Report: 'National Seismic Hazard Maps for Japan (2005)'

March 23, 2005

Earthquake Research Committee
Headquarters for Earthquake Research Promotion

The Headquarters for Earthquake Research Promotion formulated the 'Promotion of Earthquake Research - Comprehensive Basic Policies for the Promotion of Seismic Research through the Observation, Measurement, and Survey -' (April 23, 1999), in which it cited preparation of the 'National Seismic Hazard Maps for Japan' as a major area of investigation on earthquakes.

In preparation for the 'National Seismic Hazard Maps for Japan (2005)', the Subcommittee for Long-term Evaluations of the Earthquake Research Committee has undertaken evaluations of the long-term occurrence probabilities for active faults on land and subduction-zone earthquakes, and announced the results to the public. The Subcommittee for Evaluations of Strong Ground Motions has conducted evaluations of damaging ground shaking by using a procedure to predict ground motions from specified earthquakes (the 'detailed method'). Concurrently, the methodology for ground motion prediction was improved and standardized and the results were announced to the public. In addition, the Subcommittees jointly published the reports, 'Preliminary Version of the Probabilistic Seismic Hazard Maps (Specific Area)' (May 29, 2002), 'Preliminary Version of the Probabilistic Seismic Hazard Maps (Specific Area of Northern Japan)' (March 25, 2003), and 'Preliminary Version of the Probabilistic Seismic Hazard Maps (Specific Area of Western Japan)' (March 25, 2004).

The Earthquake Research Committee has recently summarized the results in the 'National Seismic Hazard Maps for Japan (2005)', which is reported here.

Publication of the Report

Following the Great Hanshin-Awaji Earthquake Disaster 10 years ago, the Headquarters for Earthquake Research Promotion was consequently established for the unified promotion of survey and research of earthquakes in Japan. The Earthquake Research Committee under the Headquarters has evaluated the possibilities of long-term earthquake occurrences on major active faults and offshore trenches in Japan. The committee has also evaluated strong ground motions to estimate the level of shaking when those earthquakes actually occur. The work has also included recent developments in earthquake research, and all of the results are made public. The present report of the Earthquake Research Committee integrates results of the long-term earthquake evaluations and evaluations of strong ground motions, and presents the results in probabilistic estimates of the future strong shaking for the whole country and deterministic predictions of strong ground motions.

Japan is one of the recognized earthquake countries in the world and preparation for seismic hazards is necessary throughout the country. With this background, it is important to make regional priorities and decide the degree of urgency for broad-based countermeasures that are undertaken. The Seismic Hazard Maps are considered useful for this purpose. The present report is to be used for new recognition of seismic hazards and is expected to increase the awareness for disaster prevention. The report also provides basic material for studying effective earthquake disaster mitigation measures for the future.

For the preparation of this report, we are very grateful to many researchers and administrative officials in related organizations for their cooperation.

March 2005

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Headquarters for Earthquake Research Promotion

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Contents

1. Introduction

1.1 Background and purpose

The Great Hanshin-Awaji Earthquake Disaster in 1995 caused the greatest damage in the postwar days of Japan, with more than 6,400 dead or missing and more than 100,000 totally collapsed buildings. With this as an impetus, the Special Measures Law on Earthquake Disaster Prevention was enacted for the purpose of reinforcement of earthquake disaster mitigation efforts. Based on that legislation, the Headquarters for Earthquake Research Promotion was established, at that time, in the Prime Minister's Office (currently in the Ministry of Education, Culture, Sports, Science and Technology), forming a new organization for earthquake surveys and research. In this structure, the Earthquake Research Committee was in charge of collection, organization, and evaluation of survey results on earthquakes, and has made efforts to promote investigation and spread basic knowledge of earthquakes, in order to reduce their damage.

The Earthquake Research Committee collected direct information on past earthquakes and published the 'Seismic Activity in Japan' (1997, addenda in 1999) with the aim of disseminating proper knowledge on earthquakes. This material compiled seismic activity across the country and information on past destructive earthquakes, and shows the regional characteristics of the seismic activity. In addition, the Earthquake Research Committee has conducted evaluations for the long-term possibilities of earthquakes on major active faults on land and regions of offshore trenches (Long-term Evaluations). The committee has also provided estimates of the strong shaking for the occurrence of specified earthquakes (Evaluations of Strong Ground Motions). The results of all of these studies are publicly released.

In April 1999, the Headquarters for Earthquake Research Promotion formulated the 'Promotion of Earthquake Research - Comprehensive Basic Policies for the Promotion of Seismic Research through the Observation, Measurement, and Survey of Earthquakes - ' (referred to as the 'Comprehensive Basic Policies'), as the guidelines for promoting seismic surveys and research over a period of about a decade. The Comprehensive Basic Policies has identified the seismic hazard maps, which integrate investigations of active faults, evaluations for long-term possibilities of earthquakes, and predictions of strong ground motion, as the first item of earthquake research for the immediate future. The present report has assembled maps, based on comprehensive policies and the above evaluations. These maps present information, such as the level of shaking that will occur across Japan in future earthquakes, and the possibility that a site will experience strong shaking during a certain period in the future.

There is a risk of damaging earthquakes, to some extent, anywhere in Japan. Accordingly, basic provisions to guard against earthquake damage should be carried out on administrative and individual levels across the country. So, survey observations/research organization and earthquake disaster mitigation measures at a fixed level are necessary. Moreover, focused efforts will be required for sites with particularly high possibilities for strong shaking By means of the seismic hazard maps in the present report, we can generally view the possibility of strong shaking caused by large earthquakes on active faults on land and regions of the offshore trenches, and recognize regional differences across Japan. The present report is expected to provide useful information for disaster prevention countermeasures for the country and local public agencies, as well as promote public awareness of disaster prevention of earthquakes.

1.2 'National Seismic Hazard Maps for Japan (2005)'

The seismic hazard maps prepared by the Earthquake Research Committee are comprised of two types of maps, **'Probabilistic Seismic Hazard Maps'** and **'Seismic Hazard Maps for Specified Seismic Source Faults'**. The 'Probabilistic Seismic Hazard Maps', show the possibilities of strong shaking for the whole country, and the regional differences can be seen. In contrast, the 'Seismic Hazard Maps for Specified Seismic Source Faults', show the distribution of strong shaking caused by individual earthquakes. It is important to choose an appropriate map depending on the kind of information required.

'Probabilistic Seismic Hazard Maps' indicate the possibility of strong shaking within a certain time period at every location (about 1 km square) on the map. These maps are prepared by combining long-term possibilities of earthquakes and estimates of the shaking produced when the earthquakes occur. For example, maps show the probability of ground motion equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present, or maps show the ground motion equal to or larger than a certain seismic intensity occurring with a 3% probability within 30 years from the present. The Earthquake Research Committee has prepared preliminary versions for the northern Japan region in fiscal year 2002, the western Japan region in fiscal year 2003, and the 'Probabilistic Seismic Hazard Maps' for the whole country at this time.

'Seismic Hazard Maps for Specified Seismic Source Faults' pay attention to specific seismic source faults and indicate, the strong shaking of the surrounding areas when an earthquake occurs. For instance, if an active fault in the neighborhood of one's residential area actually moves, it can be advantageous to know the expected level of ground shaking. Maps providing this type of information are often prepared and used to estimate damage for formulation of disaster prevention measures on the national and local levels. To improve the procedure for predicting strong ground motions and ensure that any user can obtain the same results, the Earthquake Research

Committee has promoted standardization of the methodology, which focuses on evaluation of the strong ground motions from earthquakes on active faults on land and offshore trenches, that have a large influence on the region. The committee also encourages verification of the predicted results using observed records, and has published the results. Evaluated results of 12 scenario earthquakes that have been completed and announced to the public are summarized in this report in the section on the 'Seismic Hazard Maps for Specified Seismic Source Faults'.

Because the long-term possibility of earthquakes depends on the lapse time and occurrence probability of the earthquakes, the possibility of strong shaking determined from such information varies with time. If there is acquisition of new information and improvement of the evaluation procedures from developing earthquake research, the seismic hazard map should be upgraded. For these reasons, the Earthquake Research Committee will review the seismic hazard map at appropriate times.

1.3 Composition of the report

This report consists of six chapters, including this introduction in Chapter 1:

Chapter 2 is a general outline of the 'National Seismic Hazard Maps for Japan (2005)'. Here, the basic concepts and the framework of the preparation are presented for the 'Probabilistic Seismic Hazard Maps' and the 'Seismic Hazard Maps for Specified Seismic Source Faults'. Also shown is basic information common to both maps about the classifications of earthquakes and a map showing the influence of shallow ground conditions on the shaking strength.

Chapter 3 describes the 'Probabilistic Seismic Hazard Maps'. Here, we present seismic hazard maps considering the long-term probabilities of earthquake occurrences, and explain how to read the maps.

Chapter 4 describes the 'Seismic Hazard Maps for Specified Seismic Source Faults'. Presented here is a general description of the published seismic hazard maps, together with the latest explanations of the predictions of strong ground motions by the Earthquake Research Committee.

Chapter 5 describes the applications of the 'National Seismic Hazard Maps for Japan (2005)'. The concepts for proper use of the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults', and for their complementary applications, are presented.

Chapter 6 describes future problems and outlook for the 'National Seismic Hazard Maps for Japan (2005)'.

In the 'National Seismic Hazard Maps for Japan (2005)', not only the results of the evaluations but also data and conditions used in the preparation have been published, and explanation of the releases are in an appendix.

In addition, with respect to the ‘Probabilistic Seismic Hazard Maps’ and ‘Seismic Hazard Maps for Specified Seismic Source Faults’, detailed explanations and discussion regarding data and the preparation process were assembled as separate volumes.

2. Outline of the 'National Seismic Hazard Maps for Japan (2005)'

2.1 Basic concepts

The 'National Seismic Hazard Maps for Japan (2005)' is comprised of two kinds of maps, 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults'. The Earthquake Research Committee considered that proper use of the maps is dependent on the purpose of the investigation and the requested information, and decided to prepare two types of maps for consideration of future earthquakes.

Japan has not only large earthquakes occurring on many active faults on land and in offshore areas, but also earthquakes whose locations can not be exactly predicted, so that the risk of strong shaking exists everywhere across the country. The 'Probabilistic Seismic Hazard Maps' show the possibility of strong shaking from the various types of earthquakes that may occur in the future, by considering the long-term possibility of earthquake occurrences. For example, with this map, we can see the possibility of ground motions equal to or larger than seismic intensity 6 Lower, occurring within a certain period, in an area where we live. It is also possible to analyze what kinds of earthquakes have a large contribution to the strong shaking.

On the other hand, the 'Seismic Hazard Maps for Specified Seismic Source Faults' assume a scenario[1] for the rupture of a seismic source fault, and show the strong shaking for the evaluated areas when the specified earthquake occurs. The Earthquake Research Committee has promoted the improvement and standardization of the prediction procedure for strong ground motions to enable anybody to obtain the same results as the published 'evaluation of strong ground motions', when applying the procedure to earthquakes. Of the earthquakes for which 'long-term evaluations' have been completed so far, events have been selected, considering their occurrence probability and influence on the surrounding areas, while other events were chosen to facilitate improvement of the method. The present report has assembled results of the evaluations of strong ground motions and presented them as 'Seismic Hazard Maps for Specified Seismic Source Faults'. This report also presents not only the results of evaluations, but also the latest procedures, known as the 'Recipe'. By using the 'Recipe', it should be possible for anyone to reproduce the results.

Because the two maps have different content, as mentioned above, proper use appropriate for the application is necessary. For instance, in regions with high possibility of strong shaking with 'Probabilistic Seismic Hazard Map', when an earthquake with large influence on the region of interest can be identified, it is possible to estimate damage and prepare emergency measures when the earthquake occurs, using the 'Seismic Hazard

[1] Such assumed earthquake are called scenario earthquake.

Maps for Specified Seismic Source Faults'. In considerations of earthquakes for which hypocenter locations can not be specified, we can evaluate the possibility of strong shaking with the 'Probabilistic Seismic Hazard Maps', and conduct studies of measures to cope with the results. Descriptions of the details for the proper use of both maps, are given in Chapter 5.

2.2 Methods

Shown in **Fig.2. 2-1** is a general procedure for the preparation of the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults'. The sequence of steps consists of, assuming earthquakes of interest, modeling seismic sources and subsurface structure, evaluating shaking strength and probabilities of earthquake occurrence, and preparing the map. The specific methods for preparation of each map are described in Chapters 3 and 4.

(1) Possibility of earthquake occurrence

Where and what kind of earthquake occurs, and their possibility of occurrence, are evaluated on the basis of active fault surveys, past records of earthquakes and analytical results, etc.

(2) Seismic source models

The level of shaking generally is higher as the size of the seismic source fault is larger, and as the site is closer to the source fault. Here, source models for the evaluations of strong ground motions are set, including the location and shape of the fault planes and seismic source size, based on the results of the long-term evaluations.

(3) Subsurface structure models

Seismic waves are gradually attenuated with propagation distance in the deep subsurface but amplified by the influence of structures above the seismic bedrock[2]. Accordingly, for the evaluation of strong ground motion, it is necessary to model subsurface structures near the ground surface and to evaluate their influence. In setting the subsurface model, it is divided into several sections by depth, using differences in the character of the bedrock and influences to shaking. Although requirements of the subsurface structure needed for the prediction method vary, the Earthquake Research Committee has divided the subsurface into three large sections, as shown in **Fig. 2. 2-2**.

The 'surface soil layers' are located from the surface to the engineering bedrock[3]. The 'deep sedimentary layers' are from the engineering bedrock to

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[2] Upper plane of bedrock with S-wave velocity of approximately 3 km/s.

[3] Stands for appropriate ground when designing structures in engineering fields like architecture, civil engineering and the like, and its S-wave velocity is approximately 300-700 m/s or more in many cases though depending on sort of structure and state of ground.

the seismic bedrock. And, the 'crustal structure' is deeper than the seismic bedrock.

(4) Evaluation of strong ground motions

Estimation of surface shaking is conducted with a 2-stage calculation. First, shaking on the engineering bedrock for the areas of evaluation (about 1 km square) is estimated, and then the strength of the surface shaking is calculated by adding the influence of 'surface soil layers'.

Prediction of strong ground motions at the engineering bedrock is conducted with either a 'conventional method'[4] based on a simple model or a 'detailed method'[5] based on a more elaborate model. Conceptual diagrams of each procedure are shown in Fig. 2. 2-3. In the 'Probabilistic Seismic Hazard Maps', we used a procedure that combines the evaluation of the long-term probabilities of earthquakes with the strength of shaking produced when the earthquake occurs, to evaluate the possibility of strong shaking within a certain period. Occurrence probabilities of strong shaking are evaluated from averaged values and their fluctuations in the 'conventional method'. In the 'Seismic Hazard Maps for Specified Seismic Source Faults', evaluations of strong ground motions are carried out with the 'detailed method'.

(5) Preparation of Seismic Hazard Maps

Seismic Hazard Maps are prepared by combining information, such as the distributions of seismic intensity for individual seismic source faults and the distributions of probability that strong shaking occurs within a certain period, based on the evaluated results of strong ground motions.

The seismic hazard maps shown in the present report have been prepared with a resolution of about 1 km square. Although large figures can not be shown because of the limitations of space, they are available in Appendix 4, and on the homepage[6] of the Headquarters for Earthquake Research Promotion. It is noted, however, that the maps are a generalized view of the shaking strength using a coarse grid of about 1 km square, and they do not show the detailed information of shaking strength at individual sites.

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[4] Method to evaluate the peak ground velocity obtained at the engineering bedrock of the spot to be evaluated with a convenient empirical formula when the scenario earthquake occurs. This is a method to estimate 'average shaking strength (the peak ground velocity in this report)', using the empirical formula obtained from a variety of seismic records in the past, when 'scale of earthquake (magnitude)' and 'distance from the seismic source fault to spot of evaluation' are given. From the fact that shaking strength gets smaller (attenuated) as receding from the seismic source fault in general, this formula is called as attenuation relation of shaking strength.

[5] Method to estimate seismic waveforms (temporal variation of shaking caused by earthquakes) covering the whole of frequency range considered to give large influence on emergence of disaster, and to conduct numerical calculation based on seismic source models and subsurface structures more likely to reality than treated by the 'conventional method'.

[6] Homepage URL of Headquarters for Earthquake Research Promotion: http://www.jishin.go.jp

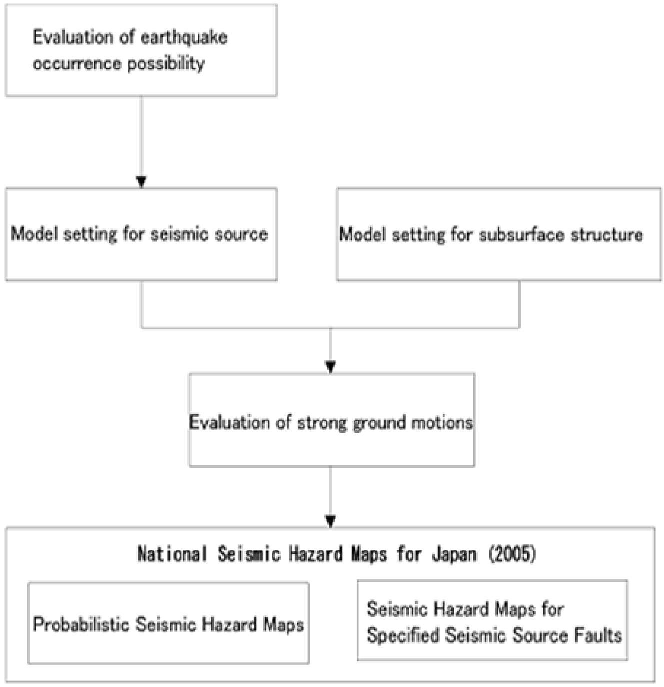


Fig. 2.2-1 General flow chart for preparation of the 'National Seismic Hazard Maps for Japan (2005)'.

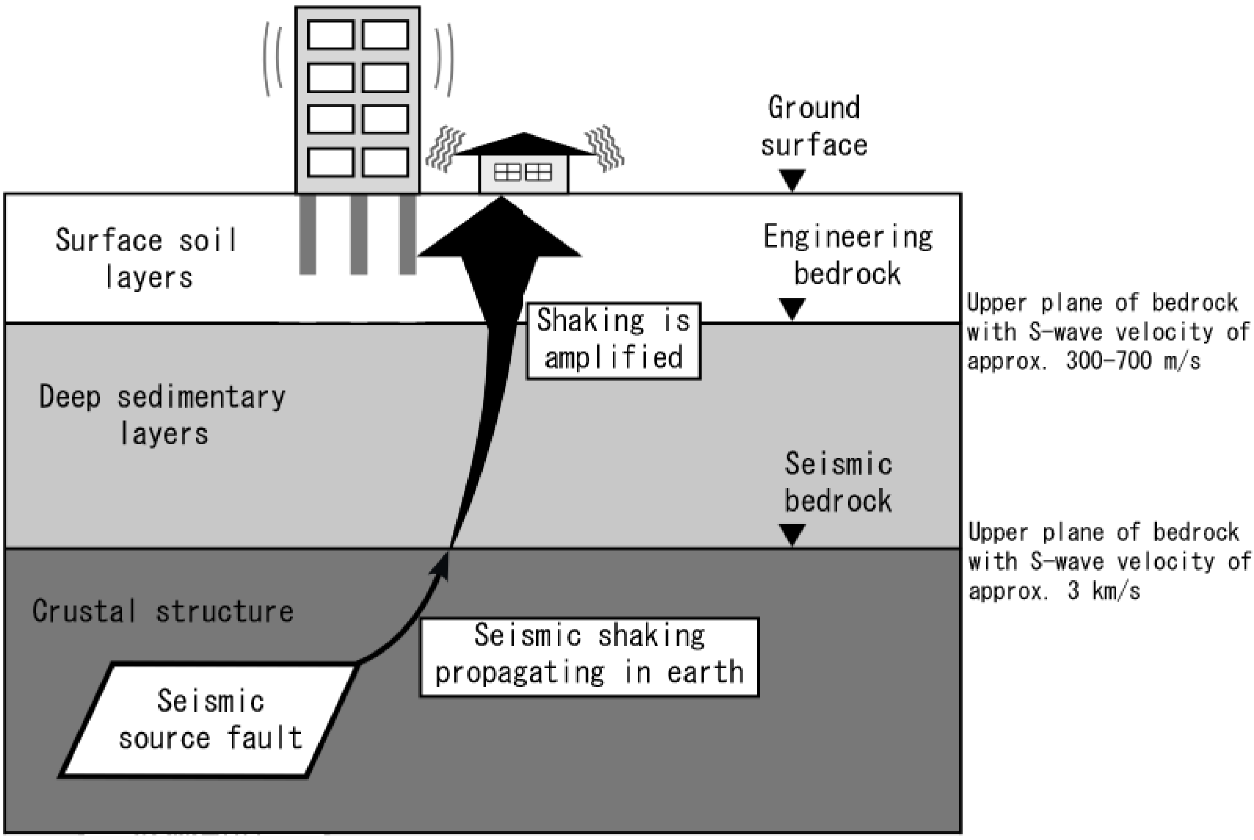


Fig 2.2-2 Diagram of subsurface structural model.

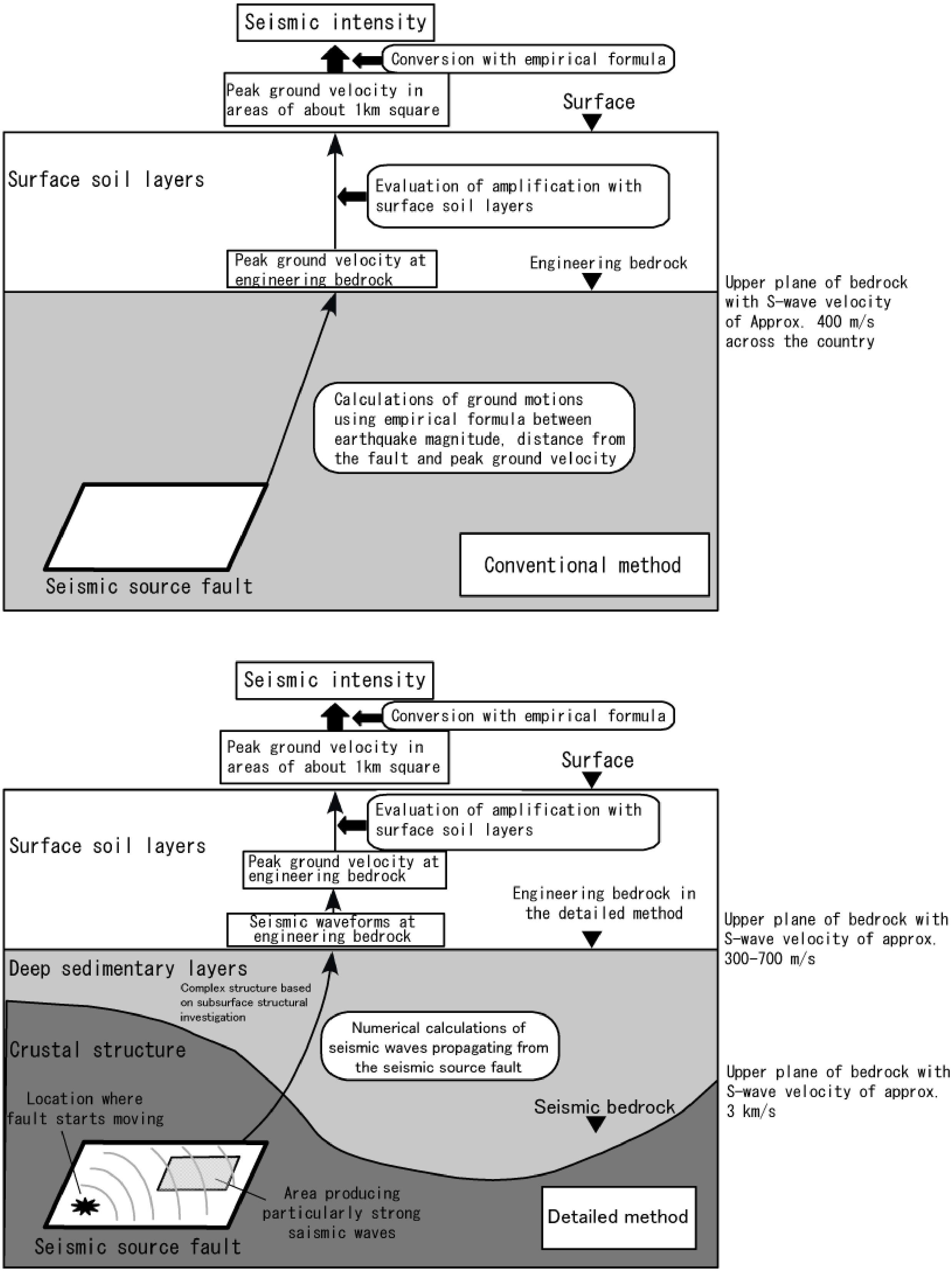


Fig. 2.2-3 Conceptual diagrams for evaluating strong ground motions with the 'conventional method' and 'detailed method'.

2.3 Earthquakes considered in the 'Seismic Hazard Maps'

For the seismic hazard maps, the effects of all types of earthquakes that produce strong shaking in Japan are included through consideration of their locations, sizes and possibilities of occurrence, through models for each type of earthquake. This section describes the types of earthquakes that have been considered in the seismic hazard maps.

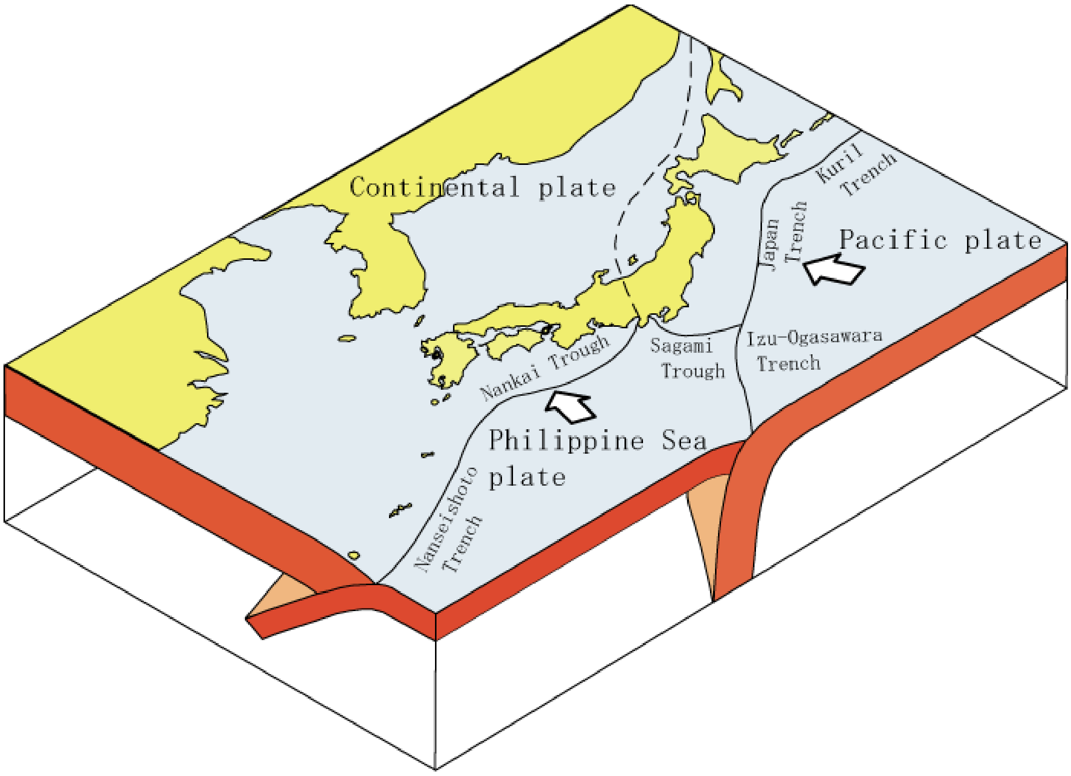
In the region of Japan, the surface of the Earth is composed of a continental plate, on which the Japan Islands are located, and the Pacific and Philippine Sea plates, which are geologic structures several tens of kilometers thick. The two oceanic plates are subducting under the continental plates (Refer to **Fig. 2. 3-1**). Earthquakes occurring in this area are largely divided into two kinds: **'earthquakes occurring on land and in coastal areas'** and **'earthquakes occurring at plate boundaries, such as offshore trenches and their vicinities'** (Refer to Fig. 2. 3-2, Earthquake Research Committee, 1999).

The majority of **earthquakes on land and in coastal areas** occur on active faults. From many faults across the country, the Earthquake Research Committee selected 98 major active fault zones, that have a high level of activity and a large social and economical influence, as the targets of fundamental surveys and observations (Headquarters for Earthquake Research Promotion, 1997). For these faults zones, evaluations of the long-term occurrence of the largest earthquakes ('characteristic earthquakes') were conducted (**Refer to Fig. 2. 3-3 and Attached Table 3-1 in Appendix 3**).

The majority of **earthquakes occurring at plate boundaries,** such as the Tokai, Tonankai and Nankai Earthquakes and the Miyagi-Oki Earthquake, are the large earthquakes that occur in the vicinity of the offshore trenches. The Headquarters for Earthquake Research Promotion defined large earthquakes at plate boundaries and within the subducting plate as **'subduction-zone earthquakes'** (Refer to Fig. 2. 3-2), and the Earthquake Research Committee has conducted evaluations of the long-term occurrences of these events (**Refer to Fig. 2. 3-3 and Attached Table 3-2 in Appendix 3**).

The classification in **Table 2. 3-1** was used to model seismic activity by earthquake type in preparation of the 'Probabilistic Seismic Hazard Maps'. The shaded portion in the table shows the major types of earthquakes distinguished by the Earthquake Research Committee, as the targets for the long-term evaluations. In the 'Probabilistic Seismic Hazard Maps', for earthquakes of which long-term evaluations have been completed, the locations, sizes and occurrence probabilities have been determined. For earthquakes without long-term evaluations, estimates of the location, size and occurrence probability have been determined based on statistical characteristics for their respective classifications.

In the 'Seismic Hazard Maps for Specified Seismic Source Faults' evaluations of the strong ground motions have so far been completed for 12 earthquakes, among the events that have long-term evaluations.



Fig, 2.3-1 Tectonic plates in the region of the Japan Islands.
Arrows in the figure show relative motion of the oceanic plates with respect to the continental plate.

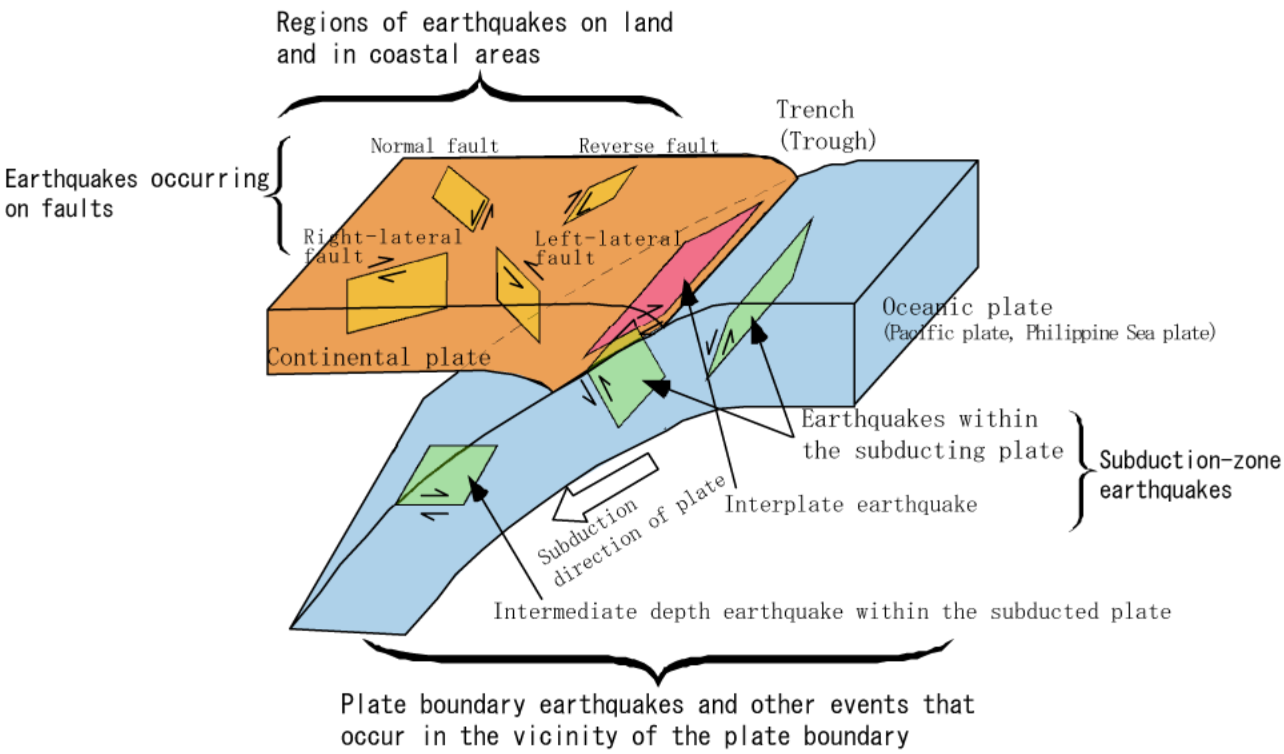


Fig. 2.3-2 Types of earthquakes occurring in the region of the Japan Islands.
Arrows on fault planes denote relative directions of slip.

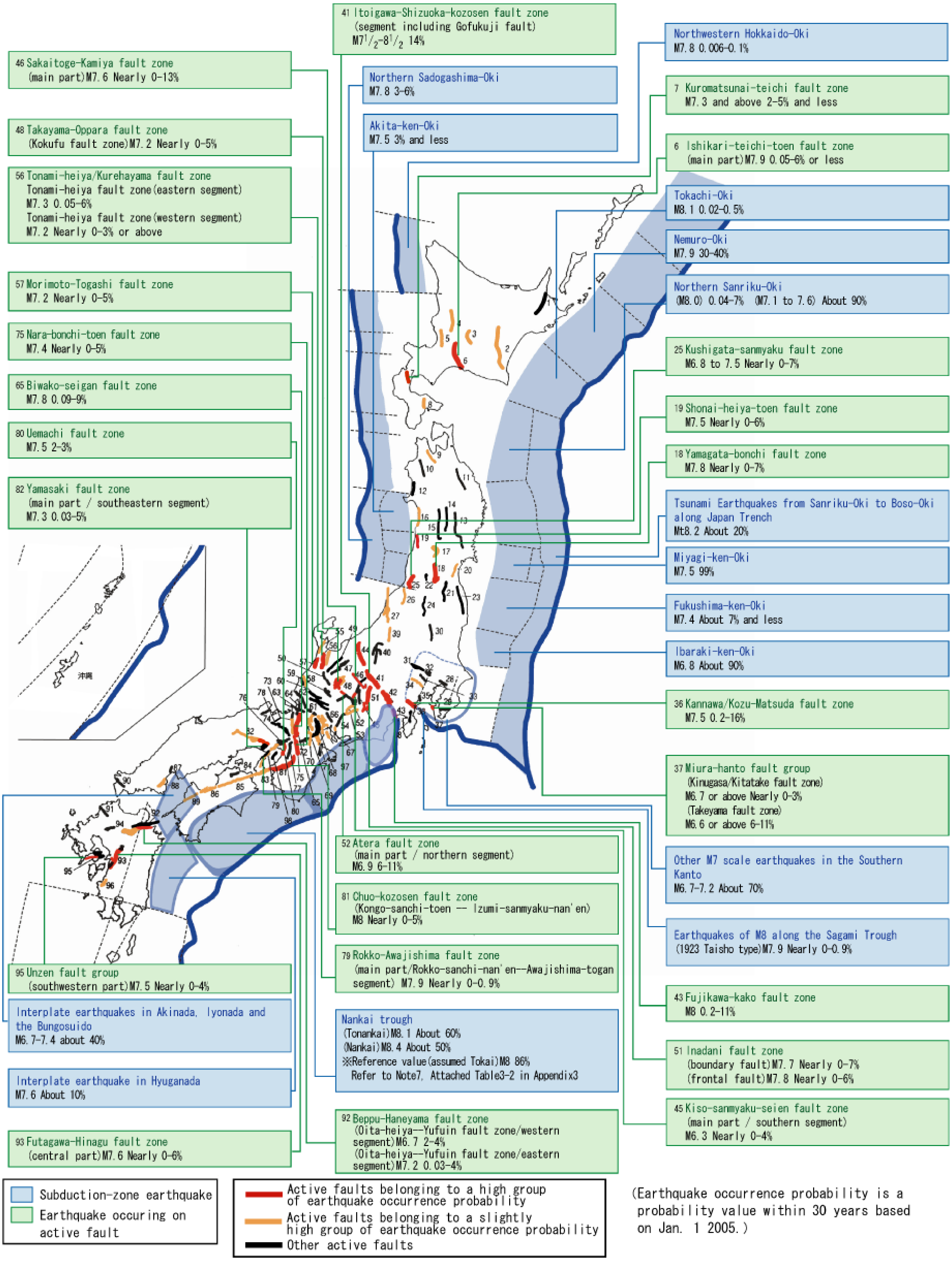


Fig. 2.3-3 The main long-term evaluation results, and locations of the 98 major active fault zones and regions of subduction-zone earthquakes. (Reference number for the fault zone are listes in the next page.)

No.	Names of Active Fault Zones
1	Shibetsu fault zone
2	Tokachi-heiya fault zone (fault zone on Tokachi Plain)
3	Furano fault zone
4	Mashike-sanchi-toen/Numata-Sunagawa Area fault zone (fault zone along the eastern margin of Mashike Mountains/Numata-Sunagawa area)
5	Tobetsu fault zone
6	Ishikari-teichi-toen fault zone (fault zone along the eastern margin of Ishikari lowlands)
7	Kuromatsunai-teichi fault zone (fault zone on Kuromatsunai lowlands)
8	Hakodate-heiya-seien fault zone (fault zone along the western margin of Hakodate Plain)
9	Aomori-wan-seigan fault zone (fault zone along the western coast of Aomori Bay)
10	Tsugaru-sanchi-seien fault zone (fault zone along the western margin of Tsugaru Mountains)
11	Oritsume fault
12	Noshiro fault zone
13	Kitakami-teichi-seien fault zone (fault zone along the western margin of Kitakami lowlands)
14	Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone (fault zone along the western margin of Shizukuishi Basin/the eastern margin of Mahiru Mountains)
15	Yokote-bonchi-toen fault zone (fault zone along the eastern margin of Yokote Basin)
16	Kitayuri fault
17	Shinjo-bonchi fault zone (fault zone on Shinjo Basin)
18	Yamagata-bonchi fault zone (fault zone on Yamagata Basin)
19	Shonai-heiya-toen fault zone (fault zone along the eastern margin of Shonai Plain)
20	Nagamachi-Rifu-sen fault zone (Nagamachi-Rifu Tectonic Line)
21	Fukushima-bonchi-seien fault zone (fault zone along the western margin of Fukushima Basin)
22	Nagai-bonchi-seien fault zone (fault zone along the western margin of Nagai Basin)
23	Futaba fault
24	Aizu-bonchi-seien/-toen fault zone (fault zone along the western/eastern margin of Aizu Basin)
25	Kushigata-sanmyaku fault zone (fault zone in Kushigata mountain range)
26	Tsukioka fault zone
27	Nagaoka-heiya-seien fault zone (fault zone along the western margin of Nagaoka Plain)
28	Tokyo-wan-hokuen fault (fault along the northern margin of Tokyo Bay) (not active fault)
29	Kamogawa-teichi fault zone (fault zone on Kamogawa Lowland)
30	Sekiya fault
31	Kanto-heiya-hokuseien fault zone (fault zone along the northwestern margin of Kanto Plain)
32	Motoarakawa fault zone (not active fault)
33	Arakawa fault (not active fault)
34	Tachikawa fault zone
35	Isehara fault
36	Kannawa/Kozu-Matsuda fault zone
37	Miura-hanto fault group (fault group on Miura Peninsula)
38	Kitaizu fault zone
39	Tokamachi fault zone
40	Shinanogawa fault zone [Nagano-bonchi-seien fault zone] (fault zone along the western margin of Nagano Basin)
41	Itoigawa-Shizuoka-kozosen fault zone (middle area) (Itoigawa-Shizuoka Tectonic Line)
42	Itoigawa-Shizuoka-kozosen fault zone (southern area) (Itoigawa-Shizuoka Tectonic Line)
43	Fujikawa-kako fault zone (fault zone on the mouth of Fuji River)
44	Itoigawa-Shizuoka-kozosen fault zone (northern area) (Itoigawa-Shizuoka Tectonic Line)

No.	Names of Active Fault Zones
45	Kiso-sanmyaku-seien fault zone (fault zone along the western margin of Kiso mountain range)
46	Sakaitoge-Kamiya fault zone
47	Atotsugawa fault zone
48	Takayama-Oppara fault zone
49	Ushikubi fault zone
50	Shokawa fault zone
51	Inadani fault zone
52	Atera fault zone
53,54	Byoubuyama-Enasan - Sanageyama fault zone
55	Ochigata fault zone
56	Tonami-heiya/Kurehayama fault zone (fault zone on Tonami Plain/Mt.Kureha)
57	Morimoto-Togashi fault zone
58	Fukui-heiya-toen fault zone (fault zone along the eastern margin of Fukui Plain)
59	Nagaragawa-joryu fault zone (fault zone along the upper reaches of Nagara River)
60	Nobi fault zone
61,62	Yanagase-Sekigahara fault zone
63	Nosaka/Shufukuji fault zone
64	Kohoku-sanchi fault zone (fault zone on Kohoku Mountains)
65	Biwako-seigan fault zone (fault zone along the western coast of Lake Biwa)
66	Gifu-Ichinomiya fault zone (not active fault)
67	Yoro-Kuwana-Yokkaichi fault zone
68	Suzuka-toen fault zone (fault zone on the eastern margin of Suzuka mountain range)
69	Suzuka-seien fault zone (fault zone on the western margin of Suzuka mountain range)
70	Tongu fault
71	Nunobiki-sanchi-toen fault zone (fault zone along the eastern margin of Nunobiki mountains)
72	Kizugawa fault zone
73	Mikata/Hanaore fault zone
74	Yamada fault zone
75	Kyoto-bonchi - Nara-bonchi fault zone (southern part) (fault zone along the eastern margin of Nara Basin)
76	Arima-Takatsuki fault zone
77	Ikoma fault zone
78	Mitoke/Kyoto-Nishiyama fault zone
79	Rokko-Awajishima fault zone
80	Uemachi fault zone
81	Chuo-kozosen fault zone (Kongo-sanchi-toen -- Izumi-sanmyaku-nan'en) (Median Tectonic Line (area from the eastern margin of Kongo mountains to the southern margin of Izumi mountain range))
82	Yamasaki fault zone
83	Chuo-kozosen fault zone (Kitan-kaikyo -- Naruto-kaikyo) (Median Tectonic Line (area from the Kitan Strait to the Naruto Strait))
84	Nagao fault zone
85	Chuo-kozosen fault zone (Sanuki-sanmyaku-nan'en -- Ishizuchi-sanmyaku-hokuen-tobu) (Median Tectonic Line (area from the southern margin of Sanuki mountain range to the eastern part of the northern margin of Ishizuchi mountain range))
86	Chuo-kozosen fault zone(Ishizuchi-sanmyaku-hokuen) (Median Tectonic Line (area along the northern margin of Ishizuchi mountain range))
87	Itsukaichi fault zone
88	Iwakuni fault zone
89	Chuo-kozosen fault zone (Ishizuchi-sanmyaku-hokuen-seibu -- Iyonada) (Median Tectonic Line (area from the western part of the northern margin of the Ishizuchi mountains to Iyonada Sea)
90	Kikukawa fault zone
91	Nishiyama fault zone
92	Beppu-Haneyama fault zone
93	Futagawa-Hinagu fault zone
94	Minou fault zone
95	Unzen fault group
96	Izumi fault zone
97	Ise-wan fault zone (fault zone in Ise Bay)
98	Osaka-wan fault zone (fault zone in Osaka Bay)

Table 2. 3-1 Classification of earthquakes occurring in the Japan Islands region.

Earthquakes occurring on land and in coastal areas	Characteristic earthquakes occurring in the 98 major active fault zones
	Earthquakes occurring on active faults on land other than the 98 major active fault zones
	Earthquakes occurring in the 98 major active fault zones, excluding the characteristics events
	Earthquakes occurring on land where active faults have not been specified
	Earthquakes classified by regional characteristics, because they do not fit any of the above categories; (Earthquakes without specified source faults in Urakawa-Oki region.)
Earthquakes occurring at plateboundaries and their vicinity, such as in the region of offshore trenches	Subduction-zone earthquakes (Large earthquakes associated with plate subduction)
	Earthquakes on the plate boundaries, other than large events
	Earthquakes within subducting (or subducted) plates, other than the large events
	Earthquakes classified by regional characteristics, because they do not fit any of the above categories; (Earthquakes in eastern margin of Japan Sea, southern area of Izushoto Islands, and vicinity of the Nanseishoto Islands, where source faults can not be specified.)

※ Earthquakes in portions with gray meshing are events for which the Earthquake Research Committee conducted long-term evaluations, because they are important targets of fundamental surveys and observations.

