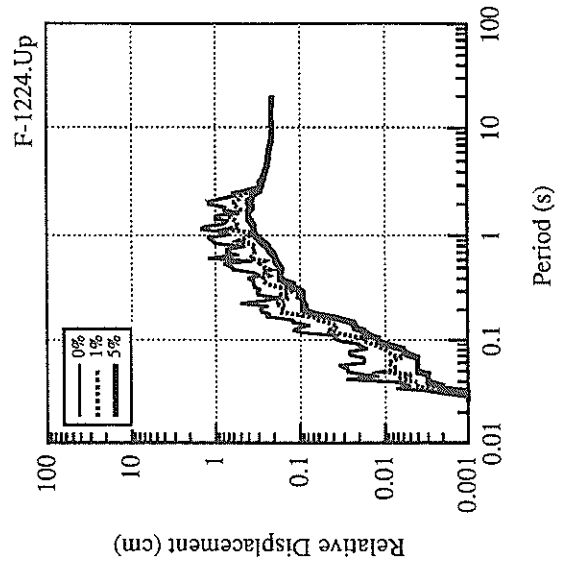
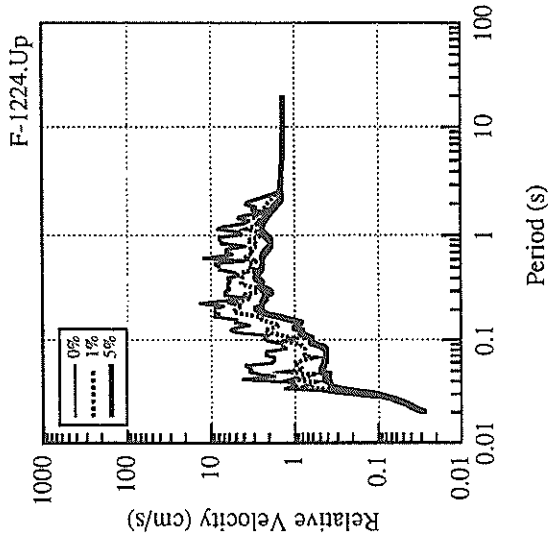


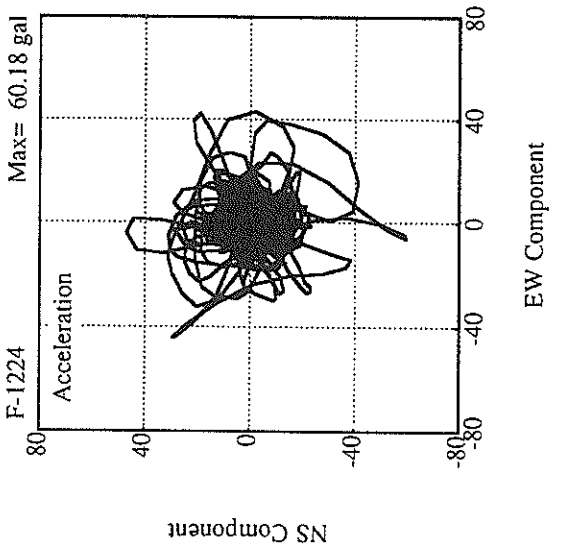
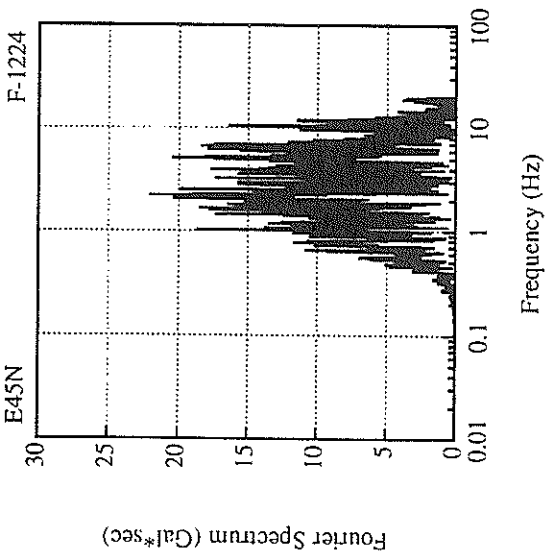
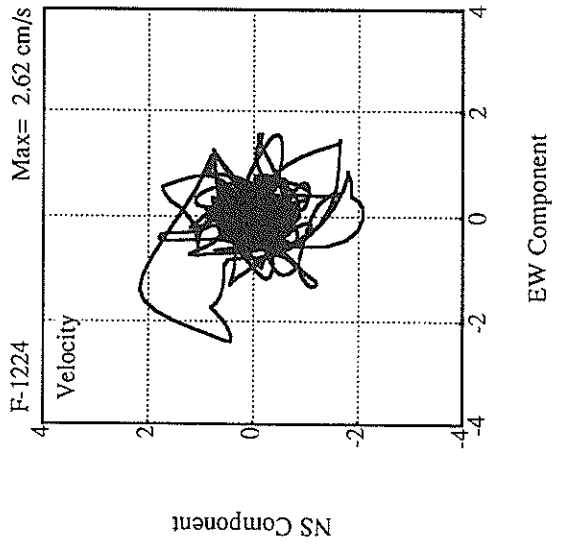
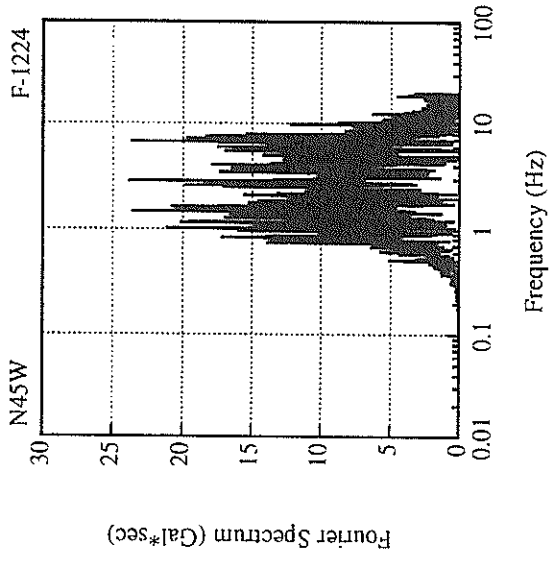
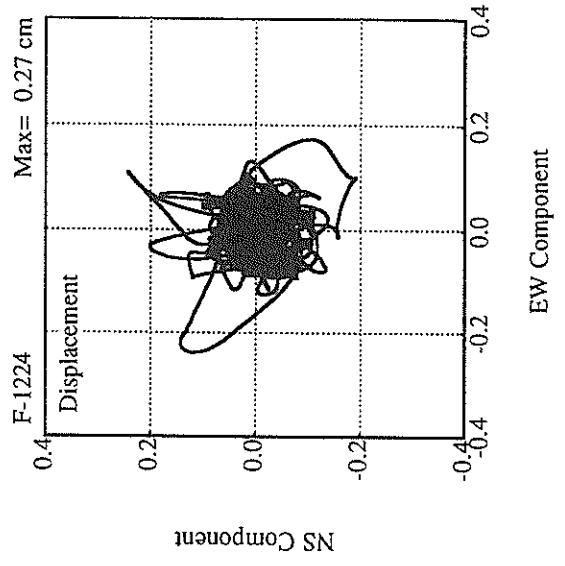
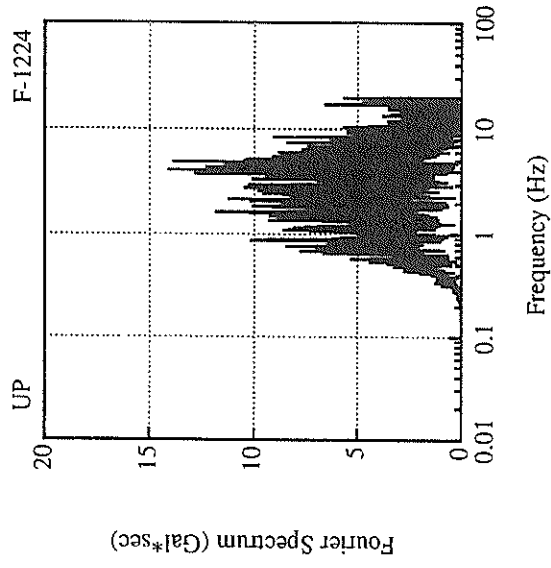












RECORD NUMBER : F-1208

STATION : SAKAIMINATO-G

EARTHQUAKE DATA

DATE AND TIME : 5:15 SEP. 4, 1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION

LATITUDE

LONGITUDE

DEPTH

JMA MAGNITUDE

WESTERN TOTTORI PREF

35° 15.5' N

133° 22.8' E

8.9KM

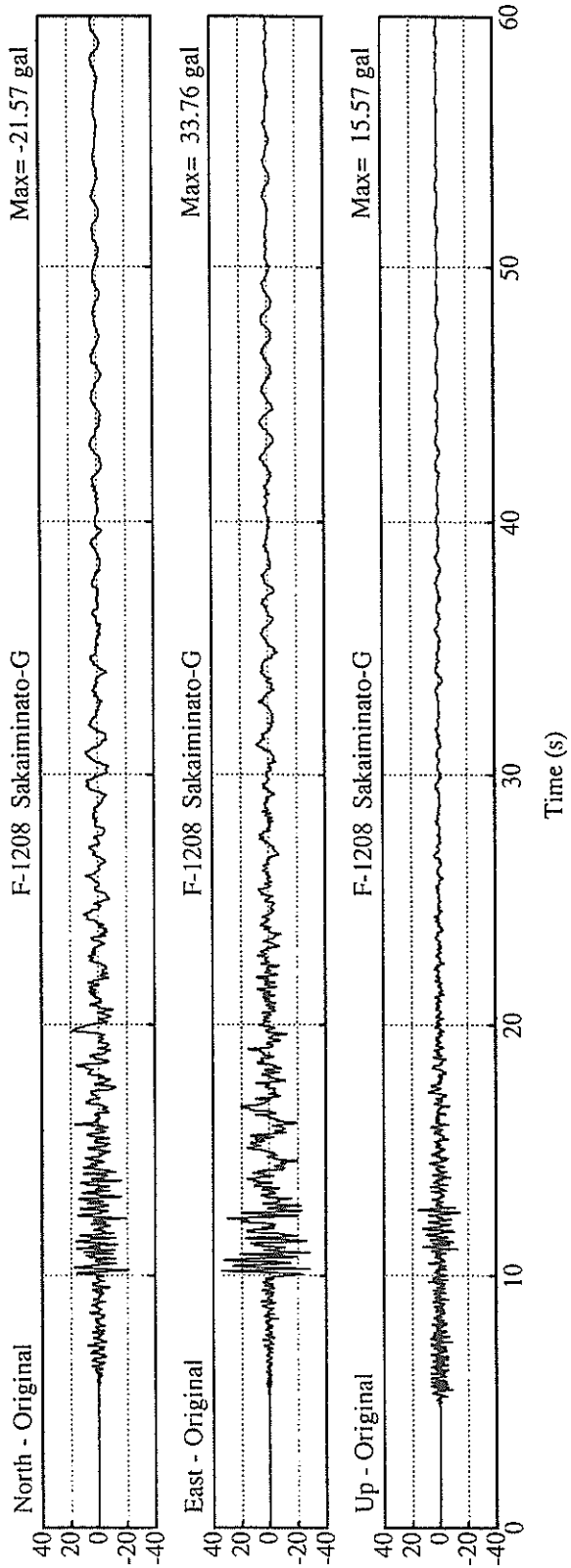
5.1

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
21.6	33.8	15.6	37.1

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1225

STATION : HIRARA-G

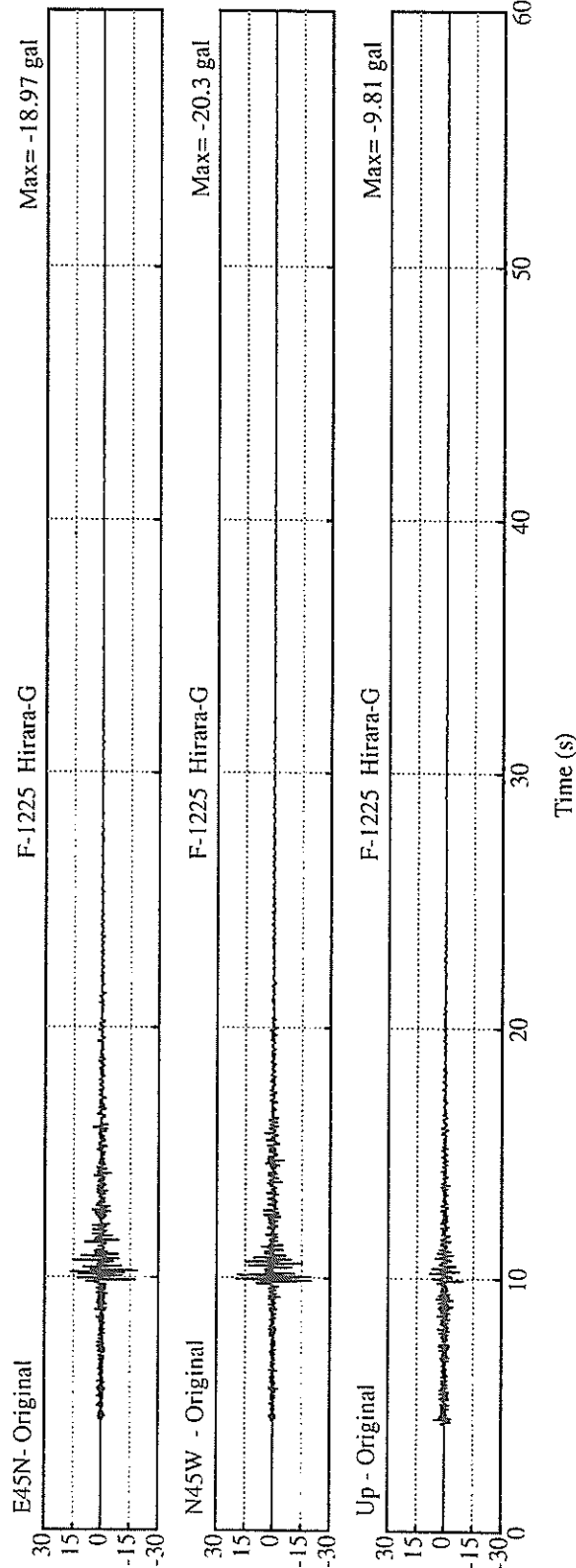
EARTHQUAKE DATA

 DATE AND TIME 20:17 SEP. 7, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NEAR MIYAKOJIMA ISLAND
 LATITUDE 24° 55.6' N
 LONGITUDE 125° 21.0' E
 DEPTH 64.0KM
 JMA MAGNITUDE 4.2

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	20.3	19.0	9.8	24.1

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : M-1571

STATION : OMAEZAKI-M

EARTHQUAKE DATA

DATE AND TIME 14:44 OCT.11,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION ENSYUNADA

LATITUDE 34° 25.2' N

LONGITUDE 138° 14.0' E

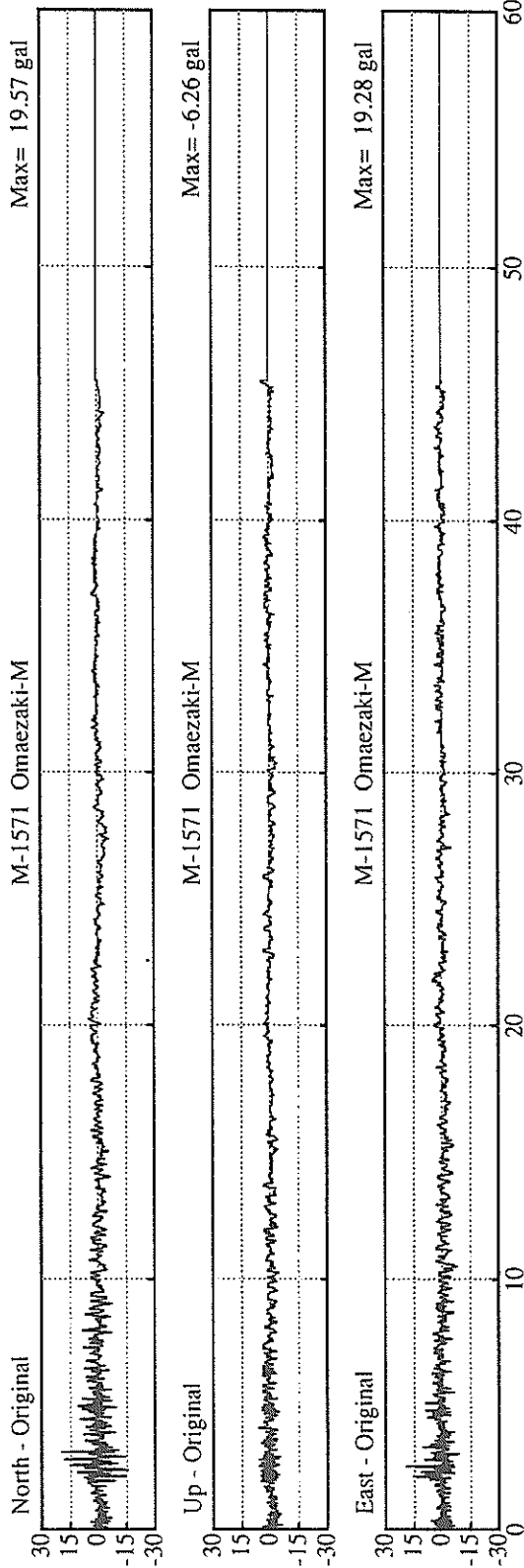
DEPTH 35.7KM

JMA MAGNITUDE 4.9

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	19.6	19.3	6.3	19.6

* RESULTANT OF HORIZONTAL COMPONENTS



Acceleration (gal)

Time (s)

RECORD NUMBER : M-1579

STATION : OFUNATO-MOUND-M

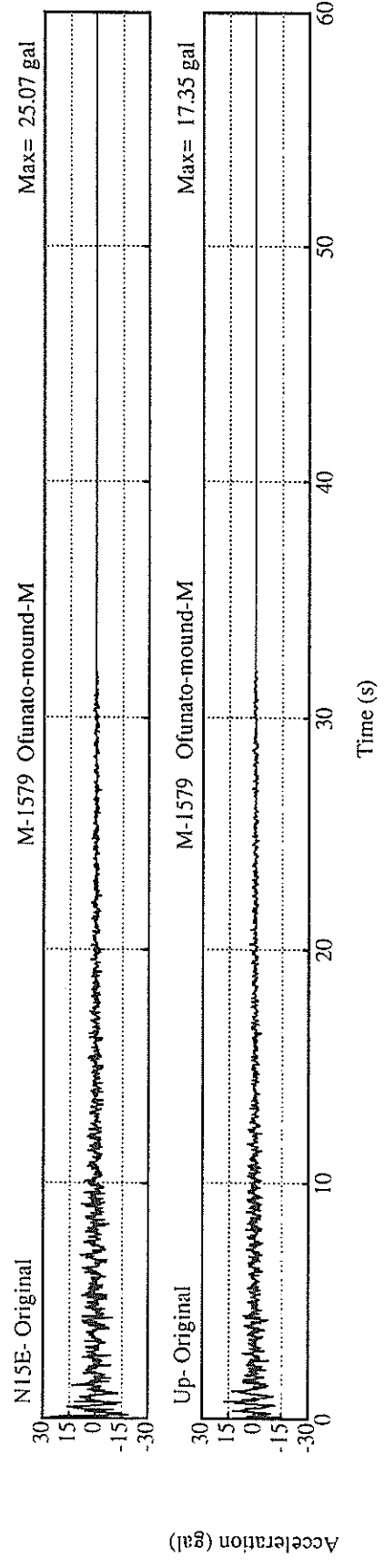
EARTHQUAKE DATA

 DATE AND TIME 18:45 OCT.11.1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF MIYAGI PREF
 LATITUDE 38° 52.0' N
 LONGITUDE 142° 10.9' E
 DEPTH 53.6KM
 JMA MAGNITUDE 5.1

PEAK VALUES OF COMPONENTS

ORIGINAL ACCELERATION (GAL)		HORIZONTAL*		
N	S	E	W	U D
25.1				17.3

* RESULTANT OF HORIZONTAL COMPONENTS



E15S component shows abnormal response.

RECORD NUMBER : F-1230

STATION : HITACHINAKA-F

EARTHQUAKE DATA

DATE AND TIME : 23:12 OCT.20,1997

LOCATION OF HYPOCENTER

E OFF IBARAKI PREF

EPICENTRAL REGION : 36° 18.8' N

LATITUDE : 140° 55.0' E

LONGITUDE : 42.6KM

DEPTH : 4.1

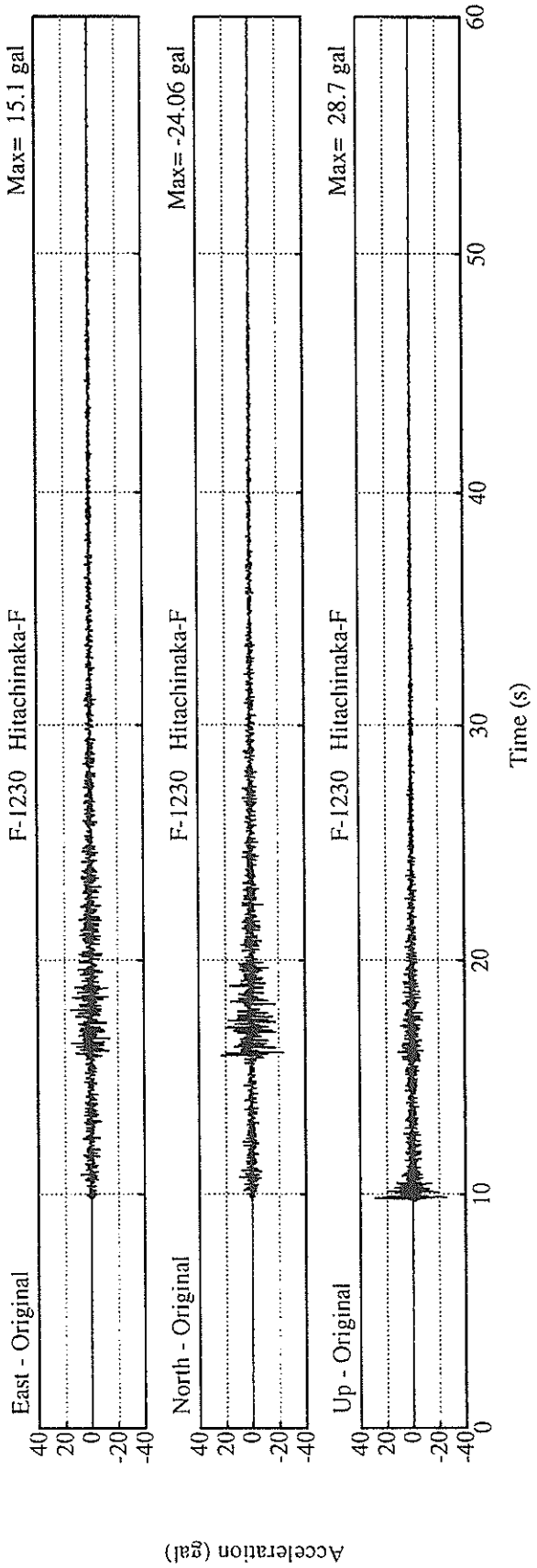
JMA MAGNITUDE : 4.1

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
24.1	15.1	28.7	24.1

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1231

STATION : HITACHINAKA-F

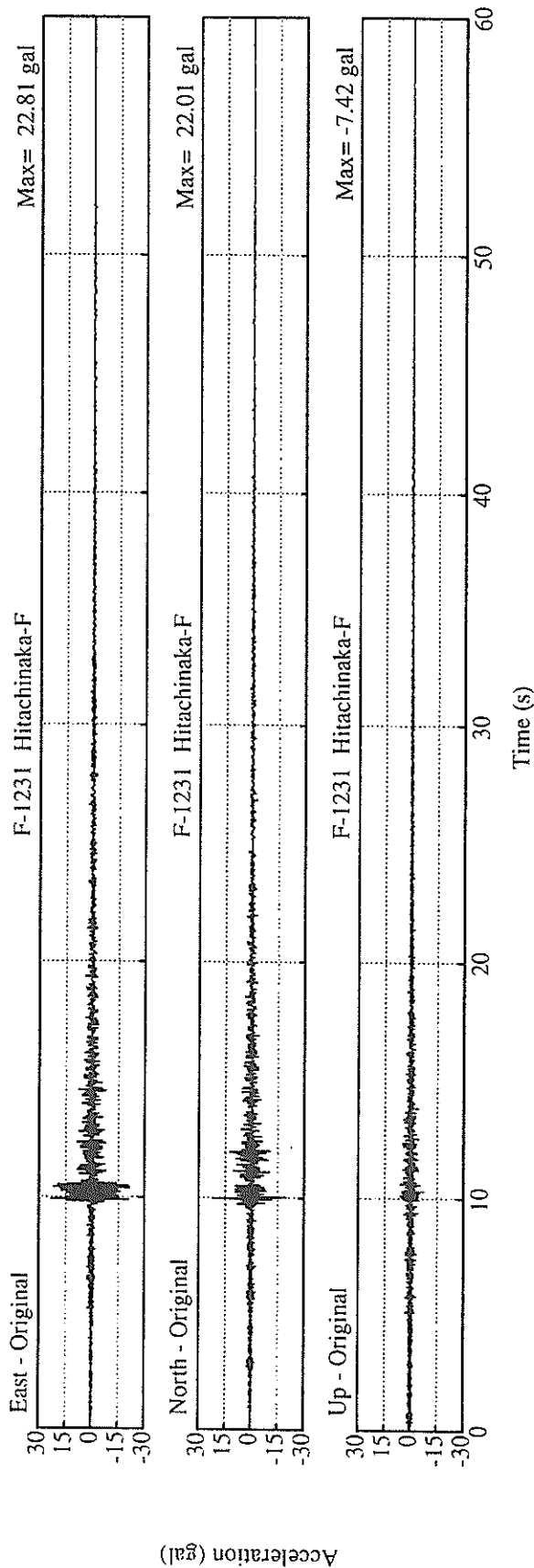
EARTHQUAKE DATA

 DATE AND TIME 7:13 NOV. 2,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION SW IBARAKI PREF
 LATITUDE 36° 3.6' N
 LONGITUDE 139° 55.4' E
 DEPTH 51.3KM
 JMA MAGNITUDE 4.3

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	22.0	22.8	7.4	26.8

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1233

STATION : HITACHINAKA-F

EARTHQUAKE DATA

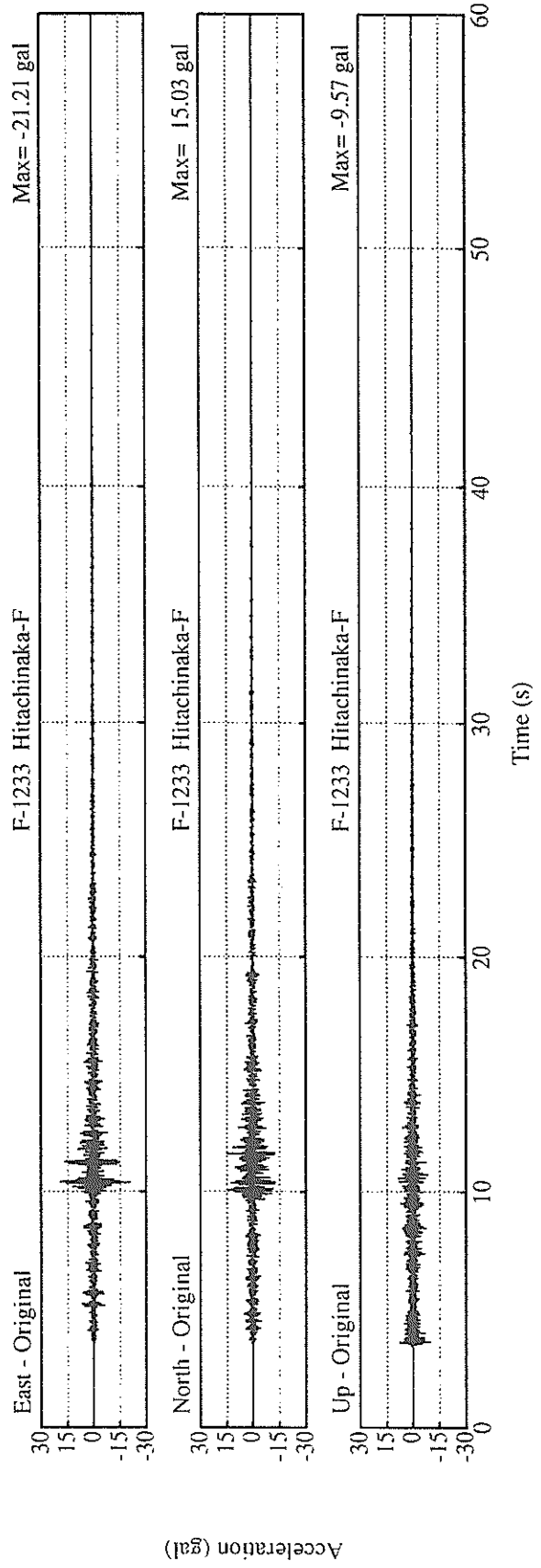
 DATE AND TIME 14:16 NOV. 8, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NORTHERN IBARAKI PREF
 LATITUDE 36° 27.6' N
 LONGITUDE 140° 36.9' E
 DEPTH 57.2KM
 JMA MAGNITUDE 3.9

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
15.0	21.2	9.6	22.3

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1234

STATION : HITACHINAKA-F

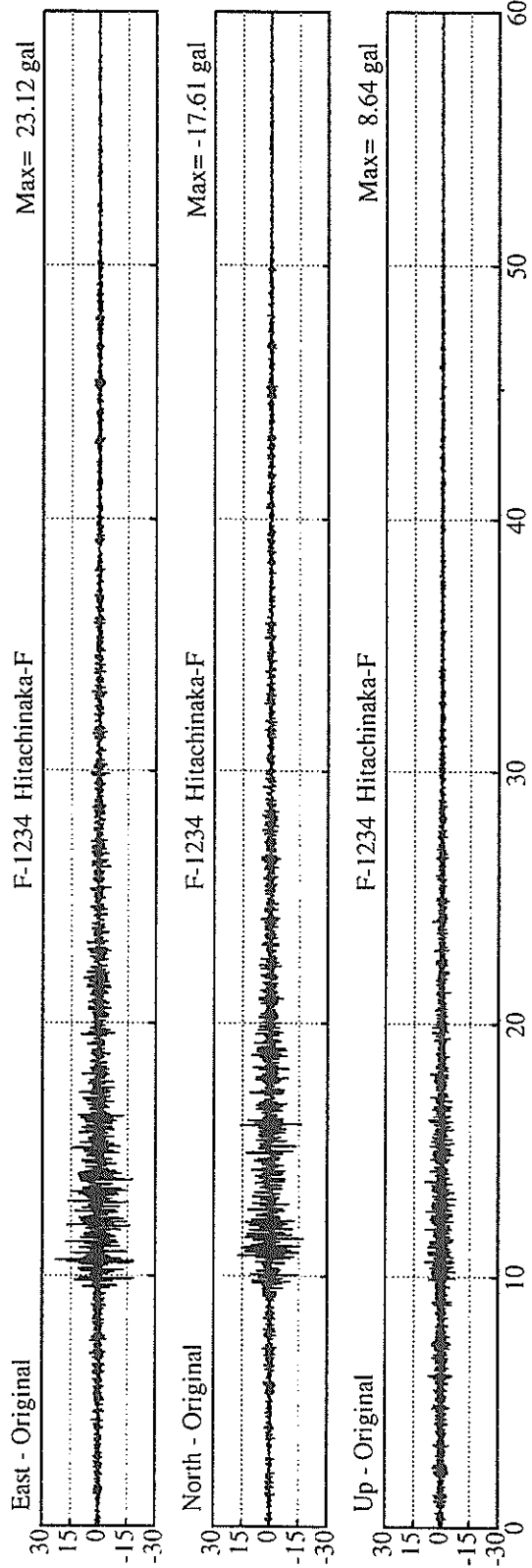
EARTHQUAKE DATA

 DATE AND TIME 13:42 NOV.15,1997
 LOCATION OF HYPOCENTER E OFF FUKUSHIMA PREF
 EPICENTRAL REGION 36° 52.4' N
 LATITUDE 141° 31.1' E
 LONGITUDE 64.0KM
 DEPTH 4.9
 JMA MAGNITUDE 4.9

PEAK VALUES OF COMPONENTS

PEAK VALUES OF COMPONENTS			
N S	E W	U D	HORIZONTAL*
17.6	23.1	8.6	23.1
ORIGINAL ACCELERATION (GAL)			

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1215

STATION : KUSHIRO-G

EARTHQUAKE DATA

 DATE AND TIME 16: 5 NOV.15,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NEMURO REGION
 LATITUDE 43° 38.8' N
 LONGITUDE 145° 5.3' E
 DEPTH 153.1KM
 JMA MAGNITUDE 6.1

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.658	0.689	1.373	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.658 0.689 1.373

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT 19.1 37.0 7.1 37.3
 ORIGINAL 28.1 53.9 12.5 54.3
 CORRECTED 27.9 53.9 12.9 54.4