2.4 Surface amplification factors

Although shaking levels on the surface are largely influenced by 'surface soil layers', the circumstances widely depend on the site. When the strong motions have the same levels on the engineering bedrock, sites of soft ground produce stronger surface shaking compared to hard sites. In the present report, 'surface soil layers' were evaluated consistently across the country using a simple model based on topography from the Digital National Land Information, which is a nation-wide database on the scale of about 1 km square. The 'surface soil layers' are also evaluated on the same scale of about 1 km square.

Fig.2. 4-1 is a map showing amplification factors for the peak ground velocity from the 'surface soil layers', assuming a homogeneous engineering bedrock across the country[7] , with the model of 'surface soil layers' described above. As mentioned in **Section 2.2**, the peak ground velocity on the surface is obtained from the level on the engineering bedrock multiplied by the amplification factor. The figure indicates that, as colors shift toward red (amplification factor increases), shaking levels on the surface become larger due to the 'surface soil layers'. Urban areas with concentrated populations are often located in extensive sedimentary basins, such as the Kanto Plain, where the national capital region has expanded, the Osaka Plain and the Kyoto/Nara Basin, where populations have expanded in the Kinki region, and the Nobi Plain where the Chukyo region has expanded. It is found that such places have soft 'surface soil layers' and high amplification factors. Although sedimentary basins often extend in the coastal regions, we can see sites with high amplification factors in basin areas for inland locations. In mountain areas, on the other hand, there are some places where strata and bedrock harder than the assumed engineering bedrock are exposed at the surface, with amplification factors less than 1. Shaking levels in such places become lower than on the assumed engineering bedrock.

In the 'Seismic Hazard Maps for Specified Seismic Source Faults', we designate 'engineering bedrock in the detailed method' as a structure that takes into account the local characteristics of the area, instead of using a homogeneous engineering bedrock across the entire country. Although absolute values of the amplification factors vary, the relative distributions, may be regarded as generally the same, such as where the amplification factors are high within the area of interest.

The bedrock condition depends on the site even within the modeled areas of about 1 km square, and unexpected levels of shaking may appear at some places. In order to estimate the shaking at a site of interest with high precision, more detailed site information is necessary. However, in this study,

[7] Considered here as rough standard was upper plane of stratum equivalent to 400 m/s as the engineering bedrock homogeneous across the country. (Refer to Footnote 3 for 'engineering bedrock'.)

the resolution is about 1 km square because the purpose is to show a generalized view of shaking levels across the country and to recognize the regional characteristics. In some instances of very strong shaking, soft ground becomes further softer producing unusual ground motions (nonlinear behavior of the ground). Detailed information of the ground conditions is required in order to calculate such behavior, and the present report has not taken this effect into account.

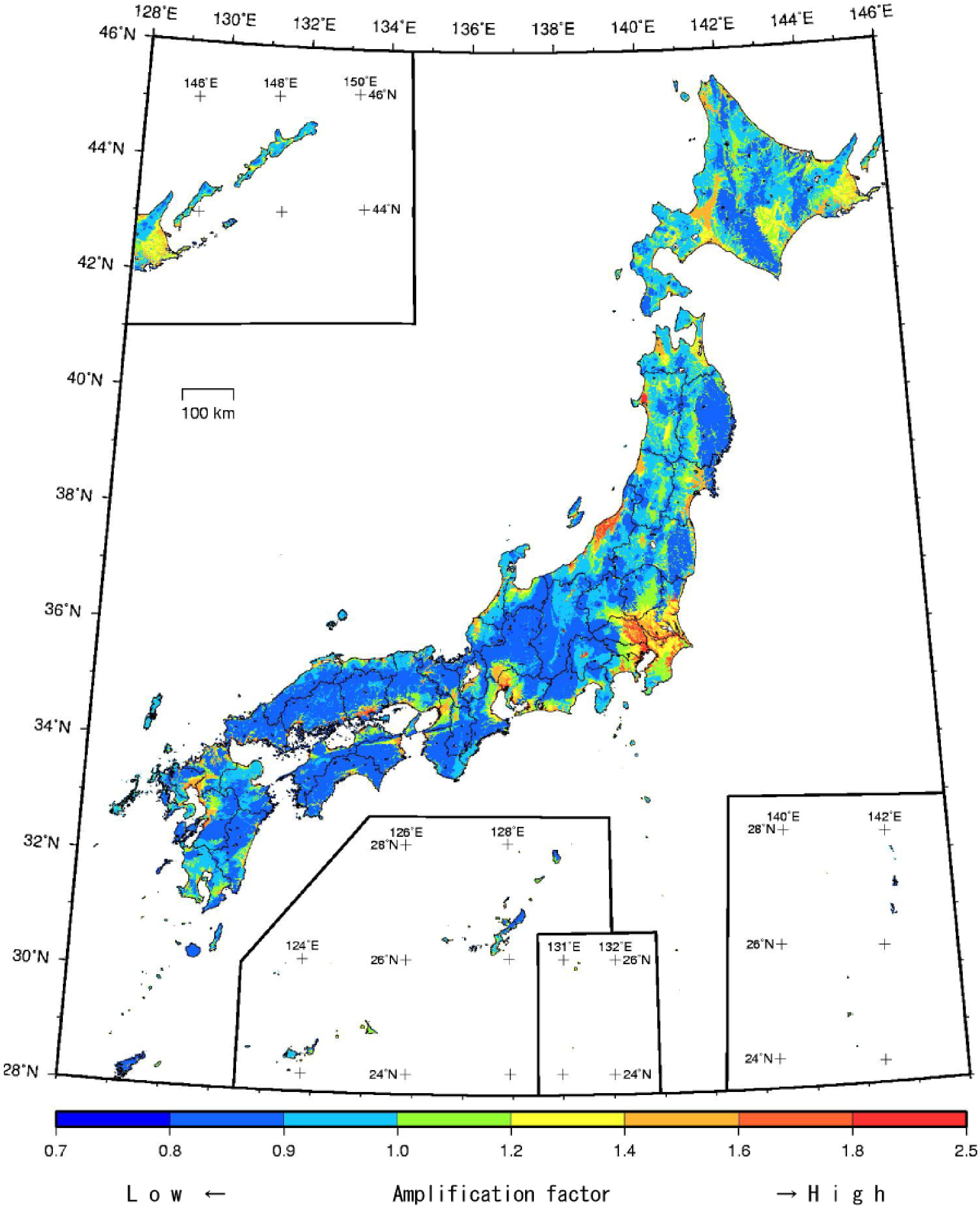


Fig. 2.4-1 Distribution of amplification factors of peak ground velocity due to the 'surface soil layers'.

3. Probabilistic Seismic Hazard Maps

3.1 Target regions and method of the Probabilistic Seismic Hazard Maps

The target region is the whole country of Japan[8].

For the probabilistic seismic hazard maps, three quantities are used, the 'time period', 'intensity' and 'probability' (of exceedance). For presentation of the maps, a convention was adopted such that two of the quantities were fixed to show the distribution of the remaining quantity, similar to the case exemplified in the Comprehensive Basic Policies. In the present report, the maps were prepared with a resolution of about 1 km square in the following combinations:

(1) Maps showing the 'probability' for a fixed 'time period' and 'intensity'
Example: Map of the probability of intensity equal to or larger than 6 Lower (exceeding instrumental seismic intensity 5.5) in 30 years from the present.

(2) Maps showing the 'intensity' for a fixed 'time period' and 'probability'
Example: Maps of intensity for a fixed probability of exceedance in 30 years from the present.

For the 'time period', January 1, 2005 is set as the starting point, following the Subcommittee for Utilizing Research Results in Society, Headquarters for Earthquake Research Promotion (2001), and a '30-year period' is used as a standard for presentation with the exception of a '50-year period' for maps (2):

- ○ Considering the time period that common citizens will acknowledge, it is appropriate to present the probability evaluations for 30-year terms.
- ○ Since building architectures have durability of 50-years, or longer so it is also necessary to evaluate terms on about 50 years.

For the fixed 'intensity' in maps (1), a value 'equal to or larger than seismic intensity 6 Lower' is used as a standard, and a value 'equal to or larger than seismic intensity 5 Lower' is also shown, as examples of levels where possible damage occurs (Refer to the Appendix 5; Explanation Table of the JMA Seismic Intensity Scale).

For the fixed 'probability' in the maps (2), cases of '3% in 30-years, is

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[8] Okinotorishima Island and Minamitorishima Island were not evaluated because of the lack of information for modeling seismic activity.

used as standard, which is one general standard for the long-term occurrence probabilities of the 98 major active fault zones (e.g. Earthquake Research Committee, 2001), and other cases of '5% in 50-years', '10% in 50-years' and '39% in 50-years' are additionally shown as examples[9]. The probabilities shown in the maps (1) were divided into values of under 0.1%, 0.1% to 3%, 3% to 6%, 6% to 26%, and 26% or above, for the 30-year periods[10].

3.2 Method

Although the basic procedure for preparing the probabilistic seismic hazard maps is the same as described in **Section 2.2**, it is explained in this section more specifically regarding the seismic modeling and evaluation of strong ground motions.

3.2.1 Evaluation model for earthquakes

In the probabilistic seismic hazard maps, we carry out evaluations of individual earthquake probabilities and setup of the seismic source model for individual earthquake, as mentioned in **Section 2.3.** From the classification of earthquakes shown in **Table 2.3-1**, the following designation was established to model earthquakes, considering the availability of long-term evaluations:

- ○ **Characteristic earthquakes occurring in the 98 major active fault zones**
- ○ **Subduction-zone earthquakes**
- ○ **Other earthquakes** (Earthquakes not considered in the long-term evaluation)
  - Earthquakes with specified source faults
    1) Earthquakes occurring on active faults on land other than the 98 major active fault zones
    2) Earthquakes occurring in the 98 major active fault zones[11], excluding the characteristic events

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[9] '5% in 50-years' and '3% in 30-years' give maps with nearly equal results, although depending on the features of the earthquakes of interest. Besides, when irregular occurrence of earthquakes not dependent on time are supposed, '5% in 50-years ', '10% in 50-years' and '39% in 50-years' correspond to maximum shaking intensities occurring, on average, once in about 1000 years, 500 years and. 100 years, respectively, (to be completely correct, these are probabilities of exceedance).

[10] '0.1% in 30-years', '3% in 30-years', '6% in 30-years' and '26% in 30-years' correspond to shaking intensities occurring, on average, once .in about 30,000 years, 1000 years, 500 years and 100 years, respectively, *(to be completely correct, these are probabilities of exceedance).

[11] Because an evaluation method is not available at the present, the seismic sources were included in 'Earthquakes occurring at onshore locations where no active faults have been specified' of the earthquakes without specified source fault locations.

- Earthquakes without specified source faults
3) Earthquakes on the plate boundaries, other than large events
4) Earthquakes within subducting (or subducted) plates, other than the large events
5) Earthquakes occurring at onshore locations where active faults have not been specified.
- Furthermore, the following earthquakes are classified considering regional characteristics, because they do not fit any of the above categories:
6) Earthquakes without specified source faults in Urakawa-Oki.
7) Earthquakes without specified source faults in the eastern margin of the Japan Sea.
8) Earthquakes without specified source faults in the southern area of Izushoto.
9) Earthquakes without specified source faults in the vicinity of the Nanseishoto.

'Characteristic earthquakes occurring in the 98 major fault zones' and **'Subduction-zone earthquakes'** which have long-term occurrence evaluations, have modeled locations and geometries of their seismic source faults, seismic sizes and long-term occurrence probabilities. For the 98 major active fault zones, the probabilities of characteristic earthquakes have been evaluated with a range of values. Also, the estimates of intense shaking result in a range of values. However, we adopt here a representative value[12] for preparation of the map. It has been a subject of investigations, how to deal with earthquake occurrence probabilities evaluated with a range of values, for the seismic hazard maps **(Refer to Section 3.5).**

For the **'Other earthquakes'** that have no long-term evaluations, the following model was prepared for the seismic hazard map. For the 'earthquakes occurring on active faults other than the 98 major active fault zones', the locations/geometries of the seismic source faults are evaluated for each earthquake, and the size and long-term probabilities of the earthquake occurrence, are modeled in accordance with the length and activity of the fault. For the earthquakes without specified source faults, we use statistical estimates for the occurrence frequency, according to their sizes and classifications, then set locations/geometries of the individual seismic source faults. With respect to earthquakes size, we evaluated the influence of only larger events (earthquakes equal to or above magnitude 5.0).

3.2.2 Evaluation of strong ground motions

In the probabilistic seismic hazard maps, the evaluation of strong

[12] The representative value used is the probability is calculated by taking a recurrence interval of the active fault and mid-values of individual ranges of the most recent event.

ground motions is expressed by the occurrence possibility of shaking equal to or above a certain intensity, within a fixed period of time from the present, at specific sites. These results are calculated by the 'occurrence probability of an earthquake within a fixed period' multiplied by the 'probability that shaking caused by the earthquake exceeds a certain intensity'. Then a summation is carried out over all earthquakes (or by earthquake classification)[13].

An 'occurrence probability within a fixed period from the present' is given to each earthquake, based on results of the evaluations shown in the previous section.

For the 'probability that shaking caused by the earthquake exceeds a certain intensity', calculations are conducted in the 'conventional method' by considering the average intensity with an attenuation relation', and statistic fluctuations of the average. The reason the attenuation relation is applied is because fluctuations of the shaking have been evaluated and the 'probability' that shaking exceeds a certain intensity can be quantified[14]. In the 'detailed method', an elaborate procedure is used in the 'Seismic Hazard Maps for Specified Seismic Source Faults', and fluctuations in shaking levels are not statistically considered, because one to several cases are selected from various scenarios for setting the seismic source model. Then, the calculations are carried out as a determination of a single intensity at the point of interest, for evaluation of each case. The utilization of the 'detailed method' in the probabilistic hazard maps has become a subject for future investigations, in considering the 'integration' of the 'probabilistic seismic hazard maps' and the 'seismic hazard maps for specified seismic source faults'[15].

For a specific site, the results ('probability of earthquake occurrence within a fixed period' multiplied by the 'probability that shaking by the earthquake exceeds a certain intensity' and summed over all earthquakes) are shown with a relation between 'intensity' and 'probability of exceedance within a fixed period', as in the example of **Fig. 3.2.2-1**[16]. Maps (1) and (2) described in **Section 3.1** represent different portions of the figure, as shown with arrows.

As seen in **Fig. 3.2.2-1**, the lower the probability becomes, the more intense is the shaking. This can be explained by the lower frequency of occurrence of large earthquakes, which corresponds to smaller probabilities. Since large earthquakes produce the strongest shaking, the lower probabilities of large earthquakes correspond to the higher levels of

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[13] Regarding the actual methods of calculation, refer to Chap. 2 of the Separate Vol. 1.

[14] Fluctuations in predictive values for intensity in the attenuation relations are statistically obtained when deriving the expressions from recordings of earthquakes. Causes of the fluctuation contain various factors other than those considered originally in the evaluation for the probabilistic seismic hazard maps.

[15] For details, refer to Chap. 5 of Separate Vol. 1.

[16] This relational curve is called a 'hazard curve'

intensities. From the view of variations of the shaking levels from the fault, the sites of strong shaking correlates with large amount of slip on the fault. Since the areas of very large slip, which are much larger than the average slip, are rare, there is a low probability of the associated strong shaking.

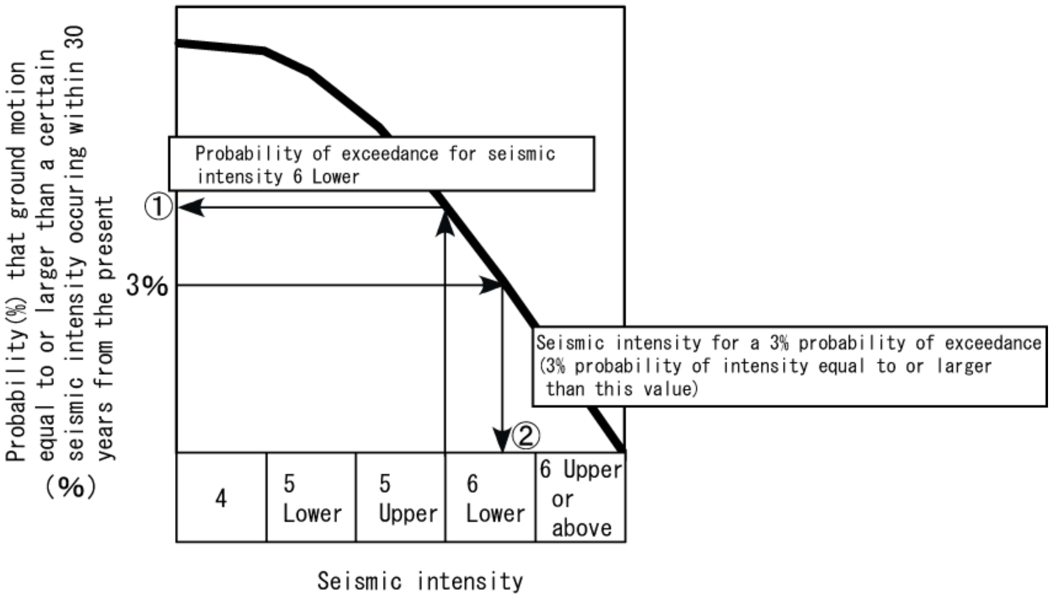


Fig. 3.2.2-1 Relation between'intensity' and 'probability'to exceed the intensity within a fixed time.

3.3 Results

3.3.1 National Seismic Hazard Maps for Japan

Shown in this section are maps for Japan considering all earthquakes, and maps for the different earthquake classifications. The probabilistic seismic hazard maps show different characteristics by changing the values of the 'time period', 'intensity' and 'probability' accordingly. In addition to the maps for all earthquakes, maps showing the different classifications of earthquakes can also be prepared. From these, it is possible to compare the differences from the earthquake classification, and it is possible to design countermeasures against the effects of different types of earthquakes.

Maps prepared at this time are based on the process shown in **Table 3.3.1-1** by taking the 'map of shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present,' as a standard example. The table shows examples of the types of maps that can be prepared, and maps with parameters other than those used in these examples can also be produced, if necessary. The time period uses January 2005 as the starting point for all maps. Hereafter, the terms 'within 30 years from the present' or 'within 50 years from the present', mean within 30 or 50 years, respectively, since January 2005.

(1) **Map including all earthquakes**

(a) Distribution of 'probabilities' with fixed 'time period' and 'intensity'

Shown in **Fig.3.3.1-1** is the distribution of probabilities that ground motions equal to or larger than seismic intensity 6 Lower, occur within 30 years from the present. In the figure, probability values are divided into units of, under 0.1%, 0.1 to 3%, 3 to 6%, 6 to 26% and 26% or above, for the period of 30 years from the present. Yellow regions are areas where shaking equal to or larger than seismic intensity 6 Lower, occurs with 'fairly high' probability, and the probability becomes 'higher' as the color shifts towards red. It is noted that the probability values and coloring designations of 'higher' or 'fairly high' are relative and not absolute determinations. Because probability values may be difficult to understand, comparisons of annual probabilities of natural disasters, accidents, and crimes are shown as for reference in the box. One difference should be pointed out for the comparison. We cannot prevent the occurrence of earthquakes, however, there are dangers, like probabilities of accidents or crime, that can be avoided, if we pay proper attention.

When we take a generalized view of all of Japan in **Fig. 3.3.1-1**, it is found that probabilities of intense shaking have a regional dependence. One striking fact is that areas with probabilities of 26% or above, spread along the Pacific coast from Shizuoka Pref. to southern Shikoku. Intense shaking equal to or larger than intensity 6 Lower, also occurs with high probability in the Kanto Plain, the Pacific side of Miyagi Pref. and the Pacific coast of Hokkaido. Areas with probabilities of 3% or above, from the west include, the Kumamoto Plain and the Pacific coast in Kyushu, nearly all of Shikoku and parts of the coast of the Seto Inland Sea, and the Kinki District to northern Nagano Pref., in central Japan. In northeast Japan, areas with probabilities of 3% or above, are seen in the Yamagata Basin. Comparing the probabilities with the distribution of amplification factors for peak ground velocity from the 'surface soil layers' in **Fig. 2.4-1**, it is found that the possibility of intense shaking is relatively high, in the sedimentary plains that have high amplification factors, compared with the surrounding areas.

Figs. 3.3.1-2(a) and **(b)** show probability maps for 'seismic intensity equal to or larger than 6 Lower' and 'seismic intensity equal to or larger than 5 Lower', respectively. **(a)** is the same as **Fig. 3.3.1-1**, reduced in scale for comparison with **(b)**. It is found from **(b)** that the probability of shaking with seismic intensity equal to or larger than 5 Lower, is high everywhere in Japan.

(b) Maps of 'intensity' with fixed 'time period' and 'probability'

Fig. 3.3.1-3(b) shows probabilistic maps of seismic intensity for 3% probability of exceedance in 30 years from the present. **(a)** is the same as **Fig. 3.3.1-1**, reduced in scale for comparison with **(b)**. **(b)** corresponds to recurrence periods of about 1000 years, indicating that, on average, every site has the possibility of experiencing shaking equal to or above this level at least once in about 1000 years. This map indicates the degree of shaking for the sum of all earthquakes corresponding to a level of occurrence probability, and it is important to understand that this distribution of intensity is different from the distribution of intensity for particular earthquakes, as shown in the 'seismic hazard map for specified seismic source faults'.

In **Fig. 3.3.1-3(b)**, areas that show seismic intensity equal to or larger than 6 Upper, exist broadly along the Pacific coast from Shizuoka Pref. to southern Shikoku, and are seen in the Tokushima Plain in eastern Shikoku, parts of the Kinki District, parts of the coast of the Kanto Plain, a linear region through Nagano Pref., the Sendai Plain and the Pacific coast of Hokkaido.

Fig. 3.3.1-4(a), (b) and **(c)** are maps of seismic intensity for probabilities of exceedance of 5%, 10% and 39%, respectively, in 50 years from the present. These maps correspond to recurrence periods of about 1000 years, 500 years and 100 years, respectively. These maps show how 'intensity' varies when changing the 'probability' (recurrence period).

A lower probability gives more intense shaking for the same time period. The reason is because, great earthquakes have lower occurrence frequency so the corresponding strong shaking has low probability, also the chance circumstances that come together to produce very strong shaking have a low probability, as mentioned in **Section 3.2**.

Table 3.3.1-1 Structure of probabilistic seismic hazard maps.

(1) Probabilistic seismic hazard maps considering all earthquakes

(a) Probabilistic seismic hazard maps of 'probability' with fixed 'time period' and 'intensity'

Figs. 3.3.1-1/2(a)/3(a)
Probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (standard case)

Changes of the seismic intensity level

Fig. 3.3.1-2(b)
Probability of ground motions equal to or larger than seismic intensity 5 Lower, occurring within 30 years from the present

(b) Probabilistic seismic hazard maps of 'intensity' with fixed 'time period' and 'probability'

Fig. 3.3.1-3(b)
Ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (recurrence period:about1000 years)

Changes of time period and probability
30 years → 50 years
3% → 5%

Fig. 3.3.1-4(a)
Ground motions of seismic intensity for a 5% probability of exceedance occurring within 50 years from the present (recurrence period:about 1000 years)

Changes of probability level

Fig. 3.3.1-4(b)
Ground motions of seismic intensity for a 10% probability of exceedance occurring within 50 years from the present (recurrence period:about 500 years)

Changes of probability level

Fig. 3.3.1-4(c)
Ground motions of seismic intensity for a 39% probability of exceedance occurring within 50 years from the present (recurrence period:about 100 years)

Broken down by earthquake classification

(2) Probabilistic seismic hazard maps separated by earthquake classification

Fig. 3.3.2-1(a) Probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Characterristic earthquakes in the 98 major active fault zones)	**Fig. 3.3.2-1(b)** Ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (Characteristic earthquakes in the 98 major active fault zones)
Fig. 3.3.2-2(a) Probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Subduction-zone earthquakes)	**Fig. 3.3.2-2(b)** Ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (Subduction-zone earthquakes)
Fig. 3.3.2-3(a) Probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Other earthquakes)	**Fig. 3.3.2-3(b)** Ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (Other earthquakes)

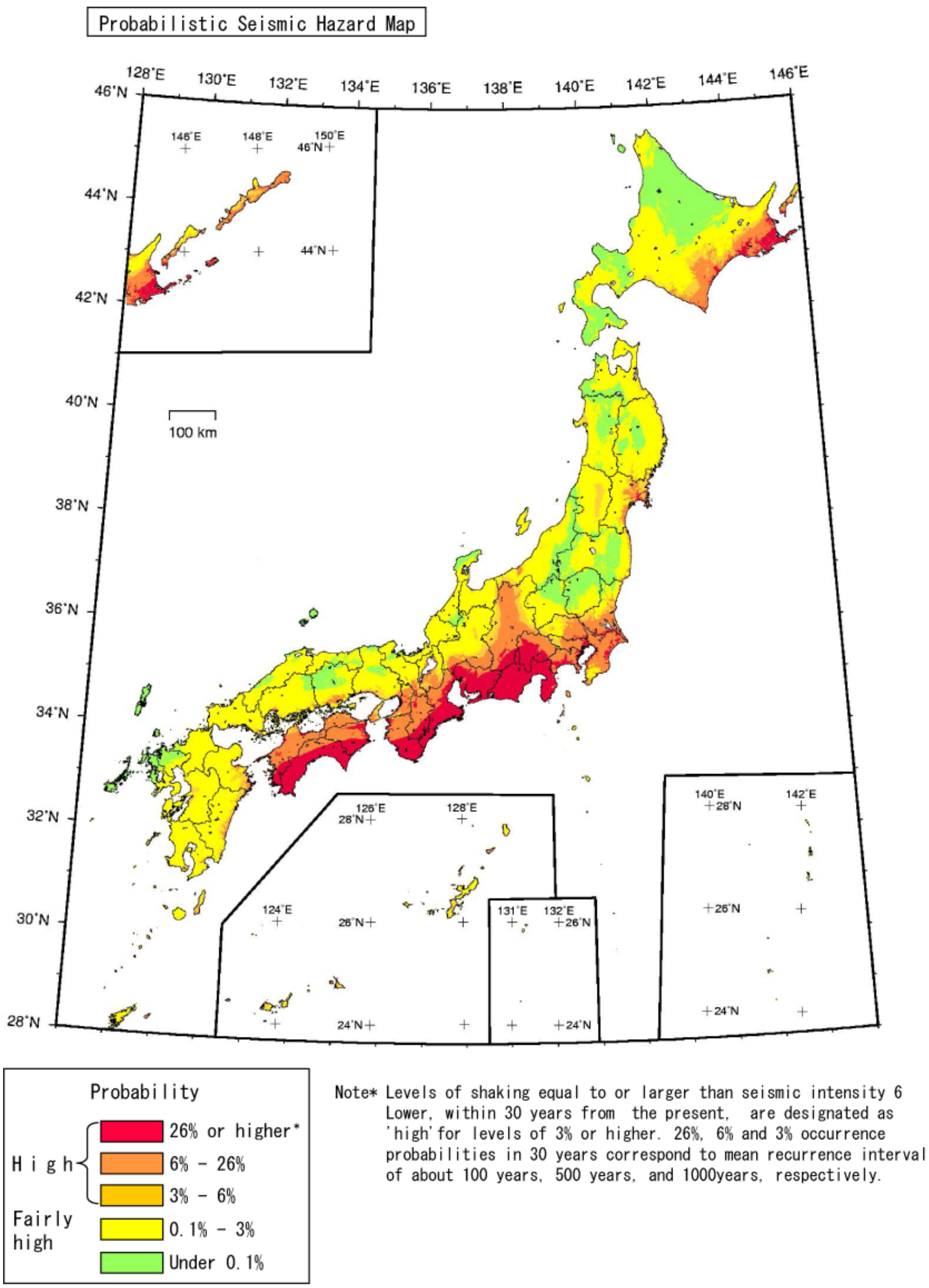
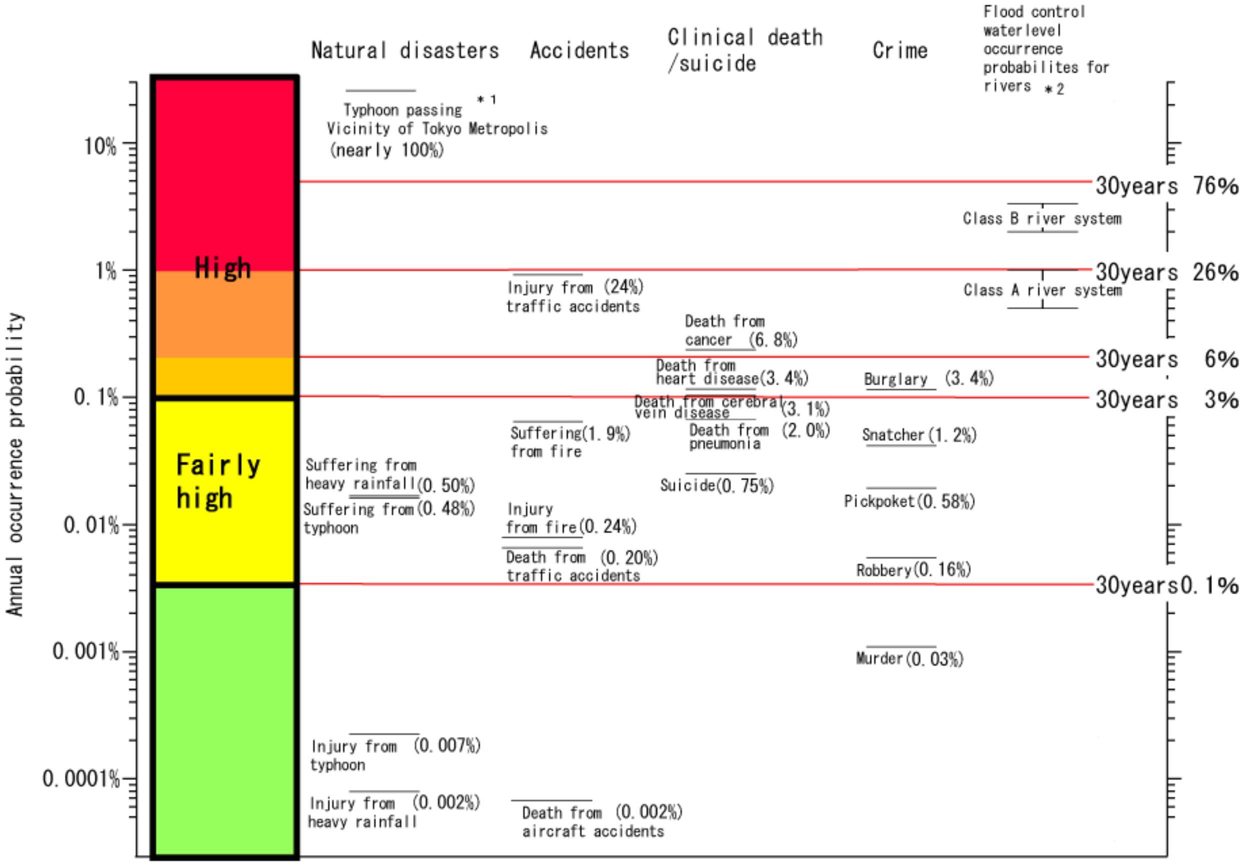


Fig. 3.3.1-1 Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present. (Start date: January 1, 2005)**

Note Values for instrumental seismic intensity larger than 5.5 (lower limit of seismic intensity 6Lower) are shown here.**

◆Statistical data on annual occurrence probabilities of natural disasters and accidents in Japan

Statistical data to show the meaning of an annual occurrence probability of several % within 30 years, in comparison with the possibilities of other disasters, accidents, and crime. Because occurrence probabilities of natural disasters, such as earthquakes and probabilities of death and injury can not be compared directly, this is presented only as reference information.



Ref. Fig.1 Comparison of annual occurrence probabilities

Figures in parentheses denote 30-year occurrence probabilities

Note 1) Probability that a typhoon passes within a 30-km radius of the seat of a prefectural government.

Note 2) Occurrence probability of precipitation for setting water level standards for design and maintenance (programmed water level) of river banks. 30-year term probabilities are not shown because, as explained on the next page, the values are set to for expected precipitation occurring in tens to hundreds of years, which cannot be used for direct comparisons.

Annual occurrence probabilities in Ref. Fig. 1 were calculated based on the following conditions and statistical data:

○ Values calculated assuming a Poisson model.

○ Aircraft accident values are for 1983 through 2002, and calculated as the rate of the deaths for the number of passengers. For other categories, the ratios are calculated with respect to the total population .

○ Considering the variations of occurrence numbers for natural disasters (typhoon, heavy rainfall and strong wind) in recent years, we used average values of annual occurrence probabilities for 1983 through 2002 , whereas annual occurrence probabilities for accidents, disease and crimes are for last year.

■Statistical data

○ Overall population: Based on the estimated population by the Statistics Bureau ,Ministry of Internal Affairs and Communications. http://www.stat.go.jp/data/jinsui/index.htm

○ Traffic accidents: The National Police Agency White Paper (1983 – 2002)

These are the road traffic statistics for the accidents accompanied by human death and injury, caused by transport of vehicles, tramcars and trains on the road. Accordingly, accidents at railroad crossings are included, but other train accidents are not included. The number of deaths in the traffic statistics is defined as those that died within 24 hours after occurrence of the accident. The number of injured is defined as those that suffered from severe injuries and flesh wounds.

○ Fire: The Fire and Disaster Management Agency White Paper (1983 – 2002)

The number deaths excludes suicides by fire. Those who died within 48 hours after injury by fire are counted as deaths. Victims from fires are the people that lived in houses that were destroyed by fire, and their numbers are counted regardless of the amount of damaged .

○ Typhoons, heavy rainfall, strong winds, and earthquakes/volcanic events: 'Japan Statistical Yearbook' by the Ministry of Internal Affairs and Communications, Statistics Bureau (1983 - 2002)

The victims are defined as those following who were unable to maintain ordinary livelihoods due to the disaster:

(1) Dead, injured and lost

(2) Members of households that suffered damage caused by complete or half collapses of homes, washouts, total or partial loss by fire, and flooding above the floor of the home.

(Based on the 'Monthly Report of Disasters' by the Security Division, Security Bureau, National Police Agency.)

○ Typhoons : Digital Typhoon (http://www.digital-typhoon.org/) (1951 - 2000)

Poisson probability of the annual occurrence = 1-exp(-λ) was calculated from the annual average number (λ= 0.3) of typhoons passing across a circle with 30-km radius and centered at the Tokyo metropolitan governmental seat, based on the route map of the typhoon (best track data) published by the Japan Meteorological Agency.

○ Aircraft accidents: Aircraft and Railway Accidents Investigation Commission, Ministry of Land Infrastructure and Transport (1983 - 2002)

Annual Statistical Report on Air Transport, Ministry of Land Infrastructure and Transport

Only domestic accidents of large passenger aircrafts are reported by the Investigation Committee. The probability has been calculated with ratio of the deaths to the number of passengers, combining regular domestic and international flights.

There have been only the following three fatal accidents in 20 years:

1985, Japan Airlines #123 crashed at Mt. Osutaka (520 deaths)

1994, China Airlines crashed at Nagoya Airport (264 deaths)

1996, Garuda Indonesia over ran the runway (3 deaths)

○ Disease: Vital Statistics of the Japan, Ministry of Health, Labour and Welfare (1995 - 2001)

Number of the deaths from pneumonia in addition to the three major causes of death: Malignant tumors (cancer), heart diseases (cardiac infarction, cardiac failure etc.) and cerebrovascular diseases (subarachnoid bleeding etc.).

Statistics have been taken from 1995, when the calculation procedures were changed, until 2001.

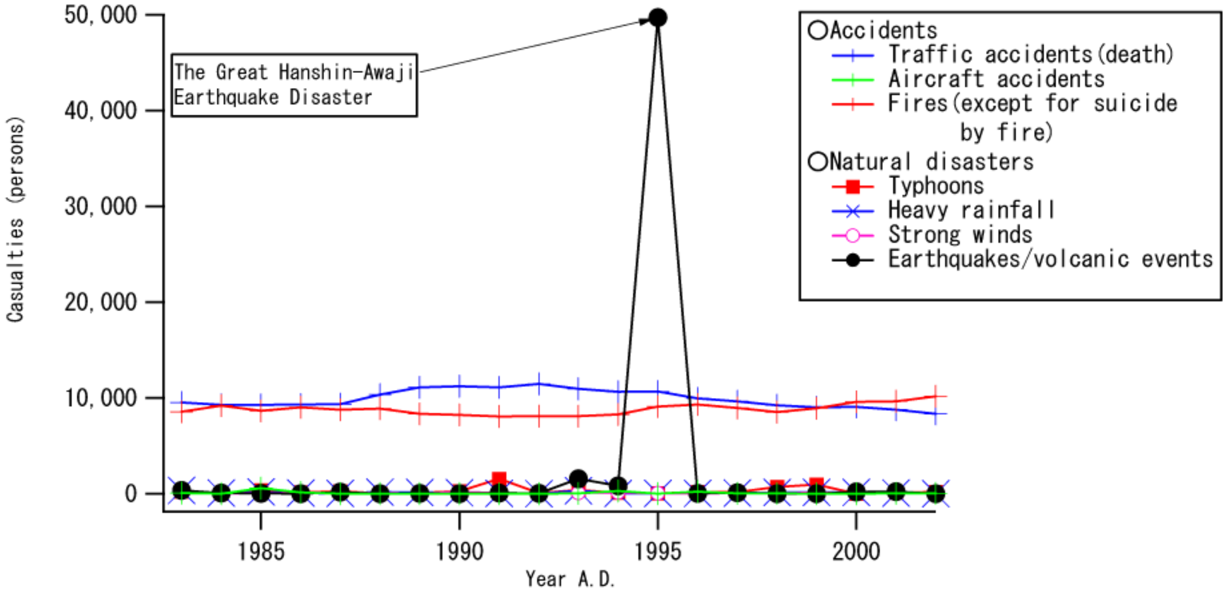
○ Suicides and crime: The National Police Agency White Paper (1989 - 2002)

Number of cases recognized as crimes of burglary, snatchers, pickpockets, robbery and murder (verified police accounts of crimes with notifications of loss), and number of suicides.

○ Flood-control water-level occurrence probabilities for rivers: The river improvement plan/the basic policy for river improvement by the River Bureau,Ministry of Land Infrastructure and Transport.

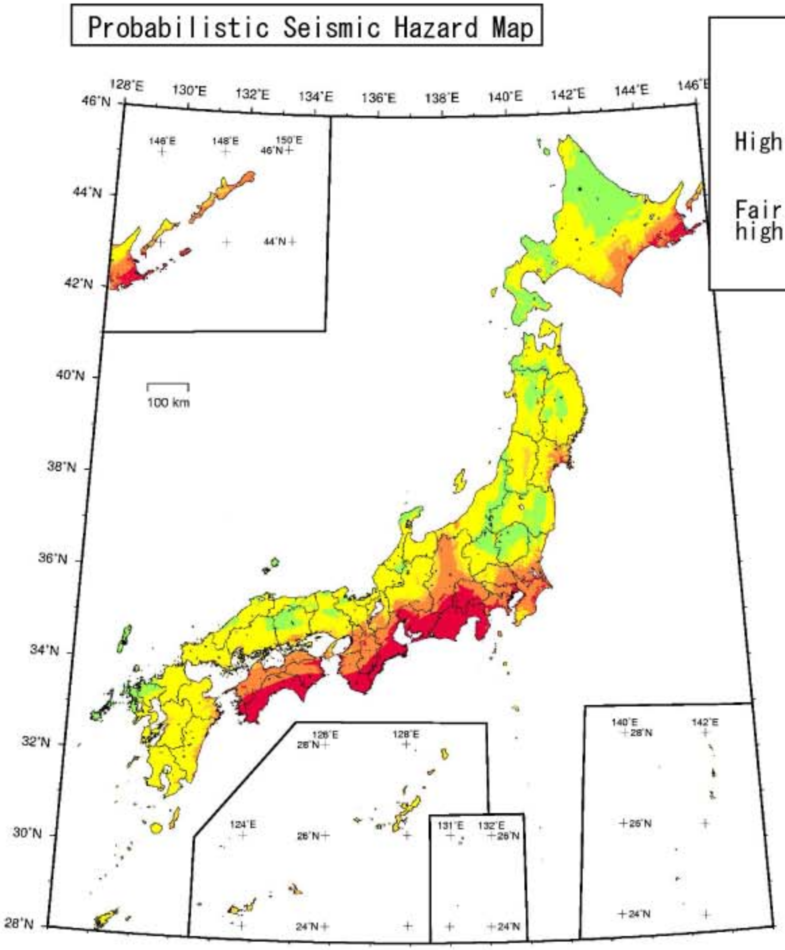
(http://www.mlit.go.jp/river/gaiyou/seibi/index.html)

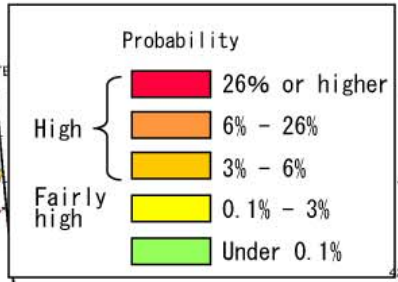
Occurrence probability of precipitation assumed for setting water levels for standards of design and maintenance (programmed water level) of the banks in flood control plans for rivers. The levels are determined by taking into account factors such as, the river administration classification, importance of peripheral areas, and characteristic of precipitation, and assuming a frequency of once in tens to hundreds of years. Class A river systems are particularly important in land conservation and for the national economy, and have been designated by government ordinance. Class B river systems have important relations with public interest, other than those for class A, and are administrated by local governments.



Ref.Fig.2 Casualties caused by accidents and natural disasters

Ref. Fig. 2 shows the casualties caused by accidents and natural disasters in the period from 1983 to 2002. This graph shows the characteristics of earthquake disasters, which cause tremendous damage, such as the Great Hanshin-Awaji Earthquake Disaster, although their occurrences are infrequent. This is different from events that cause many casualties every year, such as traffic accidents or fires.