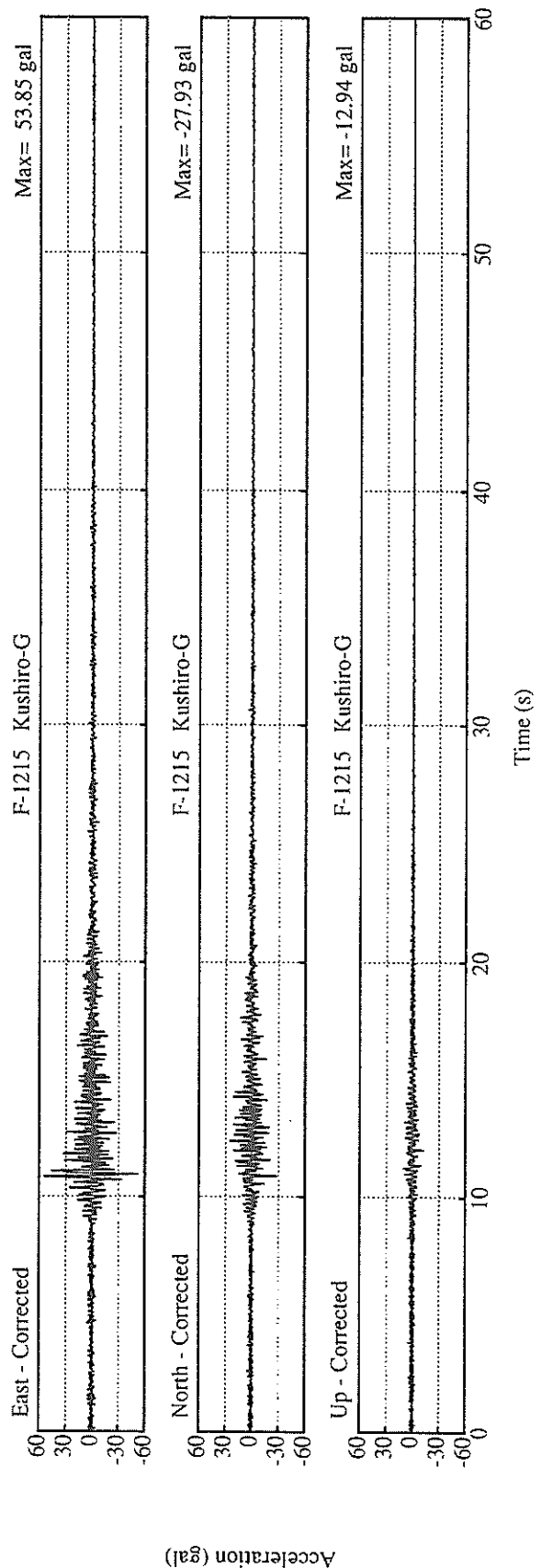
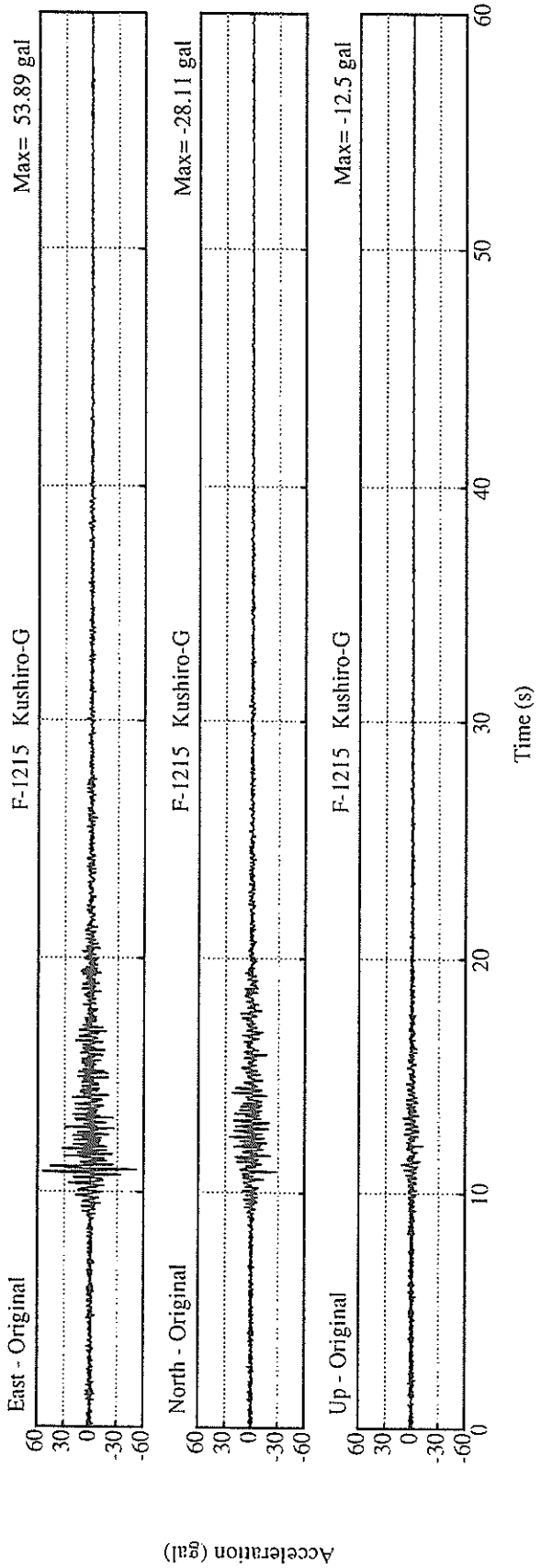
MAXIMUM VELOCITY (CM/SEC)

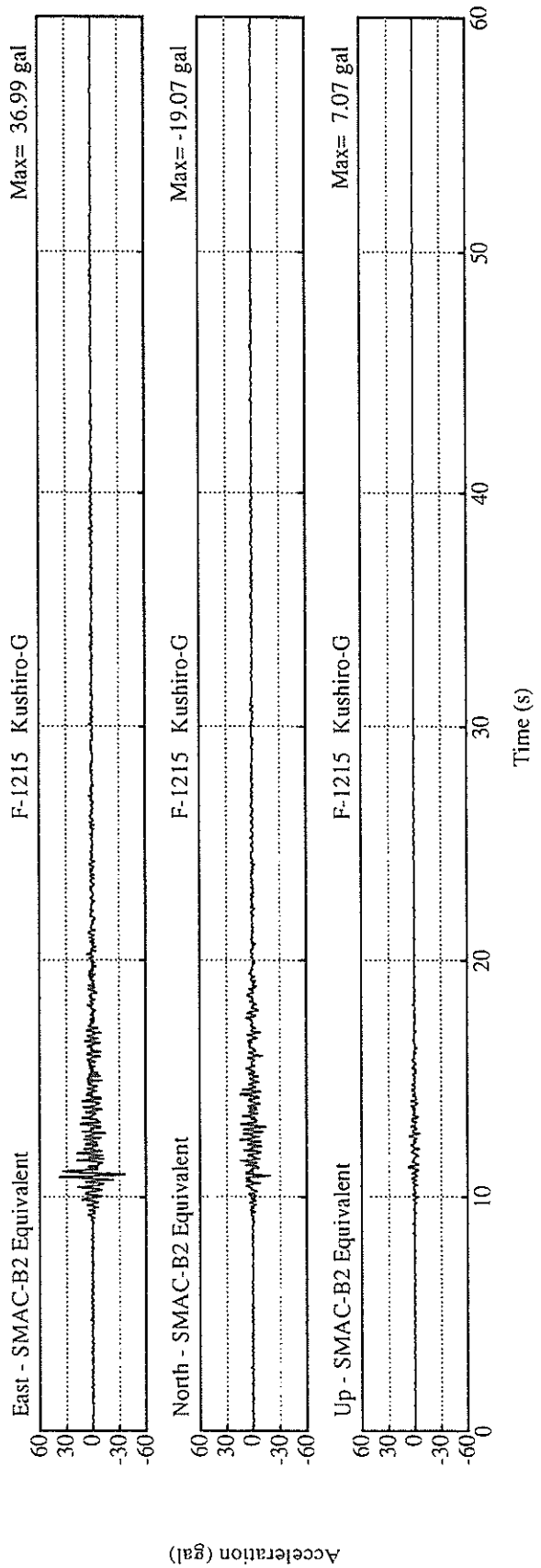
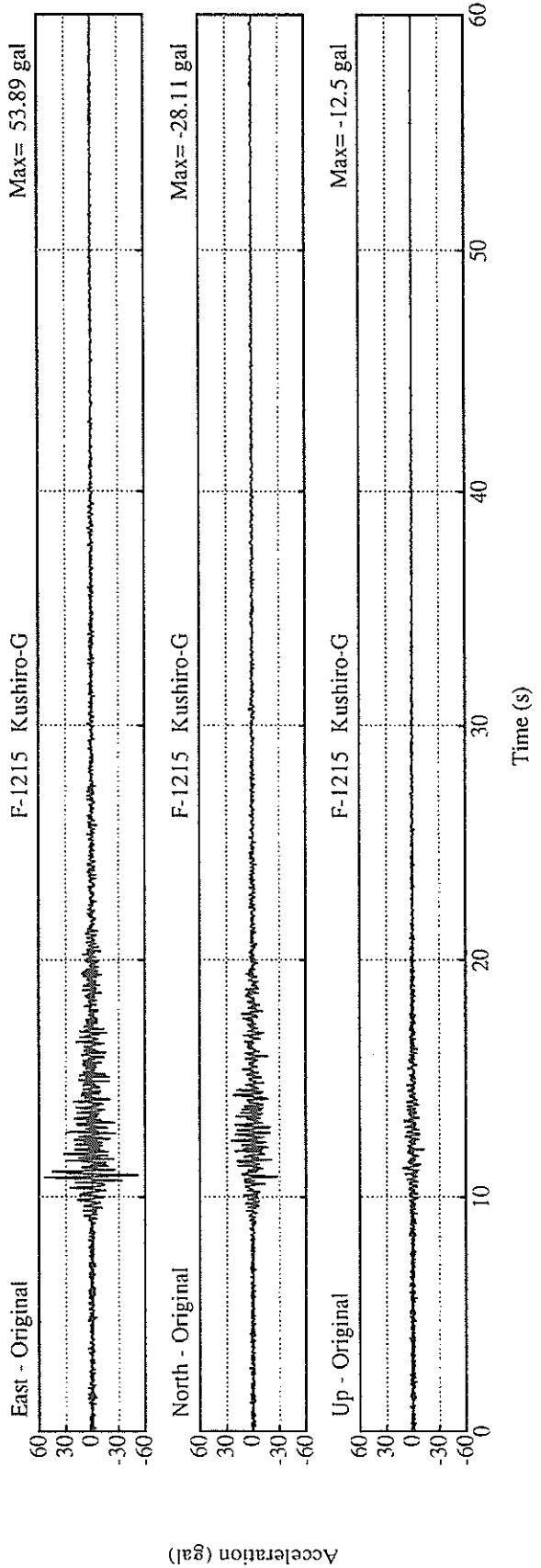
FIXED FILTER 1.05 2.08 0.40 2.08
 VARIABLE FILTER 0.90 1.96 0.34 1.99

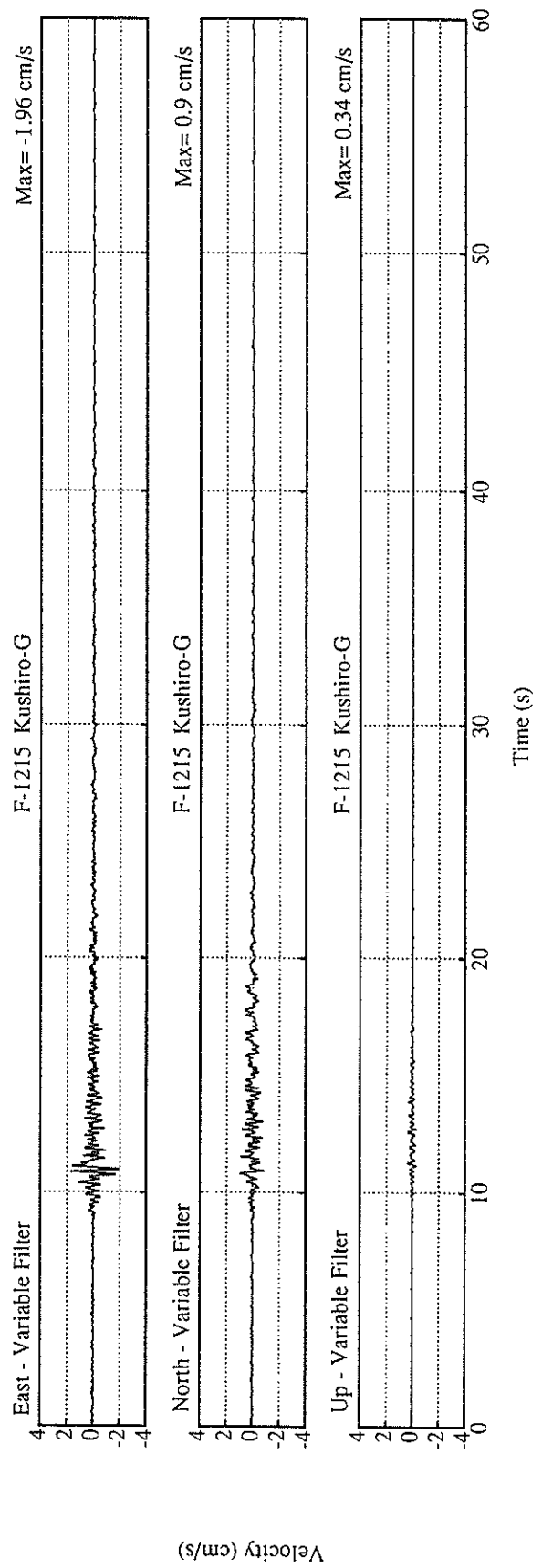
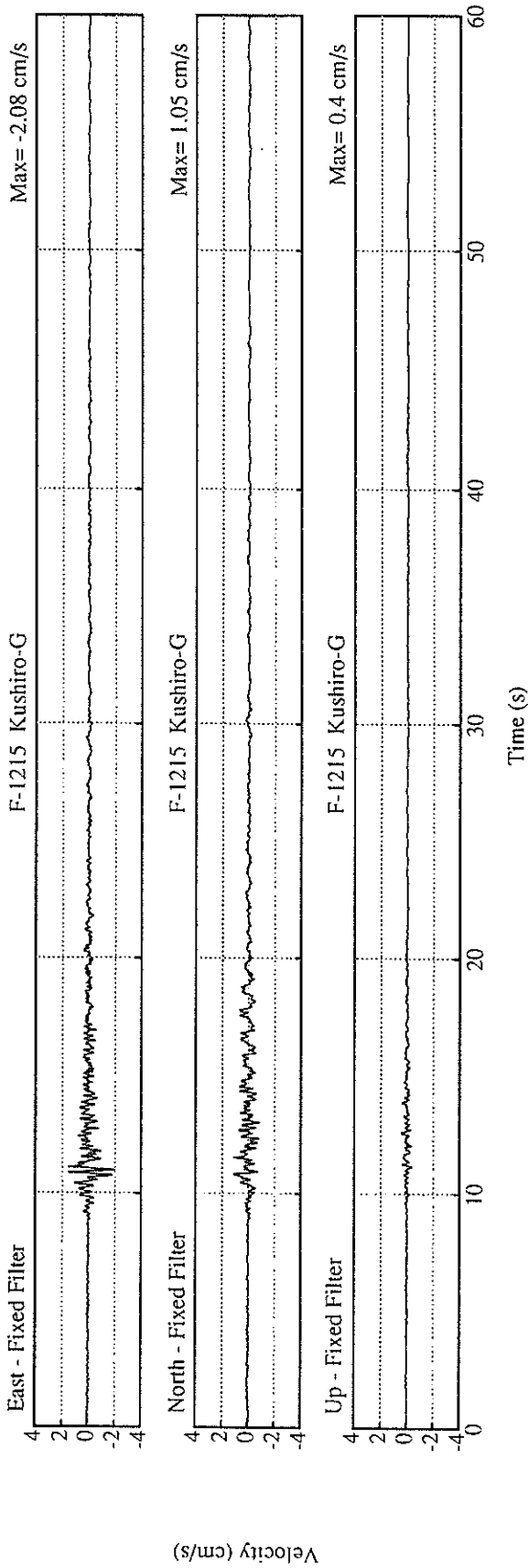
MAXIMUM DISPLACEMENT (CM)

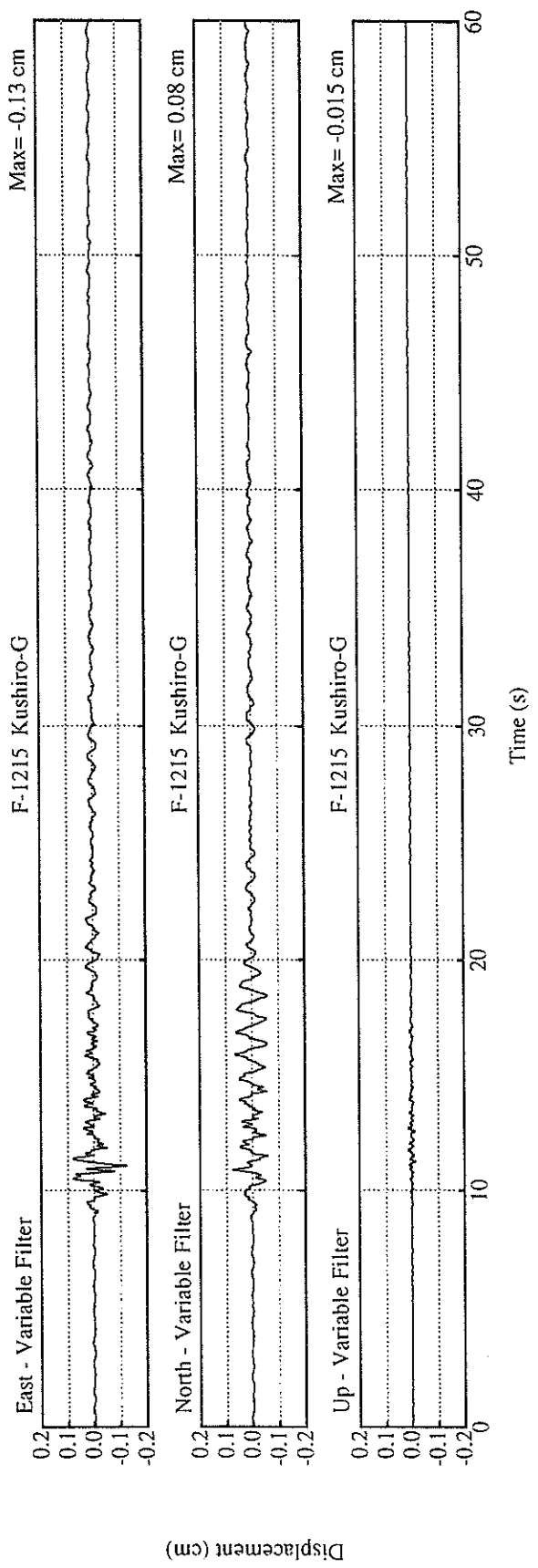
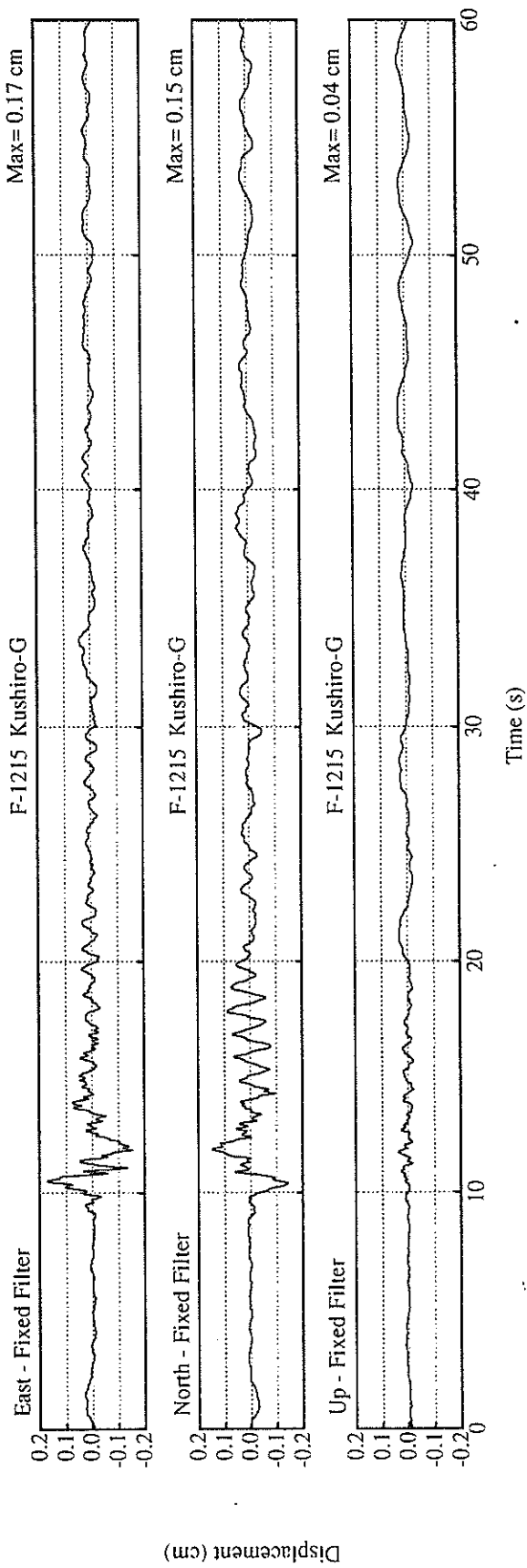
FIXED FILTER 0.15 0.17 0.04 0.21
 VARIABLE FILTER 0.08 0.13 0.01 0.13