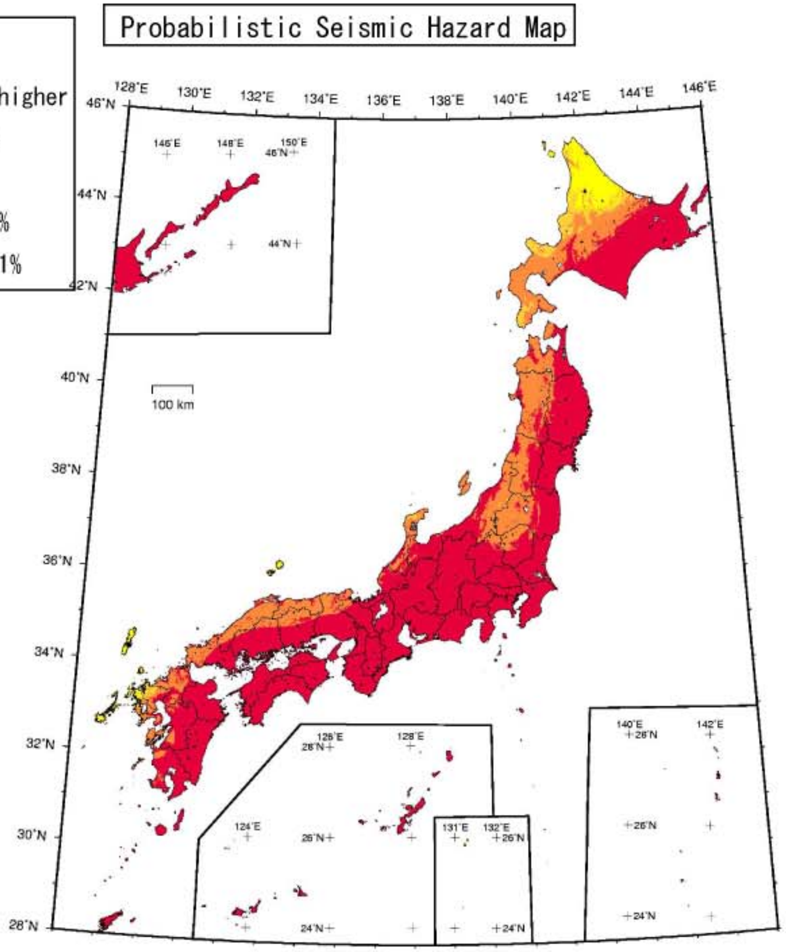
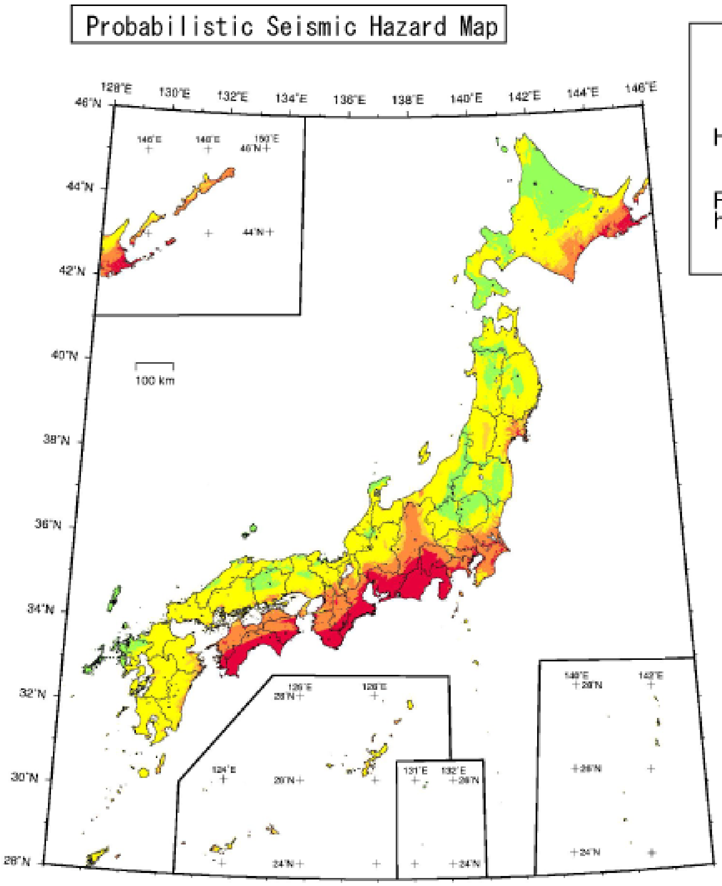
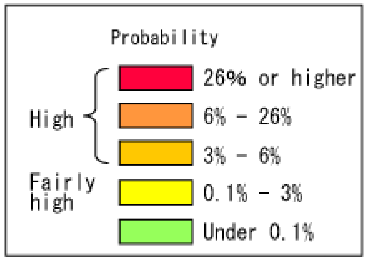


Fig. 3.3.1-2(a) Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Duplication of Fig. 3.3.1-1 for comparison).
(Start date: January 1, 2005)

Fig. 3.3.1-2(b) Distribution map of probability of ground motions equal to or larger than seismic intensity 5 Lower, occurring within 30 years from the present.
(Start date: January 1, 2005)





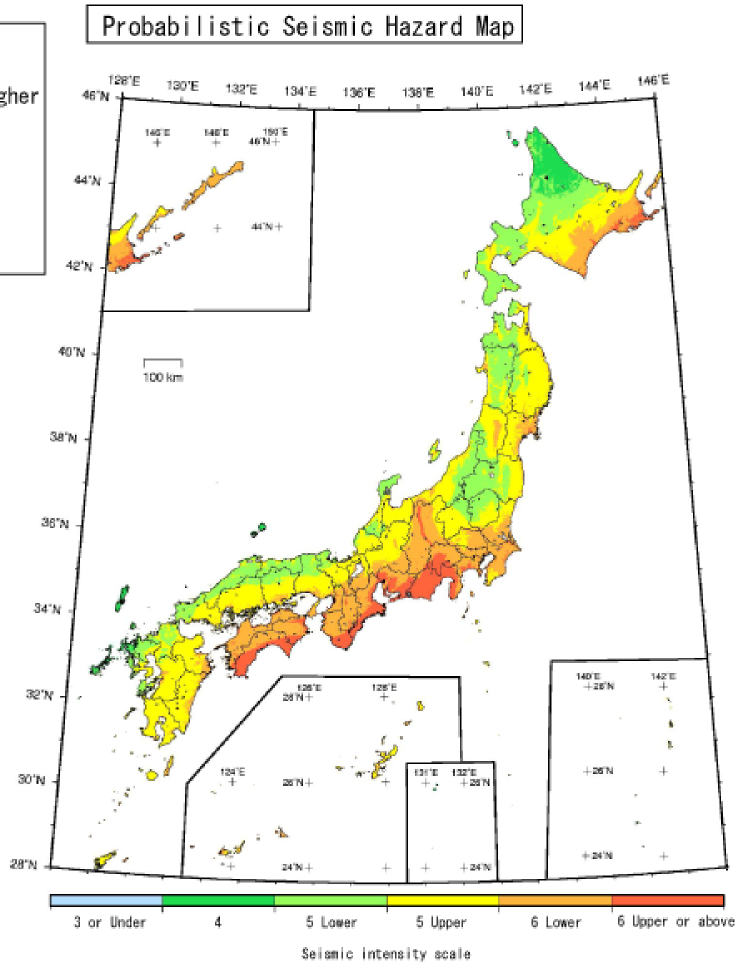


Fig. 3.3.1-3(a) Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Duplication of Fig. 3.3.1-1 for comparison).
(Start date: January 1, 2005)

Fig. 3.3.1-3(b) Map of ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present.
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

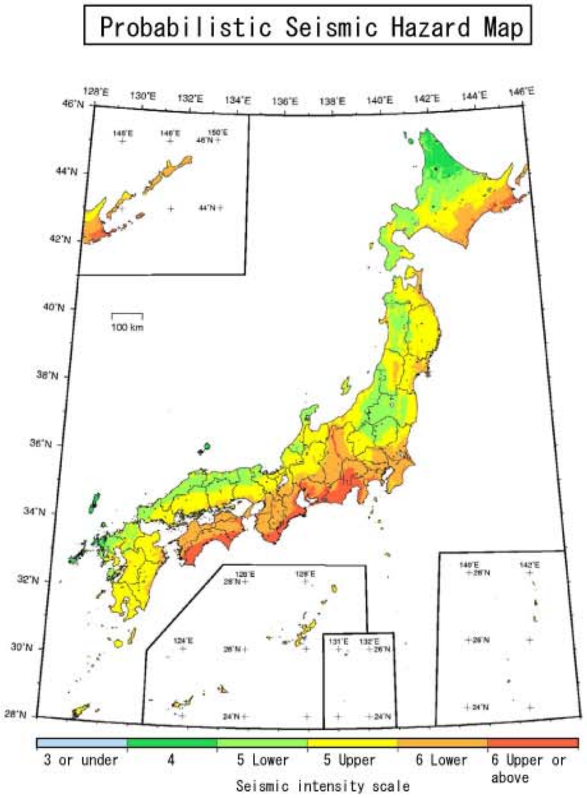


Fig. 3.3.1-4(a) Map of ground motions of seismic intensity for a 5% probability of exceedance occurring within 50 years from the present.
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

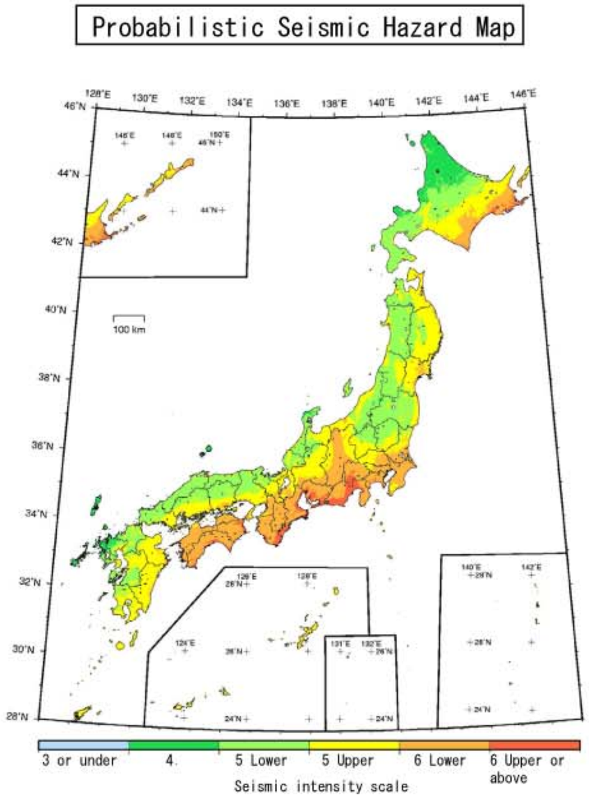


Fig. 3.3.1-4(b) Map of ground motions of seismic intensity for a 10% probability of exceedance
occurring within 50 years from the present.
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

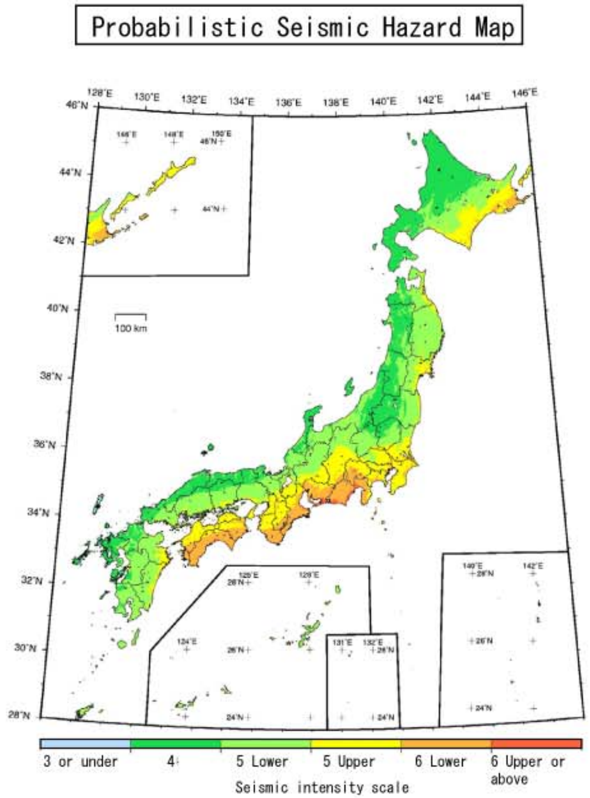


Fig. 3.3.1-4(c) Map of ground motions of seismic intensity for a 39% probability of exceedance occurring within 50 years from the present.
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

3.3.2 Maps for classifications of earthquakes

For the probabilistic hazard maps, in addition to considering all earthquakes in the target area, maps can be prepared also for specific earthquakes or earthquake classifications. Here we present maps for the three classifications: 'characteristic earthquakes in the 98 major active fault zones', 'subduction-zone earthquakes' with 'long-term evaluations', and 'other earthquakes'.

Shown in **Fig. 3.3.2-1** through **Fig. 3.3.2-3** are similar maps as in **Figs. 3.3.1-3(a)** and **(b)**. They are **(a)** probabilities for shaking equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present and **(b)** seismic intensities for a 3% probability of exceedance in 30 years from the present, for the different earthquake classifications. The influence of subduction-zone earthquakes is large for areas of the Pacific coast of Japan, whereas inland areas have high probabilities of intense shaking at sites near the 98 major active fault zones, where the occurrence probability is high. It is noted that some areas have a fairly large effect caused by the 'other earthquakes' for which long-term evaluations were not done. In particular, the Kanto area and the Pacific coast of the eastern Hokkaido have high probabilities for intense shaking from the 'other earthquakes'. One of the cited merits of probabilistic seismic hazard map is that the combined effects of 'other earthquakes' can be included even if individual earthquakes cannot be evaluated. To improve disaster mitigation for earthquakes that cannot be specifically located, such as the 2004 Niigata Chuetsu Earthquake, probabilistic seismic hazard maps are complementary to the 'seismic hazard maps for specified seismic source faults'.

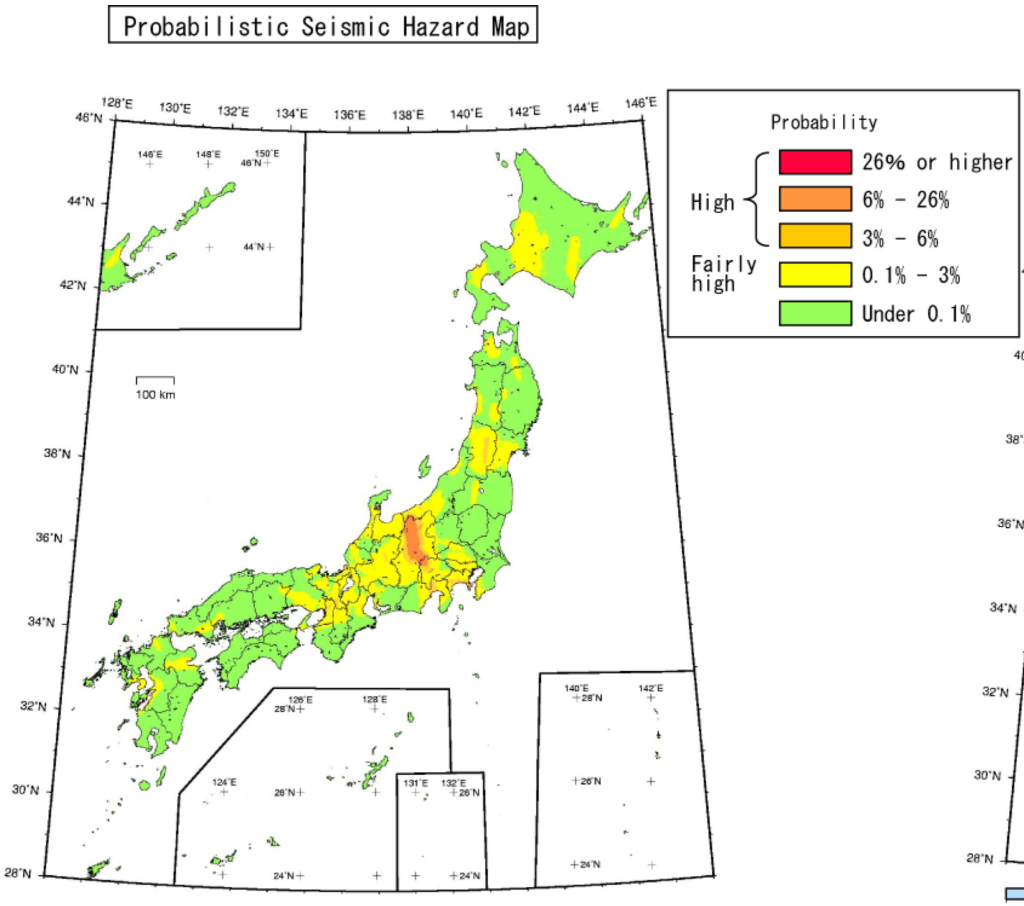


Fig. 3.3.2-1(a) Distribution map of probabilities of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (The case for only characteristic earthquakes in the 98 major active fault zones).
(Start date: January 1, 2005)

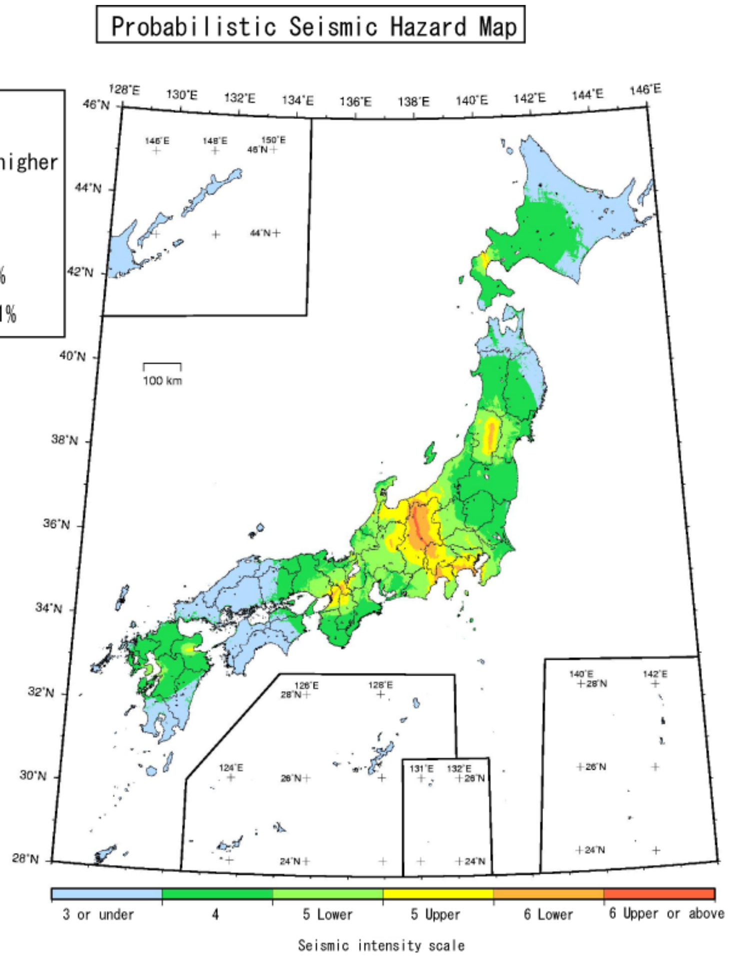


Fig. 3.3.2-1(b) Map of ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (The case for only characteristic earthquakes in the 98 major active fault zones).
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

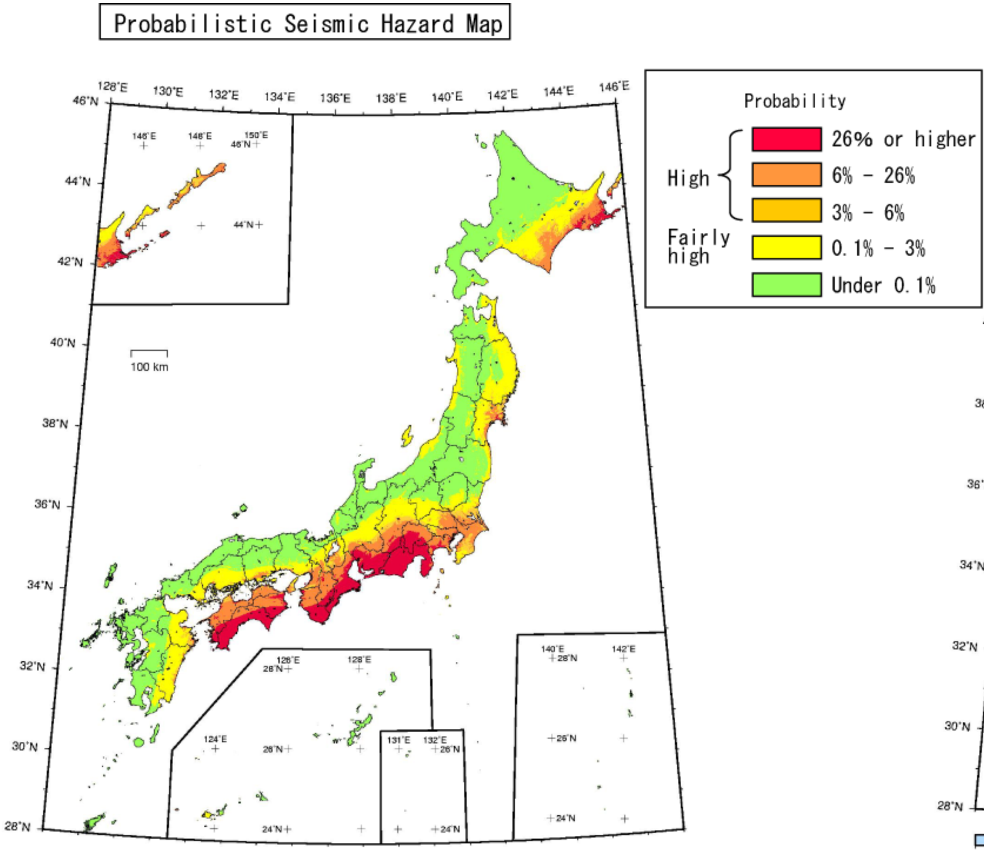


Fig. 3.3.2-2(a) Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (The case for only subduction-zone earthquakes).
(Start date: January 1, 2005)

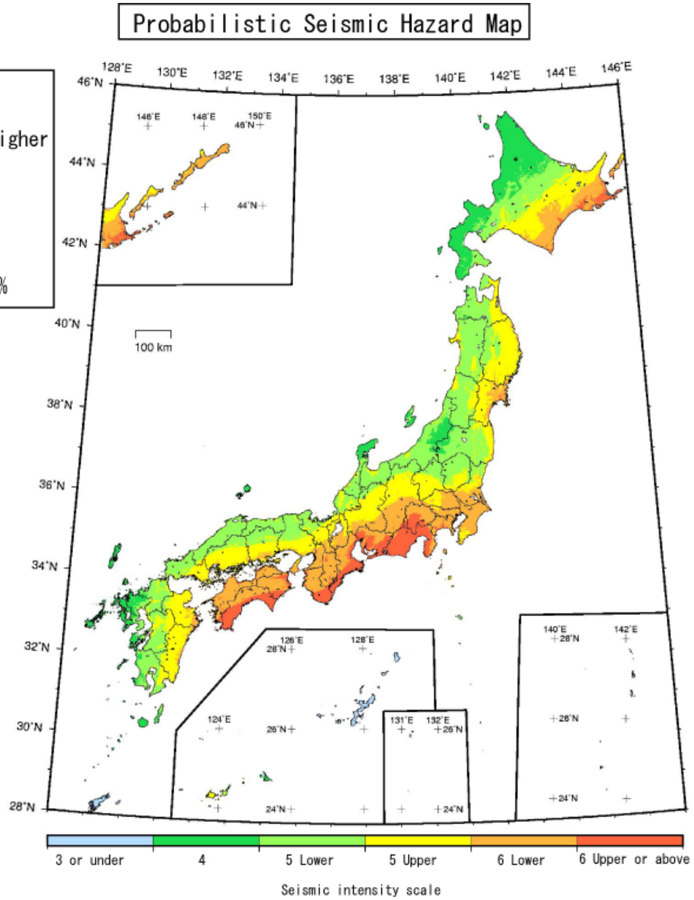
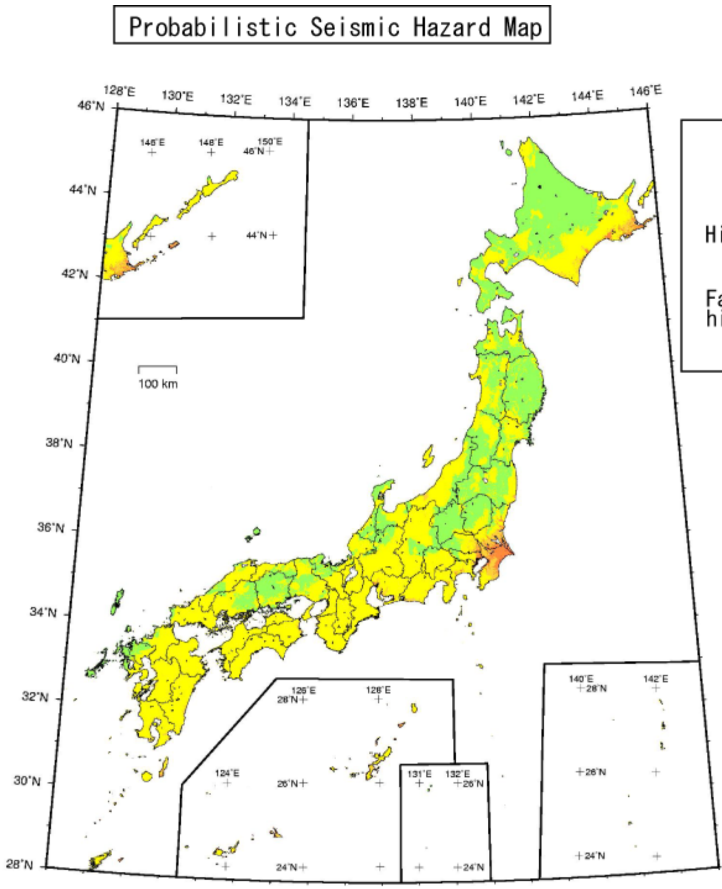
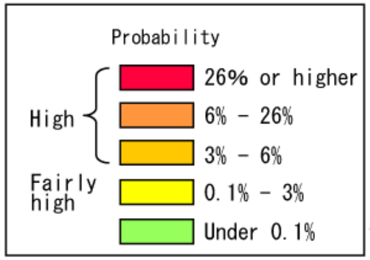


Fig. 3.3.2-2(b) Map of ground motions of seismic intensity for a 3% probability of exceedance occurring within 30 years from the present (The case for only subduction-zone earthquakes)
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)





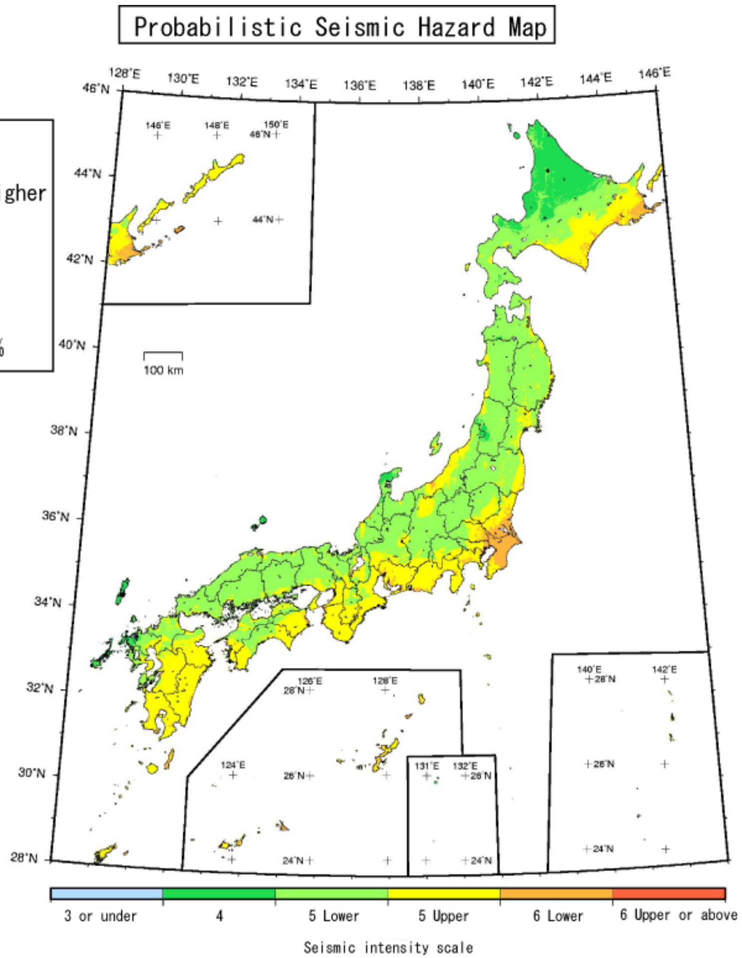


Fig. 3.3.2-3(a) Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower occurring within 30 years from the present (The case for 'Other earthquakes').
(Start date: January 1, 2005)

Fig. 3.3.2-3(b) Map of ground motions of seismic intensity at 3% probability of exceedance occurring within 30 years from the present (The case for 'Other earthquakes').
* Intensity value of 6 Upper or above, contains the possibility of seismic intensity 7.
(Start date: January 1, 2005)

3.4 Regional characteristics of the probabilistic seismic hazard maps

By dividing Japan into northern, central and western regions, we show the possibility of seismic intensity equal to or larger than 6 Lower, within 30 years from the present, at about 1 km square resolution, for the seats of the prefectural governments (seats of subprefectural governments in Hokkaido). In the present report, relative expressions of 'high' for 3% or higher and 'fairly high' for 0.1% to 3%, have been used. Furthermore, the type of earthquake and its degree of influence is shown for various locations. Bar graphs indicate the relative contribution from different types of earthquakes, to the probability of intensity equal to or larger than 6 Lower, within 30 years from the present.

Probabilities of shaking equal to or larger than seismic intensity 6 Lower, are dependent on the region, and bar graphs indicate the relative influence of different types of earthquakes, along with their numerical values. Among the evaluated regions with relatively low probabilities for seismic intensity 6 Lower or larger, there are some sites where the contribution of subduction-zone earthquakes appears relatively high. This is because the probability of nearby onshore earthquakes is low, even though the site is located in a land region. For the earthquakes on major active faults on land and subduction-zones, it is suggested to refer to the distribution maps of seismic intensities determined with the 'detailed method', shown in Chap. 4 and/or the 'conventional method' shown in Appendix 1 of the Separate Volume 2, in order to better understand the likely distribution of intensity.

3.4.1 Northern Japan region

Fig. 3.4.1-1 shows the probabilities of shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present, for northern Japan. Areas shown are Hokkaido, Aomori Pref., Iwate Pref., Miyagi Pref., Akita Pref., Yamagata Pref. and Fukushima Pref. Areas with high probability are seen on the Pacific coast of Hokkaido, the Pacific coast of Miyagi Pref. and the Pacific coast of Fukushima Pref. In addition, there are areas with high probability in the Yamagata Basin and the Hachiro-gata region of Akita Pref. Also, areas with fairly high probabilities extend across the inland areas and to the Japan Sea side. **Fig. 3.4.1-2** shows areas of major active faults on land and subduction-zone earthquakes in this region.

Fig. 3.4.1-3 shows the results of analyzing which types of earthquake largely influence the probabilities for the evaluated areas of about 1 km square, in the northern Japan region, including the seats of the prefectural and subprefectural governments.

Note that the results showing the influence of different types of earthquakes for each evaluated area, may not be representative of an entire prefecture. As seen in **Fig. 3.4.1-1**, the possibility of intense shaking is different depending on the site within each prefecture, and the degree of influence of different types of earthquakes depends on the site.

Described below are the earthquakes that influence each evaluated area.

From **Fig. 3.4.1-3**, **Sapporo City (Hokkaido)** has a fairly high possibility of shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present, and the influence is highest from the characteristic earthquakes of the 98 major active fault zones. This is caused by the Ishikari-teichi-toen fault zone which has a high occurrence probability.

For Hokkaido, results of the evaluated areas, including the seats of subprefectural governments are shown, because the region is vast. **Sapporo City (Ishikari Subpref.)** has a fairly high possibility to experience shaking equal to or larger than seismic intensity 6 Lower, similar to the seat of the Hokkaido Government. **Hakodate City (Oshima Subpref.)** has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and has a high influence from characteristic earthquakes in the northern Sanriku-Oki region, and from earthquakes occurring at sites where active faults have not been specified. **Muroran City (Iburi Subpref.)** has a high influence from earthquakes occurring at sites where active faults have not been specified. **Iwamizawa City (Sorachi Subpref.)** has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower. This is caused by the Ishikari-teichi-toen fault zone, which has a high occurrence probability. **Kutchan Town (Shiribeshi Subpref.)**and **Esashi Town (Hiyama Subpref.)** have fairly high possibilities for shaking equal to or larger than seismic intensity 6 Lower, and both towns have a high influence from earthquakes occurring at sites where active faults have not been specified. For Esashi Town, earthquakes without specified source faults, in the eastern margin of the Japan Sea also have a relatively high influence. **Wakkanai City (Souya Subpref.)** has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and has a high influence from active faults other than the 98 major active fault zones. **Rumoi City (Rumoi Subpref.)** has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and is highly influenced by characteristic earthquakes in the 98 major active fault zones. Also, earthquakes without specified source faults are next in the degree of influence for this area. Much the same is true for earthquakes that influence **Asahikawa City (Kamikawa Subpref.)**. **Abashiri City (Abashiri Subpref.)** has fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and has a high degree of influence from relatively deep and shallow earthquakes within the subducted Pacific plate. Furthermore, the degree of influence is the same for earthquakes occurring on active faults other than the 98 major active fault zones. **Urakawa Town (Hidaka Subpref.)** has a high possibility for shaking equal to or larger than seismic intensity 6 Lower. The highest influence is from the combination of ocean trench earthquakes that have long term evaluations and other subduction zone earthquakes. Moreover, the influence of earthquakes one magnitude smaller in the northern Sanriku-Oki and Tokachi-Oki/Nemuro-Oki regions, is also high. **Obihiro City (Tokachi Subpref.)**, **Kushiro City (Kushiro Subpref.)** and **Nemuro City (Nemuro Subpref.)** all have a high possibility for shaking equal to or larger than seismic intensity 6 Lower, and are highly influenced by earthquakes within the subducted Pacific plate. The influence of earthquakes in the Tokachi-Oki/ Nemuro-Oki region is also high for Kushiro City and Nemuro City.

Aomori City (Aomori Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and is highly influenced by the nearby Aomori-wan-seigan Fault Zone, among the 98 major active fault zones. The highest degree of influence is from the subduction-zone earthquakes in the northern Sanriku-Oki region.

Morioka City (Iwate Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and the degree of influence is high for subduction-zone earthquakes, such as in the Miyagi-Oki and northern margin of Sanriku-Oki regions. There is a relatively high influence from earthquakes occurring on active faults other than the 98 major active fault zones, and at locations where active faults have not been specified.

Sendai City (Miyagi Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower. This location is highly influenced by the nearby seismic source region of the Miyagi-Oki Earthquake, which has a occurrence probability of higher than 99% within 30 years from the present. Also, the influence of earthquakes is considered to be high for the

Nagamachi-Rifu-sen fault zone of the 98 major active fault zones.

Akita City (Akita Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and has the highest influence from Akita-Oki earthquakes in the eastern margin of the Japan Sea. Earthquakes on the Kitayuri fault, of the 98 major active fault zones, are considered to have a high degree of influence. The influence of earthquakes occurring at sites where active faults have not been specified, is also relatively high.

Yamagata City (Yamagata Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower. This region is predominantly influenced by the characteristic earthquakes of the Yamagata-bonchi fault zone, which belong to a group of the 98 major active fault zones with a high occurrence probability.

Fukushima City (Fukushima Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and has a high influence from characteristic earthquakes in the 98 major active fault zones and the Miyagi-Oki Earthquake.

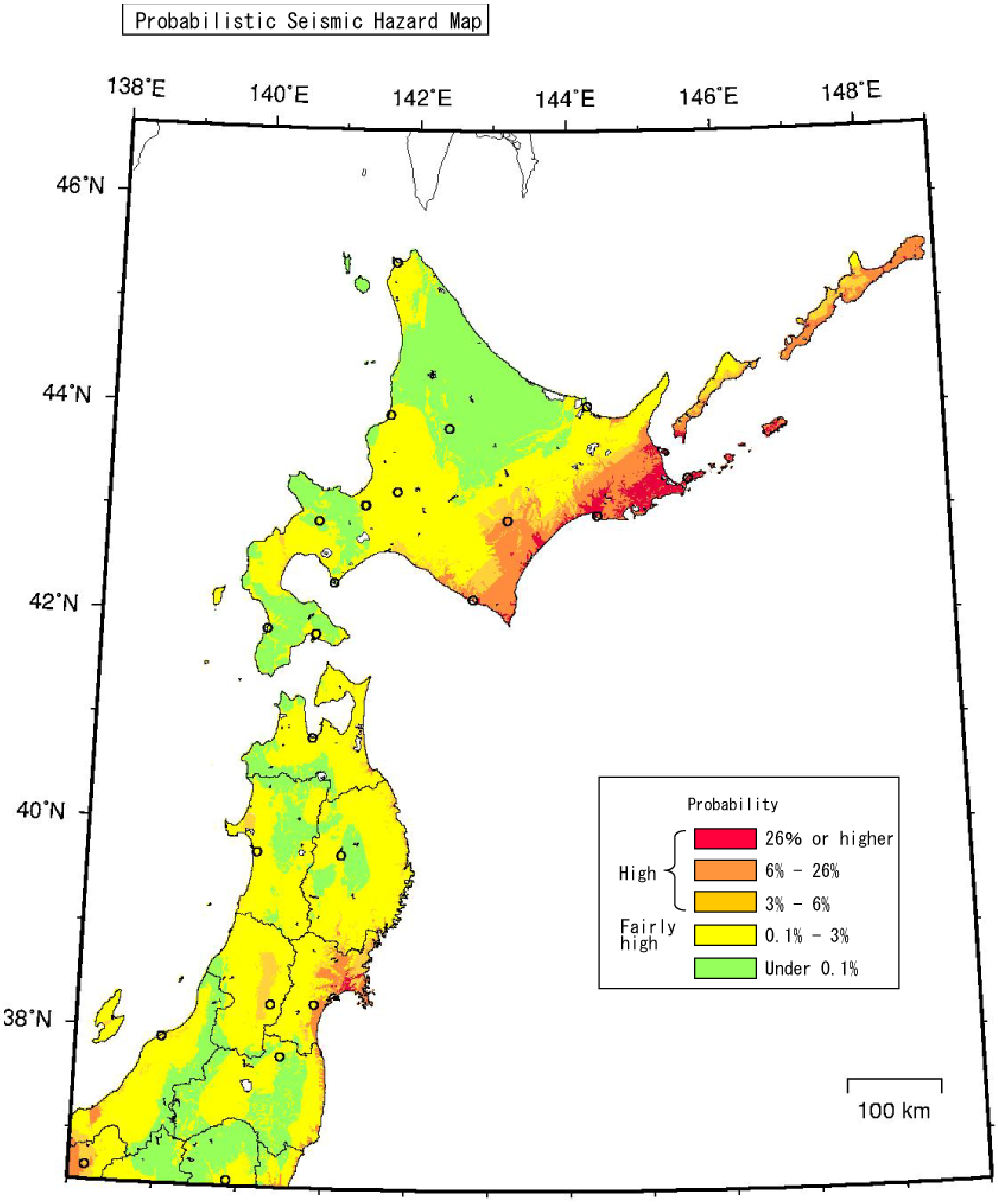


Fig. 3.4.1-1 Probabilities of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Northern Japan region).
(Start date: January 1, 2005)
○ denote seats of metropolitan, Hokkaido, prefectural and Hokkaido subprefectural governments. (Fig. 3.4.1-3 shows the degrees of influence for different types of earthquakes.)

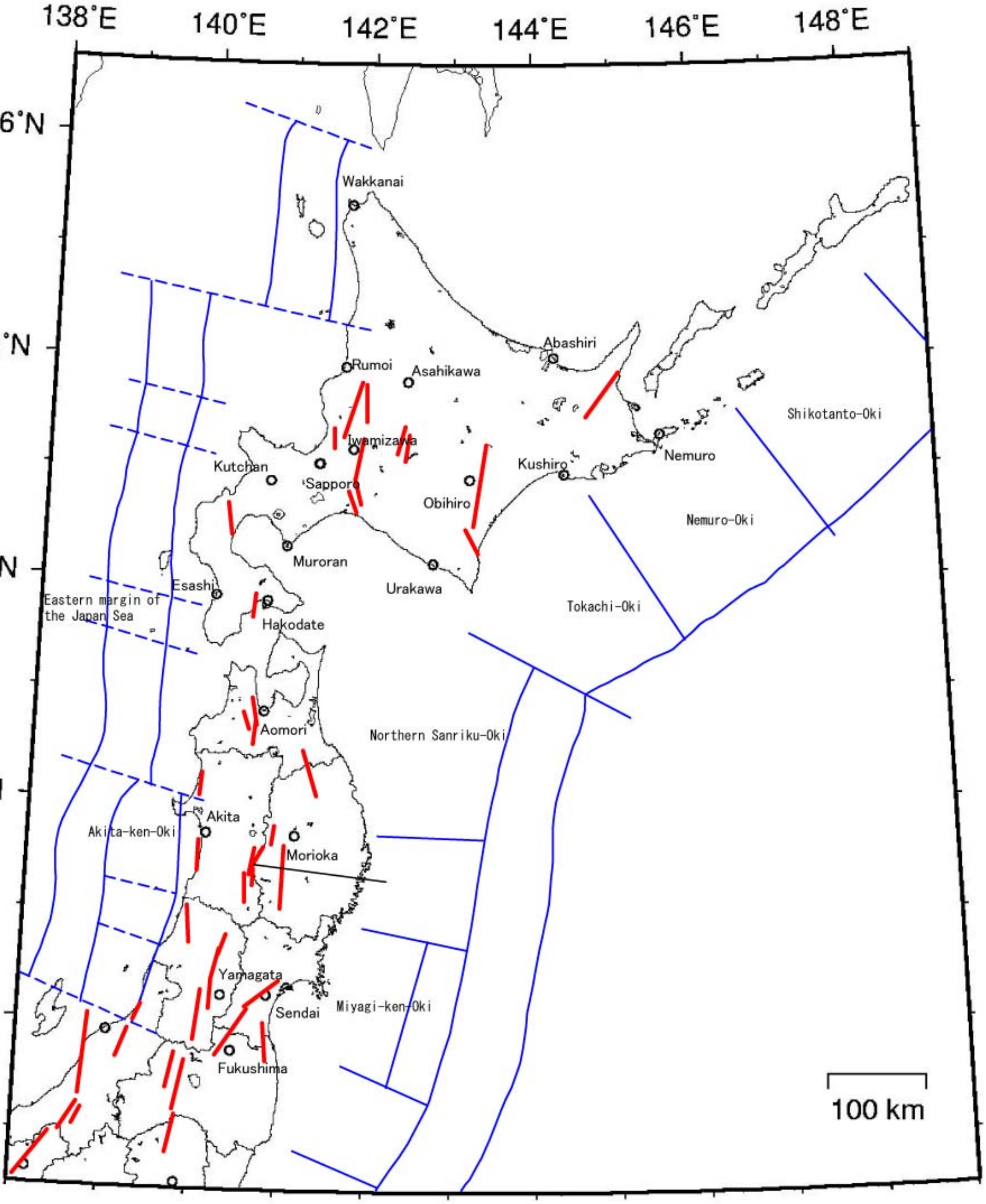


Fig. 3.4.1-2 Locations of the 98 major active fault zones and areas of subduction-zone earthquakes in the Northern Japan region.
Red lines: Upper edges of the fault models of the 98 major active fault zones
Blue lines: Areas of subduction-zone earthquakes
○ denote seats of metropolitan, Hokkaido, prefectural and Hokkaido subprefectural governments. (Fig. 3.4.1-3 shows the degrees of influence for different types of earthquakes.)

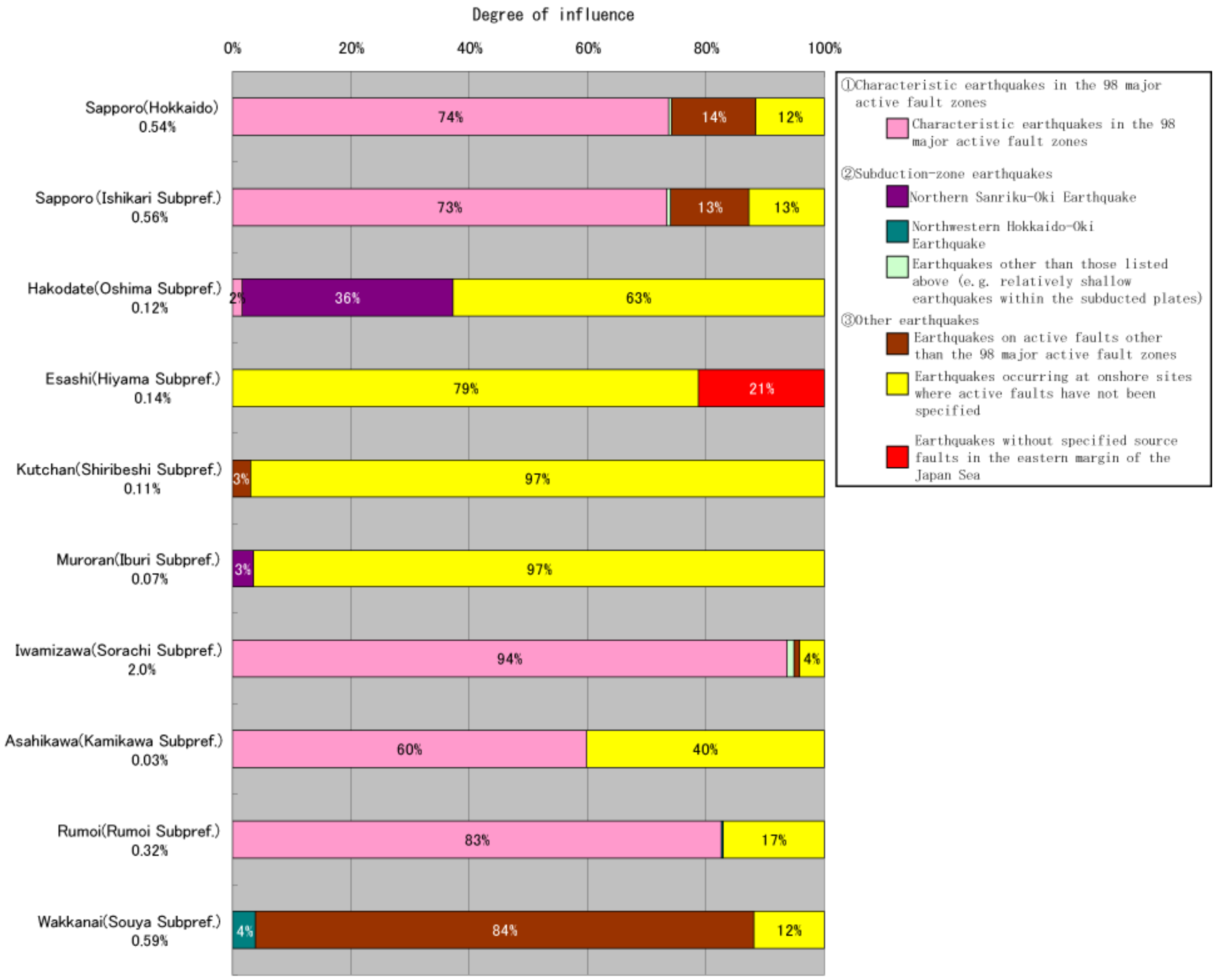


Fig. 3.4.1-3 (Part 1) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

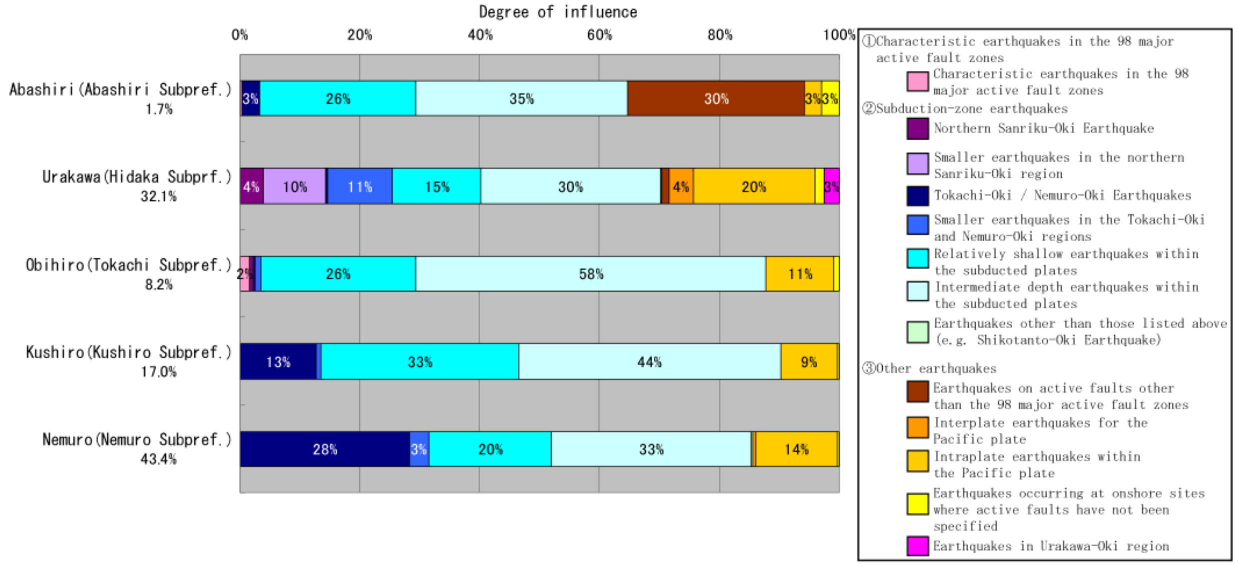


Fig. 3.4.1-3 (Part 2) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

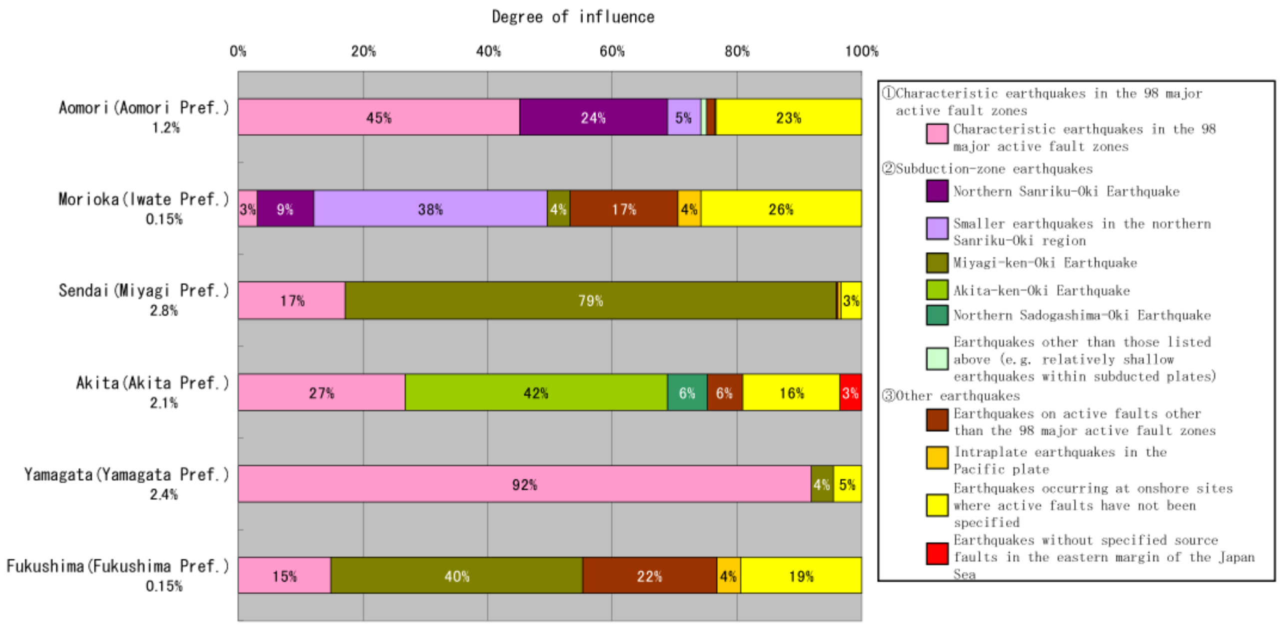


Fig. 3.4.1-3 (Part 3) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

3.4.2 Central Japan region

Fig. 3.4.2-1 shows probabilities of shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present, for the central Japan region. Areas shown are Ibaraki, Tochigi, Gunma, Saitama and Chiba, Kanagawa, Niigata, Toyama, Ishikawa, Yamanashi, Nagano, Gifu, Shizuoka and Aichi Prefectures and the Tokyo Metropolis.