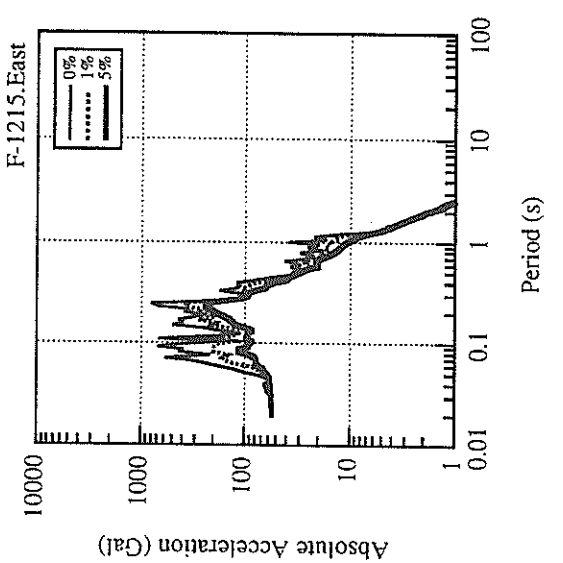
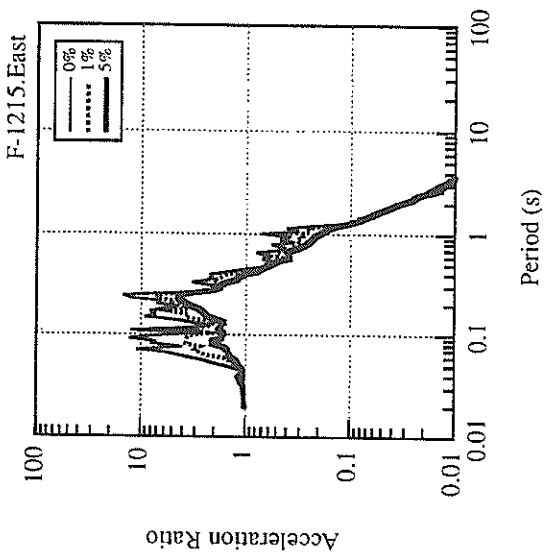
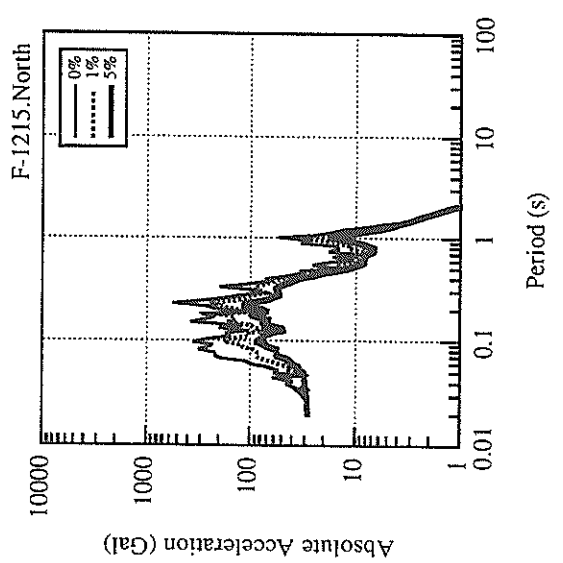
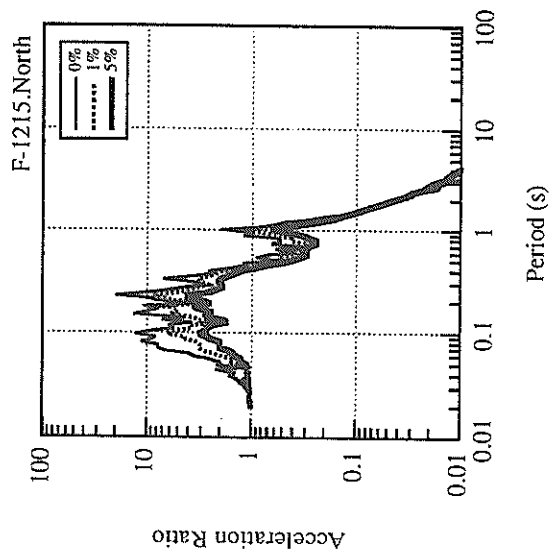
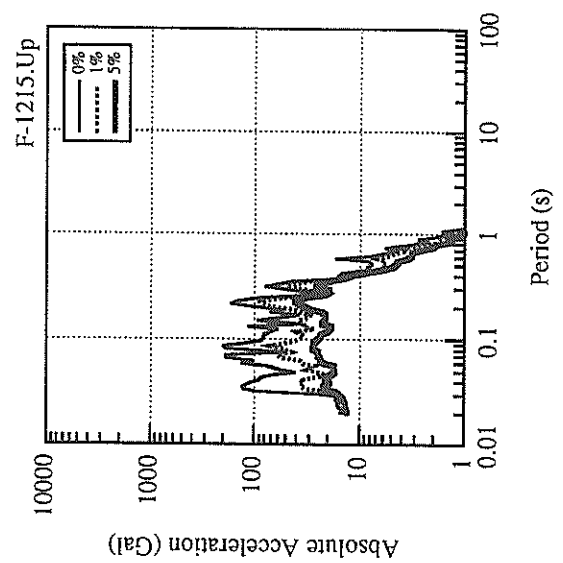
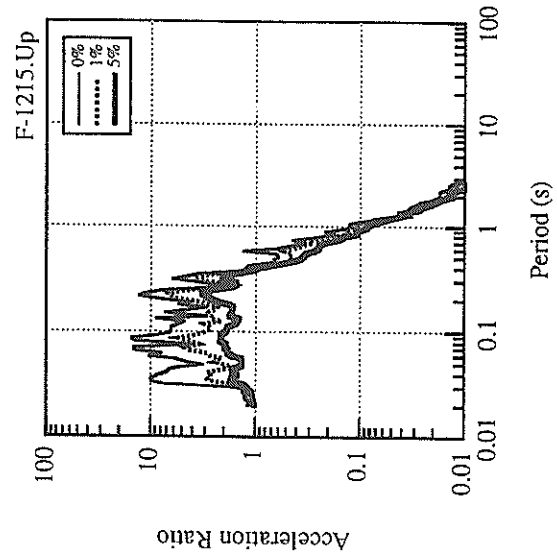
* RESULTANT OF HORIZONTAL COMPONENTS

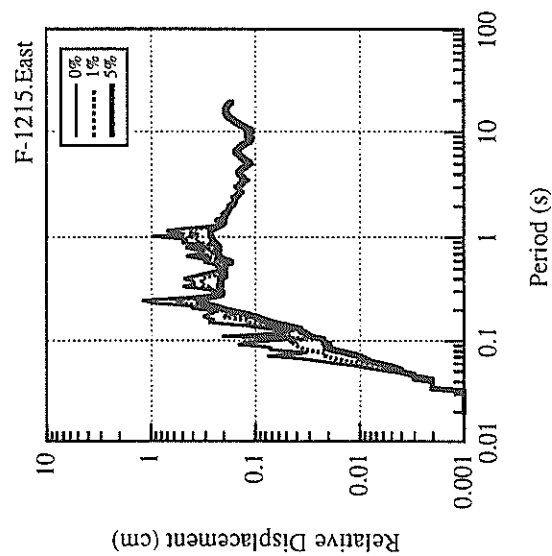
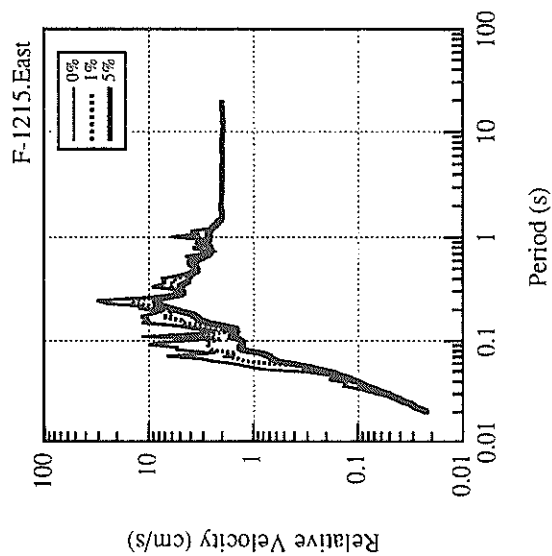
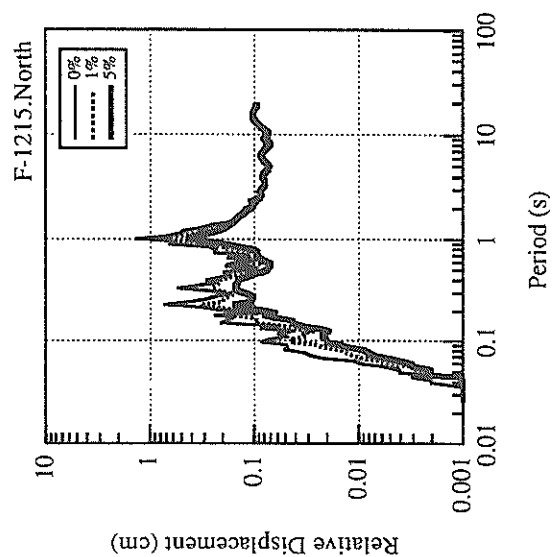
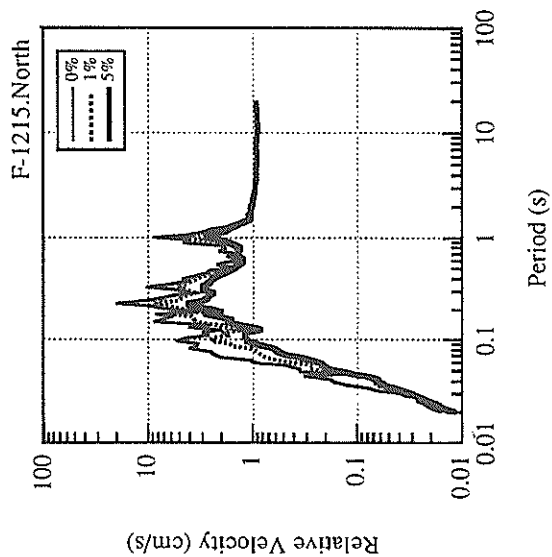
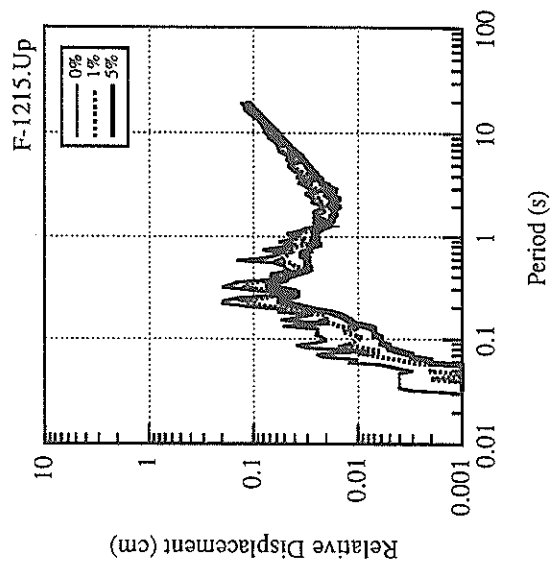
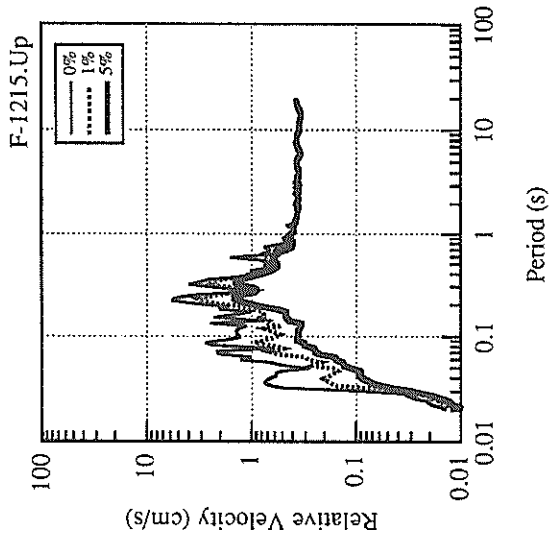