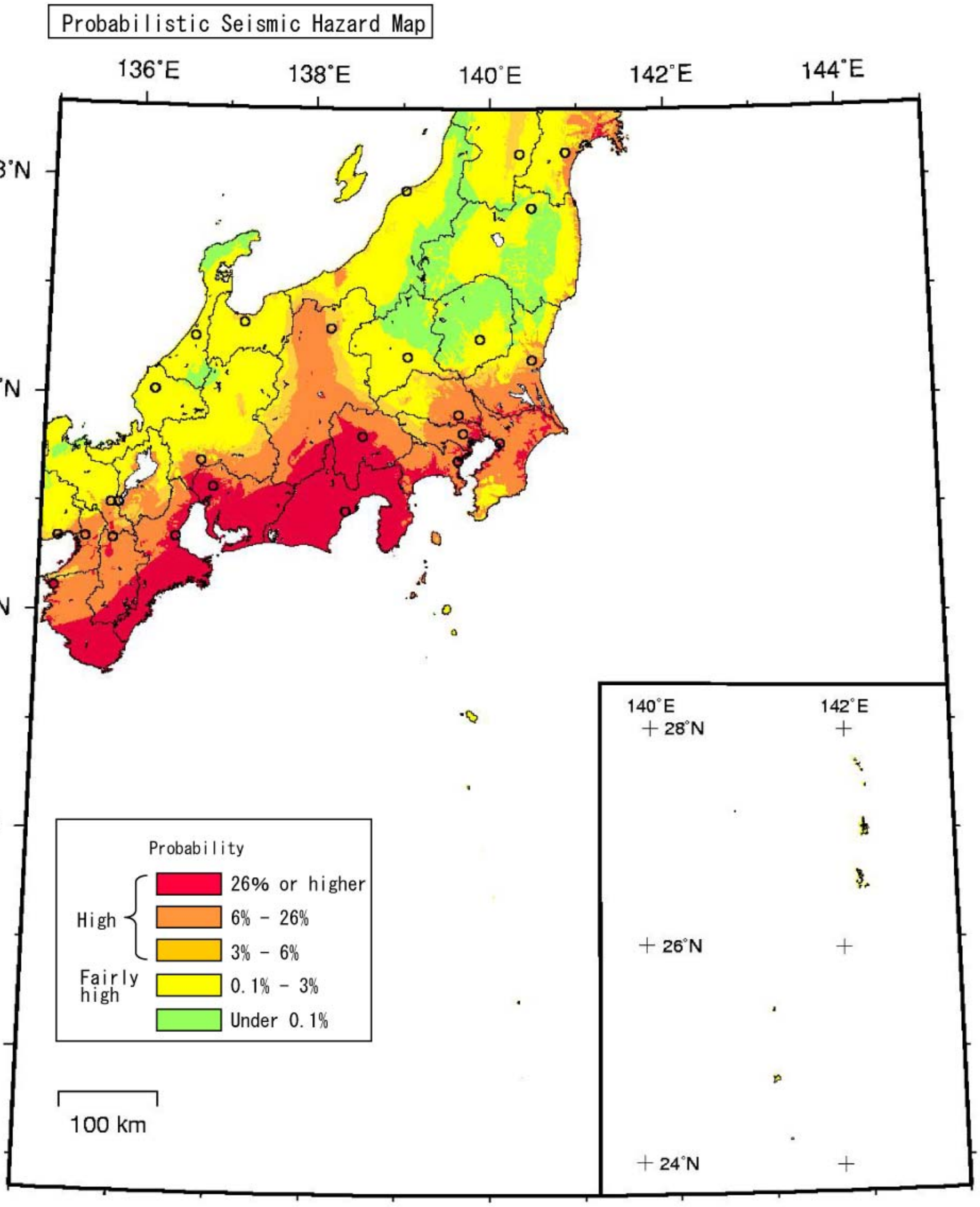


Fig. 3.4.2-1 Probabilities of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Central Japan region).
(Start date: January 1, 2005)
O denote seats of metropolitan, Hokkaido and prefectural governments.
(Fig. 3.4.2-3 shows the degrees of influence for different types of earthquakes.)

Shown in **Fig. 3.4.2-2** are regions of major active faults and subduction-zone earthquakes. These areas are largely influenced by earthquakes along the Nankai Trough (Tokai and Tonankai earthquakes), which have been evaluated with a high probability for the entire areas of Shizuoka and Aichi Prefectures. Areas with high probability extend over the whole Kanto Plain, where the Tokyo Metropolis, the prefectures of Kanagawa, Saitama and Chiba, and the southern part of Ibaraki Pref. are located. In addition, regions with high probability extend in a north-south area in central portion of Nagano Pref.

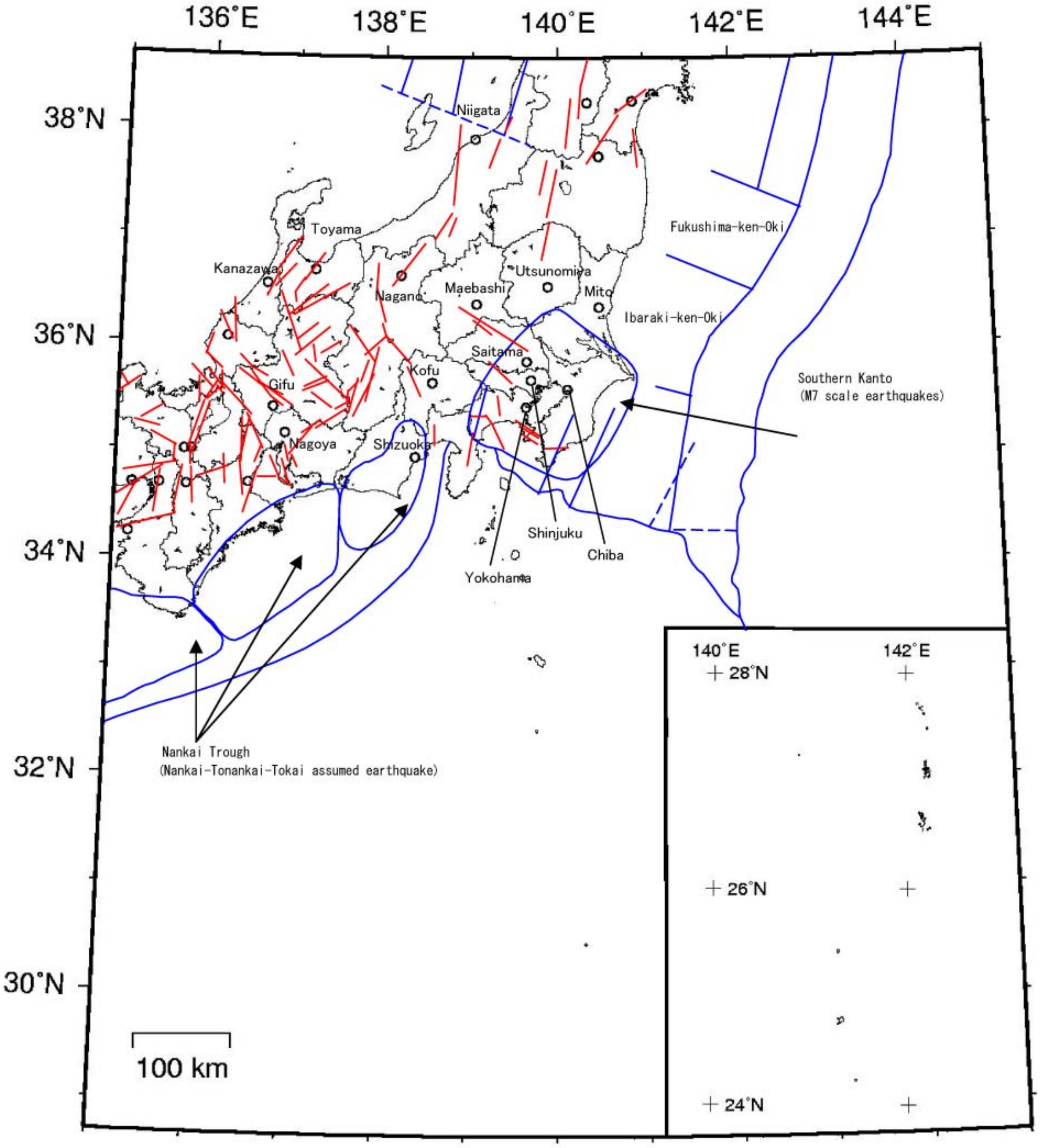


Fig. 3.4.2-2 Locations of the 98 major active fault zones and regions of subduction-zone earthquakes in the central Japan area.
Red lines: Upper edges of the fault models of the 98 major active fault zones
Blue lines: Regions of subduction-zone earthquakes
O denote seats of metropolitan, Hokkaido and prefectural governments.(Fig. 3.4.2-3 shows the dgrees of influence for different types of earthquakes.)

Fig. 3.4.2-3 shows results of analyzing which types of earthquakes highly influence the evaluated areas of about 1 km square, in the central Japan region, including the seats of prefectural and metropolitan governments. This indicates the degree of influence for earthquakes that contribute to intensities equal to or larger than 6 Lower, within 30 years from the present. Described below are the earthquakes that influence each evaluated area:

Maebashi City (Gunma Pref.) has a fairly high possibility for seismic intensity equal to or larger than 6 Lower, within 30 years from the present, and earthquakes along the Nankai Trough have a relatively high influence.

Mito City (Ibaraki Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes with magnitudes of about 7 in southern Kanto and those occurring within the subducting Pacific plate have a high influence.

Utsunomiya City (Tochigi Pref.) has a fairly high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes with magnitudes about 7 in southern Kanto have a high influence. In addition, earthquakes occurring within the subducting Pacific plate and at sites where active faults have not been specified, have relatively high degrees of influence.

Saitama City (Saitama Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes with about magnitudes 7 in southern Kanto and along the Nankai Trough have a high degree of influence.

Chiba City (Chiba Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes of about magnitude 7 in southern Kanto have the highest degree of influence. It is also found that earthquakes occurring within the subducting Pacific plate have a relatively high influence.

Shinjuku Ward (Tokyo Metropolis) has a high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes occurring in the subduction zone have a high degree of influence. Earthquakes of about magnitudes 7 in southern Kanto have the highest degree of influence. It is also found that earthquakes along the Nankai Trough have a high influence.

Yokohama City (Kanagawa Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and earthquakes that have a high degree of influence are similar to the Shinjuku Ward. In addition, earthquakes in the Kannawa/Kozu-Matsuda fault zone, which have a higher occurrence probability among the 98 major active fault zones, have a relatively high influence.

Niigata City (Niigata Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and has a high degree of influence from earthquakes in the northern Sadogashima-Oki area in the eastern margin of the Japan Sea, but the highest influence is from active faults that have not been specified.

Toyama City (Toyama Pref.) has a fairly high possibility for seismic intensity equal to or larger than 6 Lower, and characteristic earthquakes in the 98 major active fault zones have a high degree of influence. This is due to the influence of the Takayama-Oppara and Tonami-heiya fault zones that have high occurrence probabilities.

Kanazawa City (Ishikawa Pref.) has a fairly high possibility for seismic intensity equal to or larger than 6 Lower, and characteristic earthquakes in the 98 major active fault zones have a high degree of influence. This is considered to be due to earthquakes on the Morimoto-Togashi fault zone, which has a high occurrence probability.

Kofu City (Yamanashi Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower. The degree of influence is highest from the Nankai Trough and there is also influence from earthquakes in the Itoigawa-Shizuoka–kozosen fault zone.

Nagano City (Nagano Pref.) has a high possibility for seismic intensity equal to or larger than 6 Lower, and the influence is dominant from characteristic earthquakes in the 98 major active fault zones. This is due to earthquakes with high occurrence probability along the Itoigawa-Shizuoka–kozosen fault zone, which runs north-south through central Nagano Prefecture.

Gifu City (Gifu Pref.), **Shizuoka City (Shizuoka Pref.)** and **Nagoya City (Aichi Pref.)** all have a high possibility for seismic intensity equal to or larger than 6 Lower. These regions are close to seismic source regions of earthquakes along the Nankai Trough, which have a very high degree of influence.

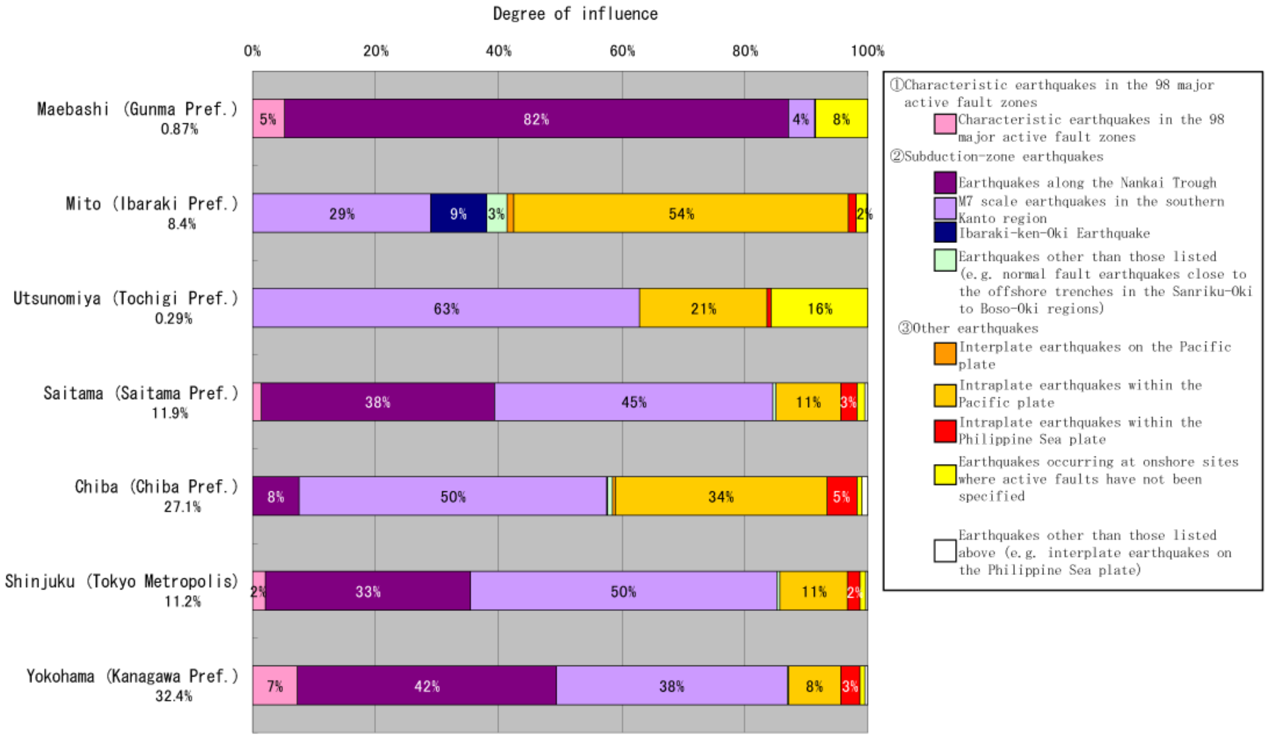


Fig. 3.4.2-3 (Part 1) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

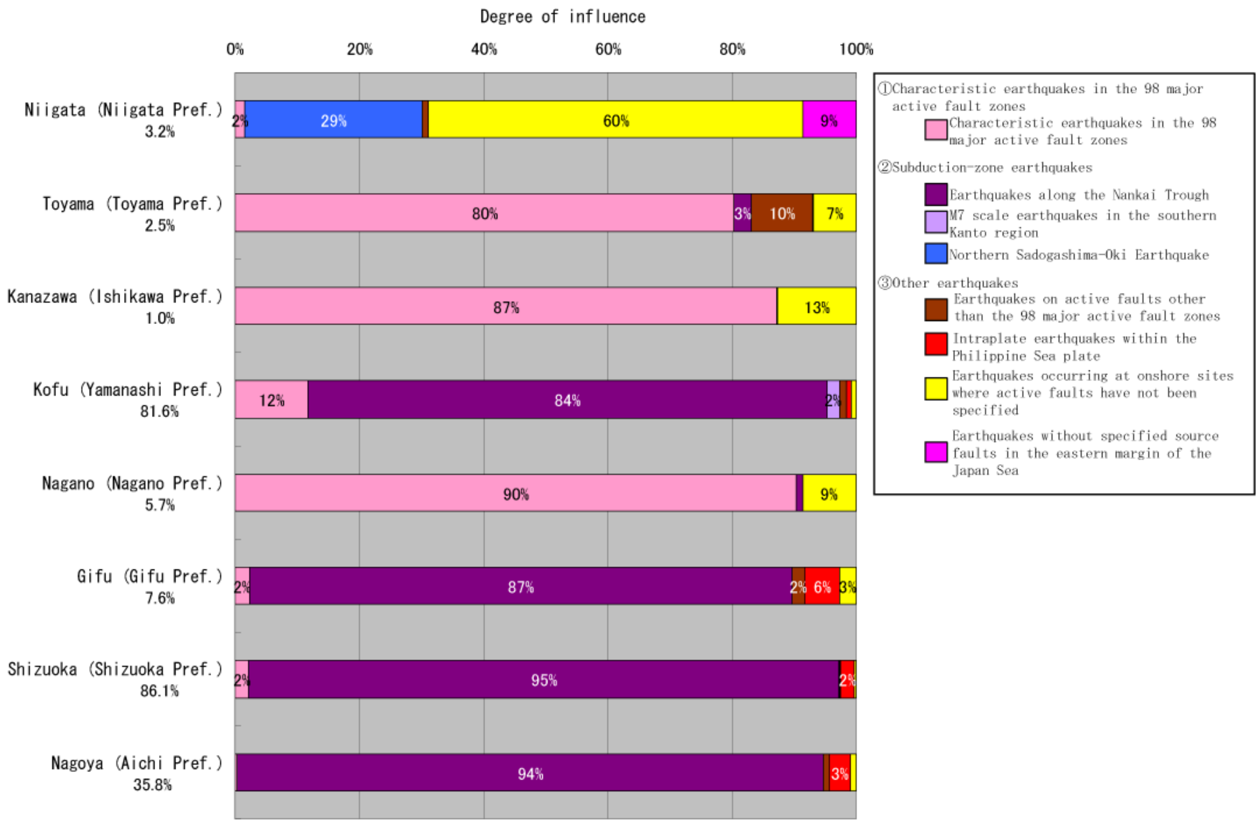


Fig. 3.4.2-3 (Part 2) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

3.4.3 Western Japan region

Fig. 3.4.3-1 shows probabilities of shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present, in the western Japan region. Areas shown are Mie, Shiga, Fukui, Nara, Kyoto, Wakayama, Osaka, Hyogo, Okayama, Hiroshima, Tottori, Shimane, Yamaguchi, Tokushima, Kagawa, Kochi, Ehime, Fukuoka, Oita, Saga, Nagasaki, Kumamoto, Miyazaki, Kagoshima and Okinawa Prefectures. Shown in **Fig. 3.4.3-2** are major active faults on land and regions of subduction-zone earthquakes. It has been evaluated in this area that the influence is large for earthquakes along the Nankai Trough (Tokai, Tonankai and Nankai earthquakes) and the probability is high in nearly all areas of the Kii Peninsula and Shikoku Island. Areas with high probability are also observed along parts of the coast of the Seto Inland Sea coast of Honshu, the Pacific coast of Oita and Miyazaki Prefs., and parts of the coast of Kumamoto Pref. Areas with high probability are also seen in the Nanseishoto. In inland areas, the probability is also high in the vicinity of Lake Biwa.

Fig. 3.4.3-3 shows the analyzed result for which types of earthquakes have high degrees of influence in the evaluation areas of about 1 km square, including the seats of prefectural governments in the western Japan region. This indicates the levels of influence for earthquakes that contribute to intensities equal to or larger than 6 Lower, within 30 years from the present. Described below are the earthquakes that influence each evaluated area:

From **Fig. 3.4.3-1**, **Tsu City (Mie Pref.)** has a high possibility for shaking equal to or larger than seismic intensity 6 Lower, within 30 years from the present. As seen from **Fig. 3.4.3-3**, earthquakes that have the highest degree of influence in Mie Pref. and the Kinki District are those along the Nankai Trough.

Otsu City (Shiga Pref.), **Kyoto City (Kyoto Pref.)**, **Osaka City (Osaka Pref.)**, **Kobe City (Hyogo Pref.)** and **Nara City (Nara Pref.)** also have high possibilities for shaking equal to or larger than seismic intensity 6 Lower. The highest degree of influence is from earthquakes along the Nankai Trough, but there is also high influence from characteristic earthquakes in the 98 major active fault zones. The Kinki District has many active faults with high occurrence probabilities, such as the Biwako-seigan, Uemachi, Nara-bonchi-toen, Yamasaki fault zones, and they have a noticeable influence.

Wakayama City (Wakayama Pref.) also has a high possibility for shaking equal to or larger than seismic intensity 6 Lower, and the degree of influence is dominant for earthquakes along the Nankai Trough.

Yamaguchi City (Yamaguchi Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and the highest degree of influence is from intraplate earthquakes within the Philippine Sea plate. Next in the degree of influence are earthquakes for active faults that have not been specified.

Matsue City (Shimane Pref.) and **Tottori City (Tottori Pref.)** have fairly high possibilities for shaking equal to or larger than seismic intensity 6 Lower, and the highest degree of influence is for earthquakes occurring on active faults that have not been specified. Earthquakes occurring at locations other than the 98 major active fault zones also give a fairly high degree of influence.

Fukui City (Fukui Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower, and the highest degree of influence is for earthquakes occurring at locations where active faults have not been specified.

Kochi City (Kochi Pref.), Matsuyama City (Ehime Pref.), Takamatsu City (Kagawa Pref.) and **Tokushima City (Tokushima Pref.)** in the four prefectures in Shikoku all have high possibilities for shaking equal to or larger than seismic intensity 6 Lower. Because these areas are close to seismic source regions along the Nankai Trough, the degree of influence is very high and dominated by the Nankai earthquakes. Also, Matsuyama city is close to the seismic source regions of intraplate earthquakes in the Akinada, Iyonada and Bungosuido areas, so these regions also produce a high degree of influence.

Okayama City (Okayama Pref.) has a high possibility for shaking equal to or larger than seismic intensity 6 Lower, and a high degree of influence for earthquakes along the Nankai Trough.

Hiroshima City (Hiroshima Pref.) has a high possibility for shaking equal to or larger than seismic intensity 6 Lower. Because it is close to regions of intraplate subduction-zone earthquakes in the Akinada, Iyonada and Bungosuido regions, these earthquakes produce a high degree of influence. Next in degree of Influence are the earthquakes along the Nankai Trough.

Fukuoka City (Fukuoka Pref.) and **Saga City (Saga Pref.)** have fairly high possibilities for shaking equal to or larger than seismic intensity 6 Lower. The highest degree of influence is from intraplate earthquakes within the subducting Philippine Sea plate[17]. Next, the degree of influence for earthquakes occurring at locations where active faults have not been specified, is high. Regarding Fukuoka City, it is found that the influence of earthquakes in the 98 major active fault zones and other active faults, is relatively high.

Nagasaki City (Nagasaki Pref.) has a fairly high possibility for shaking equal to or larger than seismic intensity 6 Lower. The highest degree of influence is from earthquakes occurring at locations where active fault have not been specified. Next in degree of influence are earthquakes in the 98 major active fault zones, which are due to the Unzen fault group. The influence of intraplate earthquakes within the subducting Philippine Sea plate is also of the same extent.

Kumamoto City (Kumamoto Pref.) has a fairly high possibility of shaking equal to or larger than seismic intensity 6 Lower. The degree of influential is highest for intraplate earthquakes within the subducting Philippine Sea plate, followed by events that occur at sites where active faults have not been specified. There is also a high degree of influence from characteristic earthquakes in the 98 major active fault zones, corresponding to the Futagawa-Hinagu fault zone.

Oita City (Oita Pref.) has a high possibility for shaking equal to or larger than seismic intensity 6 Lower. The highest degree of influence is for earthquakes along the Nankai Trough. There is also a rather high degree of influence from intraplate earthquakes in the Akinada, Iyonada and Bungosuido regions, and earthquakes within the subducting Philippine Sea plate. Also, there is a recognized degree of influence for characteristic earthquakes in the 98 major active fault zones, due to the Beppu-Haneyama fault zone located in the neighborhood.

Miyazaki City (Miyazaki Pref.) has a high possibility of shaking equal to or larger than seismic intensity 6 Lower. The highest degree of influence is from interplate earthquakes and those a magnitude smaller in the Hyuganada area. Next in degree of influence, are the intraplate earthquakes within the subducting Philippine Sea plate. The influence of events along the Nankai Trough is low in comparison with these earthquakes.

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[17] Events recognized as 'intermediate depth earthquake in the region of the Kyushu to Nanseishoto' in the 'Evaluations for seismic activity in Hyuganada and the vicinity of Nanseishoto Trench' (Earthquake Research Committee, 2004)

Kagoshima City (Kagoshima Pref.) has a high possibility for shaking equal to or larger than seismic intensity 6 Lower. The degree of influence is highest for the shallow earthquakes in the vicinity of the Nanseishoto. Next highest in degree of influence are from the intraplate earthquakes within the subducting Philippine Sea plate and events occurring at locations where active faults have not been specified.

Naha City (Okinawa Pref.) has a high possibility for shaking equal to or larger than seismic intensity 6 Lower, and the highest degree of influence is from shallow earthquakes in the vicinity of the Nanseishoto. Next highest in degree of influence are the intraplate earthquakes within the subducting Philippine Sea plate.

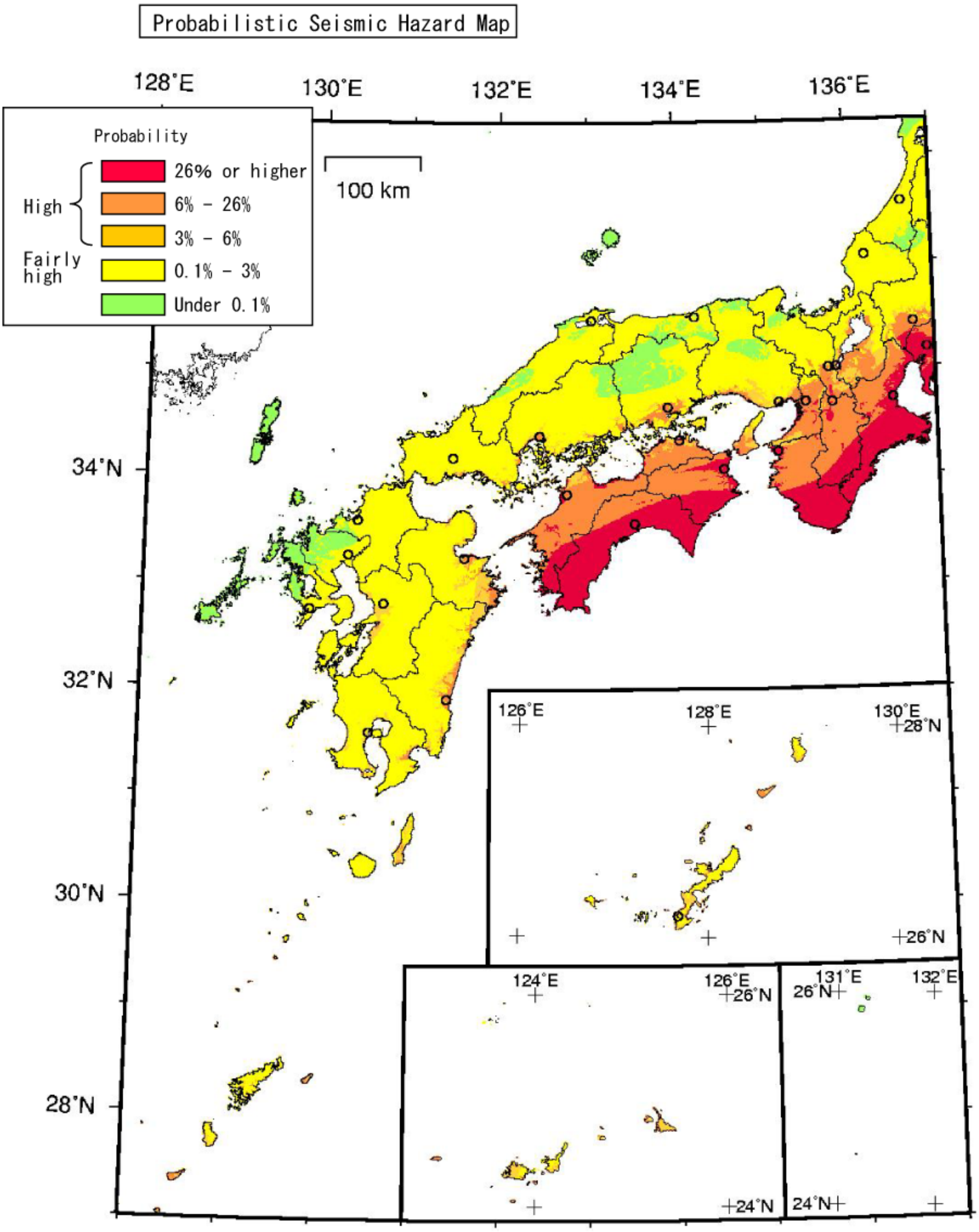


Fig. 3.4.3-1 Probabilities of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present (Western Japan area).
(Start date: January 1, 2005)
○ denote seats of metropolitan, Hokkaido and prefectural governments.
(Fig. 3.4.3-3 shows the degrees of influence for different types of earthquakes.)

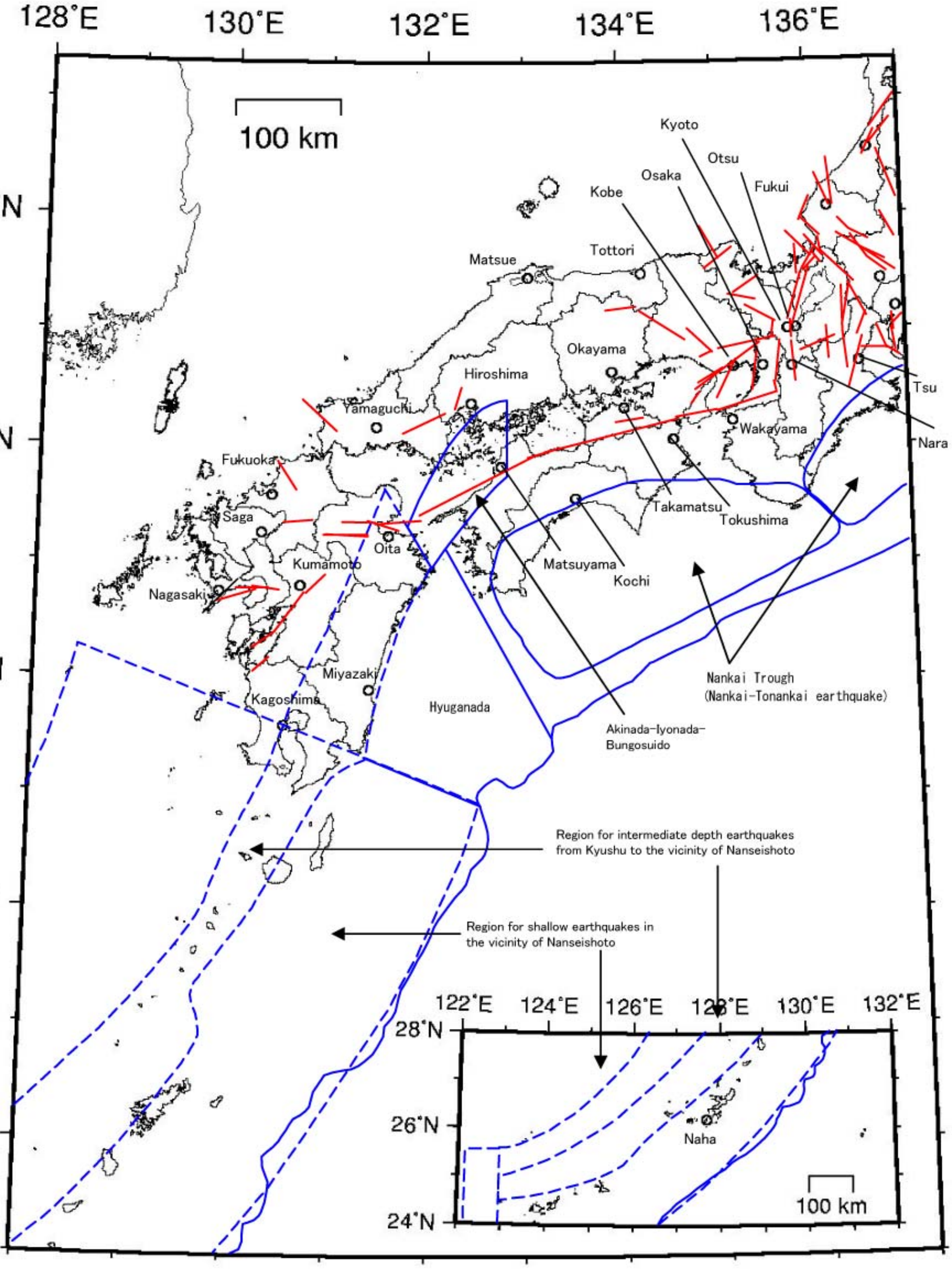


Fig. 3.4.3-2 Locations of the 98 major active fault zones and regions of subduction-zone earthquakes in the western Japan area.

Red lines: Upper edges of the fault models of the 98 major active fault zones

Blue lines: Regions of subduction-zone earthquakes

○ denote seats of metropolitan and prefectural governments.

(Fig. 3.4.3-3 shows the degrees of influence for different types of earthquakes.)

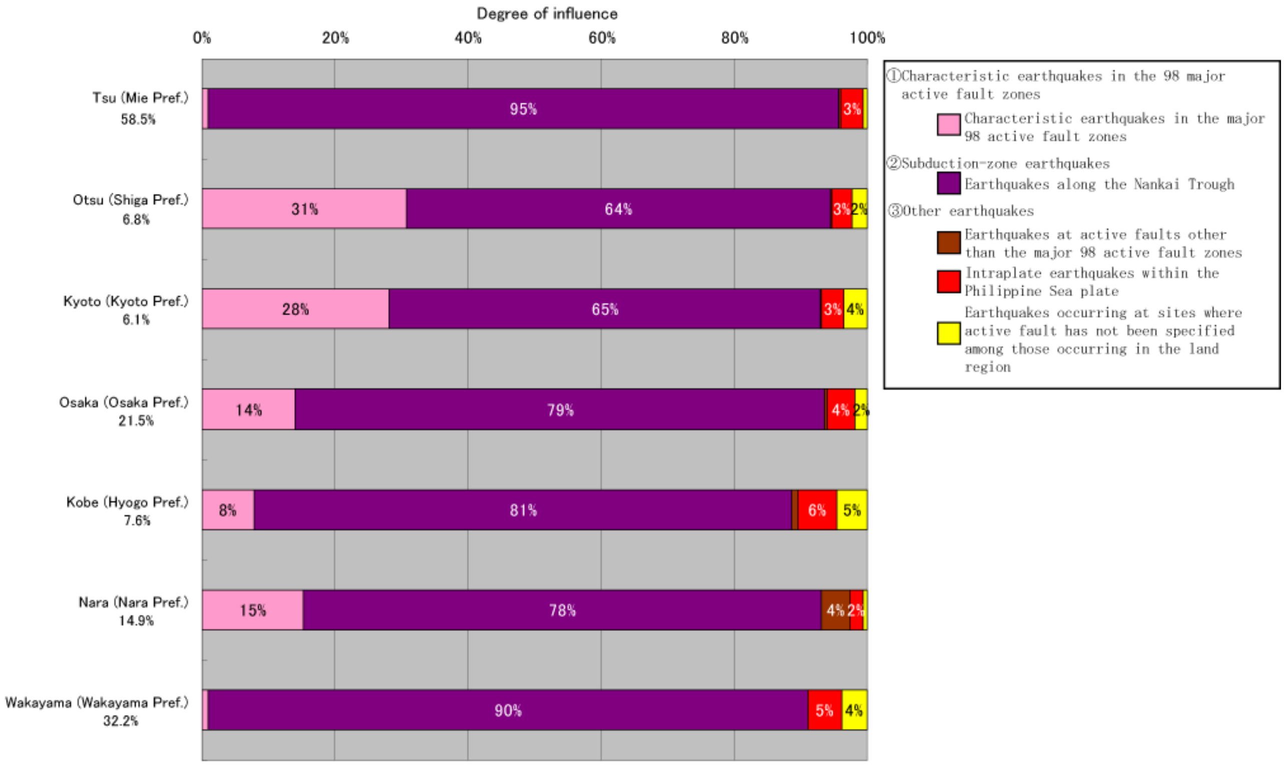


Fig. 3.4.3-3 (Part 1) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

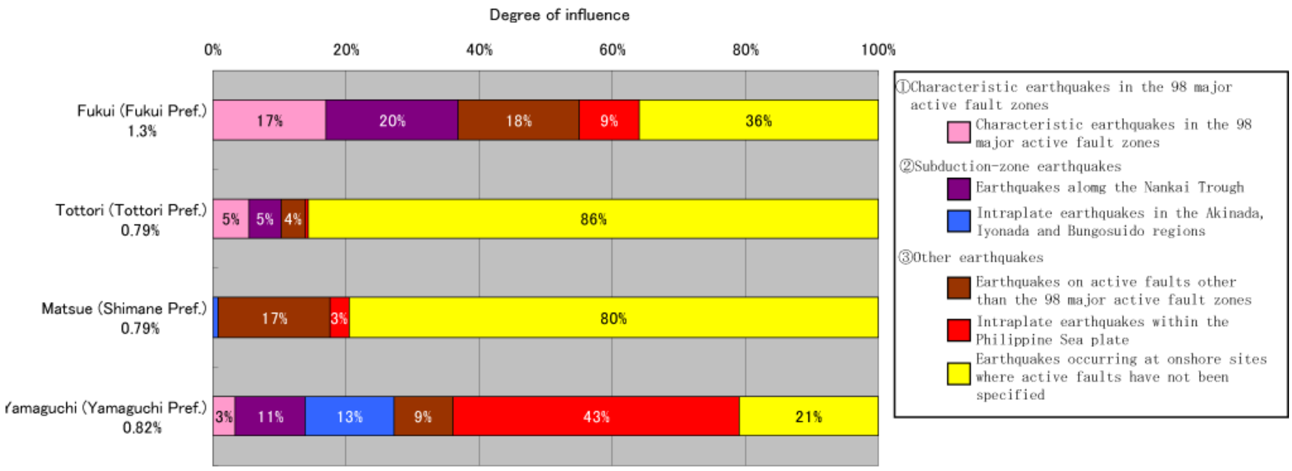


Fig. 3.4.3-3 (Part 2) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

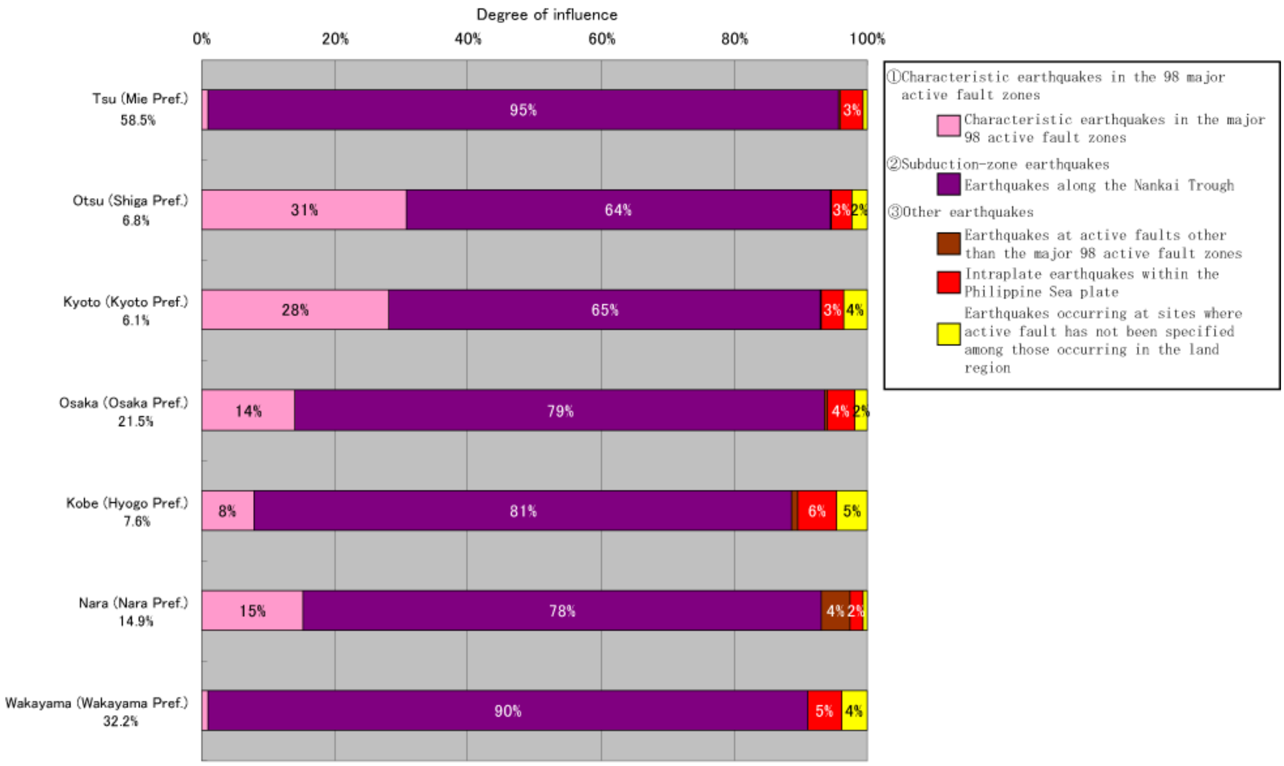


Fig. 3.4.3-3 (Part 3) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

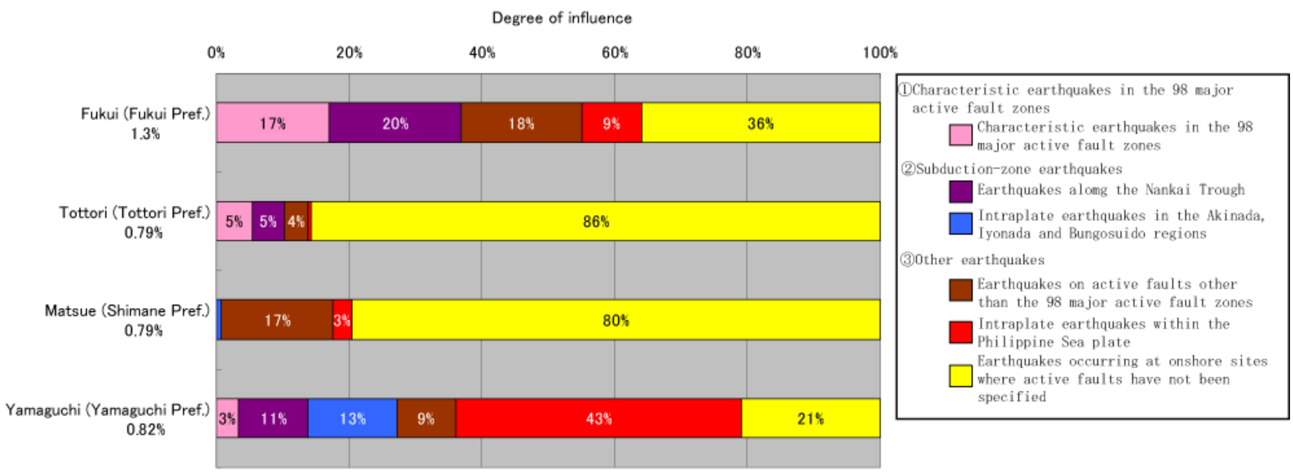


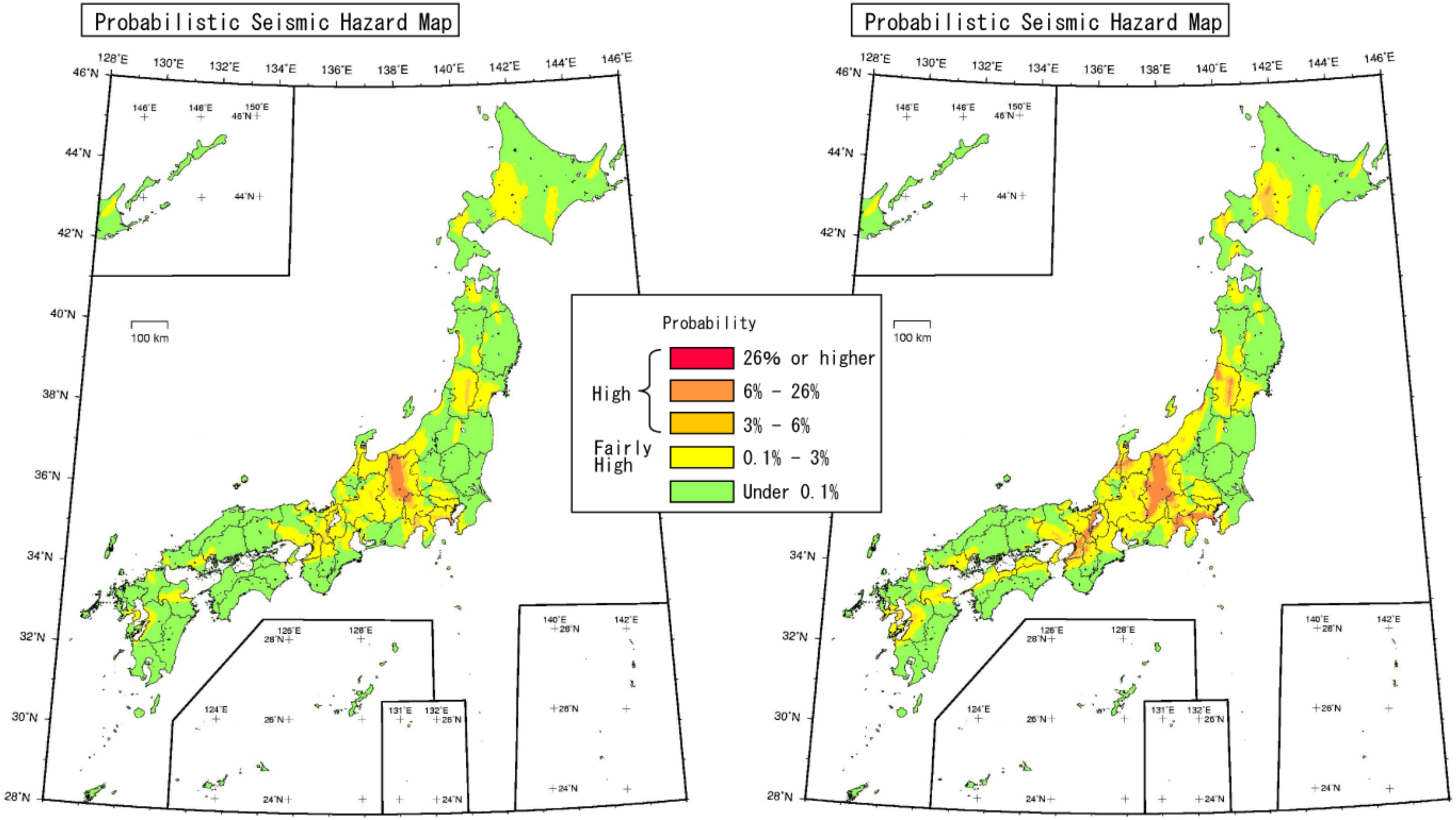
Fig. 3.4.3-3 (Part 4) Degrees of influence for different types of earthquakes that possibly contribute to the ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.

3.5 Reference maps for long-term probabilities

Shown here are maps that look at two issues with reference figures.

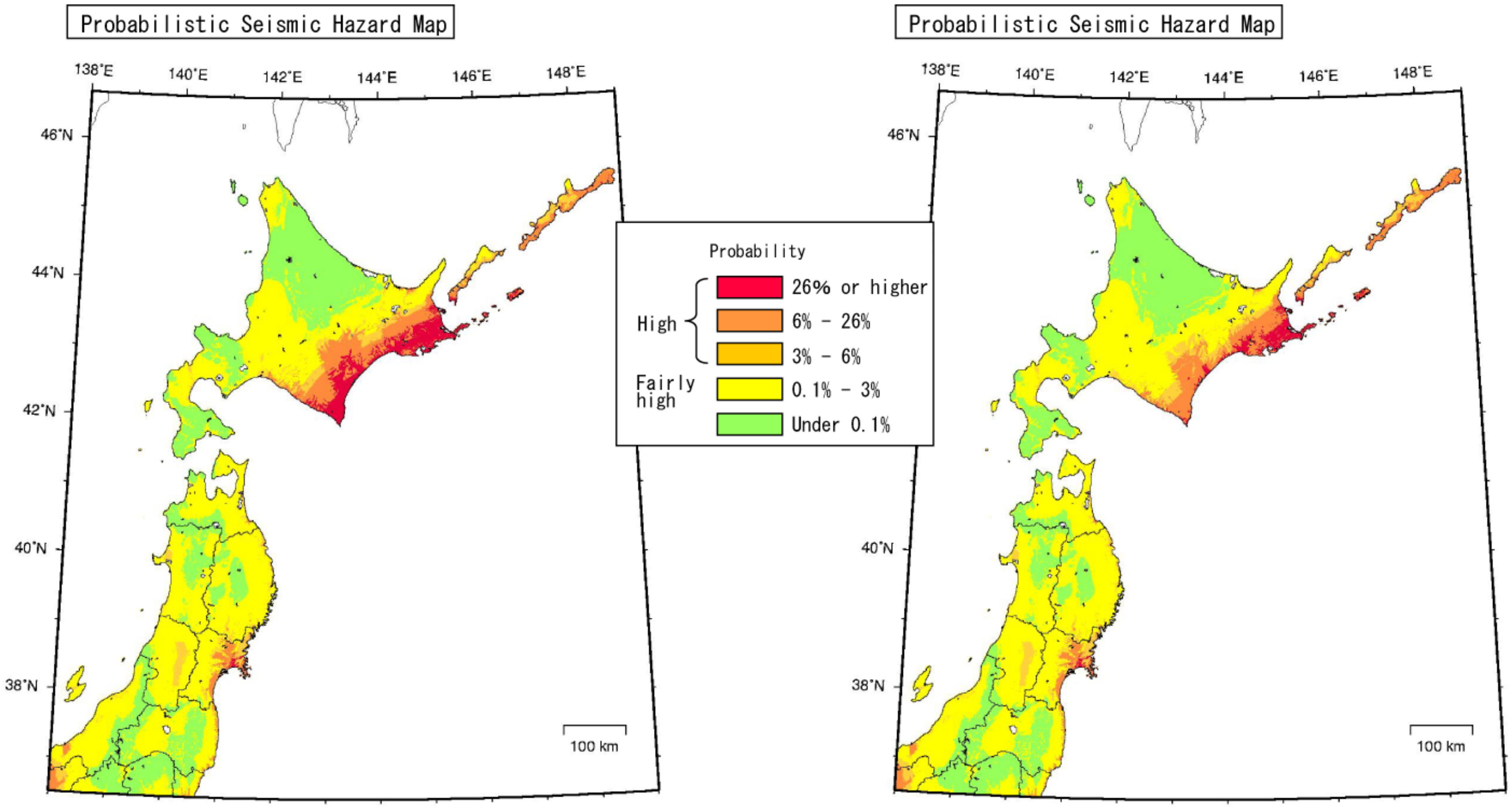
First, we show the differences in results from long-term evaluations of the 98 major active fault zones, using different representative values for the earthquake occurrence probability with a range. In the present report, when the recurrence intervals and the most recent event have ranges, the occurrence probabilities are calculated using respective central values (average case). On the other hand, evaluations of 'Faults belonging to the high group, in which earthquake occurrence probability is high, among the major active faults in our country,' have been done on the basis on using the maximum values in a range of probability estimates (maximum case). With respect to the average and the maximum cases, comparison figures are shown for reference **(Ref. Fig. 3.5-1)**. Differences between the two cases show a large difference in the occurrence probability between the average and maximum cases. Evaluated results of estimated seismic motions yield similar differences for active faults having a large range in earthquake occurrence probabilities. Therefore, it is important to reduce the range by conducting more detailed investigation in order to improve the accuracy of the seismic hazard map.

Shown next with reference figures is the extent of change in the probabilistic seismic hazard maps before and after the 2003 Tokachi-Oki Earthquake (M8.0). Compare **Ref. Fig. 3.5-2** (a) and (b). Before its occurrence, this earthquake had been evaluated as a subduction-zone earthquake with a long-term occurrence probability of about 60% (M8.1) within 30 years from January 2003 (Earthquake Research Committee, 2003). According to the long-term evaluation based on investigations conducted after the earthquake, the occurrence probability within 30 years from January 2005 has become 0.02-0.5% (M8.1±0.1) (Earthquake Research Committee, 2004). As seen from the figure, in the peripheral area from Cape Erimo to the Tokachi Plain, the probabilities of shaking equal to or larger than seismic intensity 6 Lower, were reduced after the Tokachi-Oki Earthquake occurred. It is found that possibilities of strong ground motion shown in probabilistic seismic hazard maps, vary with the occurrence of large earthquakes that have high probabilities.



Ref. Fig. 3.5-1(a) Distribution map of occurrence probabilities of ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present. (Average case: only the 98 major active fault zones) (Start date: January 1, 2005)

Ref. Fig. 3.5-1(b) Distribution map of occurrence probabilities of ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present. (Maximum case: only the 98 major active fault zones) (Start date: January 1, 2005)



Ref. Fig. 3.5-2(a) Distribution map of occurrence probabilities of ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.
Map before the Tokachi-Oki Earthquake starting on January 1, 2003

Ref. Fig. 3.5-2(b) Distribution map of occurrence probabilities of ground motions equal to or larger than seismic intensity 6 Lower, within 30 years from the present.
Map after the Tokachi-Oki Earthquake starting on January 1, 2005

4. Seismic Hazard Maps for Specified Seismic Source Faults

The Earthquake Research Committee has considered a 'detailed method' aimed at improving a strong ground motion prediction method for earthquakes with specified seismic source faults. In addition, for the purpose of establishing a 'standard methodology that can give the same results independent of the user', procedures and concepts for the model setup and strong ground motion calculation were assembled as a 'Recipe'. (The strong ground motion prediction method for earthquakes with specified seismic source faults is called the 'Recipe'.)

Shown in this chapter is a summary of results for the 12 evaluations of strong ground motions that the Earthquake Research Committee has so far conducted and publicized, as well as outlining this 'Recipe'. The committee is also investigating the applicability of the 'Recipe' using observed records of the 2000 Western Tottori Earthquake (Heisei 12th year) and the 2003 Tokachi-Oki Earthquake (Heisei 15th year), so these summaries are also presented.

In addition, the Earthquake Research Committee has studied the future probabilities for earthquakes that occur in the 98 major active fault zones and subduction-zone earthquakes, and the intensities caused by these earthquakes have been evaluated with the 'conventional method' for the 'probabilistic seismic hazard maps'. Thus, the results of the evaluations of strong ground motions are presented as reference material in Appendix 1 of the Separate Volume 2.

The Tokai, Tonankai and Nankai Earthquakes have high possibilities of occurrence and if they happen there may be large-scale earthquake disasters with very large social consequences. Evaluations of strong ground motions for the Tokai, Tonankai and Nankai Earthquakes have been conducted by the Central Disaster Management Council for the purpose of studying ways to improve and reinforce countermeasure against earthquakes, such as the designation of Areas under Intensified Measures against Earthquake Disasters. These results are presented in Appendix 2 of the Separate Volume 2.

The 'Recipe'…

For dangerous (meaning earthquakes are likely to occur) active faults on land or offshore trenches, the 'Recipe' is a standard methodology that gives the same results for any user, for the prediction of strong ground motions of probable future earthquakes. In this report strong ground motions do not mean only simple parameters, such as peak ground acceleration, peak ground velocity and seismic intensity, but also time histories of large amplitude waveforms capable of destructive power on general structures. The 'Recipe' for prediction of strong ground motions is composed of (1) Characterization of the assumed source, (2) Modeling of subsurface and bedrock structures containing the source and areas of interest, (3) Simulation method of earthquake ground motions, and (4) Verification of predicted results. Application of this 'Recipe' enables very precise prediction of strong ground motions in a broad-band period range from 0.1 to 10 sec, which is related to damage of structures, and important for disaster mitigation measures of earthquake.

('Irikura, K. and Miyake, H. (2001): Prediction of Strong Ground Motion for Scenario Earthquakes, Journal of Geography, 110, 849-875 (in Japanese), and Irikura, K. (2004): Recipe for Predicting Strong Ground Motion from Future Large Earthquake, Annuals of Disas. Prev. Inst., Kyoto Univ., No.47A. (in Japanese), partially modified)

4.1 Strong ground motion prediction method ('Recipe') for earthquakes with specified source faults

Here, is a summary of the latest 'Recipe'. **Fig. 4.1-1** shows the procedure of the strong ground motion prediction method in accordance with the 'Recipe', prepared by the Earthquake Research Committee. The 'Recipe' is made up of 4 processes: (1) Setup of characterized source model, (2) Preparation of a subsurface structural model. (3) Calculation of strong ground motions, and (4) Verification of the predicted results. Explanation of the procedure is given below.

4.1.1 Characterized source model

The seismic waves produced by the fault movements (rupture) largely depend on factors such as the geometry of the fault and characteristics of the rupture. Following the Great Hanshin-Awaji Earthquake Disaster (1995 Hyogo-ken Nanbu Earthquake), earthquake observation networks were upgraded and expanded under the leadership of the Headquarters for Earthquake Research Promotion. Using observed records of recent large earthquakes, such as the 2000 Western Tottori Earthquake (Heisei 12^{th} year) and the 2003 Tokachi-Oki Earthquake (Heisei 15^{th} year) obtained with the new observation networks, the rupture process of seismic source faults have become clarified through research on strong ground motions, such as studies to estimate geometries of faults and characteristics of ruptures (source inversion analyses), and ground motion simulation analyses. It has been consequently found that there are two types of characteristics of the seismic source important for prediction of strong ground motions: large-scale parameters of the source model representing the geometry and scale of the seismic source fault, such as the relationship between the total area and seismic moment of seismic source fault, and small-scale parameters representing the inhomogeneity of the seismic source, such as the distribution of asperities on the source fault and the amount of stress change (stress drop) (Irikura, 2004). Also, from recent results of evaluating strong ground motions, it is understood that directivity effects[18], along with the locations of asperities and the rupture initiation point, have a large influence on the strong ground motions. The characterized source model is the fault model used to reproduce strong ground motions by setting the large-scale and small-scale parameters, and other source characteristics such, as the rupture initiation point and the rupture propagation pattern, in a somewhat simple model.

The 'Recipe' has a method for setting parameters necessary for the characterized source model using relatively simple calculation formula and numerical values. For the characterized source model, we first set the large-scale parameters, such as the location, geometry, area, and seismic moment, followed by small scale parameters, such as location, number, slip dislocation, and stress drop of the asperities. We also set other parameters of the characterized source model, such as the rupture initiation point and rupture velocity. The method for setting parameters of the characterized source model differs between earthquakes occurring on active faults on land and subduction-zone earthquake, depending on the scale and activity interval of the assumed

[18] Since fault rupture propagates at a speed near the shear wave velocity, seismic waves coherently overlap in the direction of rupture propagation and have larger amplitudes. In the direction opposite to rupture propagation, seismic waves do not overlap as coherently, and the amplitudes are not magnified.

seismic source fault, along with the existing study results and quantity of information.

4.1.2 Subsurface structure model

Seismic waves produced by ruptures of faults are gradually attenuated with propagation distance in the deep subsurface, but can be amplified due to the influence of structures near the ground surface above seismic bedrock. Accordingly, earthquake ground motions on the surface are largely influenced by characteristics of the subsurface structure. Also, shallow bedrock near the ground surface and deep bedrock can have different influences on the earthquake ground motion at the ground surface. In the Great Hanshin-Awaji Earthquake Disaster, for instance, causes of the 'belt of heavy damage' were actively studied, and one cause was found to be the 3-dimensional characteristics of the deep sedimentary layers of the basin that produced local amplifications[19] at the edges. Also, similar adjacent buildings sometimes suffer a completely different degree of damage, and this is considered to be caused by surface soil layers near the ground surface that influence the local ground motions.

In preparation of the subsurface structural model in the 'Recipe', there was consideration of the differences in character of the structure. The structure is separated into a 'crustal structure' deeper than the seismic bedrock, 'deep sedimentary layers' from the seismic bedrock to the 'engineering bedrock in the detailed method', and 'surface soil layers' from the 'engineering bedrock in the detailed method' to the ground surface. Now for the 'deep sedimentary layers', a three-dimensional model has been prepared for regions covering about 70% of Japan, as shown later in **Fig. 4.2-3.** That model has some variable precision because the quantity of information depends on the location. It is necessary to determine subsurface structural models for the remaining regions, as occasions arise, and to improve existing models for the prediction of strong ground motions. For the 'surface soil layers', it is usually difficult to use plane layer models for precise prediction of ground motions over a large area, because there are large local influences and massive amounts of data are necessary for modeling. However, a plane layer technique for a large area has been recently made possible with a 'conventional method' using amplification factors based on detailed geographical information, although there is limited precision.

4.1.3 Calculation of strong ground motions

It has become possible to estimate strong ground motions in the long-period range by using theoretical procedures. For example, in elucidating the causes of the 'belt of heavy damage' in the Great Hanshin-Awaji Earthquake Disaster, theoretical simulations of three-dimensional ground motions were very useful. On the other hand, strong ground motions in the short-period range are difficult to calculate theoretically, and currently it is necessary to introduce statistic methods, because insufficient source and structure information cause large uncertainties in modeling. Accordingly, for precise prediction of strong ground motions in a broad-band period range between about 0.1 to 10 sec, which is the target of the 'recipe', it is required to combine strong ground motions calculated with two different procedures over an appropriate period range.

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[19] In sedimentary basins formed by accumulated sand, clay etc. on tray-shaped places like plains or basins in Japan, seismic waves propagating on the surface along the edges, and waves from the deeper portion of the basin, coherently overlap, resulting in amplifications in certain area. Such an amplification effect is called an edge effect.

A procedure that adopted such a concept is the hybrid synthetic method (Fujiwara, 2004).

For theoretical calculations of strong ground motions with good precision over a broad bandwidth, a hybrid synthetic method combines theoretical procedures (e.g. finite differences methods: Aoi and Fujiwara, 1999; Graves, 1996; Pitarka, 1999) for long periods where three-dimensional characterization is important, with statistical procedures (e.g. waveform synthesizing methods using a stochastic Green's function method: Kamae et al., 1991; Dan et al., 1998) for short periods where uncertainties become larger.

In evaluations of strong ground motions for earthquakes occurring on active faults on land, the effectiveness of the hybrid synthetic method has been confirmed using observation records of the 2000 Western Tottori Earthquake (Heisei 12th year) (Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2002) and other recent strong ground motion evaluations. On the other hand, application of the hybrid synthetic method to subduction-zone earthquakes still has problems. Because of issues raised in applying the hybrid synthetic method (including the characterized source model and subsurface structural model) in evaluations of the strong ground motions for the assumed Miyagi-ken-Oki Earthquake (Earthquake Research Committee, 2003), results of evaluations for an assumed Northern Sanriku-Oki Earthquake (Earthquake Research Committee, 2004a) were similarly published using the stochastic Green's function method alone. In verification of the strong ground motion prediction method, using observed records of the 2003 Tokachi-Oki Earthquake (Heisei 15th year) (Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2004), testing of the prediction of strong ground motions with the hybrid synthetic method, showed its useable range and problems in specific applications.

4.1.4 Verification of predicted results

Although calculation of strong ground motions is possible by means of methods shown in **Sections 4.1.1** through **4.1.3**, it is necessary to have a method to confirm if the obtained results are appropriate, when the calculated waveform are actually used. For this reason, the 'Recipe' has also touched on how to verify the predicted results.

Verification of predicted results is carried out by comparison of predicted results with observations from the past. However, occurrence intervals are different between earthquakes occurring on active faults on land and subducted-zone earthquakes, so that the amount of information and its contents so far obtained also have differences. Thus, in verification of the predicted results for active faults on land where observed records are scarce, we have used comparisons of estimated values derived from attenuation relations, with average characteristics of the earthquake ground motions. For subduction zones, we used comparisons with observed waveforms and/or distributions of seismic intensity, when past observed records have been obtained, in addition to comparisons with estimated values derived from attenuation relations.

Prediction of strong ground motions can be conducted by means of the process mentioned above. However, the 'recipe' has currently not yet been completed and since there are some remaining problems, it is important to continue with improvements of the 'Recipe', through evaluations of strong ground motions and verifications, in order to further upgrade the strong ground motion prediction method.

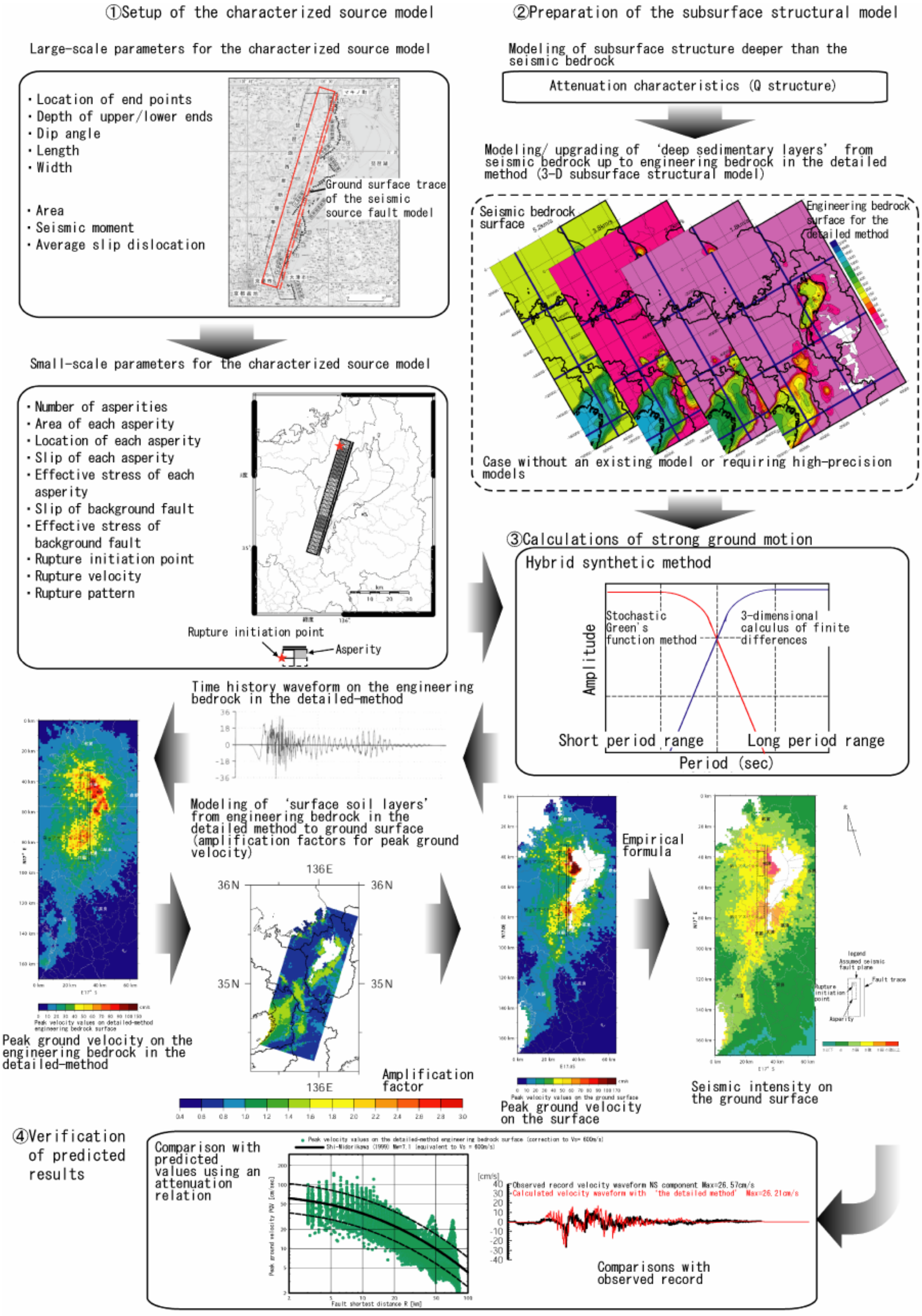


Fig. 4.1-1 Flow chart of the strong ground motion prediction method for earthquakes with specified seismic source fault ('Recipe').
(Explained in the 'Recipe' is the estimation method for peak ground velocity at the surface. Seismic intensity is shown for easier understanding for the public.)

4.2 Parameters used in evaluations

Described here are the target regions, parameters for the seismic source fault models, and subsurface structural models for 12 evaluations of strong ground motions that have been carried out and published so far by the Earthquake Research Committee. Also described are the verification results for the 'Recipe' using observed records of the 2000 Western Tottori Earthquake (Heisei 12th year) and the 2003 Tokachi-Oki Earthquake (Heisei 15th year).

Shown in **Fig. 4.2-1** is a map of target seismic source faults for past evaluations. **Fig. 4.2-2** shows the target regions for evaluation around each seismic source fault. **Fig. 4.2-3** shows regions where three-dimensional subsurface structural models and depth distribution of seismic bedrock have so far been prepared. **Table 4.2-1** is a catalogue of parameters used in respective evaluations of strong ground motions. For explanation and setup method of each parameter, refer to the **Separate Volume 2.** Also, regarding parameters set in each evaluation other than those shown here, refer to the published material for each study.

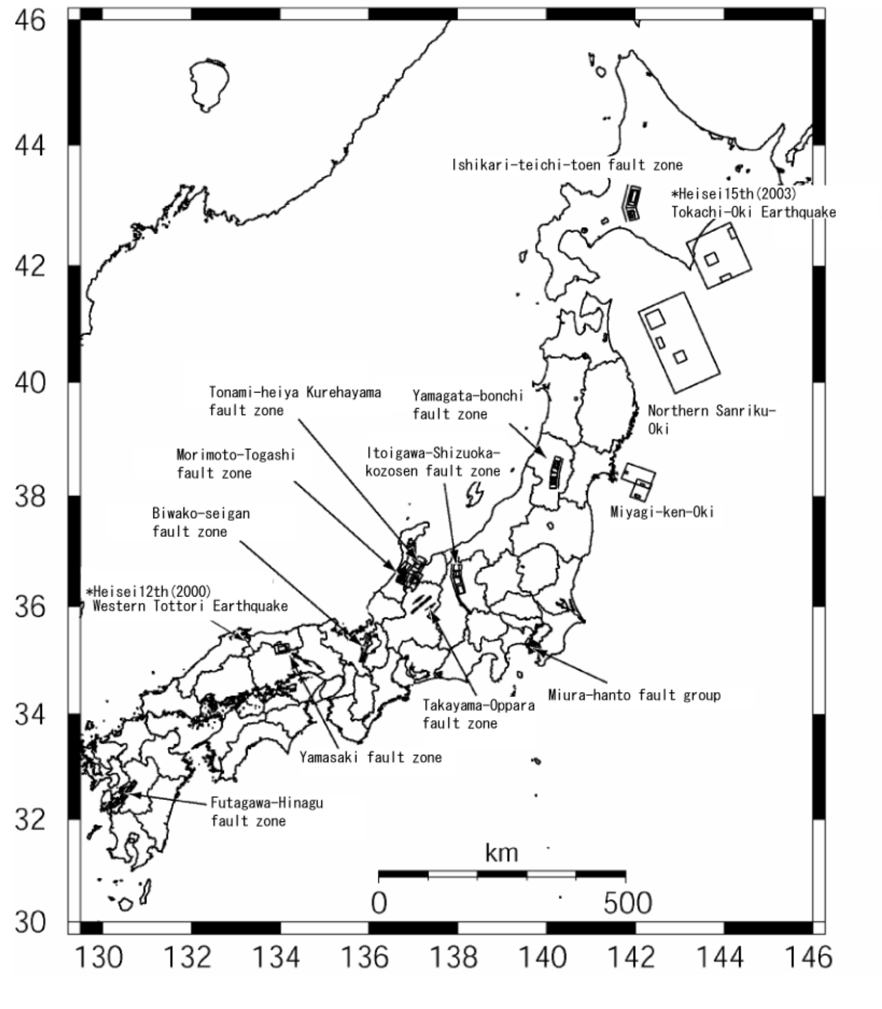


Fig. 4.2-1 Overview of locations of seismic source faults for completed evaluations.
□ shows asperities on the seismic source faults. * indicates earthquakes used for studies on the verification of the 'Recipe'.)

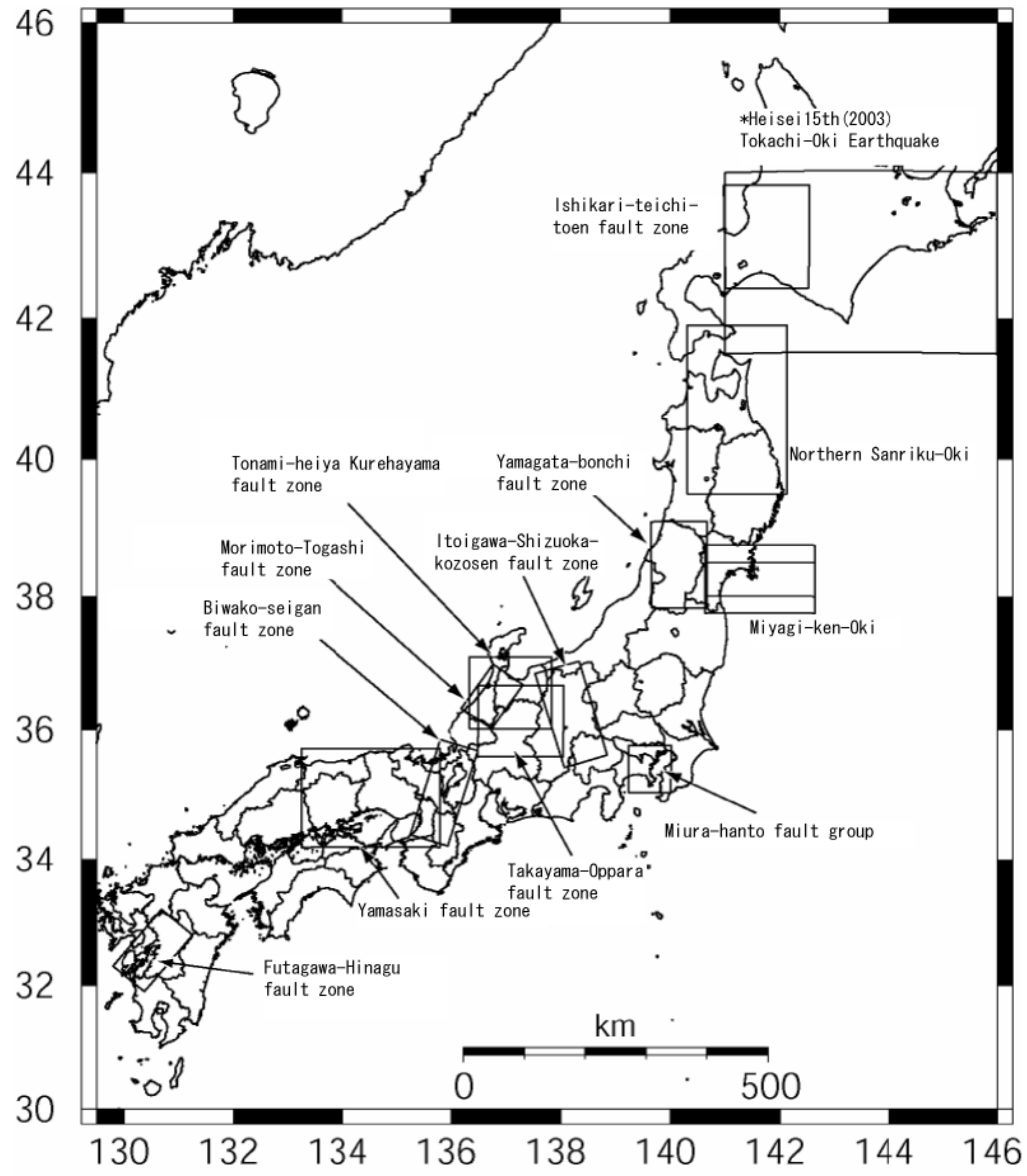


Fig. 4.2-2 Areas of evaluations of strong ground motions surrounding each seismic source fault. (Evaluations have been conducted at three points on the ground surface for the 2000 (Heisei 12) Western Tottori Earthquake.)

Table 4.2-1 (1) Parameters used in evaluation of strong ground motions that Earthquake Research Committee publicized by the end of fiscal 2004 (Part 1).

		Assumed earthquake	Itoigawa-Shizuoka-kozosen fault zone			Morimoto-Togashi fault zone					
		Type of earthquake	Earthquakes occurring in active faults			Earthquakes occurring in active faults					
		Fault zone as object	North 1; North 2; Middle 1; Middle 2 (Evaluated as 4 earthquake segments)			Morimoto-Togashi fault zone					
		Case	1	2	3	1-a	1-b	1-c	1-d	2	3
Characterized source model	Large-scale parameters	Length (km)	North 1: 26; North 2: 35; Middle 1: 17; Middle 2: 34			26					
Characterized source model	Large-scale parameters	Width (km)	North 1 and North 2: 20.2; Middle 1 and Middle 2: 13.2			20				16	26
Characterized source model	Large-scale parameters	Depths of upper edge and lower edge of fault (km)	North: 4 ,about17; Middle: 4, about18			4 ,18					
Characterized source model	Large-scale parameters	Area S of source fault (km^2)	1905			513				420	676
Characterized source model	Large-scale parameters	Seismic moment M_0(Nm)	1.5×10^{20}			1.1×10^{19}				8.2×10^{18}	1.7×10^{19}
Characterized source model	Large-scale parameters	Moment magnitude Mw	7.4			6.6				6.5	6.8
Characterized source model	Large-scale parameters	Dip angle	North 1 and North 2: 40° E (Reverse fault east-side upthrown) Middle 1 and Middle 2: 80° E (Left-lateral fault)			45° E (Reverse fault east-side upthrown)				60° E (Reverse fault east-side upthrown)	30° E (Reverse fault east-side upthrown)
Characterized source model	Large-scale parameters	Short period level A (N m/s^2)	2.8×10^{19}			1.2×10^{19}				1.1×10^{19}	1.4×10^{19}
Characterized source model	Small-scale parameters / Asperity	Gross area Sa (km^2)	637			73				60	96
Characterized source model	Small-scale parameters / Asperity	Sa/S	ca. 33%			ca. 14%					
Characterized source model	Small-scale parameters / Asperity	Stress drop (MPa)	13.1			16					
Characterized source model	Small-scale parameters / Asperity	Number	One to every segment			One					
Characterized source model	Small-scale parameters / Asperity	Area ratio	–			–					
Characterized source model	Small-scale parameters / Asperity	Location	North 1 and North 2: Near south end of fault and its top. Middle 1: Near north end of fault and its top; and Middle 2: Near center of fault and its top.	North 1 and North 2: Near north end of fault and its top. Middle 1: Near north end of fault and its top; and Middle 2: Near center of fault and its top.	North 1 and North 2: Near south end of fault and its bottom. Middle 1: Near north end of fault and its top; and Middle 2: Near center of fault and its top.	south end of fault, depth is at its center	Center of fault, depth is at its center	Center of fault, depth is at its top	Center of fault, depth is at its bottom.	south end of fault, depth is at its center	
Characterized source model	Small-scale parameters / Asperity	Locating criteria etc.	Middle 1 and Middle 2: Setting at the site where large surface slip has been confirmed by active fault survey. North 1 and North 2: Plural cases are set up in view from evaluations of strong ground motion according to 'recipe' because of no information.			Plural cases are set up in view from evaluation of strong ground motion according to 'recipe' because of no information.					
Characterized source model	Other characterized source model	Rupture initiation point	North bottom of asperity of Middle 1			South bottom of asperity	Center bottom of asperity			South bottom of asperity	
Characterized source model	Other characterized source model	Rupture velocity (km/s)	2.5			2.5					
Characterized source model	Other characterized source model	Rupture pattern	Radial (concentric in general)			Radial (concentric in general)					
Subsurface structural model		Velocity layer defined as 'engineering bedrock in the detailed method'	2.4 km/s, 1.6 km/s, 1.1 km/s, 1 km/s, 500 m/s			VS=700 m/s					
Subsurface structural model		Handling of surface soil layers	Empirical formula by Matsuoka-Midorikawa (1994) (But, calculated as 1.5 km/s when the above velocity layer exceeds it)			Empirical formula by Matsuoka-Midorikawa (1994)					
Others		fmax (Hz)	6			6					
Others		Radiation pattern factor F	0.62, 0.45			0.62					

Table 4.2-1 (2) Parameters used in evaluation of strong ground motions that Earthquake Research Committee publicized by the end of fiscal 2004 (Part 2).

		Assumed earthquake	Miyagi-ken-Oki Earthquake		Futagawa-Hinagu fault zone			Miura-hanto fault group			
		Type of earthquake	subduction-zone earthquakes		Earthquakes occurring in active faults			Earthquakes occurring in active faults			
		Fault zone as object	1978 Miyagi-ken-Oki Earthquake		Middle		Middle + Southwest	Takeyama fault zone			Kinugasa/Kitatake fault zone
		Case	A1	A2	1	2	3	1	2	3	4
Characterized source model	Large-scale parameters	Length (km)	Setup according to past references		48		74.4(48+26.4)	20			28
		Width (km)	Setup according to past references		13.9		13.9	17		13.9	17
		Depths of upper edge and lower edge of fault (km)	Setup according to past references		3, 15			3, 15			
		Area S of source fault (km^2)	2266	1449	667		1034	340		278	476
		Seismic moment M_0(Nm)	3.1×10^{20}	1.6×10^{20}	2.5×10^{19}		6.0×10^{19}	6.4×10^{18}		4.4×10^{18}	1.3×10^{19}
		Moment magnitude Mw	7.6	7.4	6.9		7.1	6.5		6.4	6.7
		Dip angle	Aligned with isobathic line of plate		60° W (Right-lateral fault)			45° N (Right-lateral fault)		60° N (Right-lateral fault)	45° N (Right-lateral fault)
		Short period level A (N m/s^2)	8.4×10^{19}	6.7×10^{19}	1.6×10^{19}		2.1×10^{19}	9.8×10^{18}		8.7×10^{18}	1.2×10^{19}
	Small-scale parameters: Asperity	Gross area Sa (km^2)	192	128	172		360(232+128)	39		28	69
		Sa/S	ca. 8%	ca. 9%	ca. 26%		ca. 35%	ca. 11%		ca. 10%	ca. 14%
		Stress drop (MPa)	1st.: 29 2nd.: 73	54	14		13	22		23	20
		Number	Two	One	Two		Middle: Two Southwest: One	One			
		Area ratio	1 : 1	–	2 : 1		2 : 1(Middle)	–			
		Location	1st: Near center of the deepest part of fault 2nd: Southeast end of fault (Due to forward modeling)	South of fault, depth is at its center	1st: Northeast of fault, depth is at its top. 2nd: Southwest of fault, depth is at its center		Middle: Same as the left. Southwest: A little northeast from center of fault, depth is at its top.	Near the east of the Miura Peninsula, depth is at its center of fault.	Near the east of the Miura Peninsula, depth is at its top of fault.	Near the east of the Miura Peninsula, depth is at its center of fault.	Near the east of the Miura Peninsula, depth is at its center of fault.
		Locating criteria etc.	Comprehensively judged from seabed survey, asperity distribution of the 1978 and 1936 earthquakes etc.		Middle: Setup at the site where average slip velocity is large. Southwest: Setup by considering influence on land area because no information is available			Setup at the east of the Miura Peninsula because its geological formation of active fault is clear.			
	Other characterized source model	Rupture initiation point	Near seismic source location of 1978 Miyagi-ken-Oki Earthquake	Near seismic source location of 1936 Miyagi-ken-Oki Earthquake	Northeast bottom of the 1st. asperity.	Southwest bottom of the 2nd. asperity.	Southwest bottom of the 2nd. asperity of Middle.	Central bottom of asperity			
		Rupture velocity (km/s)	3.0		2.5			2.3			
		Rupture pattern	Radial (concentric in general)		Radial (concentric in general)			Radial (concentric in general)			
Subsurface structural model		Velocity layer defined as 'engineering bedrock in the detailed method'	VS=700 m/s, and VS=400 m/s		VS=500 m/s			VS=700 m/s, and VS=500 m/s			
		Handling of surface soil layers	Empirical formula by Matsuoka-Midorikawa (1994)		Empirical formula by Matsuoka-Midorikawa (1994)			Empirical formula by Matsuoka-Midorikawa (1994)			
Others		fmax (Hz)	13.5		6			6			
		Radiation pattern factor F	0.62		0.445			0.445			

Table 4.2-1 (3) Parameters used in evaluation of strong ground motions that Earthquake Research Committee publicized by the end of fiscal 2004 (Part 3).