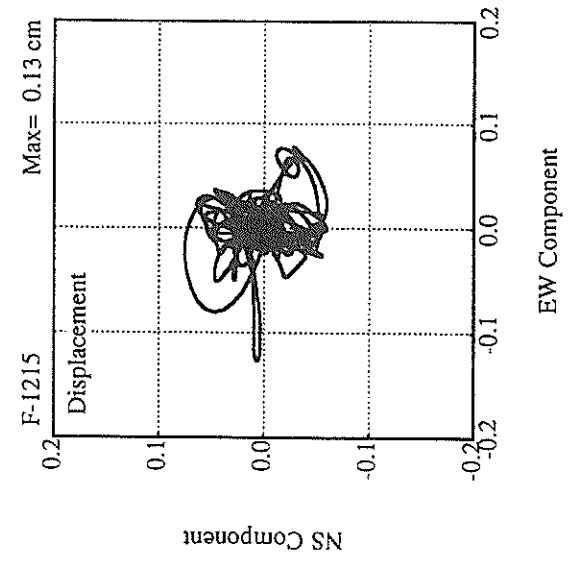
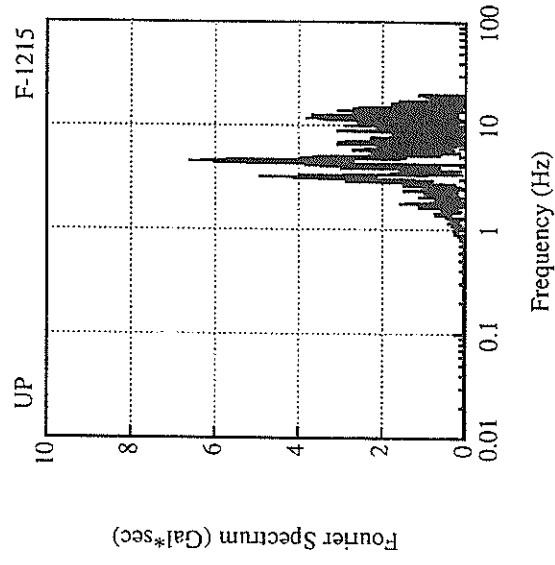
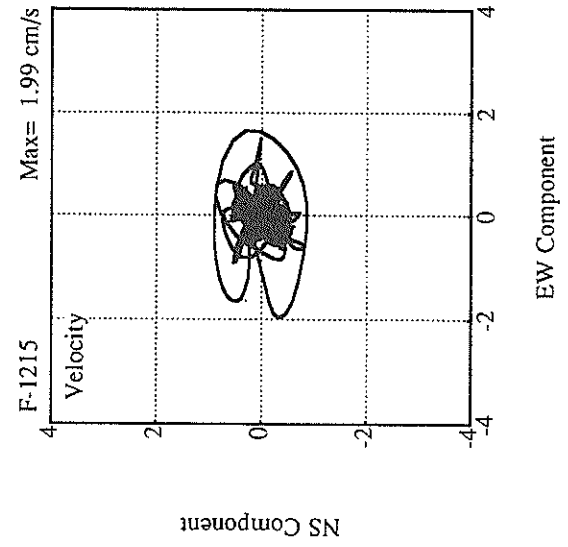
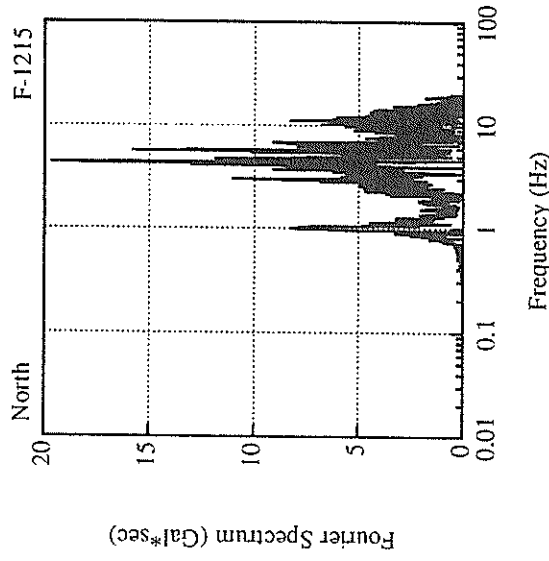
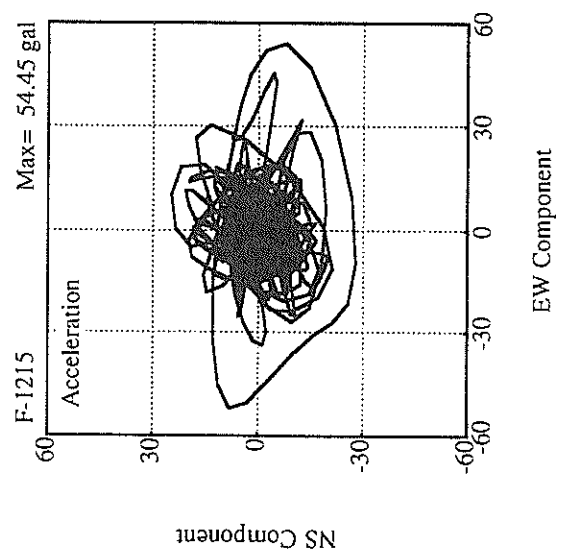
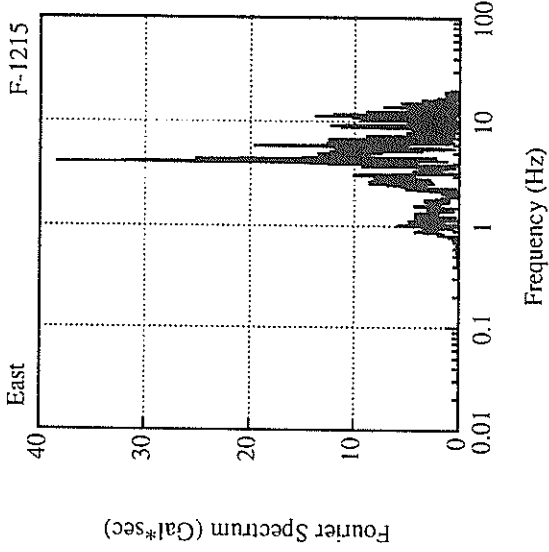












RECORD NUMBER : F-1221

STATION : TOKACHI-G

EARTHQUAKE DATA

 DATE AND TIME 16: 5 NOV.15,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION NEMURO REGION
 LATITUDE 43° 38.8' N
 LONGITUDE 145° 5.3' E
 DEPTH 153.1KM
 JMA MAGNITUDE 6.1

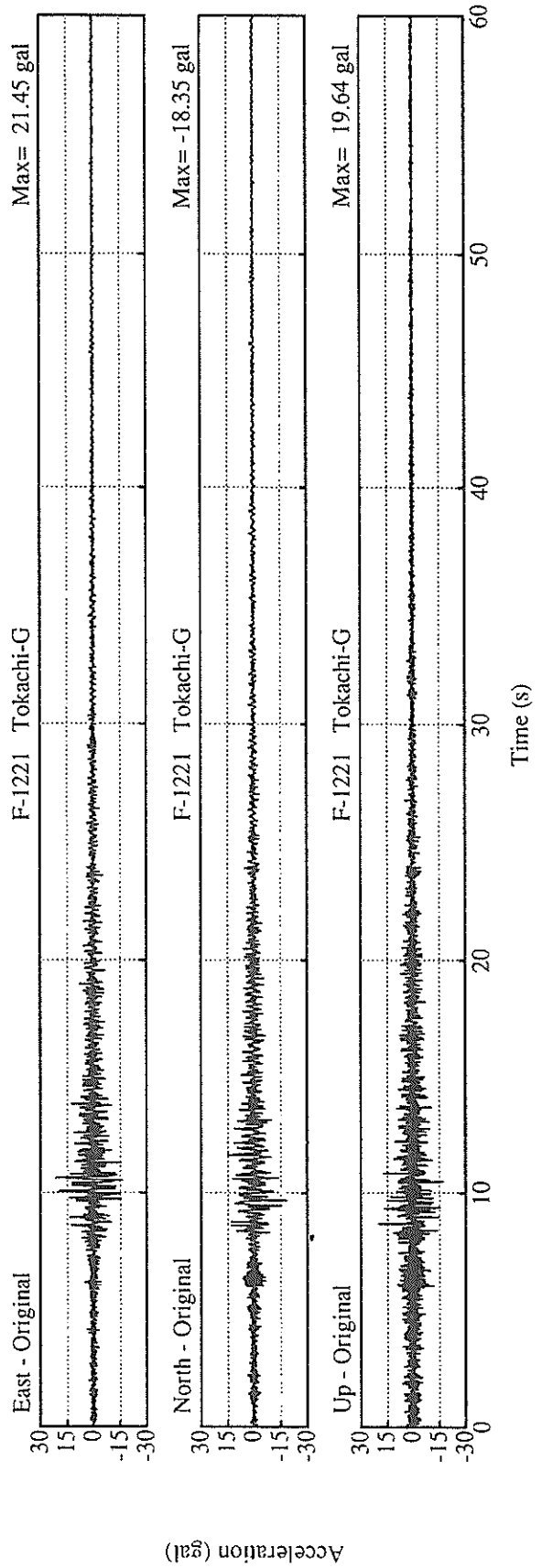
PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*

18.3	21.4	19.6	24.0

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1226

STATION : AKITA-GB

EARTHQUAKE DATA

 DATE AND TIME 12:50 NOV.23,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION W OFF AKITA PREF
 LATITUDE 39 58.5' N
 LONGITUDE 138 50.8' E
 DEPTH 40.8KM
 JMA MAGNITUDE 5.6

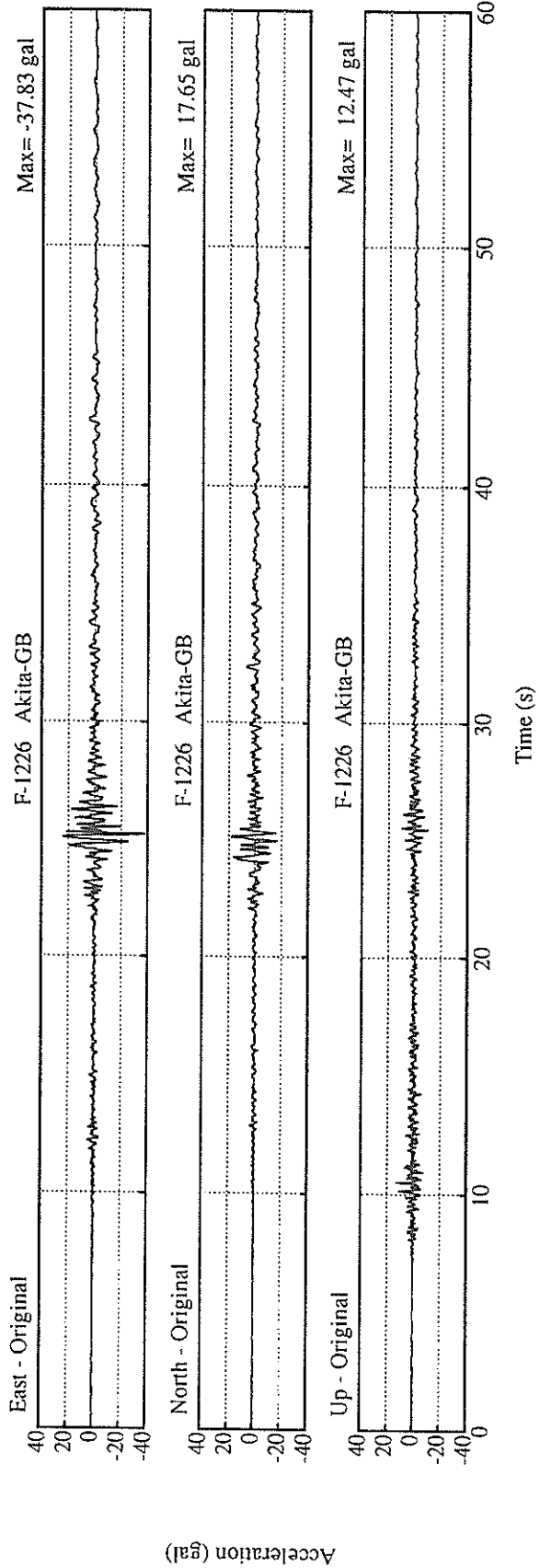
PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*

17.6	37.8	12.5	37.9

ORIGINAL ACCELERATION (GAL)

* RESULTANT QF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1227

STATION : AKITA-G

EARTHQUAKE DATA

 DATE AND TIME 12:50 NOV.23,1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION W OFF AKITA PREF
 LATITUDE 39°58.5' N
 LONGITUDE 138°50.8' E
 DEPTH 40.8KM
 JMA MAGNITUDE 5.6

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
FC (HZ)	0.366	0.304	0.567	

PARAMETER OF THE VARIABLE FILTER

FC (HZ) 0.366 0.304 0.567

MAXIMUM ACCELERATION (GAL)

SMAC-B2 EQUIVALENT	34.0	90.4	7.7	90.6
ORIGINAL	47.4	137.3	15.1	137.3
CORRECTED	47.6	136.8	14.5	136.8

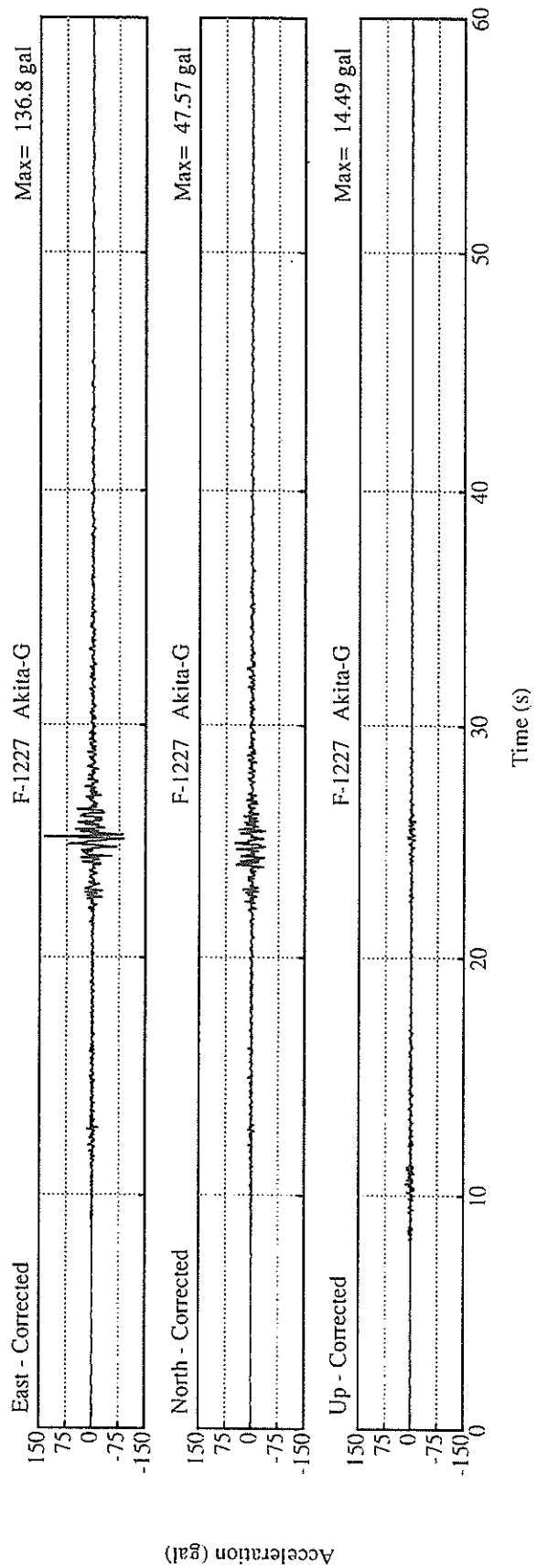
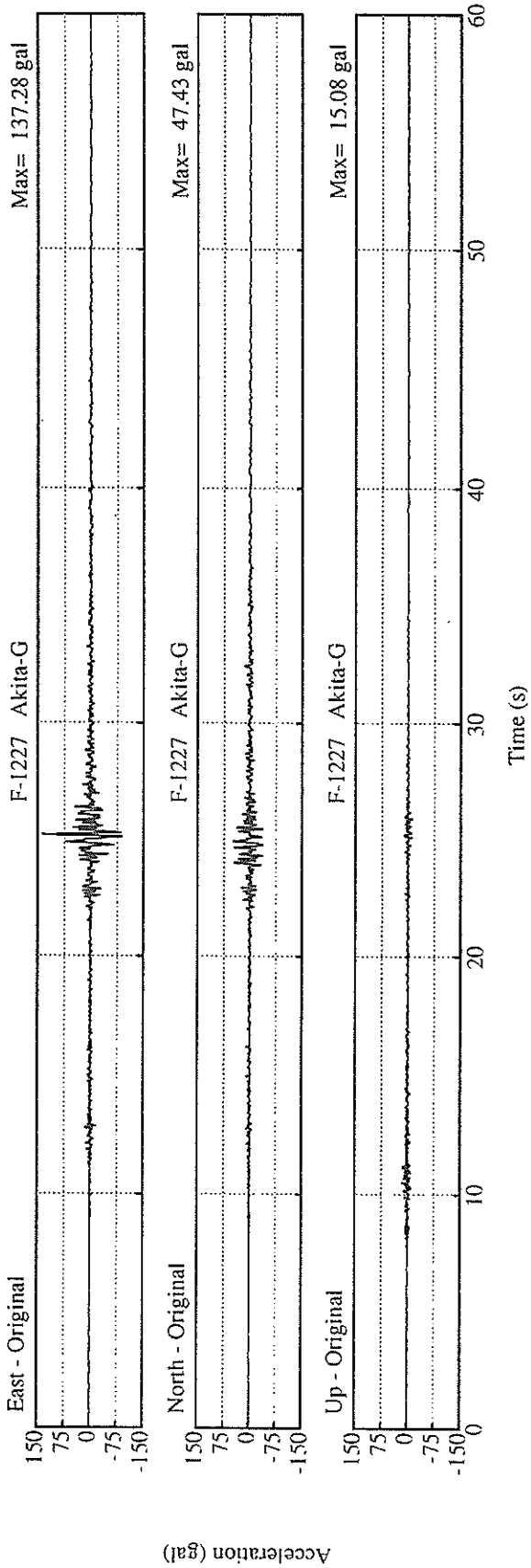
MAXIMUM VELOCITY (CM/SEC)