Category	Parameter	Yamagata-bonchi fault zone				Tonami-heiya/Kurehayama fault zone				Northern Sanriku-Oki
	Type of earthquake	Earthquakes occurring in active faults				Earthquakes occurring in active faults				Subduction-zone earthquakes
	Fault zone as object	Yamagata-bonchi fault zone (North/South)				East Tonami fault zone		West Tonami fault zone	Kurehayama fault zone	1968 Tokachi-Oki Earthquake
	Case	1	2	3	4	1	2	3	4	1
Characterized source model / Large-scale parameters	Length (km)	60				30		26	30	ca. 170
Characterized source model / Large-scale parameters	Width (km)	17				22.6		22.6	22.6	ca. 100
Characterized source model / Large-scale parameters	Depths of upper edge and lower edge of fault (km)	4, 16				4, 20				Setup according to existing reference.
Characterized source model / Large-scale parameters	Area S of source fault (km^2)	1020				552		572	660	16884
Characterized source model / Large-scale parameters	Seismic moment M_0(Nm)	5.8×10^{19}				1.7×10^{19}		1.8×10^{19}	2.4×10^{19}	3.5 x 1021
Characterized source model / Large-scale parameters	Moment magnitude Mw	7.1				6.8		6.8	6.9	8.3
Characterized source model / Large-scale parameters	Dip angle	45° W (Reverse fault west-side upthrown west)				45° E (Reverse fault east-side upthrown)		45° W (Reverse fault west-side upthrown)	45° W (Reverse fault west-side upthrown)	Setup according to existing reference.
Characterized source model / Large-scale parameters	Short period level A (N m/s^2)	2.0×10^{19}				1.4×10^{19}		1.4×10^{19}	1.5×10^{19}	1.9×10^{20}
Characterized source model / Small-scale parameters / Asperity	Gross area Sa (km^2)	349				120	80	127	162	1500
Characterized source model / Small-scale parameters / Asperity	Sa/S	ca. 34%				ca. 22%	ca. 14%	ca. 22%	ca. 25%	ca. 9%
Characterized source model / Small-scale parameters / Asperity	Stress drop (MPa)	12.6				15		15	14	1st.: 34 2nd.: 34 3rd.: 85
Characterized source model / Small-scale parameters / Asperity	Number	Two				One	Two	One	One	Three
Characterized source model / Small-scale parameters / Asperity	Area ratio	2 : 1				–	2 : 1	–	–	9 : 4(1st and 2nd) (3rd is set from existing reference.)
Characterized source model / Small-scale parameters / Asperity	Location	1st: Center of fault in the north, depth is at its top. 2nd: Center of fault in the south, depth is at its top.	1st: Center of fault in the south, depth is at its top. 2nd: Center of fault in the north, depth is at its top.	1st: Center of fault in the north, depth is at its bottom. 2nd: Center of fault in the south, depth is at its bottom.	1st: Center of fault in the south, depth is at its bottom. 2nd: Center of fault in the north, depth is at its bottom.	Southwest end of Takashozu fault, depth is at its center.	1st: Southwest end of Takashozu fault, depth is at its center. 2nd: Center of Takashozu fault, depth is at its center.	Southwest end of fault, depth is at its center.	Center of fault, depth is at its center	1st: Northwest of fault, depth is the deepest portion. 2nd: Center of fault, depth is its center. 3rd: Center of fault, depth is the deepest portion. (Due to forward modeling)
Characterized source model / Small-scale parameters / Asperity	Locating criteria etc.	Plural cases are set up in view from evaluation of strong ground motion according to 'recipe' because of no information.				Setup at a site where average slipping velocity is large.			Set up according to 'recipe' because of no information	Setup according to existing reference.
Characterized source model / Other characterized source model	Rupture initiation point	Center bottom of the 1st. asperity and the 2nd. asperity	Center bottom of the 1st. asperity and the 2nd. asperity	Center bottom of the 1st. asperity and the 2nd. asperity	Center bottom of the 1st. asperity and the 2nd. asperity	Southwest bottom of asperity	Southwest bottom of the 1st. asperity	Southwest bottom of asperity	Center bottom of asperity	Near seismic source of the 1968 Tokachi-Oki Earthquake
Characterized source model / Other characterized source model	Rupture velocity (km/s)	2.5				2.5				2.5
Characterized source model / Other characterized source model	Rupture pattern	Radial (concentric in general)				Radial (concentric in general)				Radial (concentric in general)
Subsurface structural model	Velocity layer defined as 'engineering bedrock in the detailed method'	VS=800 m/s, and VS=500 m/s				VS=450 m/s (Not constant though)				VS=500 m/s
Subsurface structural model	Handling of surface soil layers	Empirical formula by Matsuoka-Midorikawa (1994)				Empirical formula by Fujimoto-Midorikawa (2003)				Same as the left
Others	fmax (Hz)	6				6				13.5
Others	Radiation pattern factor F	0.445				0.445				0.62

Table 4.2-1 (4) Parameters used in evaluation of strong ground motions that Earthquake Research Committee publicized by the end of fiscal 2004 (Part 4).

	Assumed earthquake	Biwako-seigan fault zone		Takayama-Oppara fault zone					Ishikari-teichi-toen fault zone			
	Type of earthquake	Earthquakes occurring in active faults		Earthquakes occurring in active faults					Earthquakes occurring in active faults			
	Fault zone as object	Biwako-seigan fault zone		Takayama fault zone			Kokufu fault zone	Inohana fault zone	Ishikari-teichi-toen fault zone			
	Case	1	2		2	3	4	5	1	2	3	4*
Characterized source model / Large-scale parameters	Length (km)	60		48			28	24	42 + 26			
Characterized source model / Large-scale parameters	Width (km)	16		14			14	14	24			
Characterized source model / Large-scale parameters	Depths of upper edge and lower edge of fault (km)	3, 18		3, 17					7, 24			
Characterized source model / Large-scale parameters	Area S of source fault (km^2)	960		672			392	336	1487			
Characterized source model / Large-scale parameters	Seismic moment M_0(Nm)	5.1×10^{19}		2.5×10^{19}			8.5×10^{18}	6.3×10^{18}	1.2×10^{20}			
Characterized source model / Large-scale parameters	Moment magnitude Mw	7.1		6.9			6.6	6.5	7.3			
Characterized source model / Large-scale parameters	Dip angle	70° W (Reverse fault west-side upthrown)		90° (Right-lateral fault)					45° W (Reverse fault east-side upthrown)			
Characterized source model / Large-scale parameters	Short period level A (N m/s^2)	2.0×10^{19}		1.6×10^{19}			1.1×10^{19}	9.8×10^{18}	2.6×10^{19}			–
Characterized source model / Small-scale parameters / Asperity	Gross area Sa (km^2)	284		167			68	53	656			320
Characterized source model / Small-scale parameters / Asperity	Sa/S	ca. 30%		ca. 25%			ca. 17%	ca. 16%	ca. 44%			ca. 22%
Characterized source model / Small-scale parameters / Asperity	Stress drop (MPa)	14.2		14.2			15.5	15.9	11, 9			24.3
Characterized source model / Small-scale parameters / Asperity	Number	Two		Two			One	One	Two			
Characterized source model / Small-scale parameters / Asperity	Area ratio	2 : 1		2 : 1			–	–	16:6			
Characterized source model / Small-scale parameters / Asperity	Location	1st: Northeast of fault, depth is at its center. 2nd: Southwest of fault, depth is at its center.		1st: Northeast end of fault, depth is at its center. 2nd: Center of fault, depth is at its center.		1st: Southwest end of fault, depth is at its center. 2nd: Center of fault, depth is at its center.	Center of fault, depth is at its center	Center of fault, depth is at its center	1st: Center of fault at the north side, depth is its center. 2nd: Center of fault at the south side, depth is its center.			
Characterized source model / Small-scale parameters / Asperity	Locating criteria etc.	Setup at the site where average slipping velocity is large.		Setup at the site where average slipping velocity is large				Setup according to 'recipe' because of no information	Setup at the site where average slipping velocity is high.			
Characterized source model / Other characterized source model	Rupture initiation point	North bottom of the 1st. asperity	South bottom of the 2nd. asperity	Northeast bottom of the 1st asperity	Southwest bottom of the 2nd asperity	Southwest bottom of the 1st asperity	Central bottom of asperity	Central bottom of asperity	North bottom of the 1st asperity	South bottom of the 2nd asperity	South bottom of the 1st asperity	
Characterized source model / Other characterized source model	Rupture velocity (km/s)	2.4		2.5					2.5			
Characterized source model / Other characterized source model	Rupture pattern	Radial (concentric in general)		Radial (concentric in general)					Radial (concentric in general)			
Subsurface structural model	Velocity layer defined as 'engineering bedrock in the detailed method'	VS=430 m/s		VS=750 m/s					VS=480 m/s			
Subsurface structural model	Handling of surface soil layers	Same as the right		Empirical formula by Fujimoto-Midorikawa (2003)					Empirical formula by Fujimoto-Midorikawa (2003)			
Others	fmax (Hz)	6		6					6			
Others	Radiation pattern factor F	0.445		0.445					0.445			

Note: Case 4 of the Ishikari Lowland east-rim fault zone does not estimate seismic intensity distribution because purpose of conducting was improvement of 'recipe'

Table 4.2-1 (5) Parameters used in evaluation of strong ground motions that Earthquake Research Committee publicized by the end of fiscal 2004 (Part 5).

Assumed earthquake				Yamasaki fault zone								
Type of earthquake				Earthquake occurring at active fault				Earthquake occurring at active fault				
Fault zone as object				Northwest main part of Yamasaki fault zone + Southeast part (Ohara fault, Hijima fault, Yasutomi fault, Biwakou fault)				Northwest Main part of Yamasaki fault zone (Ohara fault, Hijima fault, Kuresaka-Toge fault)		Southeast Main part of Yamasaki fault zone	Southeast Main part of Yamasaki fault zone + Kusatani fault	Nagisen fault zone
Case				1-1	1-2 Note (Evaluated as 2 active sections (segments))	1-3 Note	1-4 Note	2-1	2-2	3	4	5
Characterized source model	Large-scale parameters		Length (km)	80				52		30	30 + 14	32
			Width (km)	18				18		18	18	24
			Depths of upper edge and lower edge of fault (km)	7, 21								
			Area S of source fault (km^2)	1440				936		540	792	832
			Seismic moment M_0(Nm)	1.2×10^{20}				4.9×10^{19}		1.6×10^{19}	3.5×10^{19}	3.9×10^{19}
			Moment magnitude Mw	7.3				7.1		6.7	7	7
			Dip angle	90° (Left-lateral fault)				90° (Left-lateral fault)		90° (Left-lateral fault)	90° (Southeast part of Yamasaki fault zone: Left-lateral fault. Kusatani fault: Right-lateral fault)	45° N (Reverse fault upthrown north)
			Short period level A (N m/s^2)	2.6×10^{19}	Segment 1: 2.0×10^{19} Segment 2: 1.6×10^{19}	–		1.9×10^{19}		1.3×10^{19}	1.7×10^{19}	1.8×10^{19}
	Small-scale parameters	Asperity	Gross area Sa (km^2)	594	594	310	310	288		116	220	238
			Sa/S	ca. 41%	ca. 41%	ca. 22%	ca. 22%	ca. 31%		ca. 21%	ca. 28%	ca. 29%
			Stress drop (MPa)	12.6	12.5	24.2	14.4	12.6		14.7	13.9	13.7
			Number	Three	Segment 1: Two Segment 2: One	Three		Two		One	Two	One
			Area ratio	2 : 1 : 1	2 : 1 (segment 1)	2 : 1 : 1		2 : 1		–	2 : 1	–
			Location	1st: Northwest end of northwest main Yamasaki fault zone, depth is center of the fault. 2nd: Northwest end of Yasutomi fault, depth is its center. 3rd and Segment 2: Center of southeast main Yamasaki fault zone, depth is center of the fault.				1st: Northwest end of northwest main Yamasaki fault zone, depth is center of the fault. 2nd: Northwest end of Kuresaka-Toge fault, depth is its center.		Center of southeast part of Yamasaki fault zone, depth is at its center	1st: Center of Southeast Yamasaki fault zone, depth is at its center. 2nd: Northeast end of Kusatani fault, depth is at its center.	Center of Nagisen fault zone, depth is at its center.
			Locating criteria etc.	Setup at the site where average slipping velocity is high.								Set up according to 'recipe' because of no information
	Other characterized source model		Rupture initiation point	Northwest bottom of the 1st asperity				Northwest bottom of the 1st. asperity	Southeast bottom of the 2nd. asperity	Northwest bottom of asperity	Southwest bottom of the 2nd. asperity	Central bottom of asperity
			Rupture velocity (km/s)	2.5								
			Rupture pattern	Radial (concentric in general)								
Subsurface structural model			Velocity layer defined as 'engineering bedrock in the detailed method'	Vs=590 m/s, and Vs=550 m/s								
			Handling of surface soil layers	Empirical formula by Matsuoka-Midorikawa (1994)								
Others			fmax (Hz)	6								
			Radiation pattern factor F	0.445								

Note: Cases 1-2, 1-3 and 1-4 of Yamasaki fault zone have not estimated seismic source distribution because implementing purpose was improvement of 'recipe'.

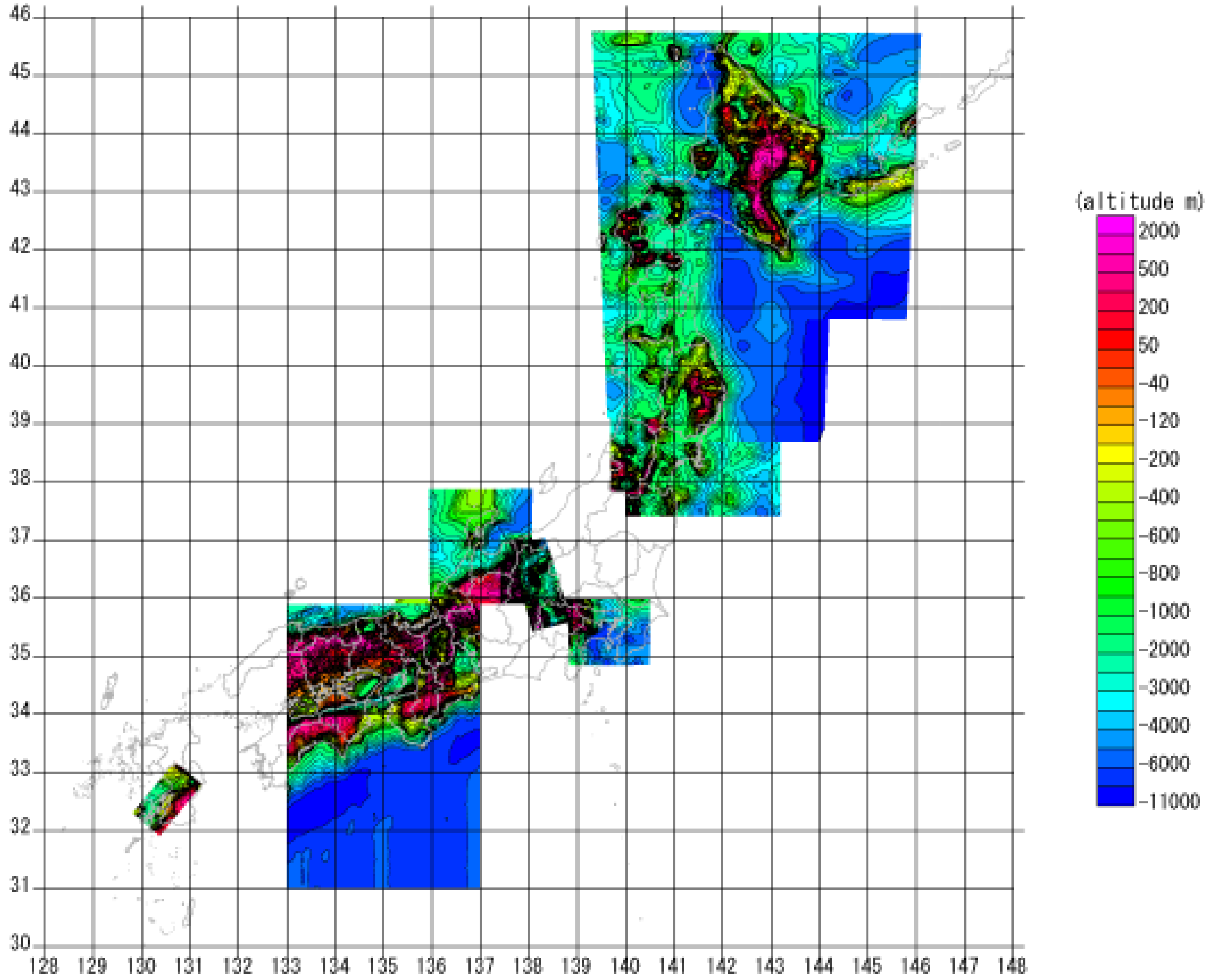


Fig. 4.2-3 Subsurface structural model of the 'deep sedimentary layers' prepared to date for the evaluations of strong ground motions.
(Elevation diagram of bedrock surface: Provided by the National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution)

4.3 Summary of completed evaluations

Shown here is a summary of 12 completed evaluations of strong ground motions published by the Earthquake Research Committee, and verification results of the 'Recipe' using observed records of the 2000 Western Tottori Earthquake (Heisei 12th year) and 2003 Tokachi-Oki Earthquake (Heisei 15th year). With respect to the 12 evaluations, we explain the seismic source fault models and distributions of seismic intensity, and recommend reference to **Section 4.2** regarding other parameters. For regions that have predicted intensities equal to or larger than 6 Upper, the intensity may be 7. Figures shown here of seismic intensity distributions and values at individual sites contain uncertainties to some extent. When more precise results are required, more accurate information on the bedrock conditions at each site may be needed.

For the following evaluations,

* Evaluations of strong ground motions for the assumed earthquakes in the Biwako-seigan fault zone (Earthquake Research Committee, 2004b),
* Evaluations of strong ground motions for the assumed earthquakes in the Yamasaki fault zone (Earthquake Research Committee, 2005), and
* Evaluations of strong ground motions for the assumed Miyagi-ken-Oki Earthquake (Earthquake Research Committee, 2003),

and verifications of the 'Recipe'

* Verification results of the 'Recipe' using observed records of the Western Tottori Earthquake (Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2002), and
* Verification results of the 'Recipe' using observed records of the 2003 Tokachi-Oki Earthquake (Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee, 2004),

please refer to the **Separate Volume 2** and published data and reports for each individual evaluation for more details.

However, in the 'Evaluation of strong ground motions for the Miyagi-ken-Oki Earthquake', there were some remaining points to be corrected later. Revaluations of these portions were carried out and released in a partially corrected version on December 14, 2005. The corrected results are published here.

4.3.1 Evaluations of the Itoigawa-Shizuoka tectonic line fault zone (Outline)

(1) Seismic source fault

For evaluations of strong ground motions in the Itoigawa-Shizuokatectnic line fault zone, we assumed a seismic source fault model, with four earthquake segments, 'North 1', 'North 2', Middle 1' and 'Middle 2', that move simultaneously, as shown in **Fig. 4.3.1-1.** Referring to recent cases of active faults, a single asperity was placed in each segment. Locations of the asperities were set in the vicinity where large slip has been found on the ground surface for the two middle segments. Because such information is not available for the two northern segments, three cases were assumed: Case 1 has asperities on the upper portions of the southern ends of each northern segment. Case 2 is the same but the asperities are located near the north ends of each northern segment. Case 3 has asperities located on the lower portions of the southern ends of each northern segment. The rupture initiation point (hypocenter) was estimated from the fault geometry and set at the north end of segment Middle 1, and its depth was set at the bottom of the asperity.

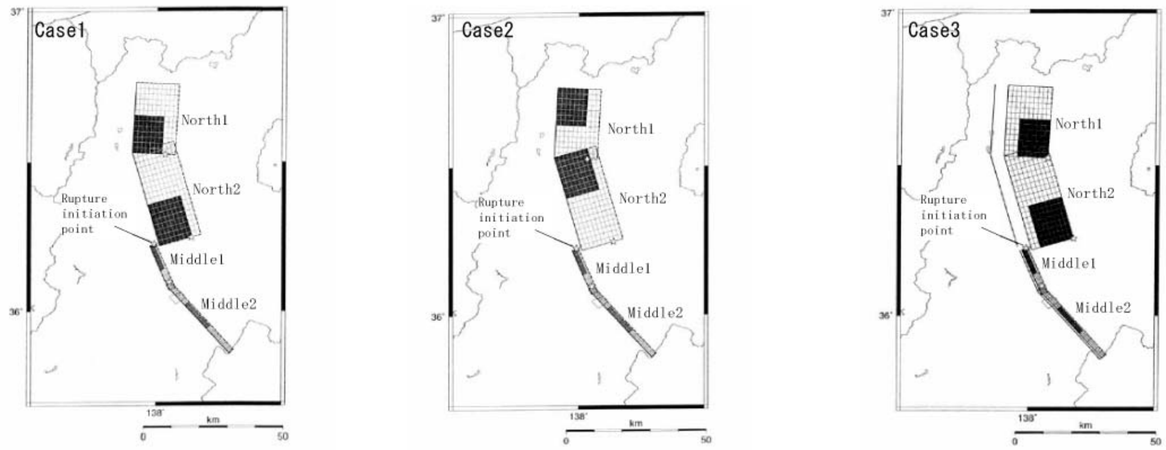


Fig. 4.3.1-1 Assumed seismic source fault model (★: Rupture initiation point; ☆: Rupture initiation point in the southwest; ■: asperity).

(2) Estimated strong ground motion

Based on the seismic source fault model and subsurface structural model, strong ground motions were calculated on a mesh with spacings of about 1 km square for the area of the evaluation. **Fig. 4.3.1-2** shows the seismic intensity distributions for the respective cases. Case 1 shows numerous regions of seismic intensity equal to or larger than 6 Upper, such as immediately above and west of the asperity in the 'North 2' segment (edge of the Matsumoto Basin). Case 2 has different locations of asperities, with many areas of seismic intensity of only about 5 Upper. Sites in Case 2 that show seismic intensity larger than for Case 1 are located near the northern part of the 'North 1' segment (in the vicinity of Otari Village). In all of the areas near the north segments for Case 3, the seismic intensity is lower compared to Case 1, because the location of asperity is deeper. For a particular site, the seismic intensity predicted in each case differs by about 1 to 2 units, indicating that the locations of asperities have a large influence on the results. Furthermore, sites in the Kofu Basin, which have thick sedimentary layers, show seismic intensities equal to or larger than 6 Upper, although they are distant from the fault.

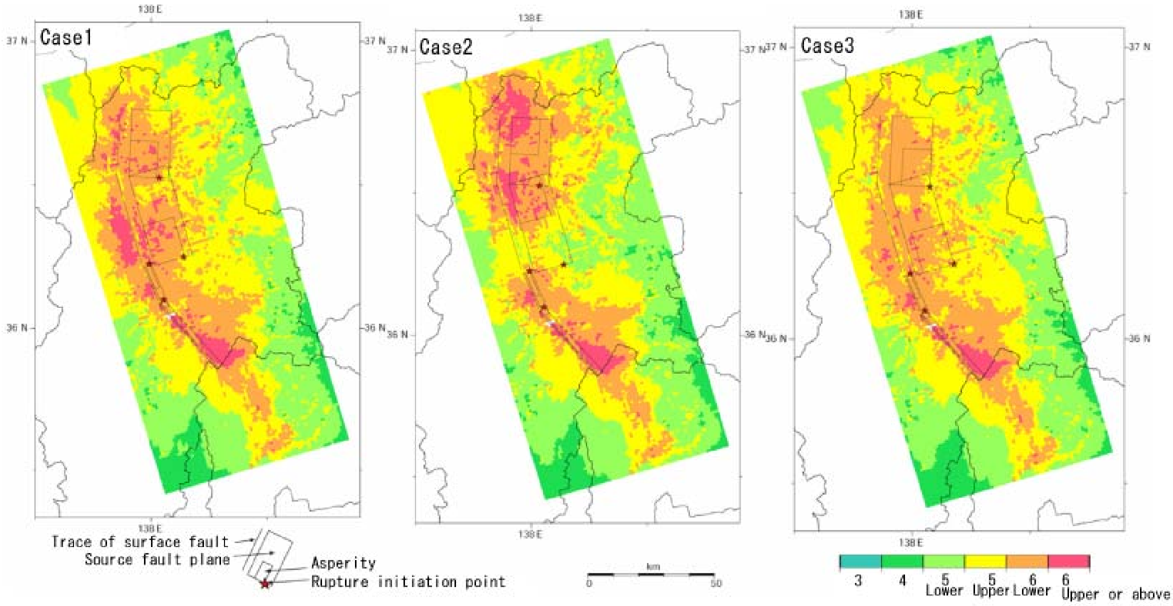


Fig. 4.3.1-2 Results of the predictions of strong ground motions with the 'detailed method': Distribution of seismic intensity at the ground surface.

4.3.2 Verification of the 'Recipe' using observed records of the Western Tottori Earthquake (Outline)

(1) Purpose

Using a seismic source fault of the '2000 Western Tottori Earthquake (Heisei 12th year)' (M7.3), which produced many useful observed records, we calculated strong ground motions based on the 'Recipe' to verify the method. By comparing the calculations with observed records, we study the applicability and problems of the 'Recipe'. Ground motions were calculated for borehole sites of KiK-net (Hino, Hakuta and Hokubo) in the vicinity of the seismic source fault, so that it was possible to evaluate the separate influences of the seismic source and the subsurface structure (Refer to **Fig. 4.3.2-1**).

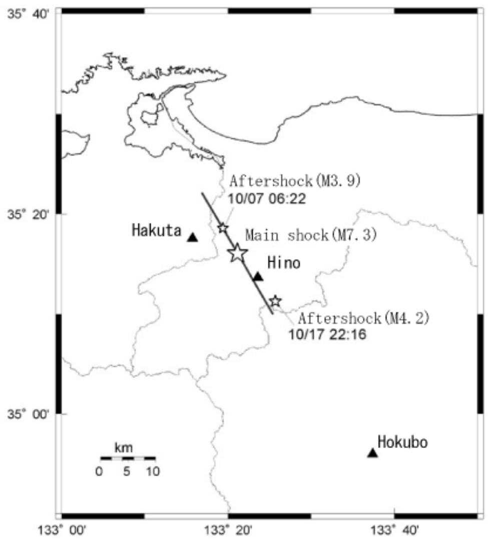


Fig. 4.3.2-1 Seismic source fault model. (☆: Rupture initiation point; ▲: Observation station of KiK-net where waveforms were compared.)

(2) Verification procedure

The simple procedure of the verification method for evaluating the strong ground motions, is shown in **Fig. 4.3.2-2**.

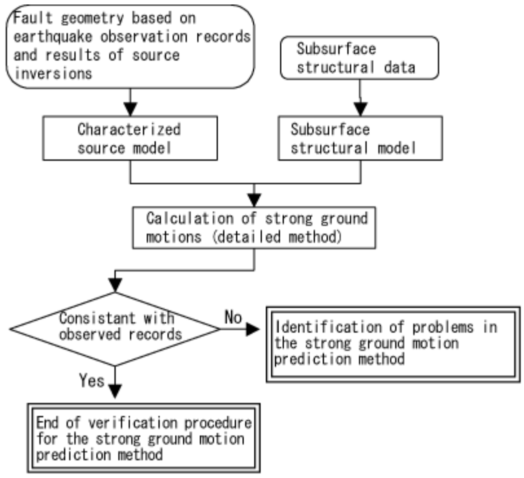


Fig. 4.3.2-2 Flow chart for the verification procedure.

(3) Seismic source fault model and subsurface structural model

Using results from existing studies of the seismic records, values were set for the large-scale parameters of the characterized source model (excluding the seismic moment), for the small sale parameters, such locations and number of the asperities, and for the location of the rupture initiation point. The number of asperities was two. The area of the asperities was set as 22% of the total area of the seismic source fault in Case 1, with reference to Irikura and Miyake (2000): The 1st and 2nd asperities were 16% and 6%, respectively, of the total area. In Case 2, combinations of parameters were tried by trial and error, to match the observed records, with reference to research results that also analyzed the seismic recordings (**Fig. 4.3.2-1**, **Fig. 4.3.2-3** and **Table 4.3.2-1**). The subsurface structural model was approximated with a one-dimensional model at all sites, and layers above the seismic bedrock (shear-wave velocity, Vs=3 km/s) were determined using the borehole information from KiK-net. Layers below the seismic bedrock were based on the structure used by Kyoto University to determine earthquake hypocenters for this region (Refer to **Table 4.3.2-2**, for information on Hakuta and Hokubo).

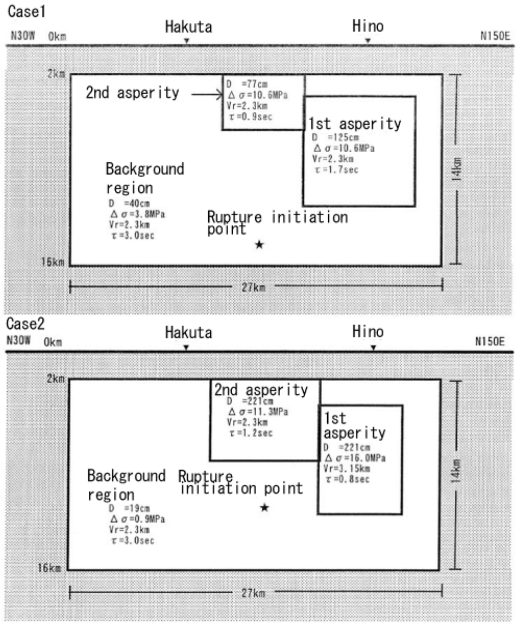


Fig. 4.3.2-3 Locations of asperities and large and small-scale parameters.

Table 4.3.2-1 Seismic source fault parameters.

Seismic source characteristics	Fault parameters		Case 1 (Using procedure of Ito-Shizu interim report)	Case 2 (Best explainable of observed records)
Earthquake scale			JMA magnitude (M) 7.3	
Large-scale parameters	Location of seismic source fault		Refer to Fig. 2	Same as the left
	Strike		Refer to Fig. 2	Same as the left
	Dip angle		90°	Same as the left
	Length of seismic source fault		27km *1	Same as the left
	Width of seismic source fault		14km	Same as the left
	Area of seismic source fault		378km² *2	Same as the left
	Depths of upper edge and lower edge of fault		2, 16km	Same as the left
	Seismic moment		7.0E+18N・m	9.6E+19N・m
	Average slip dislocation		56cm	77cm
	Short-period level of acceleration seismic source spectrum		1.0E+19N・m/s²	1.1E+19N・m/s²
Small-scale parameters	Total asperity	Seismic moment	3.1E+18N・m	7.9E+18N・m
		Gross area	83km²	108km²
		Average slip dislocation	112cm	221cm
	1st asperity	Area	60km² *3	54km² *4
		Average slip dislocation	125cm	221cm
		Seismic moment	2.5E+18N・m	3.9E+18N・m
		Effective stress	10.6MPa	16.0MPa
		Rise time	1.7sec	0.8sec
	2nd asperity	Area	23km² *5	54km² *6
		Average slip dislocation	77cm	221cm
		Seismic moment	5.7E+17N・m	3.9E+18N・m
		Effective stress	10.6MPa	11.3MPa
		Rise time	0.9sec	1.2sec
	Background region	Seismic moment	3.9E+18N・m	1.7E+18Nm
		Area	295km² *7	270km² *8
		Average slip dislocation	40cm	19cm
		Effective stress	3.6MPa	0.9MPa
		Rise time	3.0sec	3.0sec
	fmax		5Hz	Same as the left
Other seismic source characteristics etc.	Rupture initiation point		Refer to Fig. 3 (Depth: ca. 14 km)	Refer to Fig. 3 (Depth: ca. 10 km)
	Rupture propagation pattern		Radial	Same as the left
	Rupture velocity		2.3km/s	2.3(3.15 only for the 1st asperity)km/s

※ S-wave velocity in seismic source region: 3.5 km/s; Rigidity: 3.3×10^{10} N/m²

*1 Actual calculation was carried at 26 km. (Because seismic source was divided with meshes of 2 km x 2 km, the same hereunder.)
*2 Actual calculation was carried in the range of 26 km x 14 km.
*3 Actual calculation was carried in the range of 8 km x 8 km.
*4 Actual calculation was carried in the range of 8 km x 6 km.
*5 Actual calculation was carried in the range of 8 km x 4 km.
*6 Actual calculation was carried in the range of 8 km x 6 km.
*7 Actual calculation was carried in the range of (26 km x 14 km - 8 km x 8 km - 6 km x 4 km).
*8 Actual calculation was carried in the range of (26 km x 14 km - 8 km x 6 km - 8 km x 6 km).

Table 4.3.2-2 One-dimensional subsurface structural model of evaluation point.

Hino Layer no.	Density (g/cm2)	P-wave velocity (km/s)	S-wave velocity (km/s)	Attenuation characteristic Qp	Attenuation characteristic Qs: Theoretical method	Attenuation characteristic Qs: Stochastic Green's function method or amplification characteristic	Layer thickness (km)	
1	1.6	-	0.09	-	-	7.9	0.004	
2	1.6	-	0.06	-	-	7.9	0.007	
3	2.1	-	0.23	-	-	7.9	0.009	Engineering
4	2.2	2.10	0.56	100	50	Frequency dependent	0.022	bedrock
5	2.4	2.60	0.79	200	100	Frequency dependent	0.058	
6	2.6	3.70	1.20	400	200	Frequency dependent	0.080	
7	2.6	4.65	1.75	400	200	Frequency dependent	0.320	Seismic
8	2.6	5.50	3.00	400	200	Frequency dependent	1.500	bedrock
9	2.7	6.05	3.50	550	270	Frequency dependent	14.000	
10	2.8	6.60	3.82	800	400	Frequency dependent	22.000	
11	3.1	8.00	4.62	1000	500	Frequency dependent		

Hokubo Layer no.	Density (g/cm2)	P-wave velocity (km/s)	S-wave velocity (km/s)	Attenuation characteristic Qp	Attenuation characteristic Qs: Theoretical method	Attenuation characteristic Qs: Stochastic Green's function method or amplification characteristic	Layer thickness (km)	
1	1.6	-	0.12	-	-	6.8	0.003	Engineering
2	2.1	2.25	1.20	200	100	Frequency dependent	0.007	bedrock
3	2.6	4.65	1.75	300	150	Frequency dependent	0.032	
4	2.6	4.65	2.25	300	150	Frequency dependent	0.558	Seismic
5	2.6	5.50	3.00	400	200	Frequency dependent	1.500	bedrock
6	2.7	6.05	3.50	550	270	Frequency dependent	14.000	
7	2.8	6.60	3.82	800	400	Frequency dependent	22.000	
8	3.1	8.00	4.62	1000	500	Frequency dependent		

Calculating conditions:
1. Waveform calculation with hybrid method was conducted on engineering bedrock surface.
2. Calculation of amplification characteristic from engineering bedrock surface to sensors installed at the bottom of borehole, evaluation point, was conducted with multi-reflection theory of SH wave, and influence above the engineering bedrock was also considered.

(4) Results

Using the above model, results of the calculated strong ground motions of the 2000 Western Tottori Earthquake were compared with observed records from KiK-net borehole sites at Hino, Hakuta and Hokubo. For calculating strong ground motions, the hybrid synthetic method was used in Case 1, while the empirical Green's function method, using records of aftershocks as impulse waveforms, was used in Case 2. Results of Hino and Hokubo are shown as examples in **Figs. 4.3.2-4 and 2-5**. The calculations for Case 1 roughly conformed to values of instrumental seismic intensity and the observed spectral levels, except at Hokubo. For Case 2, there was good agreement for envelopes of velocity waveforms, including Hokubo. These results verify the appropriateness of the procedure for evaluations of strong ground motion and the characterized seismic source model.

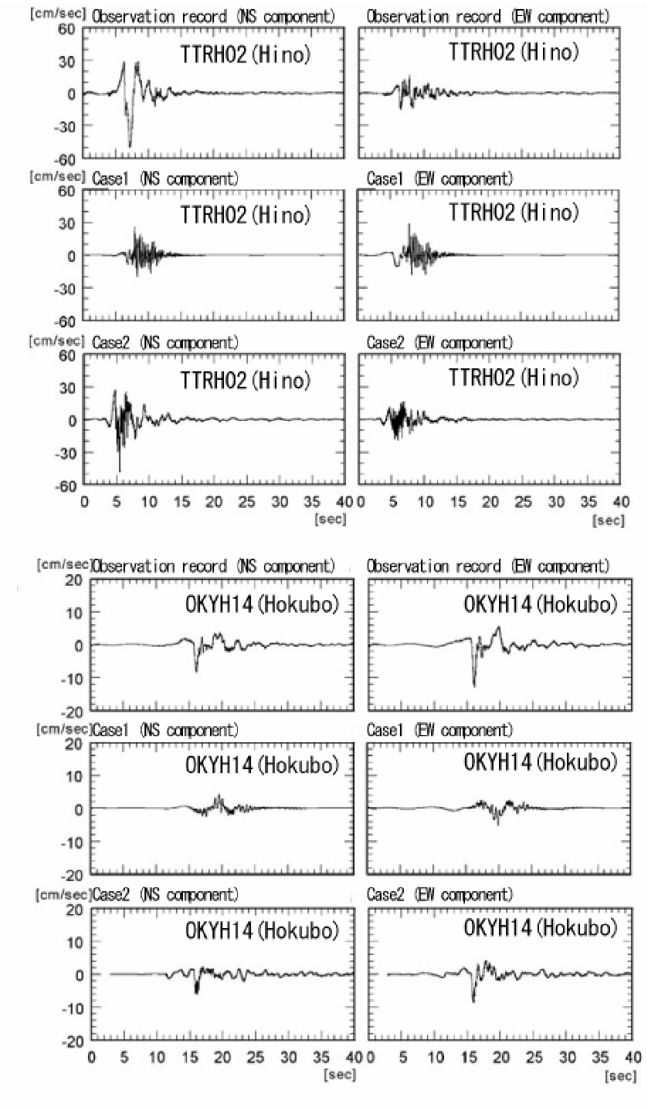


Fig. 4.3.2-4 Comparison of velocity waveforms recorded on borehole sensors (For each station the observed waveforms and calculated waveforms for Case 1 and Case 2 are shown).

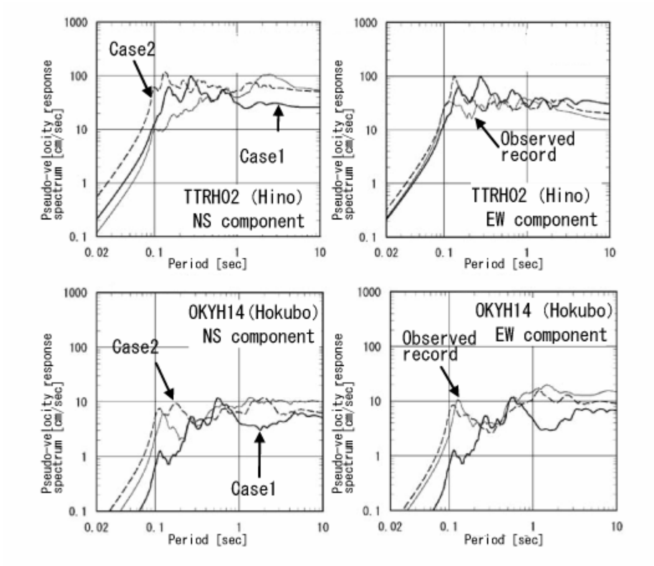


Fig. 4.3.2-5 Comparison of 5% damping pseudo velocity response spectra for borehole sensors (For each station the observed response spectrum and the calculated spectra for Case 1 and Case 2 are shown)

(5) Summary

From the results of this report, the following are issues that are needed to improve the strong ground motion prediction method:

* Establishment of a method to objectively set the locations of asperities and the rupture initiation point.

* Establishment of a method for determining the local characteristics in setting the stress drop.

* Establishment of a more appropriate method for estimating the uncertainty associated with the rupture propagation pattern and rupture velocity.

4.3.3 Evaluations of the Morimoto-Togashi fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motion of earthquakes of the Morimoto-Togashi fault zone, we assumed seismic source faults composed of a single segment, as shown in **Fig. 4.3.3-1.** The 'long-term evaluation of the Morimoto-Togashi fault zone' (Earthquake Research Committee, 2001) stated that 'sufficient data are lacking on the dip and deep geometry of the fault plane'. So considering typical reverse faults, three dip angles of the fault were used, 30, 45 and 60 deg. Useful information is not available for estimating the location of the asperity and the rupture initiation point, so based on calculated values of the average long-term slip velocity from data, such as of fault displacements, we placed the asperity at the southern end of the fault. The rupture initiation point was assumed to be at the southern end of the seismic source fault, considering the splay geometry of the fault. For the case of a 45 deg dip, we also considered a case where the asperity and rupture initiation point were placed at the center of the seismic source fault, as a scenario that has a relatively large influence on downtown of Kanazawa. For this case, we also investigated the variations in the distributions of earthquake ground motions caused by changing the depth of the asperity to the center, top and bottom portions of the fault.

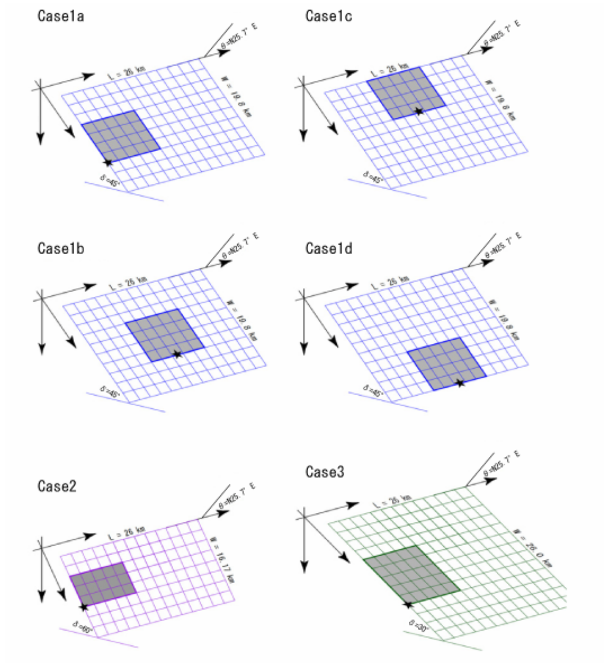


Fig. 4.3.3-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, strong ground motions were calculated on a mesh with spacings of about 1 km square, for the evaluated region. Among the six cases calculated, we show the predicted strong ground motions for Case 1a, Case 1b and Case 2. In Case 1a there was an area approximately 100 km^2 in size, with seismic intensities equal to or larger than 6 Upper, near downtown Kanazawa, located northwest of the asperity. This is caused by both thick sedimentary layers with high amplification factors for the ground velocity and directivity effects. In Case 2, where the dip of the seismic source fault was changed, the areas showing seismic intensities equal to or larger than 6 Upper, are larger compared with Case

1a, influenced by the placement of the asperity on the western side, which has higher amplification factors. In Case 1b, which has the asperity at the center, areas of seismic intensity equal to or larger than 6 Upper, and equal to or larger than 6 Lower, both become larger compared to Case 1a. This is caused by setting the rupture initiation point at a location, where directivity effects easily appear over a wide area. Also, the southern part of the Tonami Plain, located northeast of the seismic source fault, shows seismic intensities of 6 Lower, in a relatively wide area because of the closer location of the asperity. With respect to the downtown vicinity of Takaoka City and the northern part of Komatsu City, the results show seismic intensities of 5 Lower, in Case 1a and 5 Upper in Cases 2 and 1b. This is because these areas are located in plains regions with high surface amplification factors, although being relatively far from the seismic source fault (**Fig. 4.3.3-2**).

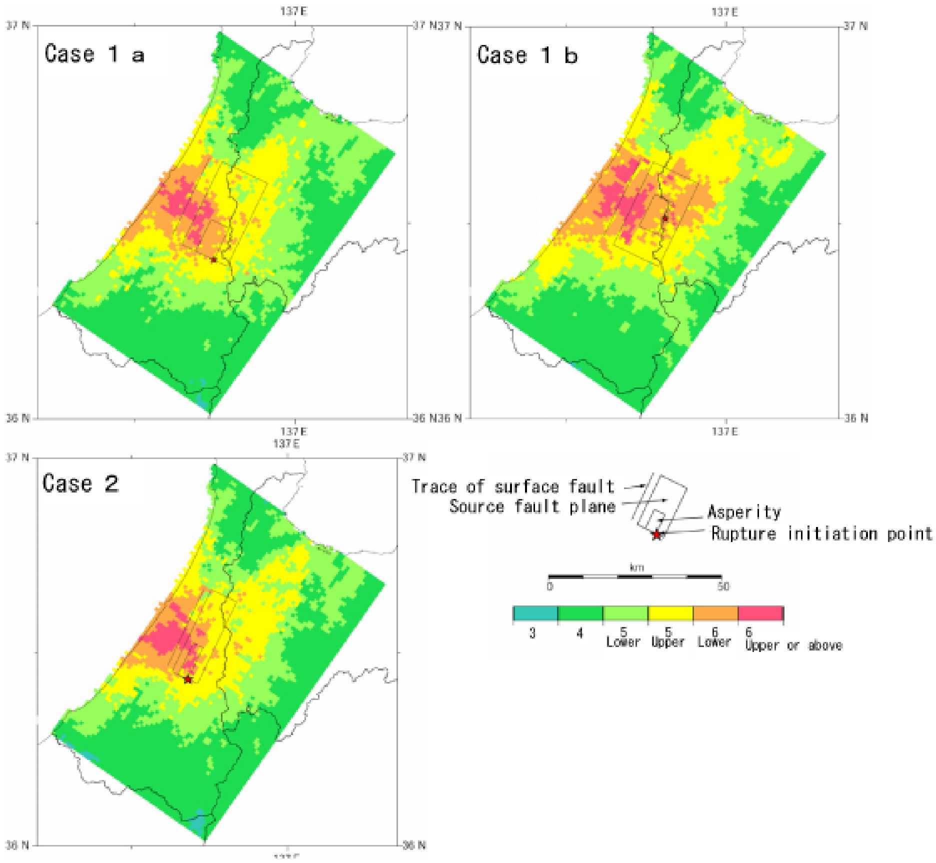


Fig. 4.3.3-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity at the ground surface.