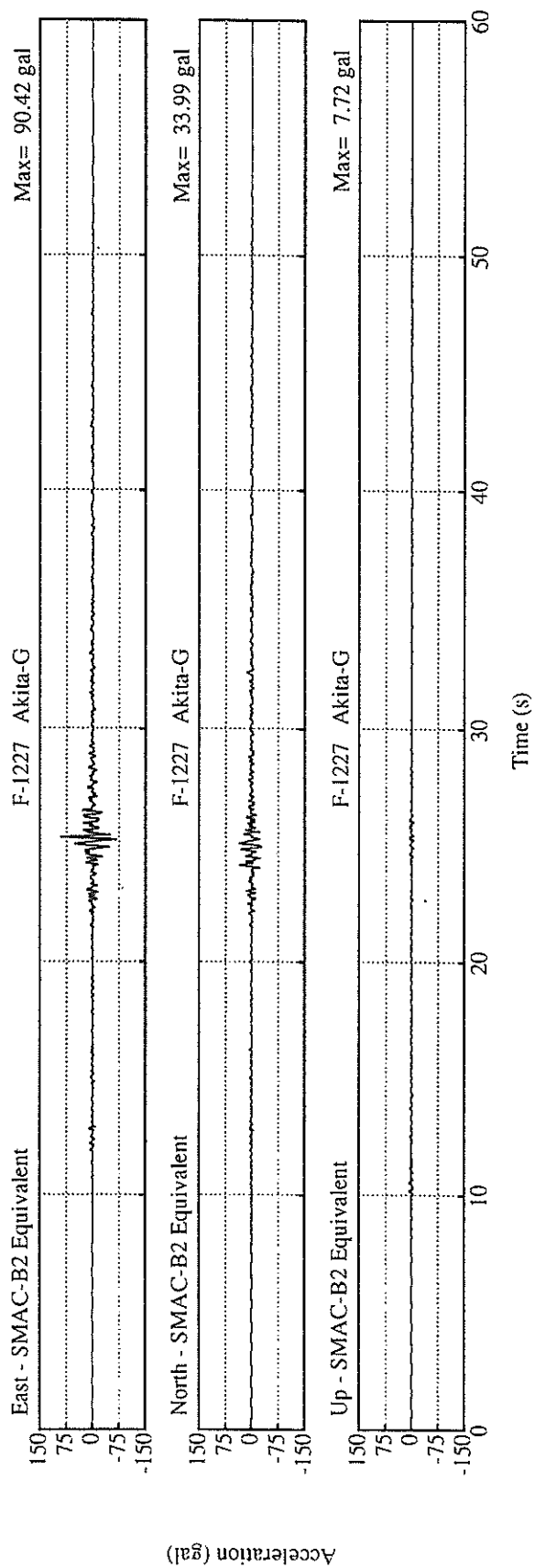
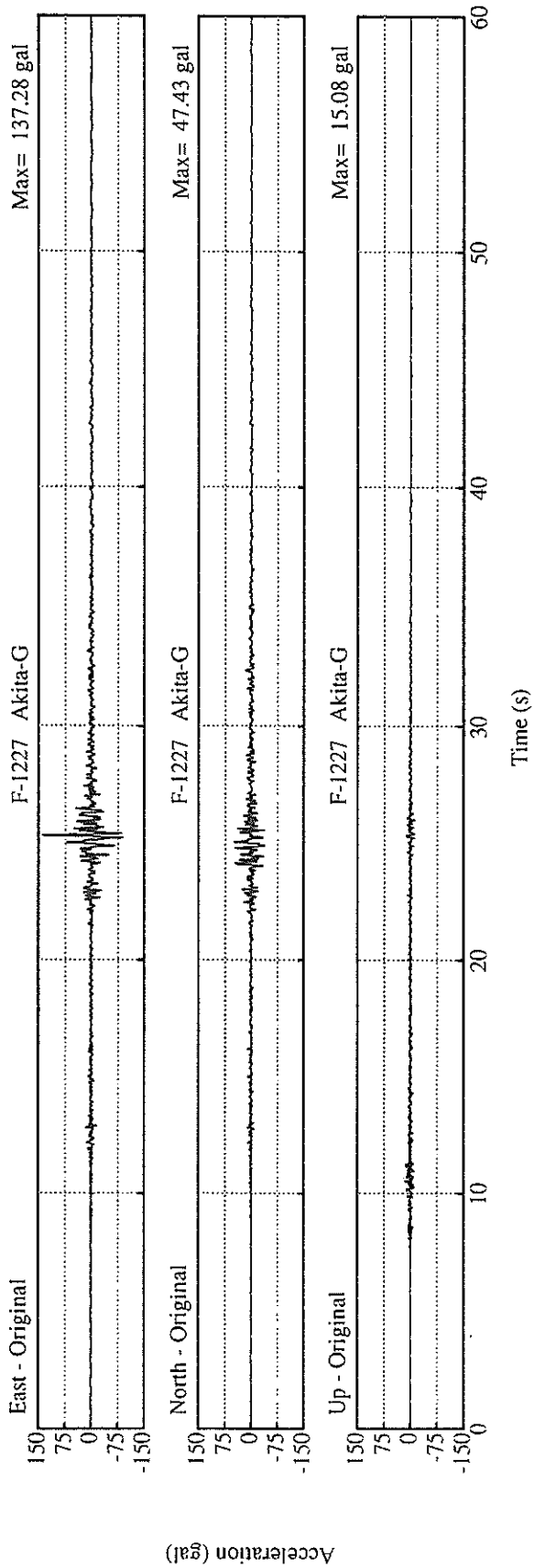
FIXED FILTER	2.25	4.06	0.43	4.10
VARIABLE FILTER	2.33	4.10	0.40	4.11

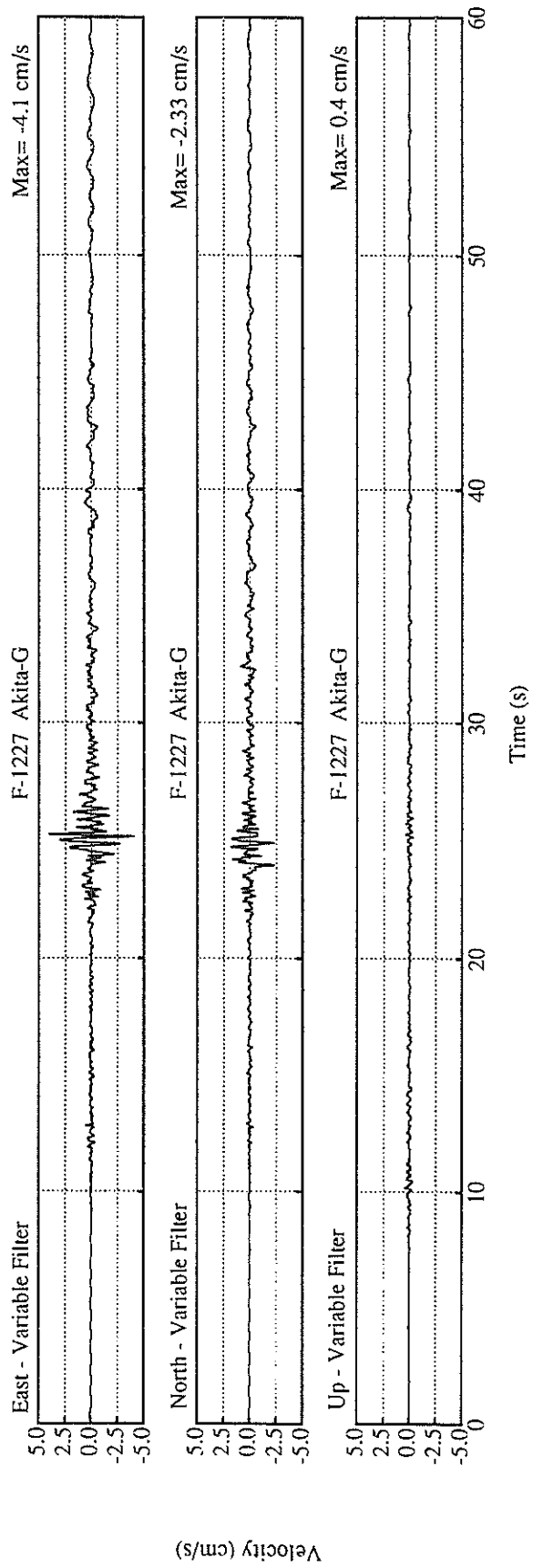
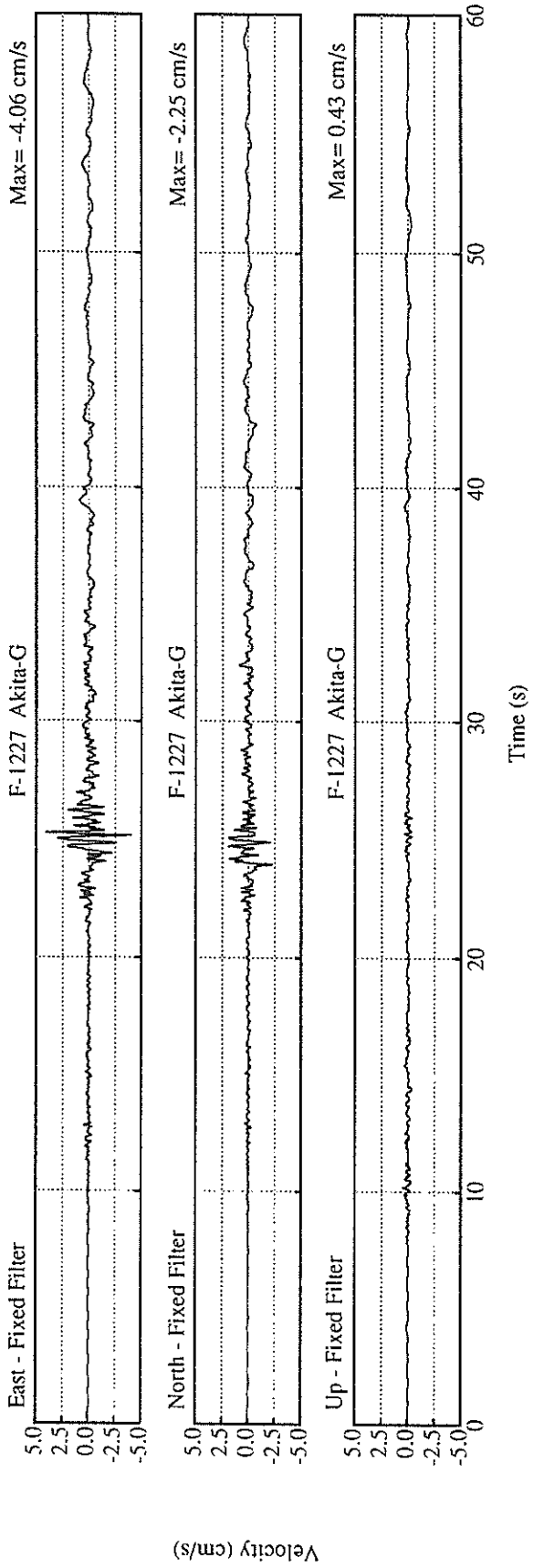
MAXIMUM DISPLACEMENT (CM)

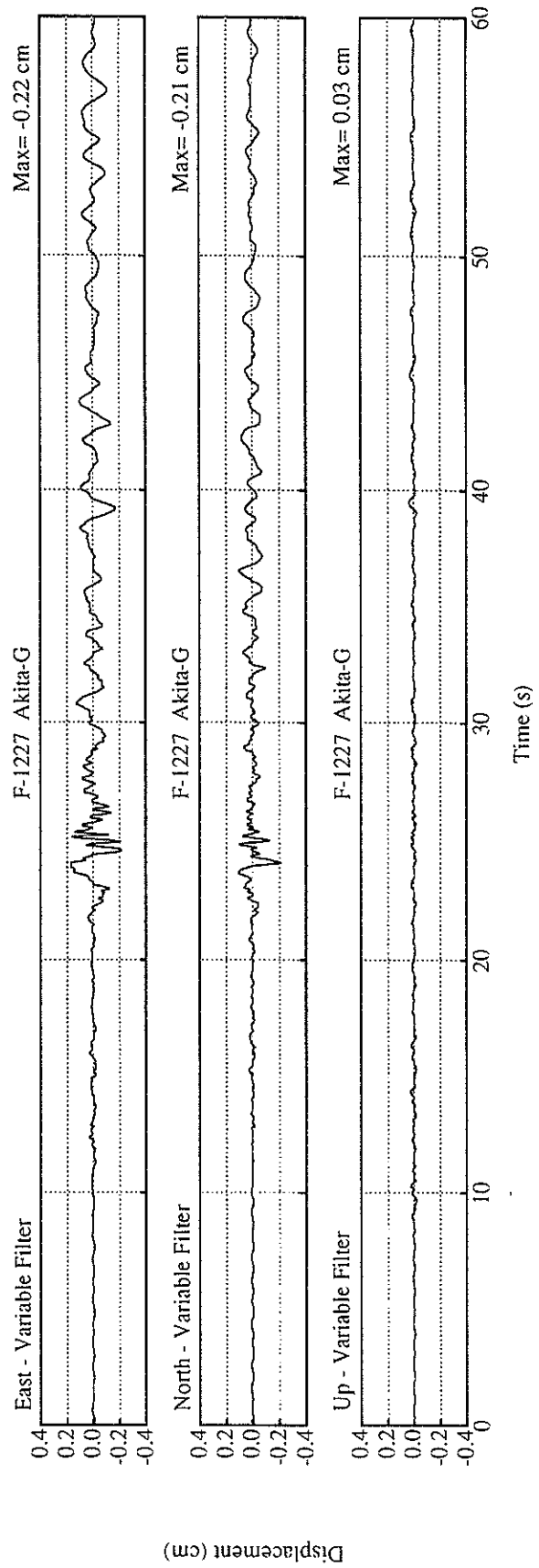
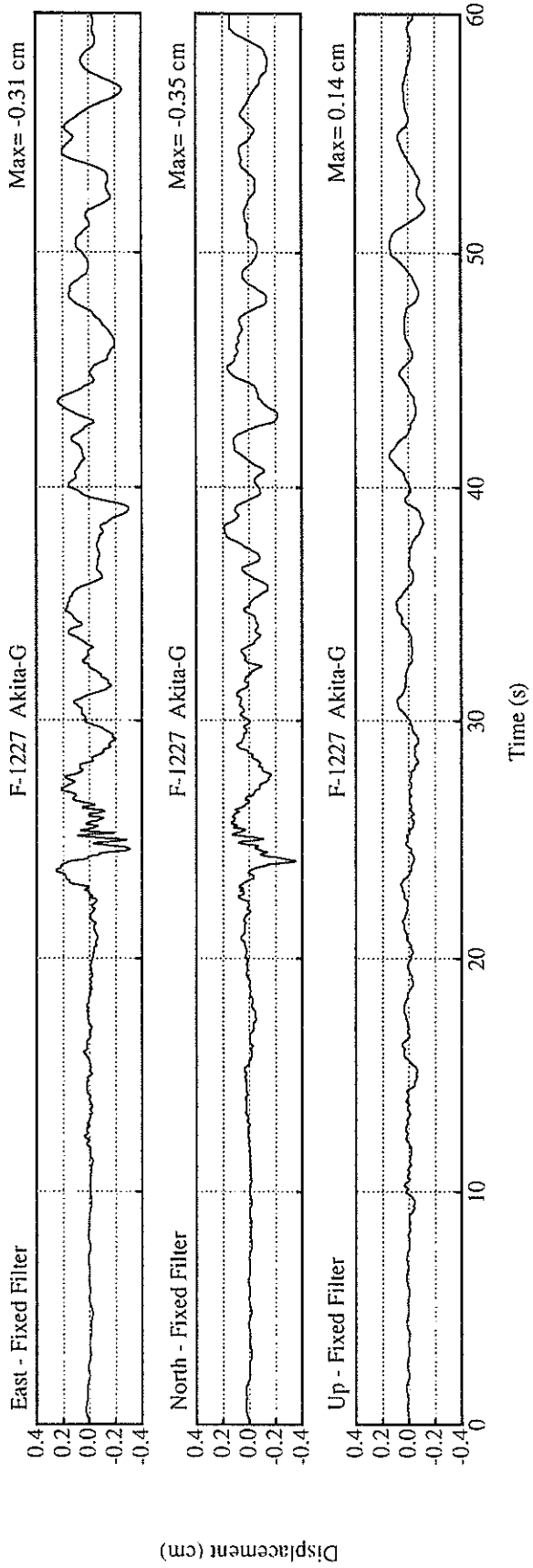
FIXED FILTER	0.35	0.31	0.14	0.38
VARIABLE FILTER	0.21	0.22	0.03	0.26

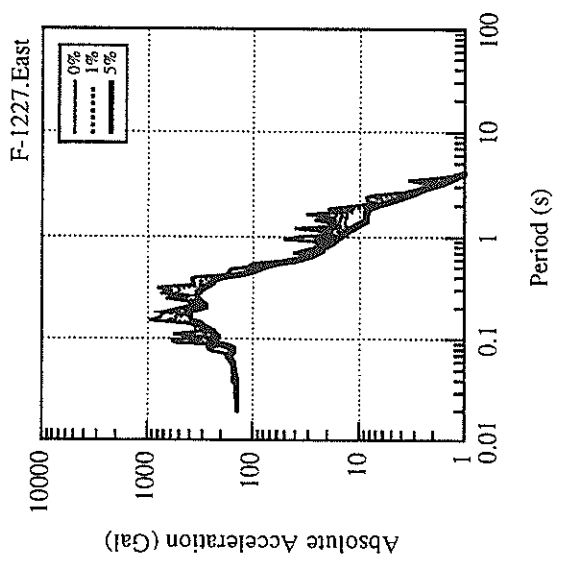
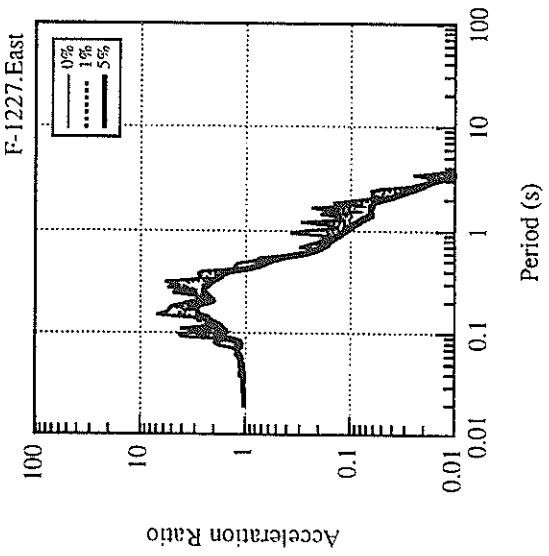
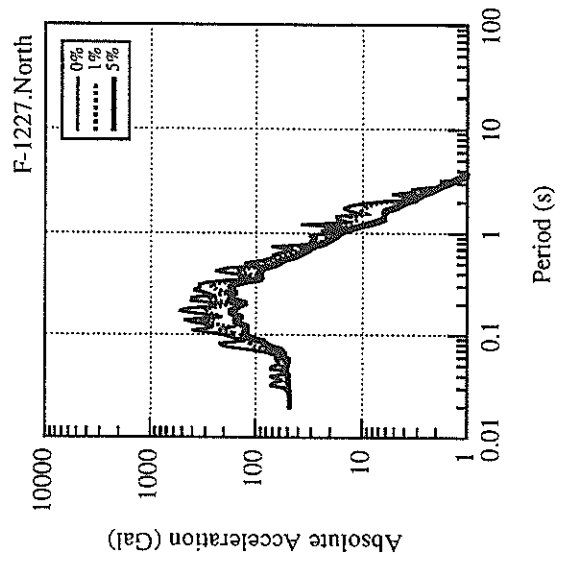
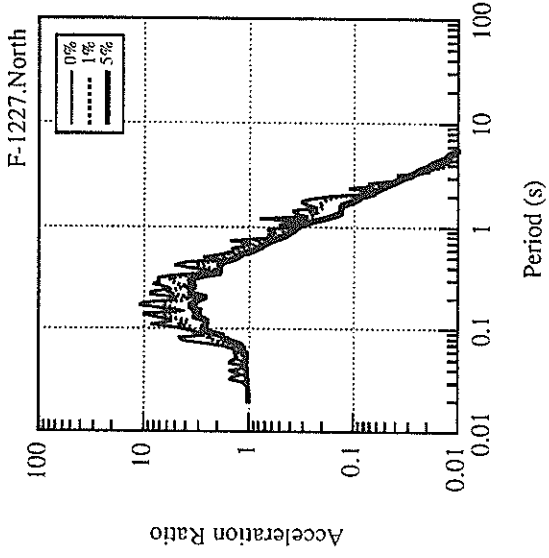
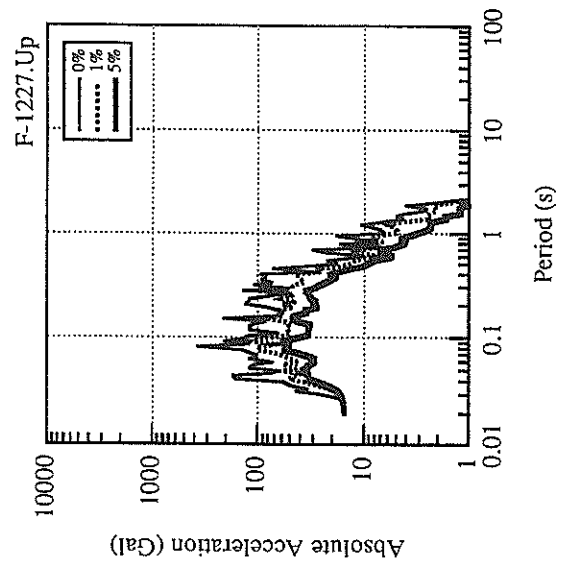
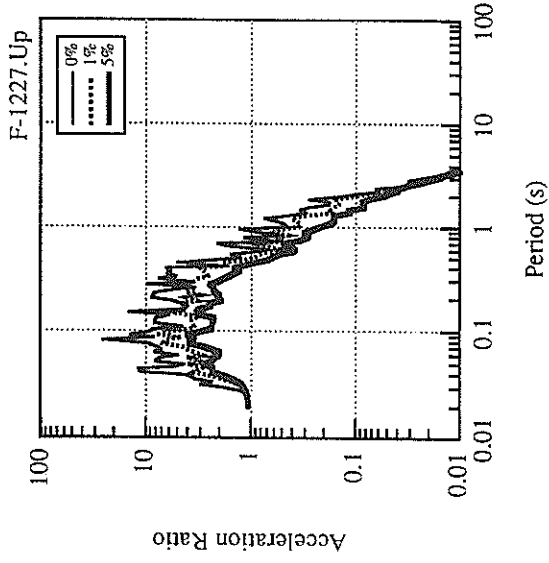
* RESULTANT OF HORIZONTAL COMPONENTS

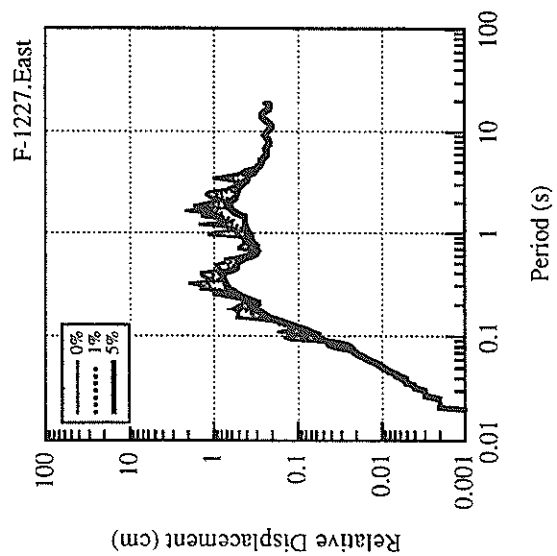
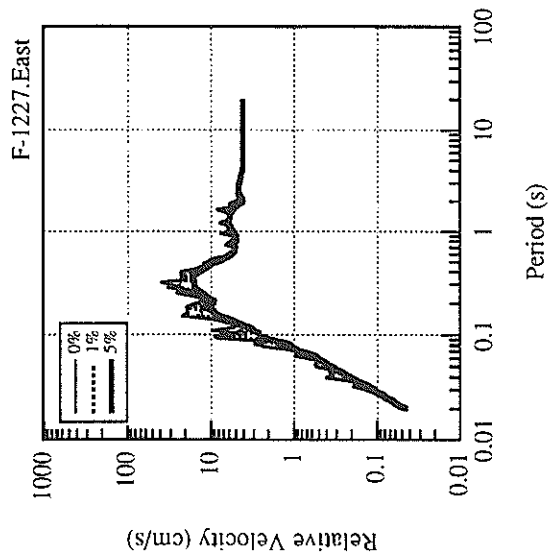
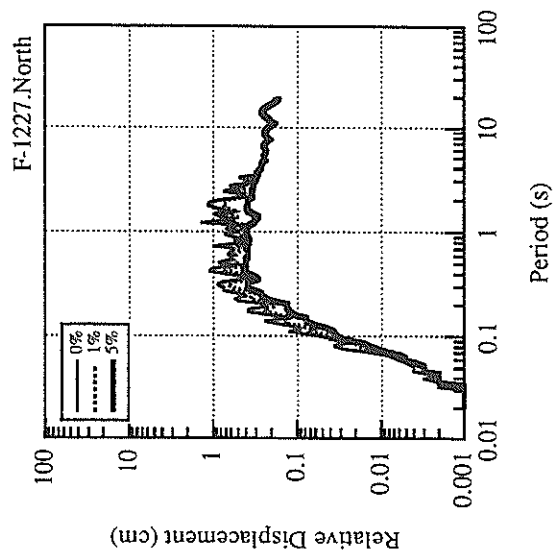
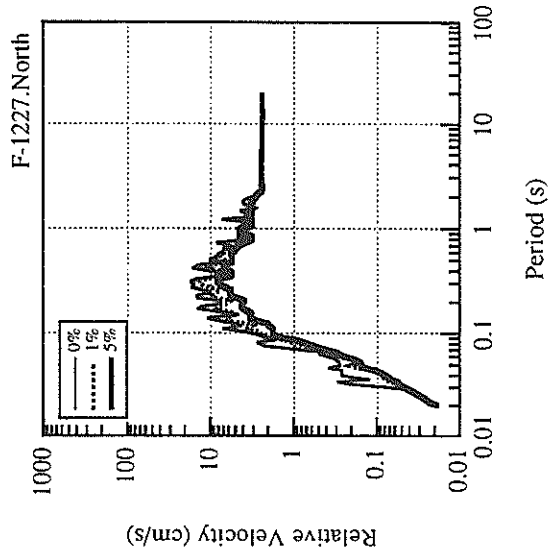
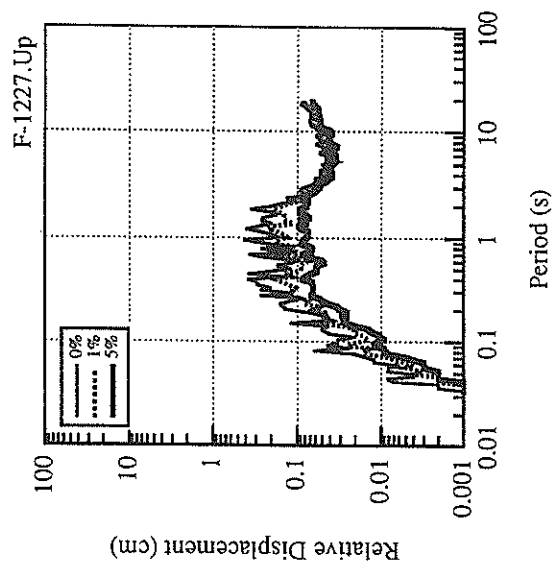
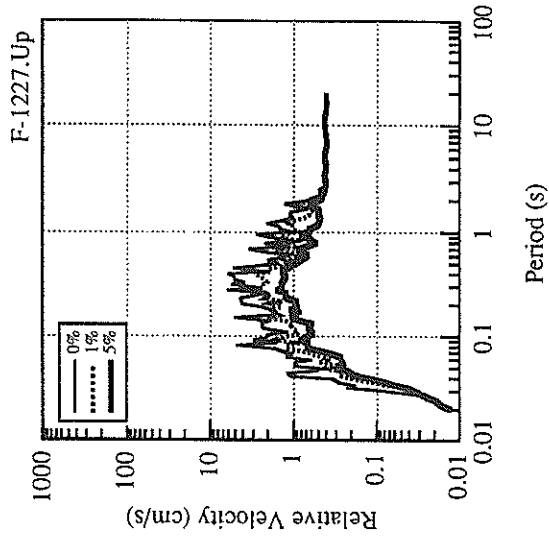


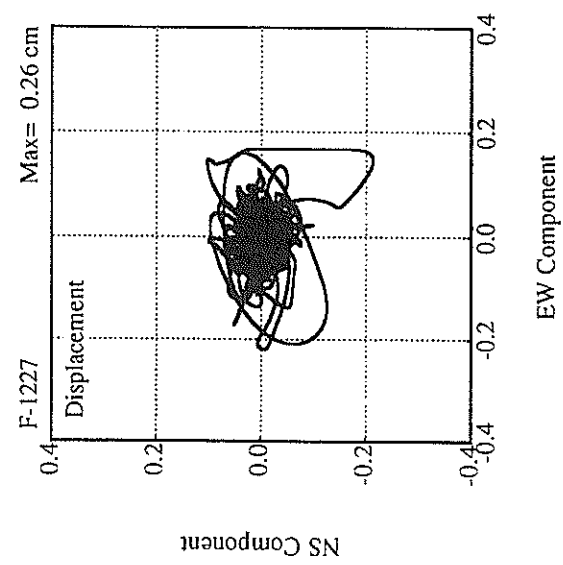
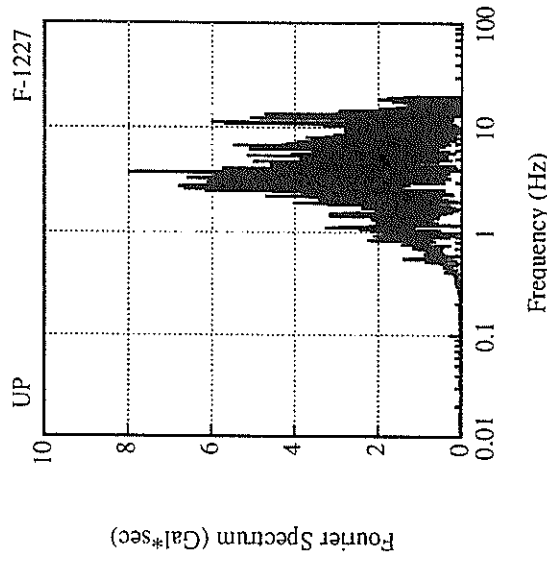
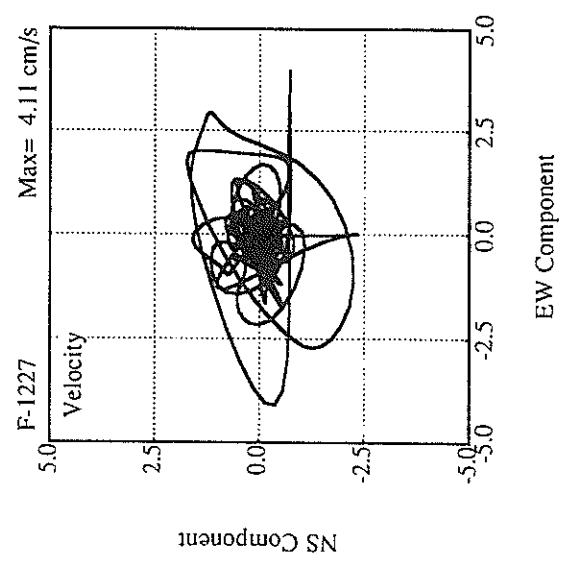
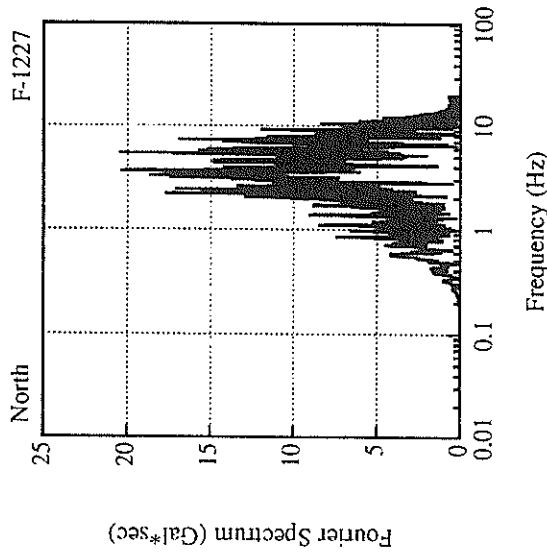
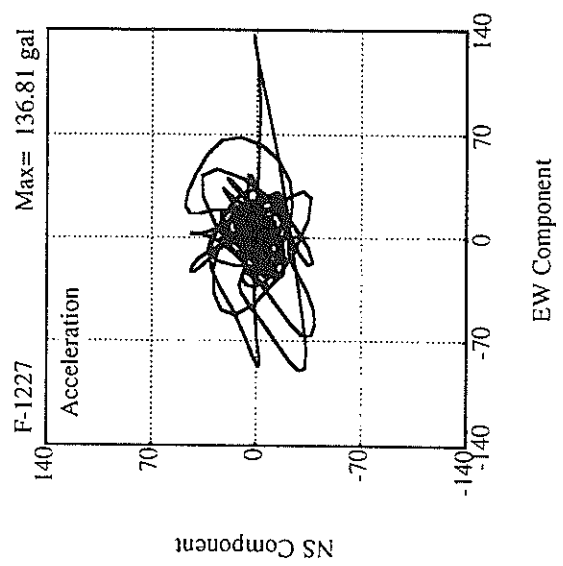
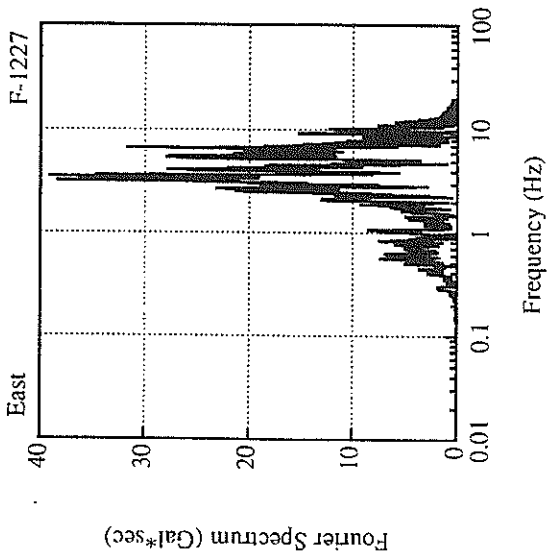












RECORD NUMBER : F-1211

STATION : ONAHAMA-JI-G

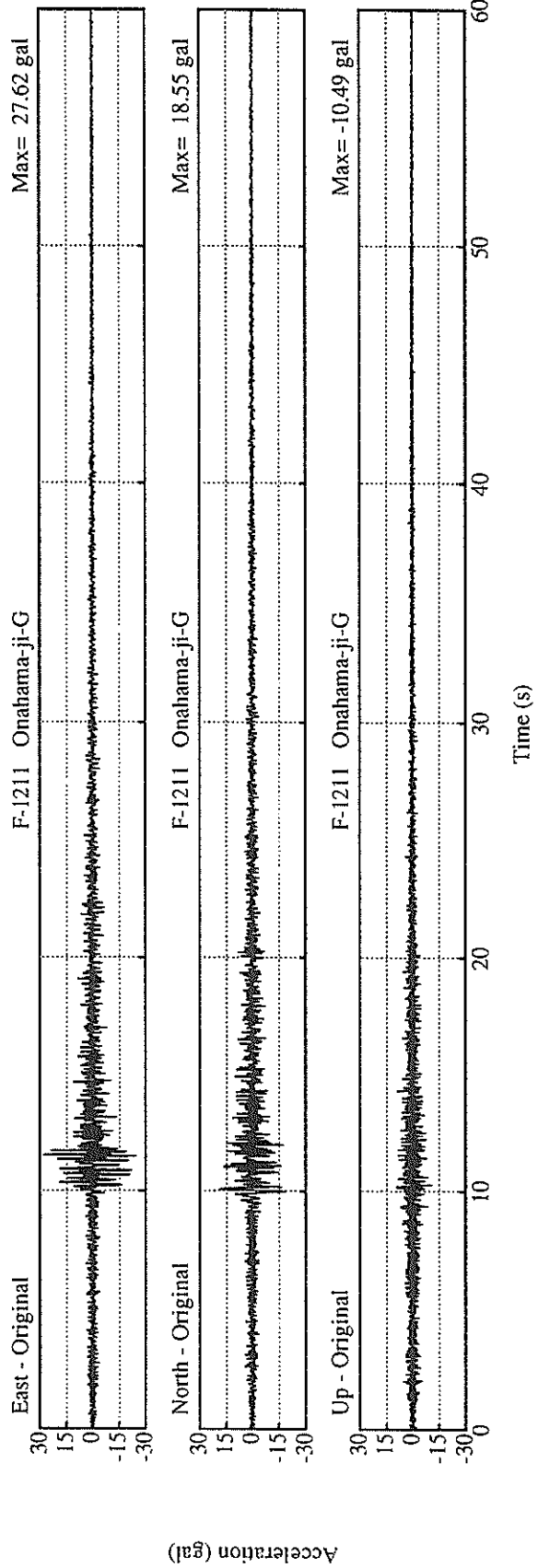
EARTHQUAKE DATA

 DATE AND TIME 12:50 DEC. 7, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF FUKUSHIMA PREF
 LATITUDE 37° 42.9' N
 LONGITUDE 141° 46.7' E
 DEPTH 83.4KM
 JMA MAGNITUDE 5.3