4.3.4 Evaluations of the Miyagi-ken-Oki Earthquake (Outline)

Partially corrected on December 14, 2005

(1) Seismic source fault

For the Miyagi-ken-Oki Earthquake, two types of earthquakes, 'single' and 'linked', were assumed for the evaluation of the strong ground motions (Refer to **Fig. 4.3.4-1**). Shown here is a summary for the 'single' model. There were two assumed cases for the seismic source region in the 'single' earthquake: seismic source regions of earthquakes similar to those in 1978 (A1) and 1936 (A2) (called Cases A1 and A2, respectively) were set. Information was referenced to distributions of microearthquakes and recent investigations of seafloor structures, and fault models (asperity distribution in particular) of the earthquakes in 1978 and 1936. Regarding Case A1, we modified the geometry of the seismic source fault, asperity, and fault parameters so that the calculated results of the strong ground motions are more consistent with the observed records obtained for the 1978 Miyagi-ken-Oki Earthquake. Case 2 was also modified correspondingly.

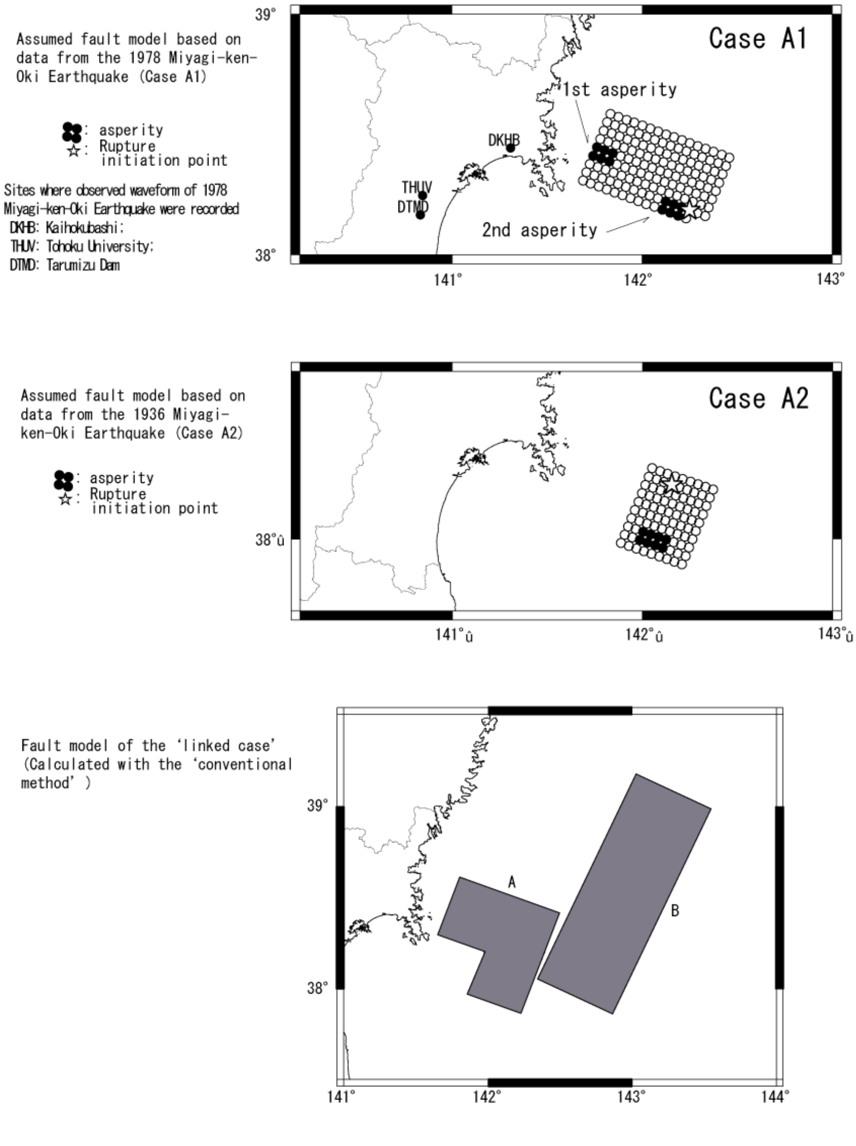
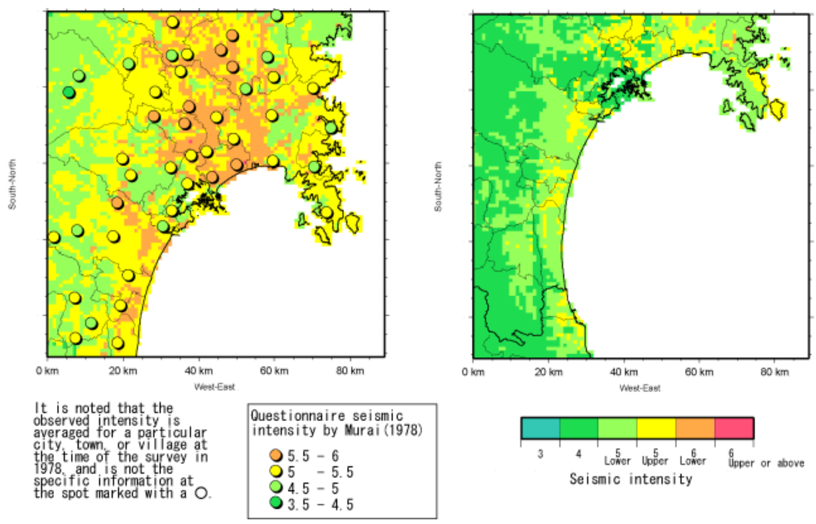


Fig. 4.3.4-1 Assumed seismic source fault model (★: Rupture initiation point; ●: asperity).

(2) Estimated strong ground motion

Calculations of the strong ground motions with a stochastic Green's function method were carried out on a mesh with about 1 km square spacings for the evaluated area. The distribution of seismic intensity is shown in **Fig. 4.3.4-2**. For Case A1, along the lower reaches of old Kitakami River, which has soft surface soil layers and high amplification factors, there are seismic intensities 6 Lower over a wide area. Areas with seismic intensities estimated as equal to or larger than 6 Upper, are also found though limited to a very narrow range. On the other hand, Case A2, which has a smaller seismic source than Case A1, shows fairly small ground motions, partly because the asperity and rupture initiation point are not situated at locations that amplify the ground motions in the evaluated region. Shown in the figure is seismic intensity distribution from a questionnaire distributed by Murai (1979) along with results for Case A1. In the comparison, the areas equivalent to seismic intensity 6 Lower, from the questionnaire correspond in general to areas of seismic intensity 6 Lower, of the predicted results, and there is good correspondence in seismic intensities at other sites. For Case A1, we also compared calculated strong motions to the observed records from the 1978 Miyagi-ken-Oki Earthquake obtained at Kaihokubashi and Tarumizu Dam (Public Works Research Institute, Ministry of Construction, 1978) and records obtained by Tohoku University (Building Research Institute, Ministry of Construction) to verify the results. There was generally good agreement in the overall shape of the envelopes and good correspondence between the observed records and calculated results.



Case A1 (Comparison with questionnaire seismic intensity)

Case A2

Fig. 4.3.4-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity at the ground surface.

4.3.5 Evaluations of the Futagawa-Hinagu fault zone (Outline)

(1) Seismic source fault

For the strong ground motion evaluation of the Futagawa-Hinagu fault zone, we assumed seismic source fault models, with cases where the Middle segment slips alone (Cases 1 and 2) and a case where the Middle and Southwest segments are activated simultaneously (Case 3), as shown in **Fig. 4.3.5-1**. When the Middle segment is activated alone, two asperities were set up. For the rupture initiation point, we assumed two cases because there is no information to specify its location. The initiation was set at the northern end of the Northern asperity in Case 1, and at the southern end of the Southern asperity in Case 2. The influence of the change in the location was shown in the results. In Case 3, the number and locations of the asperities in the Middle segment and the rupture initiation point were the same as in Case 2, and another asperity was placed in the southwest. Since seismic parameters scale with earthquake size, compared to the case where the Middle segment moves alone, we set parameters, such as the effective stress of each asperity to larger values. The dip of the fault was set at 60 deg to the northwest in every case, with reference to the 'long-term evaluation for the Futagawa-Hinagu fault zone' (Earthquake Research Committee, 2002) and the focal mechanism of moderate earthquakes that occur in the vicinity of the fault zone.

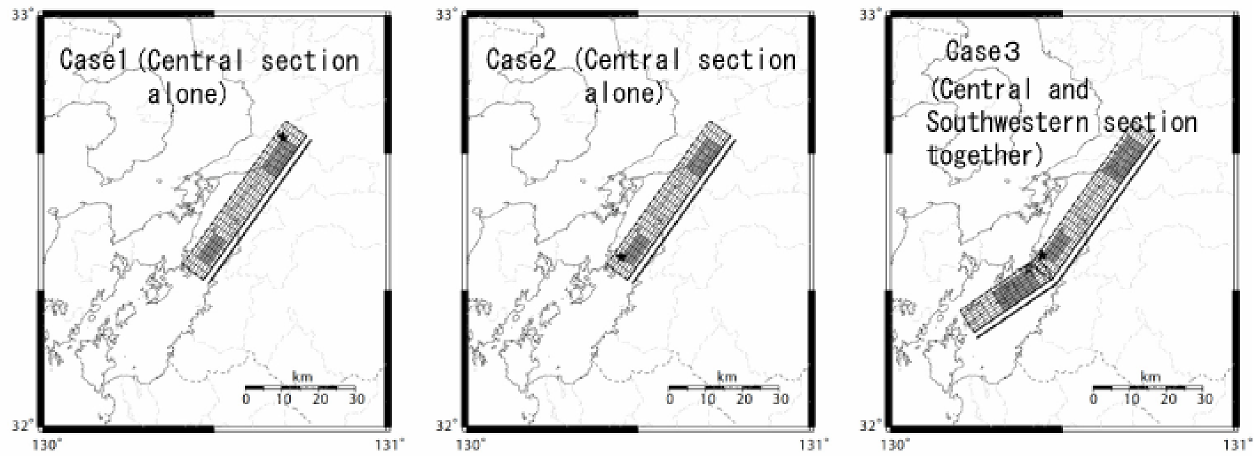


Fig. 4.3.5-1 Assumed seismic source fault model (★: Rupture initiation point; ☆: Rupture initiation point in the southwest; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, calculations of the strong ground motions were carried out on a mesh with about 1 km square spacings over the evaluated region. **Fig. 4.3.5-2** shows the distribution of seismic intensity for each case. In Cases 1 and 2, the seismic intensity is large in the region, with high amplification factors of surface soil layers from Kumamoto City through Yatsushiro City, located just above the fault. In comparison with Case 1, Case 2 has a larger area of intensity equal to or larger than 6 Upper, and a larger region of 5 Upper extending in the northeast (piedmont of Mt. Aso). In the vicinity of Kumamoto City and to the northeast, there are directivity effects because the rupture started in the southwest and propagated to the northeast. In addition, earthquake ground motions were amplified due to deep sedimentary layers. Compared to Case 2, Case 3 has a larger regions of seismic intensity 6 Lower, and equal to or larger than 6 Upper. In addition, parameters, such as area and effective stress of the asperity, are larger corresponding to the increase in the whole size of the earthquake, although the geometry of the asperity in the Middle segment is nearly the same as Case 2. Also, since seismic waves propagating from the segment in the southwest add to the waves from the Middle segment, they amplify the seismic intensity in Case 3.

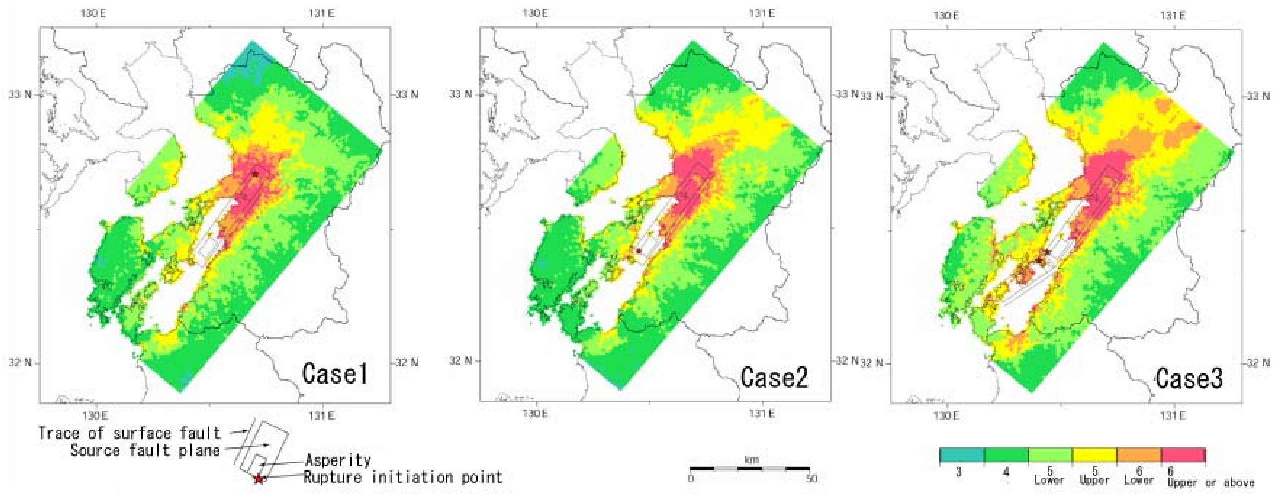


Fig. 4.3.5-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity at the ground surface.

4.3.6 Evaluations of the Miura-hanto fault group (Outline)

(1)Seismic source fault

In the evaluation of strong ground motions for the Miura-hanto fault group, we assumed three cases on the Takeyama fault zone and one case on the Kinugasa-Kitatake fault zone for the seismic source fault model, as shown in **Fig. 4.3.6-1.** In the Takeyama fault zone, an asperity was set in the eastern portion of the Miura Peninsula. Depths of the asperity were assumed to be located at a central depth of the fault (Case 1) and at the top of the fault (Case 2). For the dip of the seismic source fault, we assumed cases of 45 deg (Cases 1 and 2) and of 60 deg (Case 3). In the Kinugasa-Kitatake fault zone, we assumed only one case (Case 4) with location and depth of the asperity, and dip of the seismic source fault similar to Case 1.

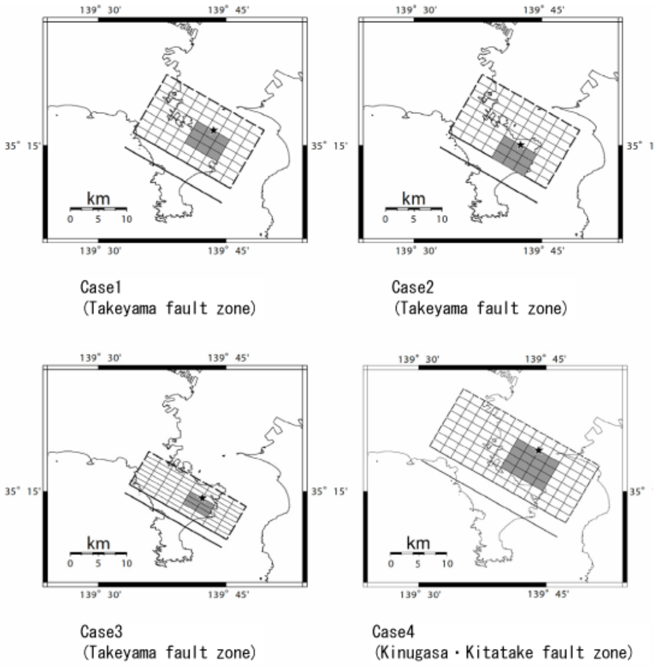


Fig. 4.3.6-1 Assumed seismic source fault model
(★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, calculations of strong ground motions were carried out on a mesh with a spacing of about 1 km square, over the evaluated area. **Fig. 4.3.6-2** shows the distribution of seismic intensity for each case. Case 1 shows seismic intensities equal to or larger than 6 Lower, in a broad area, including the entire Miura Peninsula and coastal areas of Chigasaki, Yokohama and Futtsu cities , with sites of seismic intensity equal to or larger than 6 Upper, in the neighborhood immediately above the seismic source fault. In Case 2, there are seismic intensities equal to or larger than 6 Upper, over a wider area than Case 1, around the south central part of the Miura Peninsula. In Case 3, because the distance from the asperity to the ground surface is shorter, when viewed in the direction of the rupture propagation due to high angle of fault,

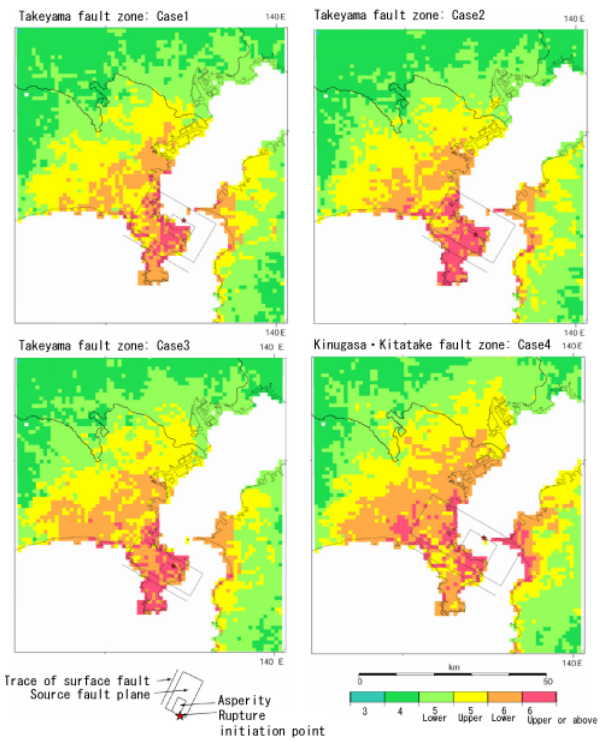


Fig. 4.3.6-2 Results of prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

directivity effects become prominent in the south and expand the area of seismic intensity equal to or larger than 6 Upper, in comparison with Case 1. In comparison of the areas of seismic intensities 5 Upper and 6 Lower, for Cases 1 through 3, large differences are not seen among the three cases. In Case 4, the seismic source fault is wider from the east-southeast to the west-northwest, compared with the case for the Takeyama fault zone, so the area of seismic intensity equal to or larger than 6 Upper, is larger in the areas of Fujisawa and Futtsu cities near the ends of the fault, in comparison with Cases 1 to 3.

4.3.7 Evaluations of the Yamagata-bonchi fault zone (Outline)

(1) Seismic source fault

In the evaluation of strong ground motions for the Yamagata-bonchi fault zone, we assumed a seismic source fault model composed of a single segment, as shown in **Fig. 4.3.7-1.** The geometry of the seismic source fault was set with a small change of strike, from the distribution of seismic faults recognized on the ground surface. Two asperities with different sizes were assumed. Because of the lack of information to specify their locations, we assumed four cases that varied the geometrical relationships and depths of the asperities. Case 1: The larger asperity in the north and a shallow asperity in the south; Case 2: A larger asperity in the south and a shallow in the north; Case 3: A larger asperity in the north and a deep asperity in the south; Case 4: A larger asperity in the south and a deep asperity in the north. The rupture initiation point was set at the central bottom of the larger asperity.

(2) Estimated strong ground motions

Based on the seismic source fault model and the subsurface structural model, calculations of strong ground motions were carried out on a mesh with about 1 km square spacings for the evaluated area. **Fig. 4.3.7-2** shows the distribution of seismic intensity for each case. Regions where strong shaking equal to or larger than seismic intensity 6 Lower, significantly change with the location and depth of the asperities. In Case 1, regions of seismic intensity equal to or larger than 6 Upper, spread toward the east from the areas directly above the two asperities. Directivity effects and the influence of the subsurface structure (basin) cause the seismic intensity to become larger towards the east in the region of northern asperity and the northeast in the region of the southern asperity. In Case 2, seismic intensities become larger in the area of the southern asperity and smaller in the area of the northern asperity, compared to Case 1, because the larger asperity exists in the south. In Case 3, the seismic intensity becomes smaller than in Case 1, particularly in the neighborhood of the small asperity, because the location of the asperity is deeper. Similar patterns are also recognized when comparing Cases 2 and 4.

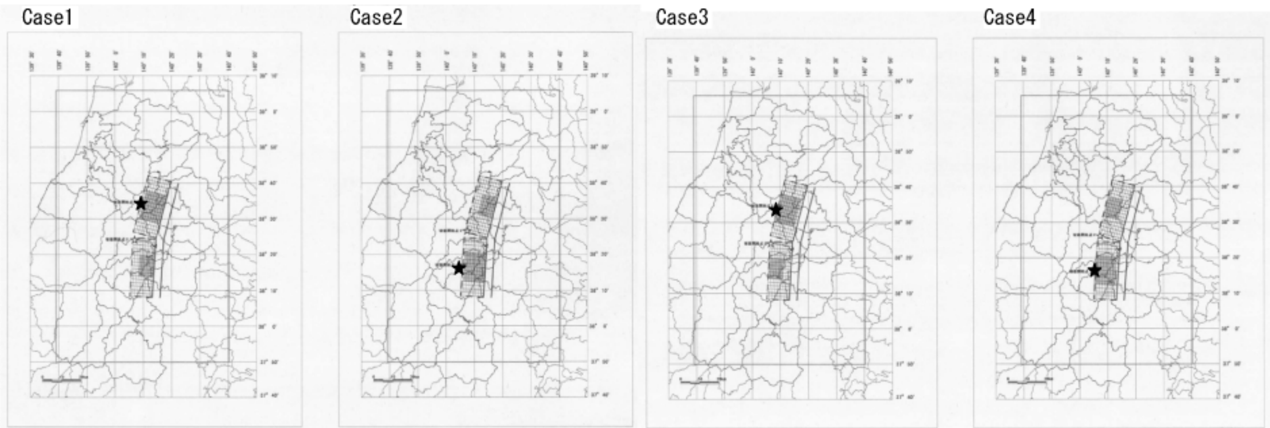


Fig. 4.3.7-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity; □: evaluated region).

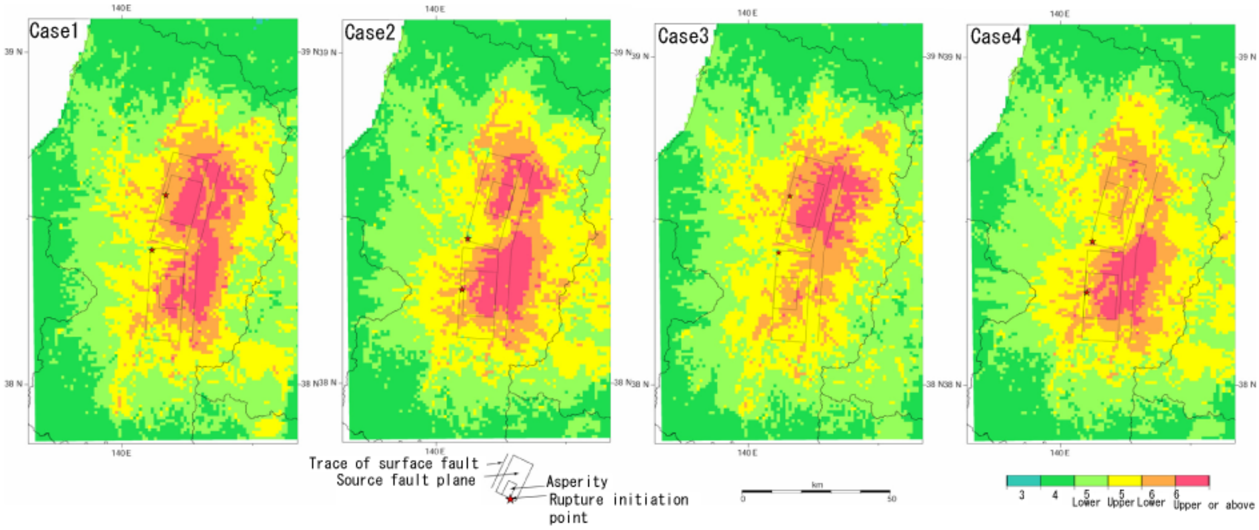


Fig. 4.3.7-2 Results of prediction of strong ground motions with the ‘detailed method’: Distribution of seismic intensity on the ground surface.

4.3.8 Evaluations of the Tonami-heiya fault zone /Kurehayama fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions of the Tonami-heiya fault zone /Kurehayama fault zone, we assumed two cases for the eastern part of the Tonami-heiya fault zone and one case for the western part of the Tonami-heiya fault zone and Kurehayama fault zone, in the seismic source fault model, as shown in **Fig. 4.3.8-1.** The dip of each fault plane was assumed to be 45 deg, from considerations that it is a reverse fault and from the results of geophysical exploration surveys. Typically we set one asperity in a fault segment, but a model with two asperities was also assumed for the eastern part of the Tonami-heiya fault zone. For the Tonami-heiya fault zone (eastern and western parts), we placed the asperity at a location where the estimated average displacement of the fault was relatively large, and the rupture initiation point was set at the bottom corner of the asperity. For the Kurehayama fault zone, the asperity was placed at the center of the fault because such information, as mentioned above, is not available, and the rupture initiation point was set at the central bottom of the asperity.

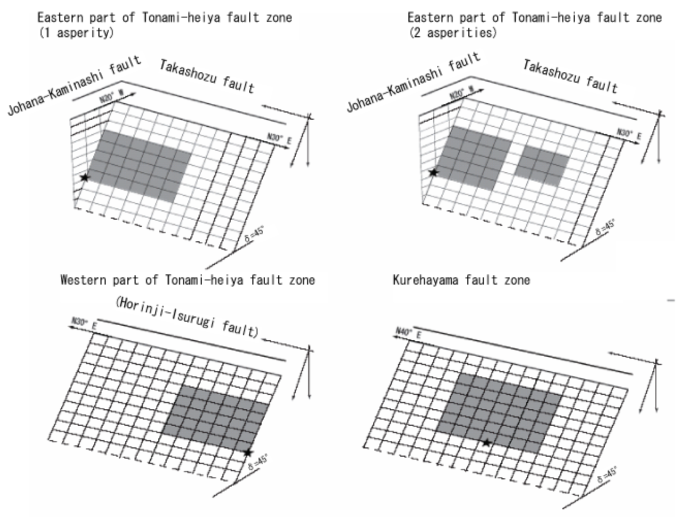


Fig. 4.3.8-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault and subsurface structural model, calculations of strong ground motions were carried out on a mesh with spacings of about 1 km square for the evaluated area. **Fig. 4.3.8-2** shows the distribution of seismic intensity for each case. In the eastern part of the Tonami-heiya fault zone, the distribution of seismic intensity does not show large differences between cases with one and two asperities. There is shaking of intensity 6 Lower, directly above the fault and parts of the surrounding area. In the western part of Tonami-heiya fault zone, close to the asperity, over a wide area of the Kanazawa plain, which has high amplification factors, there are seismic intensities 6 Lower, and some sites with intensities of 6 Upper. In the Kurehayama fault zone, earthquake ground motions nearly above the asperity are large caused by directivity effect, because the rupture initiation point is at the central bottom of the asperity. Also, shaking equal to or larger than seismic intensity 6 Upper, was predicted over a wide area from Takaoka City to Toyama City because of the thick sedimentary layers (deep sedimentary layers) that have high amplification factors.

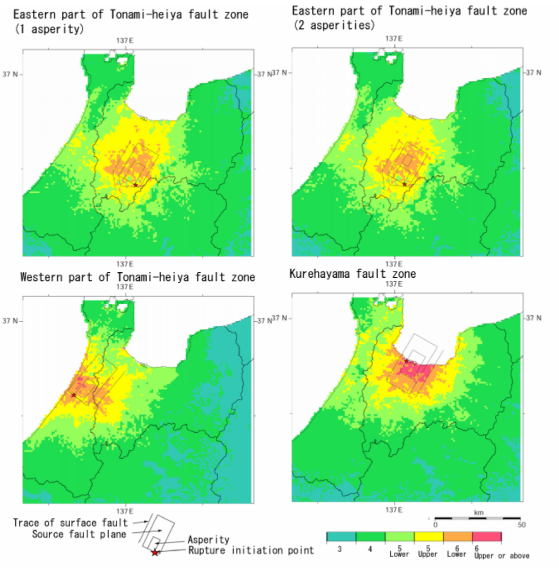


Fig. 4.3.8-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

4.3.9 Evaluations of the Northern Sanriku-Oki Earthquake (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions for an assumed Northern Sanriku-Oki Earthquake, we set parameters for the seismic source fault referring to existing analyzed results of the 1968 Tokachi-Oki Earthquake. In modeling the 1968 event, however, the model setup was done using information obtained at the time of the 'Evaluations of strong ground motions assuming the Miyagi-ken-Oki Earthquake', in part because information available for the Tokachi-Oki analysis is scarce compared to the 1978 Miyagi-ken-Oki Earthquake. For rupture velocity, we tested a range of velocities, with reference to existing research results, and we adopted a value for which the calculated waveforms are the most consistent with the observed records of the 1968 Tokachi-Oki Earthquake (Refer to Fig. 4.3.9-1).

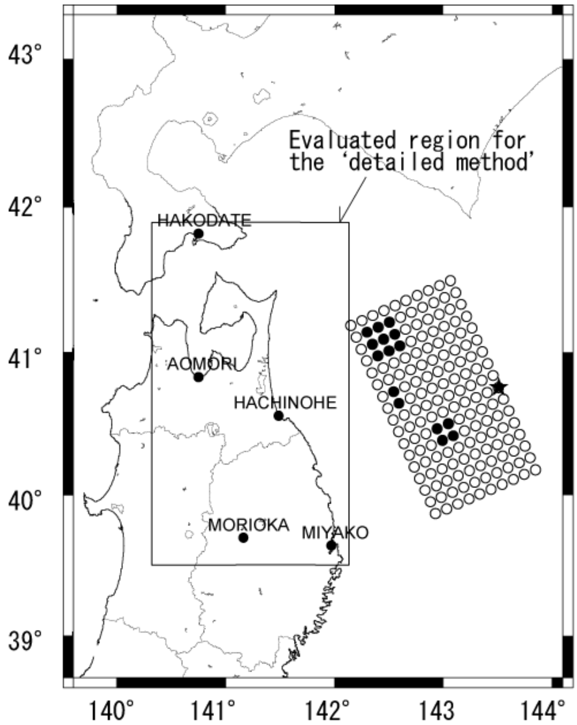


Fig. 4.3.9-1 Assumed seismic source fault model (★: Rupture initiation point; ●: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault and subsurface structural model, we calculated strong ground motions using a stochastic Green's function method, with the 'detailed method' for a mesh with spacings of about 1 km square for the evaluated area. **Fig. 4.3.9-2** shows the distribution of seismic intensities on the ground surface. Seismic intensities of 6 Lower cover a wide area north of Hachinohe City to Misawa City and the northern part of Mutsu City, which is relatively close to the seismic source fault. Seismic intensity 5 Upper was predicted over a broad area in east central Aomori Pref., excluding parts of the mountain area. The observed seismic intensities from the 1968 Tokachi-Oki Earthquake by the Japan Meteorological Agency (1969) and Aomori Prefecture (1969), are also shown in the figure. The region with shaking of seismic intensities of V and VI during the 1968 Tokachi-Oki Earthquake and the results of the evaluations of strong ground motions, are roughly consistent.

Results of the prediction of strong ground motions were also verified using comparisons of the calculated waveforms with the observed waveforms obtained at Hachinohe, Aomori and Miyako for the 1968 event. It seems that the local structure has nonlinear effects of the soil layers in the areas of the observation, particularly at Aomori and Miyako sites, and the bedrock structural model and analytical procedure used at this time could not fully reproduce the observed waveforms.

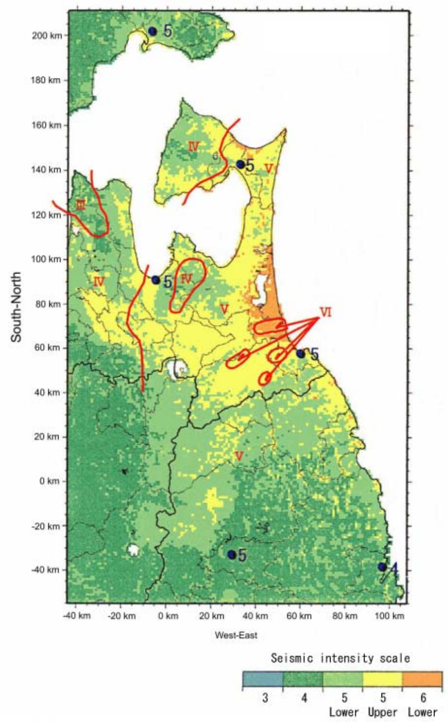


Fig. 4.3.9-2 Results of prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.
Observed seismic intensities from Aomori Prefecture(1996) are shown by red lettering and by the Japan Meteorological Agency are shown by blue lettering.

4.3.10 Evaluations of the Biwako-seigan fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions for the Biwako-seigan fault zone, we assumed a seismic source fault model composed of single segment and two asperities with different sizes, as shown in **Fig. 4.3.10-1**. The dip of the seismic source fault model was set at 70 deg (west dip) considering the local hypocentral distribution of microearthquakes and the relation with the Hanaore fault zone, which is situated to the west. Two cases were assumed for the rupture initiation point: one located at the northern bottom of the north (1st) asperity (Case 1) and the other at the southern bottom of the south (2nd) asperity (Case 2).

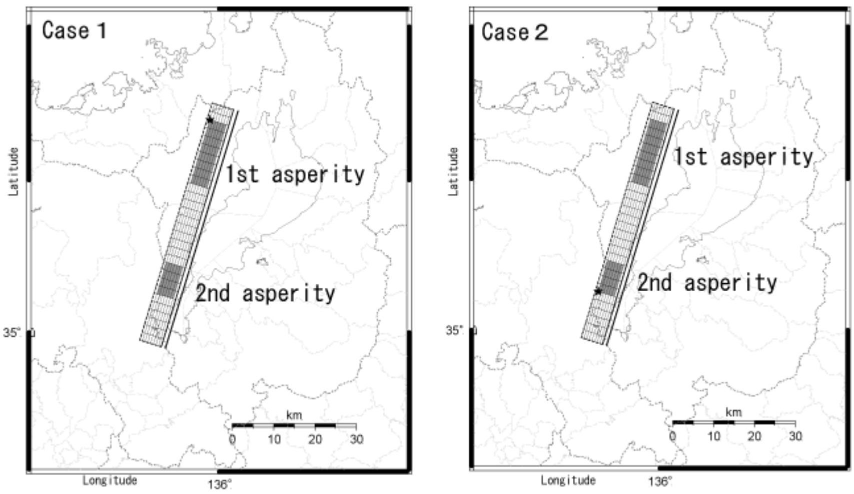


Fig. 4.3.10-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, we calculated strong ground motions on a mesh with spacings of about 1 km square for the evaluated region. **Fig. 4.3.10-2** shows the distribution of seismic intensity for each case. Intensities equal to or larger than 6 Lower, were predicted in the region located close to the asperity, which has high amplification factors in the 'surface soil layers'. In Case 1 there was strong shaking equal to or larger than seismic intensity 6 Upper, on the southeastern side of the 1st asperity, due to directivity effects since this asperity is located in the rupture propagation direction. Also, there are seismic intensities of 5 Upper, in the eastern part of the Osaka Plain, far from the seismic source fault and parts of the Osaka Bay coast (6 Lower at limited sites on the Osaka Bay coast). In Case 2, particularly large seismic intensities were predicted on the east side of the 2nd asperity, with intensities equal to or larger than 6 Upper, at various sites. The eastern Osaka Plain and parts of the Osaka Bay coast that showed areas of seismic intensity 5 Upper, in Case 1, did not exceed about seismic intensity 4 in almost all areas for Case 2, because the areas were located in a direction opposite to the rupture propagation.

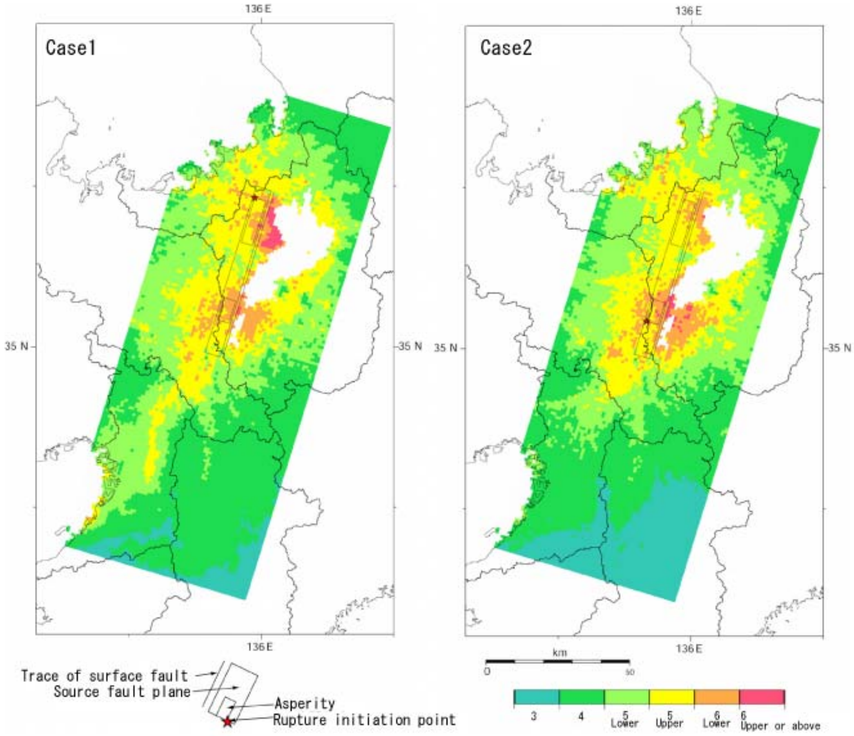


Fig. 4.3.10-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

4.3.11 Evaluations of the Takayama-Oppara fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions for the Takayama-Oppara fault zone, we assumed seismic source fault models with a total of five cases, composed of three cases on the Takayama fault zone for the largest area of the seismic source fault, and one each on the Kokufu and Inohana fault zones, as shown in **Fig. 4.3.11-1**.

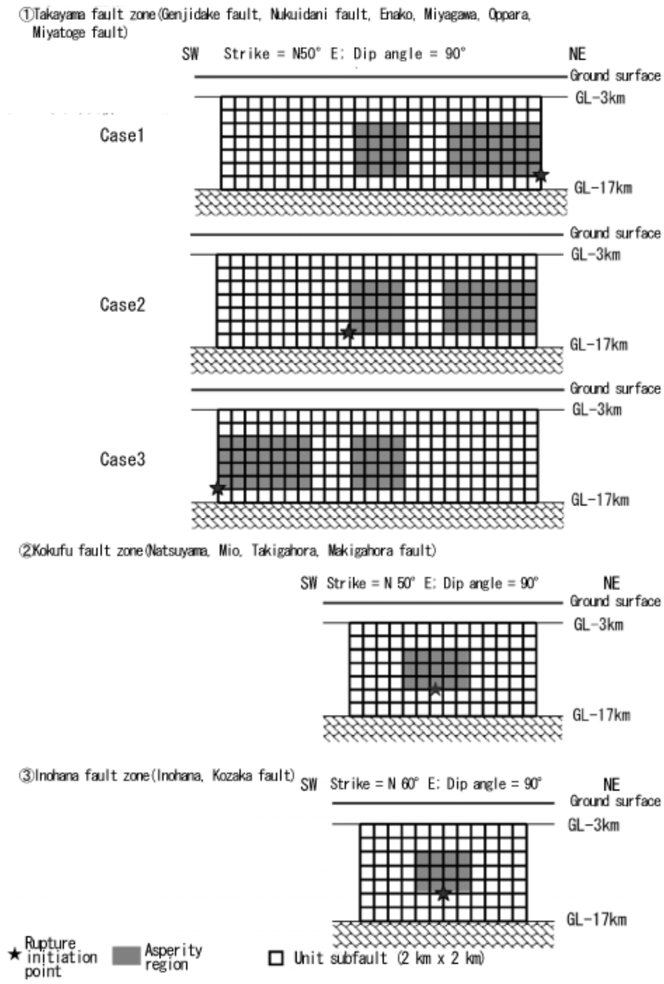


Fig. 4.3.11-1 Assumed seismic source fault model (Takayama fault zone, Kokufu fault zone and Inohana fault zone).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, we calculated strong ground motions on a mesh with spacings of about 1 km square for the evaluated area. **Fig. 4.3.11-2** shows the distribution of seismic intensity for each case. Predicted in Cases 1 and 3 were seismic intensities equal to or larger than 6 Upper, in the region of the asperity set at the center of the seismic source fault model. Predicted in Case 2 were seismic intensities equal to or larger than 6 Upper, in very limited areas in the region of the rupture initiation point, and there was a maximum of 6 Lower in the northeastern areas of the fault zone. Predicted in Takayama City close to the seismic source fault were seismic intensities of 5 Upper to 6 Lower, in Cases 1 and 2, and intensities equal to or larger than 6 Upper, in a very limited area of the south in Case 3. For the cases of the Kokufu and Inohana fault zones, the areas of seismic intensity equal to or larger than 6 Upper were very limited because the size of seismic source fault is smaller than for the Takayama fault zone. Seismic intensities of 6 Lower, were predicted in general, near the fault zone.

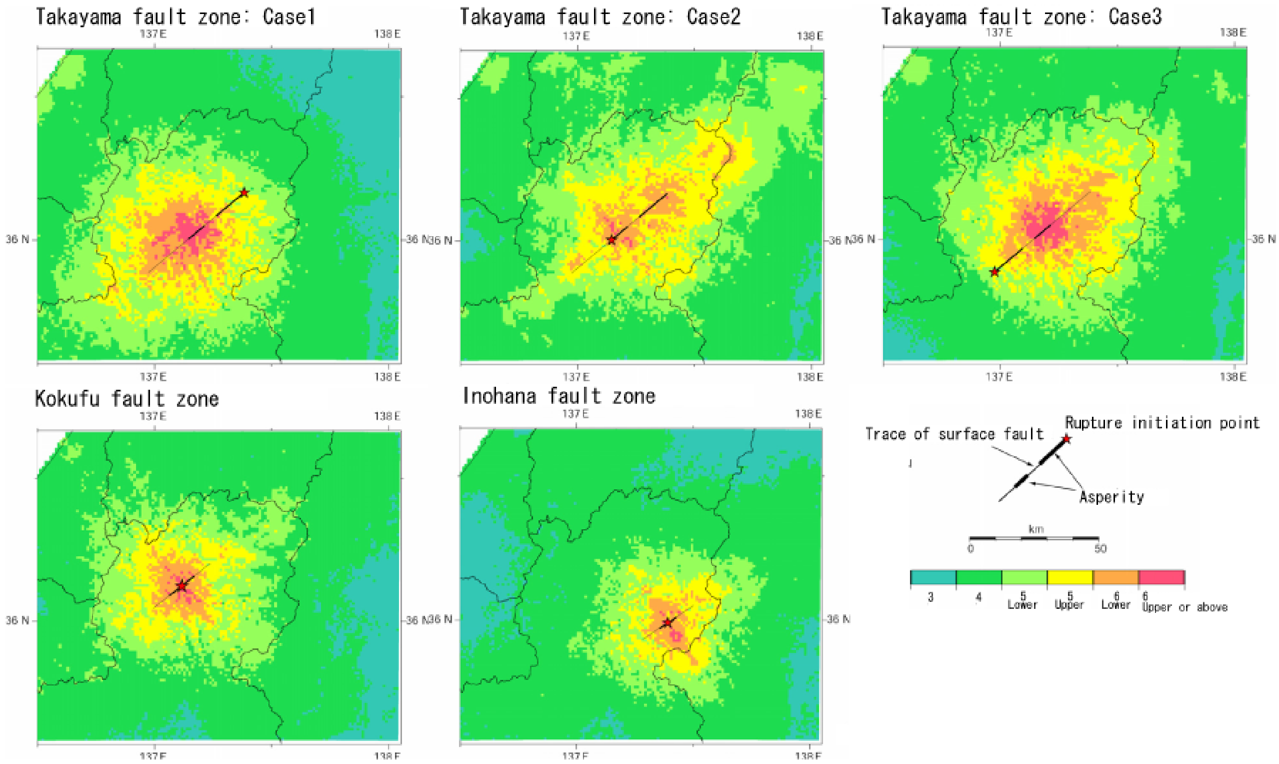


Fig. 4.3.11-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

4.3.12 Evaluations of the Ishikari-teichi-toen fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions for the Ishikari-teichi-toen fault zone, we assumed a seismic source fault model that had a change of strike with two asperities in the north and south of different sizes, as shown in **Fig. 4.3.12-1**. The reason for the two asperities is that there are two peaks in the average slip velocity, estimated from terrace displacements recognized in the arcuate traces of the ground surface, which correspond to the 'main part of fault zone'. The dip of the seismic source fault model was set at 45 deg (east dip) from the distribution of hypocenters of microearthquakes. Because of the lack of information for specifying the location of the rupture initiation point, in Case 1 it was located at the northern bottom of the north (1st) asperity. In Case 2 it was located at the southern bottom of the south (2nd) asperity. In Case 3 it was located at the southern bottom of the north (1st) asperity. Differences in the predicted results due to the difference of the rupture initiation point were shown.