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	18.5	27.6	10.5	27.6

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1237

STATION : HITACHINAKA-F

EARTHQUAKE DATA

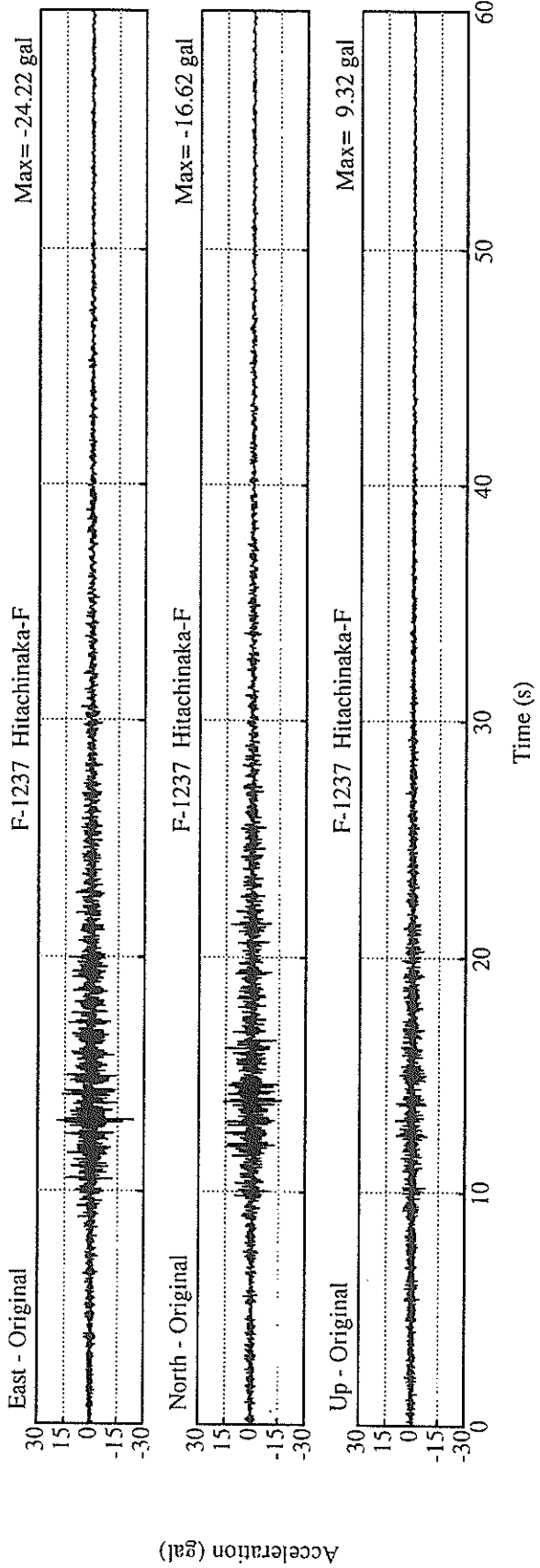
 DATE AND TIME 12:50 DEC. 7, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF FUKUSHIMA PREF
 LATITUDE 37° 42.9' N
 LONGITUDE 141° 46.7' E
 DEPTH 83.4KM
 JMA MAGNITUDE 5.3

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
16.6	24.2	9.3	27.4

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : S-2682

STATION : SOMA-S

EARTHQUAKE DATA

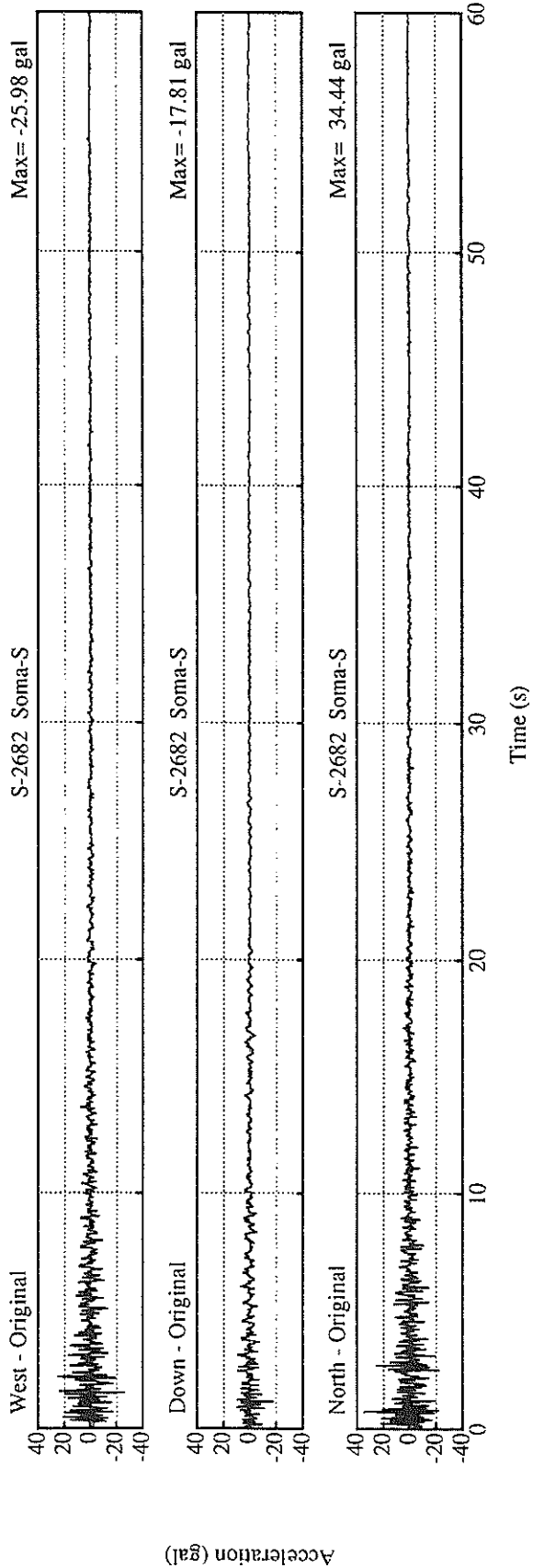
 DATE AND TIME 12:50 DEC. 7, 1997
 LOCATION OF HYPOCENTER
 EPICENTRAL REGION E OFF FUKUSHIMA PREF
 LATITUDE 37° 42.9' N
 LONGITUDE 141° 46.7' E
 DEPTH 83.4KM
 JMA MAGNITUDE 5.3

PEAK VALUES OF COMPONENTS

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N S	E W	U D	HORIZONTAL*		
34.4	26.0	17.8	34.8		

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1299

STATION : HANASAKI-F

EARTHQUAKE DATA

DATE AND TIME : 6: 3 DEC.22,1997

LOCATION OF HYPOCENTER

EPICENTRAL REGION : OFF NEMURO PENINSULA

LATITUDE : 43° 8.4' N

LONGITUDE : 146° 25.1' E

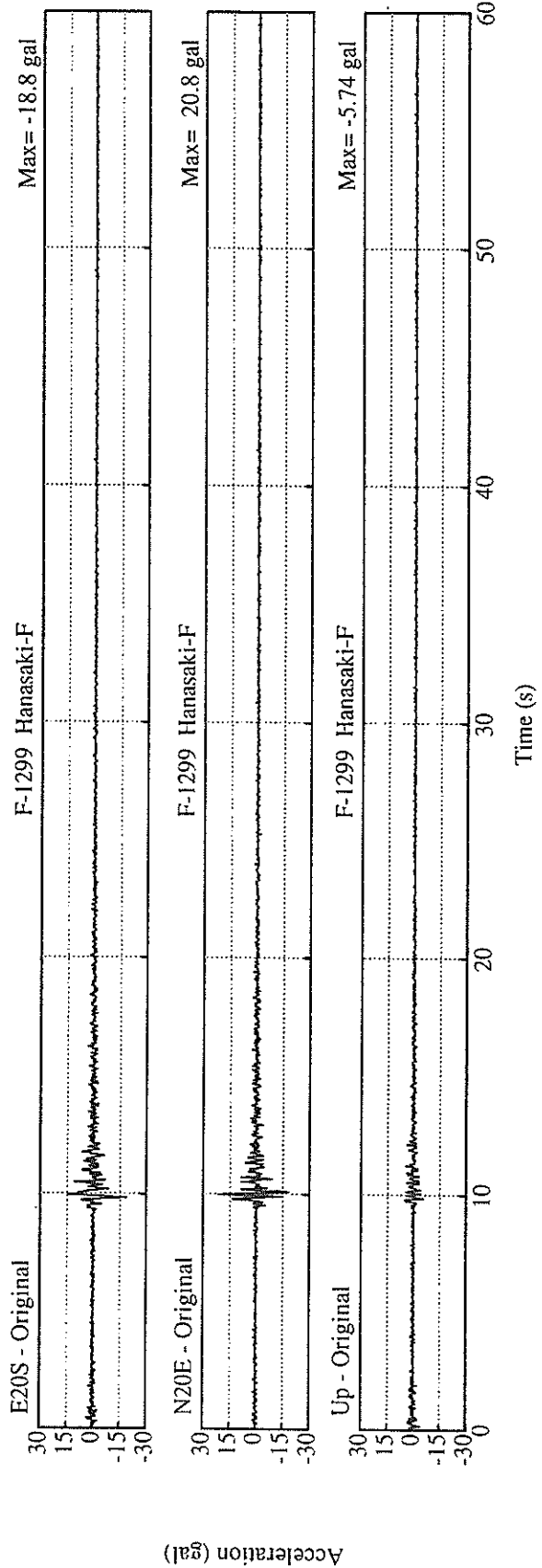
DEPTH : 52.1KM

JMA MAGNITUDE : 5.0

PEAK VALUES OF COMPONENTS

	N S	E W	U D	HORIZONTAL*
ORIGINAL ACCELERATION (GAL)	20.8	18.8	5.7	21.8

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1217

STATION : KUSHIRO-G

EARTHQUAKE DATA

 DATE AND TIME : 4: 8 DEC.23,1997
 LOCATION OF HYPOCENTER : TOKACHI REGION
 EPICENTRAL REGION : 42° 58.7' N
 LATITUDE : 143° 29.3' E
 LONGITUDE : 113.3KM
 DEPTH : 5.1
 JMA MAGNITUDE : 5.1

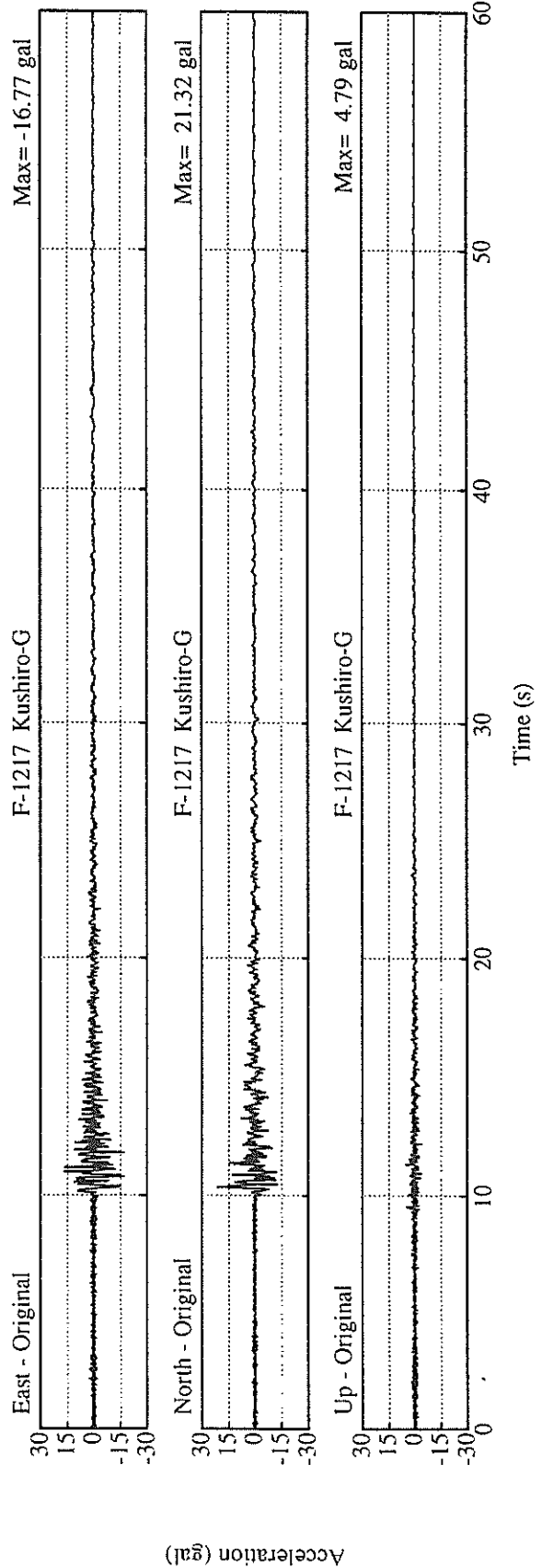
PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*

21.3	16.8	4.8	25.0

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



RECORD NUMBER : F-1279

STATION : HITACHINAKA-F

EARTHQUAKE DATA

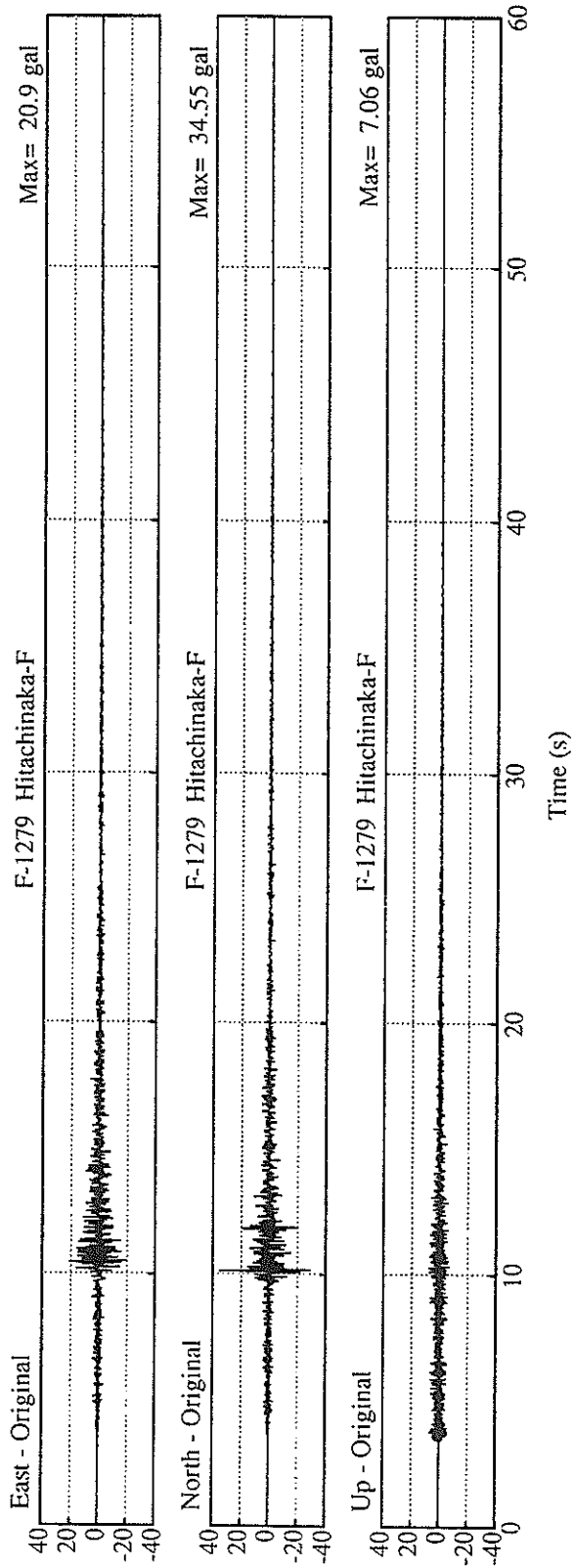
 DATE AND TIME : 15:18 DEC.23,1997
 LOCATION OF HYPOCENTER :
 EPICENTRAL REGION : E OFF IBARAKI PREF
 LATITUDE : 36°14.7' N
 LONGITUDE : 140°56.1' E
 DEPTH : 42.2KM
 JMA MAGNITUDE : 4.2

PEAK VALUES OF COMPONENTS

N S	E W	U D	HORIZONTAL*
34.6	20.9	7.1	34.6

ORIGINAL ACCELERATION (GAL)

* RESULTANT OF HORIZONTAL COMPONENTS



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