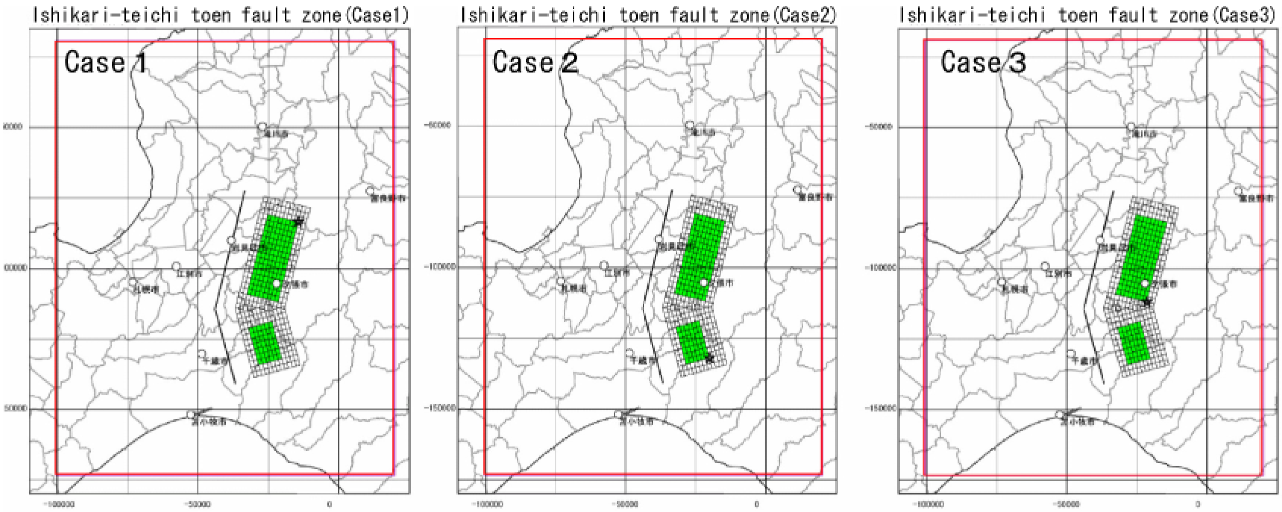


Fig. 4.3.12-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault and subsurface structural model, we calculated strong ground motions on a mesh with spacings of about 1 km square for the evaluated region. **Fig. 4.3.12-2** shows the distribution of seismic intensity for each case. Areas with large seismic intensity are seen on the west side of the surface trace of the fault. In Case 1 there are seismic intensities equal to or larger than 6 Upper, along the rupture propagation direction extending to vicinity of Tomakomai City on the southern surface trace of the seismic source. This is due to the combined effects of directivity along with amplification of fairly long-period ground motions, influenced by thick sedimentary layers ('deep sedimentary layers'), and the amplification of the short-period ground motion due to the 'surface soil layers' in the lowlands. In Case 2 there are seismic intensities equal to or larger than 6 Upper, west of the 1st asperity in the central area, and Case 3 has nearly the same distribution of seismic intensities as Case 2. There are predicted seismic intensities equal to or larger than 6 Upper, in northeastern Sapporo far from the seismic source fault in both cases, and this is due to ground motions with fairly long-periods amplified by the influence of thick sedimentary layers. Also, compared to Case 1, in Cases 2 and 3, there is a northern region of large seismic intensities, with intensity 6 Lower, extending north to Takikawa City.

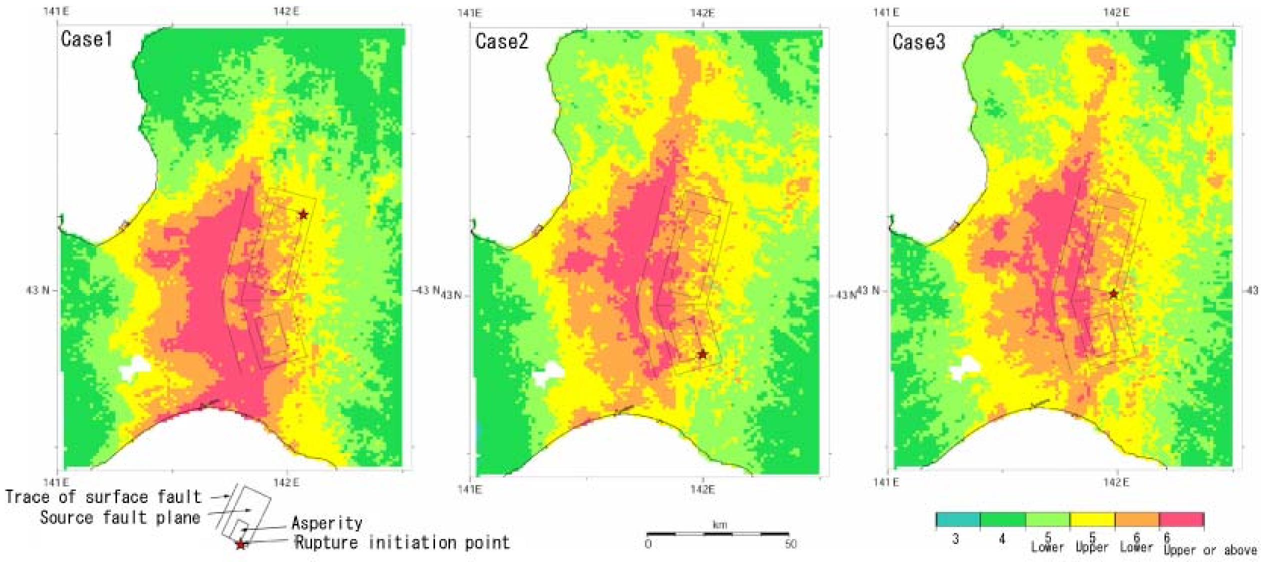


Fig. 4.3.12-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

4.3.13 Verification results using observed records of the 2003 Tokachi-Oki Earthquake (Outline)

(1) Purpose

Using a seismic source fault of the '2003 Tokachi-Oki Earthquake (Heisei 15th year) (M8.0) (called the Tokachi-Oki Earthquake), which produced many useful observation records, we calculated strong ground motions based on the 'Recipe' to verify the method for subduction-zone earthquakes. By comparing the calculations with observed records, we study the applicability and problems of the 'Recipe'.

(2) Verification procedure

A simple procedure of the verification method for evaluations of strong ground motions is shown in **Fig. 4.3.13-1**.

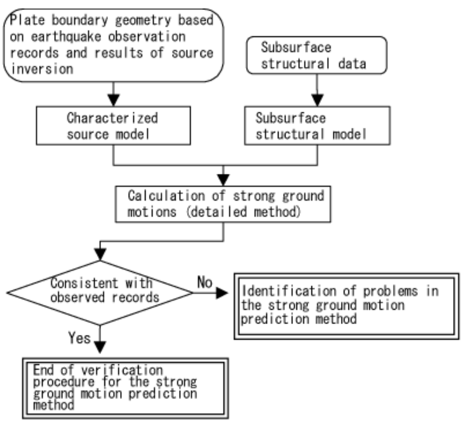


Fig. 4.3.13-1 Flowchart for the verification procedure.

(3) Seismic source fault model and subsurface structural model

Based on existing research results on the seismic source characteristics of the 2003 Tokachi-Oki Earthquake, we set parameters of seismic source fault model. For the location and geometry of the seismic source fault, we referred to the model by Honda et al. (2004). The number of asperities was set to three, with reference to the results of source inversion analyses. The rupture initiation point in the seismic source fault model corresponds to the epicenter location by the Japan Meteorological Agency (Refer to **Fig. 4.3.13-2**). From the depth distribution of the bedrock surface of **Fig. 4.3.13-3**, seismic bedrock is deep in areas of the Ishikari and Tokachi Plains.

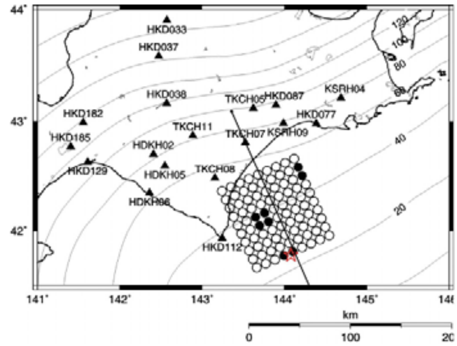


Fig. 4.3.13-2 Seismic source fault model. (☆: Rupture initiation point; ●: asperity. Also shown in the figure are observation sites of K-NET and KiK-net stations for which waveforms were compared.)

Table 4.3.13-1 Seismic source fault parameters.

		Item	Parameter	(Unit)
Large-scale parameters		Fault location	Refer to Fig. 2	–
		Strike	N246° E	–
		Dip angle	18°	–
		Fault area	9000	km^2
		Depth of upper edge of fault	22	km
		Depth of lower edge of fault	53	km
		Rupture initiation point	Refer to Fig. 2	–
		Rupture propagation pattern	Radial	–
		Static stress drop (circular crack)	3.0	MPa
		Seismic moment	1.05×10^{21}	N•m
		Moment magnitude	8.0	–
		Rigidity	4.68×10^{10}	N/m^2
		Average slip dislocation	249.6	cm
		S-wave velocity	3.9	km/s
Small-scale parameters	Total asperity	Seismic moment	1.69×10^{20}	N•m
		Area	722.4	km^2
		Average slip dislocation	499.3	cm
		Effective stress	37.4	MPa
		Short-period level	9.34×10^{19}	$N•m/s^2$
	1st asperity (Near rupture initiation point)	Seismic moment	3.50×10^{19}	N•m
		Area	180.6	km^2
		Average slip dislocation	413.6	cm
		Effective stress	37.4	MPa
		Short-period level	5.42×10^{19}	$N•m/s^2$
	2nd asperity (Near fault center)	Seismic moment	9.89×10^{20}	N•m
		Area	361.2	km^2
		Average slip dislocation	584.9	cm
		Effective stress	37.4	MPa
		Short-period level	7.66×10^{19}	$N•m/s^2$
	3rd asperity (Near north end of fault)	Seismic moment	3.50×10^{19}	N•m
		Area	180.6	km^2
		Average slip dislocation	413.6	cm
		Effective stress	37.4	MPa
		Short-period level	5.42×10^{19}	$N•m/s^2$
	Background region	Seismic moment	8.83×10^{20}	N•m
		Area	8277.6	km^2
		Average slip dislocation	227.8	cm
		Effective stress	4.1	MPa
		Short-period level	4.05×10^{19}	$N•m/s^2$
Other seismic source characteristics		Rupture velocity	2.8	km/s
		Rupture initiatoin point	Epicenter of 2003 Tokachi -Oki Earthquake	–
		Rupture pattern	Concentric	–

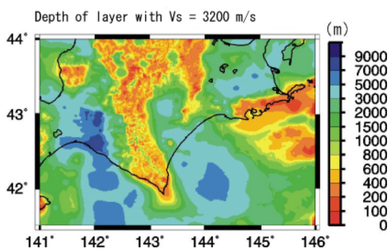


Fig. 4.3.13-3 Depth distribution of bedrock surface.

(4) Evaluated results

Fig. 4.3.13-4 shows comparisons of the calculated waveforms using a stochastic Green's function method and a theoretical procedure, with the observed records from locations on the thick sedimentary bedrock (HKD129, refer to **Fig. 4.3.12-2**). For period longer than 5 sec, the results calculated with only the stochastic Green's function method underestimate the data, but the results can be improved with some theoretical considerations. Taking into account the thick, 'deep sedimentary layers', a 3-dimensional subsurface structural model can be theoretically considered in a 3-dimensional model. **Fig. 4.3.13-5** is an example of a comparison of the observed waveforms and the calculated results using a hybrid synthetic method, along with the observed and calculated pseudo-velocity response spectra. The crossover period has been set at 5 sec. Observed records are generally consistent with the calculated results. **Fig. 4.3.13-6** shows a comparison of results for the instrumental seismic intensity distribution. In the regions of the Ishikari and Yubetsu plains with thick sedimentary layers and the northern side of the volcanic front, we can see regions where the calculated results are larger than the observed records. This is because the empirical formula used in the 'Recipe' for estimating instrumental seismic intensity from peak ground velocity, tends to over-estimate the instrumental seismic intensity with respect to earthquake ground motions having predominant periods longer than 2 sec. In other regions, generally corresponding results were obtained for the calculated and observed values.

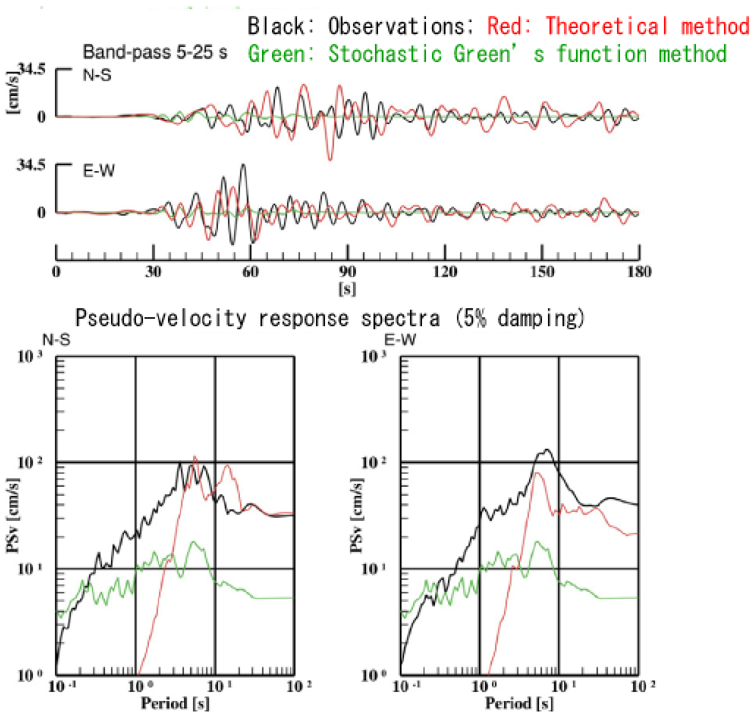


Fig. 4.3.13-4 Comparison of calculated results of the stochastic Green's function method and the theoretical method with observed records.

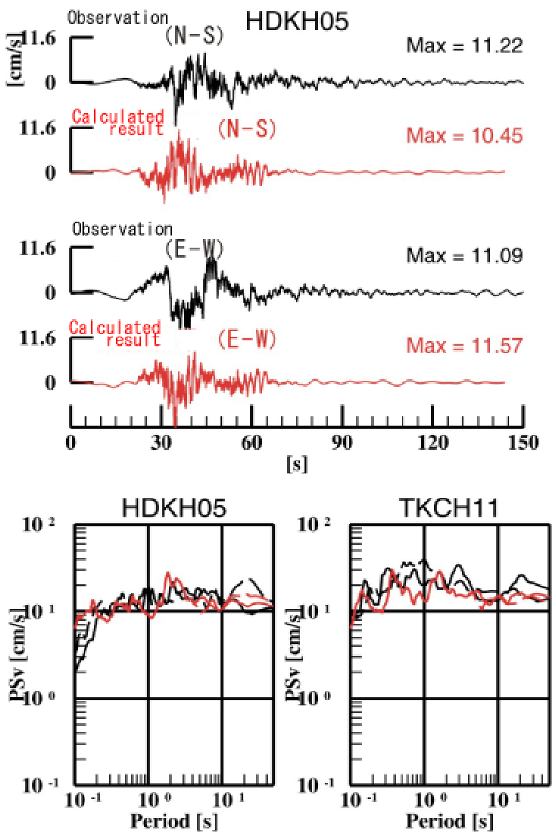


Fig. 4.3.13-5 Waveforms of observed records and calculated results (HDKH05), and comparison of observed and calculated pseudo-velocity response spectra for a damping coefficient of 5% (HDKH05 and TKCH11)

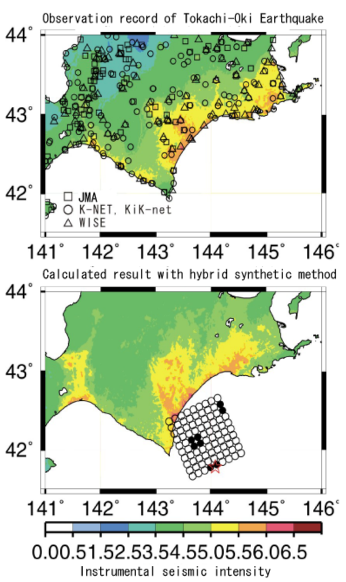


Fig. 4.3.13-6 Comparison of observed records of the Tokachi-Oki Earthquake with calculated results for strong ground motions using the hybrid synthetic method.

(5) Summary

It was found that strong ground motions by the present 'Recipe' for the period range shorter than about 1 sec or longer than about 5 sec are generally in harmony with the observed data. It is necessary to improve the 'Recipe' and increase the precision of large-scale 3-dimensional subsurface structural model, including the seismic source region, to increase the accuracy of predictions for strong ground motions with a period range of several sec (from about 1 to 5 sec).

4.3.14 Evaluations of the Yamasaki fault zone (Outline)

(1) Seismic source fault

In the evaluations of strong ground motions for the Yamasaki fault zone, we assumed several seismic source fault models, as shown in **Fig. 4.3.14-1**. For one case the Ohara fault, Hijima fault, Yasutomi fault and the southeastern part of the main part of the Yamasaki fault zone, all simultaneously are active (Model 1). In another case, the Ohara fault, Hijima fault and Kuresaka-toge fault, which are northwestern part of the main part of the Yamasaki fault zone, move together (Model 2). The third case is for the southeastern part of the main part of the Yamasaki fault zone (Model 3). In the fourth case, the southeastern part of the main part of the Yamasaki fault zone and the Kusatani fault are simultaneously active (Model 4). The last case is for the Nagisen fault zone (Model 5). In Model 1, three asperities were placed on the three segments and the rupture initiation point was set at the bottom northwestern edge of the 1st asperity. In Model 2, two asperities were placed on the two segments and two cases were carried out with the rupture initiation points at bottom northwest edge of the 1st asperity (Case 2-1) and the bottom southeast edge of the 2nd asperity (Case 2-2). For Model 3, the asperity was placed at the center of the fault and the rupture initiation point was put at the bottom northwestern edge of the asperity. For Model 4 a large asperity (1st asperity) was placed at the center of the southeastern segment of the main part of the Yamasaki fault zone, and a small asperity (2nd asperity) at the northeastern end of the Kusatani fault, with reference to the results of the trench survey near Kusatani. The rupture initiation point was put at the bottom northeast edge of the 2nd asperity, from the consideration that the two faults (fault zones) possibly were simultaneously active in the past. For Model 5, the asperity was placed at the center of the fault zone as an average case, and the rupture initiation point was put at the bottom center edge of the asperity.

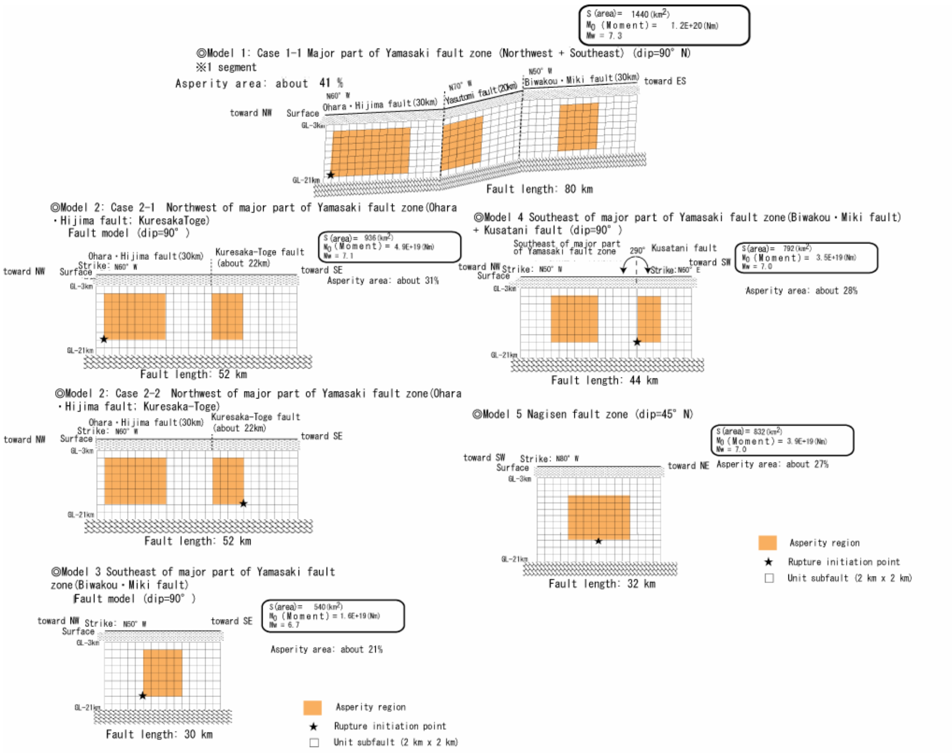


Fig. 4.3.14-1 Assumed seismic source fault model (★: Rupture initiation point; ■: asperity).

(2) Estimated strong ground motions

Based on the seismic source fault model and subsurface structural model, we calculated strong ground motions for a mesh with spacings of about 1 km square for the evaluated region. **Fig. 4.3.14-2** shows the distribution of seismic intensity for each case. In Case 1-1 of Model 1, there were generally seismic intensities of 6 Lower to 5 Upper near the Ohara fault, Hijima fault, and in the vicinity of the seismic source fault for the southeastern segment of the main part of the Yamasaki fault zone. In the area of the Yasutomi fault, however, the seismic intensity was 5 Upper, even near the fault. Also, seismic intensity 6 Lower, was predicted through eastern Himeji City, into Miki City and even to the coastal area of Kobe City. Although Case 2-1 of Model 2 shows a pattern nearly the same as Case 1-1, the southeastern segment of the main part of Yamasaki fault zone is not included in the earthquake, so that the seismic intensity was predicted as 5 Upper to 5 Lower in this region. Case 2-2 does not show large differences from Case 2-1 for the distribution of seismic intensity in the region of the seismic source fault zone. In the Kurayoshi Plain region of western Tottori Pref. somewhat far from the seismic source fault, generally seismic intensities of 5 Upper to 5 Lower with values equal to or larger than 6 Lower in a limited areas, were predicted. This was due to directivity effects and amplification of seismic waves in the 'deep sedimentary layers' and 'surface soil layers. On the coast of Kobe City, on the other hand, shaking remained at seismic intensities 5 Lower to 4 because the location is in the opposite direction to the rupture propagation. In Model 3, generally seismic intensity 6 Lower was predicted around the seismic fault. Also predicted were region of seismic intensity equal to or larger than 6 Upper, in some areas of Takasago City and Kakogawa City and intensity 6 Lower in the coastal areas of Kobe City. In Model 4 generally seismic intensity 6 Lower was predicted around the seismic fault, and equal to or larger than 6 Upper, around the seismic source fault in s ome areas of Himeji, Takasago, Kakogawa, and Kasai cities . In the coastal area of Kobe City where seismic intensity 6 Lower was predicted in Model 3, seismic intensity remained at 5 Upper, because Kobe is located in the opposite direction to the rupture propagation. In Model 5 generally seismic intensities of 6 Lower to 5 Upper are seen directly above the asperity and to the south. In comparison with evaluated results of other earthquakes, the seismic intensity in the region of the seismic source fault is somewhat smaller for the size. This is because bedrock in the region of the seismic source fault was very hard and amplification of seismic waves between the seismic bedrock and ground surface was small.

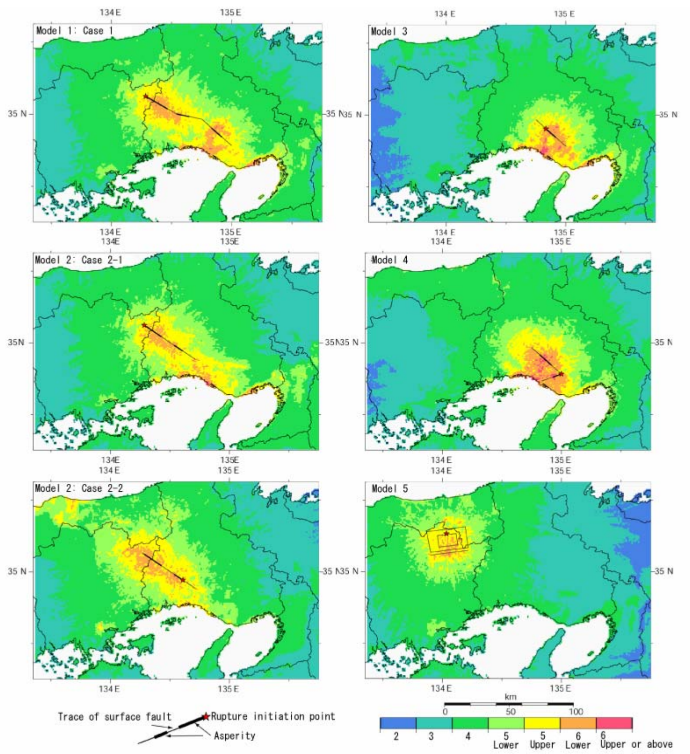


Fig. 4.3.14-2 Results of the prediction of strong ground motions with the 'detailed method': Distribution of seismic intensity on the ground surface.

5. Utilization of 'National Seismic Hazard Maps for Japan (2005)'

The 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults' prepared by the Earthquake Research Committee are used to elevate the awareness of earthquake disaster prevention, as stated in the Comprehensive Basic Policies, and further assumed to be used for the following:

- **Matters relating to survey observations on earthquakes**
  - **Focused investigations of earthquakes**
- **Matters relating to regional residents**
  - **Promoting awareness of earthquake disaster prevention among local residents**
- **Matters relating to earthquake disaster mitigation measures**
  - **Basic data in land-use planning and earthquake resistance design for facilities and structures**
- **Matters relating to risk[21] evaluation**
  - **Basic data in risk evaluation for locating important facilities, land use for industries, calculating rates for earthquake insurance**

Maps shown in this volume are a generalized view of the entire country of Japan, showing information of seismic intensities with a resolution of about 1 km square on the ground surface, but also provided are, intensity and waveform data for the engineering bedrock that were produced as part of the preparation process. Calculated waveforms on the engineering bedrock are data used for evaluations of strong ground motion for preparing the 'Seismic Hazard Maps for Specified Seismic Source Faults', and have been utilized as input earthquake ground motions for earthquake resistance design. And, the 'Probabilistic Seismic Hazard Maps' have been utilized as basic data for calculating rates for earthquake insurance, in addition to priority ranking and studies of promoting earthquake resistance for school facilities (Survey and study on promotion of earthquake residence to school facilities cooperators meeting, 2003), study on the urgency of earthquake resistance projects, and data for intensified surveys observations of earthquakes (Headquarters for Earthquake Research Promotion, 2001).

In the future, further usage is expected by improving the precision of the strong motion predictions and preparation of local detailed maps.

With respect to the role of future utilizations of the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults', we describe two subjects in the following sections. The first is usage of the maps based on their respective characteristics, and the second is complementary methods of proper use and integration of the two maps. Case examples and discussions on engineering applications are described by the Study Committee for Engineering Applications of the National Seismic Hazard Maps (2004).

5.1 Utilization of 'Probabilistic Seismic Hazard Maps'

[21] Refer to **Appendix 1** regarding 'seismic risk'

5.1.1 Appropriate ways to interpret the maps

Because the 'Probabilistic Seismic Hazard Maps' are usually not familiar to people, we first describe the information shown on the maps and its usage.

(1) Probability maps with fixed 'time period' and 'intensity'

We can recognize regional differences in possibilities of strong shaking , by using the map that shows the possibility of intensity equal to or larger than seismic intensity 6 Lower, within 30 years from the present. The map can be used as basic data for planning strategies to set priorities for the progress of local measures, and setting intensity levels for countermeasures to be undertaken.

(2) Intensity Map with fixed 'time period' and 'probability'

We can recognize regional difference in shaking intensities that occur at least once in about 1000 years, by using the map of intensity for a 3% probability of exceedance in 30 years from the present (recurrence period of about 1000 years). The map can be used as basic data to study the expected degree of shaking, when considering the response to the strong shaking of a rare earthquake at a given site.

5.1.2 Utilization considering characteristics of the maps

'Probabilistic Seismic Hazard Maps' include all earthquakes that can influence strong shaking, including the earthquakes other than the major ones specified, that may produce strong shaking. For the earthquakes that occurred in 2003 in Miyagi-Oki and northern Miyagi-ken, the 2000 Western Tottori earthquake, and the 2004 Niigata Chuetsu earthquake, long-term evaluations had not been conducted. However, these events have been classified as 'earthquakes without specified source faults' and their influence (on the probabilistic hazard maps) have been considered. The 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults' are complementary, in considering the hazardous nature of earthquakes without specified source faults.

In addition, we can quantitatively compare the possibility of economical loss due to earthquakes, with other natural disasters and accidents, using the annual occurrence probabilities based on the results of the 'Probabilistic Seismic Hazard Maps'. Therefore, the maps can be used as basic data for risk evaluation in insurance, and risk management of structures, and others.

5.1.3 Utilization for earthquake disaster prevention and earthquake resistance design

Utilization of the map can be considered for relative comparisons of the possibilities of strong shaking between sites, for prioritization of locations for disaster prevention measures, seismic strengthening, and the like. Further, they can be considered as basic data, such as for denoting earthquake ground motion levels for design and information for regional factors. In 'Promotion of Earthquake-resistance for School Buildings', the concept of utilization to determine priority ranking has been shown. Using the generalized maps of all of Japan, priority ranking for equipment and facilities, can be done on a national or prefectural level. When used on the scale of local municipalities, the small area of interest requires detailed map information (Refer to **Section 6.1.1**). Furthermore, in order to be used for decision-making in earthquake countermeasures, it is important not only to have information about the possibility of strong shaking, but also to indicate what degree of damage is possible for the structures.

Probabilistic predictions of earthquake ground motions have generally been used to set levels of earthquake ground motions for design and seismic strengthening at individual sites, based on detailed information. The international standard (ISO3010, 2000), for instance, has shown how rarely occurring intensity should be considered, depending on the damage level of structures. Since data used for preparation of the 'Probabilistic Seismic Hazard Maps' are released, the information can also be used for detailed evaluations of individual locations.

5.2 Utilization of 'Seismic Hazard Maps for Specified Seismic Source Faults'

'Seismic Hazard Maps for Specified Seismic Source Faults' have been prepared based on precise results for prediction of strong ground motions, by considering characteristics specific to the earthquake of interest, and ground motion characteristics of the bedrock due to 3-dimensional subsurface structures in the region. Using these maps, we can show the level of shaking in the surrounding region when the assumed earthquake occurs. Also, calculated waveforms on the engineering bedrock can be obtained for broad areas. Moreover, calculated waveforms can be used for seismic response analysis of structures with various properties, because prediction of strong ground motions over a broad band frequency range is possible with the 'detailed method'. From this viewpoint, the 'Seismic Hazard Maps for Specified Seismic Source Faults' have many uses as follows:

5.2.1 Utilization for earthquake disaster prevention

For seismic disaster prevention, the maps provide basic data for planning of seismic hazard mitigation programs, emergency measures for seismic hazards, and the like. When municipalities formulate local disaster prevention programs, they specify earthquakes to be assumed, depending on the occurrence possibility and/or degree of influence, calculate the strong ground motions for this earthquake, then predict the damage. Based on this predicted results, disaster prevention programs are formulated. In this process, the 'Seismic Hazard Maps for Specified Seismic Source Faults' have been used to provide accountability to residents and the administrations, .

The 'Seismic Hazard Maps for Specified Seismic Source Faults' can be used in the formulations of disaster prevention measures and emergency restoration programs of lifeline, such as water supplies and gas facilities, in cases where extensive damages are assumed. The maps can provide required information on the location and degree of damage, when an earthquake occurs, along with scenarios of countermeasures.

Usage in real-time earthquake disaster prevention is also considered. Earthquake damage can be mitigated, if we can predict the level of shaking for the region before the seismic waves arrive. With future improvements in performance of computers and calculation procedures, it is expected that the 'Recipe' can be applied to real-time prediction of strong ground motions.

5.2.2 Utilization for earthquake resistance design of structures

Calculated waveforms on the engineering bedrock can be used as input ground motions for the design of earthquake resistant structures. Regarding important structures, such as high-rise buildings and very long bridges, earthquake resistance designs have been conducted by using seismic waveforms on the engineering bedrock. It was difficult in the past to calculate the influence of active faults on land and subduction-zone earthquakes in the region of the construction site, and difficult to estimate seismic waveforms considering the seismic characteristic of the regional bedrock. So observed seismic waveforms, regardless of the site, had been used similarly across the whole country. As seen from the 'Probabilistic Seismic Hazard Maps', however, the earthquake ground motion does not similarly occur everywhere across Japan, and shaking is different from area to area. Also, since the 1995 Hyogo-ken Nanbu (Kobe) Earthquake, estimates of seismic waveforms considering seismic source and ground motion characteristics of subsurface structures have been made possible, which allow improvement of the strong ground motion prediction methods by the Headquarters for Earthquake Research Promotion. For example, seismic waveforms that take into account the regional characteristics currently are in use for input earthquake ground motions in earthquake resistance design of high rise buildings, base-isolated structures and structures of high importance.

In earthquake resistance design civil engineering structures, earthquake ground motions used for safety evaluations have been specified as follows in the 'Guideline for Earthquake-resistance Design for Civil Engineering Structure (preliminary report), Earthquake Engineering Committee, Japan Society of Civil Engineers'[22]: The greatest possible earthquake for a specified seismic source fault, though extremely rare, is used as the candidate for the ground motions of safety evaluations of structures against very strong earthquake ground motions , without regard to the value of its occurrence probability.

Introduced in the Building Standard Law of Japan (issued on June 12, 1998) were design methods that prescribed the seismic performance, which are the goals of the structures. For these design methods, and for earthquake resistance designs of common structures, input earthquake ground motions have been set for the engineering bedrock. Accordingly, earthquake resistance design methods set with seismic waveforms have so far been applied only to relatively important structures, and reflected in common structures to some extent. In the future, reasonable earthquake resistance design methods using earthquake ground motions for site specific ground motions may be possible, although some problems remain. There is much information required for the prediction of strong ground motions in the 'detailed method', and sometimes the designer's judgment is required in setting parameters. In such cases, the 'Recipe' with its standard methodologies is useful. From the point of cost, however, it is difficult to design structures based on strong ground motions with the 'detailed method', for buildings with relatively low importance. For such cases, waveforms can be used from completed evaluation results that have been disclosed by the Earthquake Research Committee. For this use, the Committee has released seismic waveforms on the engineering bedrock, and already has received about 20 requests from design offices.

5.2.3 Elucidation of physical phenomena

Much knowledge has been obtained through the evaluations of strong ground motions to date. The results showed that strong ground motions strongly depend on characteristics of the rupture process of the seismic source fault, for example the locations of rupture initiation point and

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[22] Japan Society of Civil Engineering (2001): Guidelines for Earthquake-resistance Design for Civil Engineering Structure (preliminary report), Seismic Design Standards Subcommittee, Earthquake Engineering Committee, : (http://www.jsce.or.jp/committee/eec2/taishin/index.html)

asperities. This is because the seismic source fault is not homogeneous and strong shaking is produced from asperities on the fault. Also and the levels of ground shaking are affected by directivity effects,[23] which change with the relative locations between the rupture initiation point, asperities, and evaluation site.

It is also considered that comparison with observed records of past earthquakes, to verify the methods of the strong ground motion prediction, is important in elucidating the physics of ground motions. Based on such studies, it may be possible in the future to predict with higher precision the realistic physical phenomena, and improve earthquake disaster prevention methods and earthquake resistance design.

Results of strong ground motions that the Earthquake Research Committee has already announced to the public are for only very basic cases. Because the data used for the evaluations are also presented together with the results, they are expected to be valuable for future strong ground motions.

5.3 Proper use and integration of the two maps

5.3.1 Complementary characteristics and proper use of the maps

The 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults' have complementary characteristics, and it is hoped that proper use can be made of them.

The 'Probabilistic Seismic Hazard Maps' deal with various uncertainties, such as earthquake possibilities and ground motion level fluctuations at the time of the earthquake. It will be possible that they can be used for decision-making, after considering the uncertainty factors. However, because the 'Probabilistic Seismic Hazard Maps' do not show the distribution of seismic intensities for a single earthquake, there is a problem in understanding the actual level of shaking presented in the maps. A characteristic of the 'Probabilistic Seismic Hazard Maps' is that regional differences in the level of strong ground motion can be evaluated by looking at the possibility that strong shaking occurs within a fixed period, rather than by considering an individual earthquake.

In contrast, the 'Seismic Hazard Maps for Specified Seismic Source Faults' uses specific values of physical parameters for a seismic source fault and subsurface structure. Then, assuming that a specified earthquake may occur in the future, intensity distributions are predicted, with a detailed method. As experienced in the 1995 Hyogo-ken Nanbu Earthquake, strong shaking connected with damage is largely affected by local characteristics in the seismic source fault and subsurface structure. The 'Seismic Hazard Maps for Specified Seismic Source Faults' based on the 'detailed method', is effective for understanding the causes of such shaking. Also, as mentioned in **Section 5.2.3**, it is a feature of maps prepared with the 'detailed method', that ground motions can be physically explained. Because intensity distributions have been produced using average values of intensity and its statistical fluctuations, in the 'Probabilistic Seismic Hazard Maps', specific locations of damage, and its physical cause cannot be explained. A characteristic of the 'Seismic Hazard Maps for Specified Seismic Source Faults' is that if an earthquake with a large influence

[23] The process where seismic waves coherently overlap in the direction of rupture propagation, because fault rupture propagates at a speed near the shear wave velocity of seismic waves, resulting in larger amplitudes. In the direction opposite to rupture propagation, seismic waves do not overlap as coherently, and the amplitudes are not magnified.

on evaluation area of interest has been specified in advance, the distribution of the strong shaking in the surrounding regions can be predicted and precise evaluations carried out under certain specified conditions.

Considering the different characteristics of the two maps, the following are examples of proper and complementary use:

- **Determining earthquakes that influence the region of interest**

  When one or several earthquakes have a large influence on a region of interest, use of the 'Seismic Hazard Maps for Specified Seismic Source Faults' is appropriate. On the other hand, when it is necessary to consider occurrences of earthquakes without specified source faults, or synthetic probabilities from several large earthquakes, it is appropriate to use of the 'Probabilistic Seismic Hazard Maps'. Also, the 'Probabilistic Seismic Hazard Maps' are appropriate because we can see what kinds of earthquakes have a large influence for the evaluated site, as shown in **Section 3.4**. Therefore a possible usage of the two maps is to determine the likely earthquake source from the 'Probabilistic Seismic Hazard Maps' and then use the 'Seismic Hazard Maps for Specified Seismic Source Faults' for the specific distributions of intensity.

- **Predicting of intensities**

  When studying priority rankings of countermeasures dependent on possible intensities that may occur within a fixed time period, use of the 'Probabilistic Seismic Hazard Maps' is appropriate. To understand the character and size of the damage from intensity distributions for a specified earthquake, use of the 'Seismic Hazard Maps for Specified Seismic Source Faults' is appropriate. 'Probabilistic Seismic Hazard Maps' have a characteristic that intensities caused by earthquakes with relatively low probability are hardly reflected on the map. In this case, a complementary evaluation of the expected ground motion from the 'Seismic Hazard Maps for Specified Seismic Source Faults' is useful.

With respect to the proper uses of the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults', some recent case examples are presented.

McGuire (2001) showed an example of proper uses for the two different types of maps, as shown in **Fig. 5-1**. On the left side of the figure are items regarded as uses of the 'Seismic Hazard Maps for Specified Seismic Source Faults' , whereas on the right side are uses of the 'Probabilistic Seismic Hazard Maps'. The 'Seismic Hazard Maps for Specified Seismic Source Faults' have been regarded as appropriate for preparations of emergency response in disaster prevention measures, evaluations for areas with high seismic activity, such as in the immediate neighborhood of active faults or subduction-zone earthquakes, and for strong shaking over broad areas. On the other hand, 'Probabilistic Seismic Hazard Maps' have been regarded as appropriate for evaluations of the level of earthquake resistance design and strengthening in disaster measures, in areas with low seismic activity, and for evaluations of strong shaking at specified sites. This classification is one example that will be discussed in the future.

In the field of construction, the 'Seismic Design Menu 2004' (Special Committee of the Comprehensive Study of Earthquake Disaster Prevention, Architectural Institute of Japan, 2004) has been proposed for reasonable performance-based design. This plan has shown an ideal standard for performance-based design, where the designer can clearly specify the process with respect to the demand of the client. When setting safety levels for an in-service period (for example, 50 years), the earthquake ground motion level is set by means of a probabilistic evaluation of the earthquake ground motions. This results in conditions where buildings allowing only little damage for relatively rare strong shaking demand high safety levels, whereas those allowing damage to some extent even from relatively weak ground motions that occur often, have a low safety level. Furthermore, when a safety level, namely allowable degree of damage, from an earthquake occurring on a active fault near the building is demanded by a client, earthquake ground motion levels are set with deterministic evaluations (evaluation of earthquake ground motions with a specified seismic source fault). It will be possible to utilize the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults' in such proper situations.

5.3.2 Integration of the two maps

The proper usages described in the previous section for the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults', are based on the complementary characteristics of the two maps and represent an example of their integrated use. Studies on other integration techniques have recently been conducted.

One is the introduction of the 'detailed method' into the probabilistic prediction of earthquake ground motions. Evaluations of strong ground motions with the 'detailed method' are done by selecting specified scenarios, regarded as appropriate, out of a large number of cases. For application to the probabilistic prediction of earthquake ground motions, it is necessary to evaluate the fluctuations of the intensity calculated with the 'detailed method', based on a multitude of scenarios, and there are examples of such studies[24]. There are also examples that have adopted the 'detailed method' in probabilistic evaluations of earthquake ground motions for probabilistic safety evaluations, not for maps but for important structure at a specific location. .

There is case example in the United States of the utilization of 'Probabilistic Seismic Hazard Maps' combined with 'Seismic Hazard Maps for Specified Seismic Source Faults'. 'Probabilistic Seismic Hazard Maps' in the US have been prepared based on seismological and geological knowledge, and from this map another map has been prepared to set the engineering load in earthquake resistance design of structures. Levels of realistic intensity have been set by combining intensities obtained from 'Probabilistic Seismic Hazard Maps' along with ground motions obtained by modeling a specific seismic source fault that produces very strong shaking but with low probability [25].

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[24] Refer to Yamada et al. (2004).
[25] Refer to Frankel et al. (2000, 2002) for 'Probabilistic Seismic Hazard Map', and Leyendecker et al. (2000) for maps of engineering utilization.

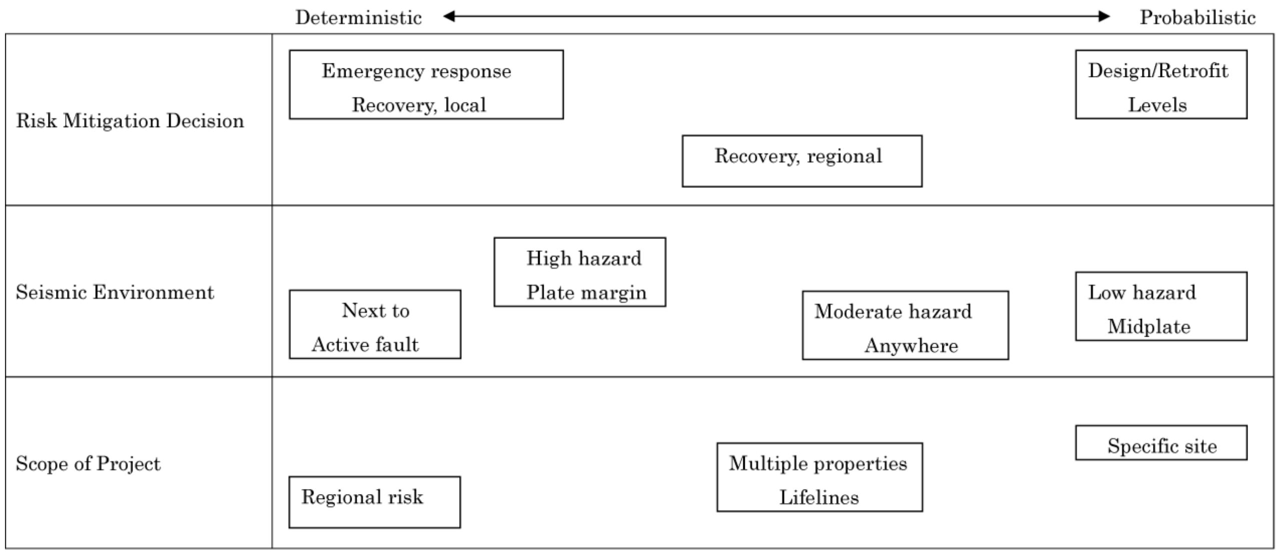

Fig. 5-1 Seismic risk applications in the deterministic-probabilistic spectrum. McGuire(2001)

6. Towards the future

6.1 Problems for utilization and integration of the seismic hazard maps

6.1.1 Towards a detailed map

The 'National Seismic Hazard Maps' for Japan(2005)' have been prepared with a resolution of about 1 km square for generally viewing the whole country, and providing basic information. At present, detailed data on the 'surface soil layers' have been limited and intensities have been evaluated with the 'conventional method'. Although a huge bedrock database must be collected in preparation of detailed maps on the national level, detailed bedrock data will be available with relative ease on the local municipality level in limited areas. There are some municipalities, such as, Yokohama City, Aichi Pref. and Shiga Pref., which have already prepared detailed maps for improving regional disaster prevention programs, increasing public awareness of disaster prevention, and promoting seismic retrofit. For the 'Seismic Hazard Maps for Specified Seismic Source Faults', prediction of strong ground motions can also be conducted with the 'detailed method' according to the 'Recipe', using a seismic source fault model and a subsurface structural model. The Earthquake Research Committee has also released those models to the public. It is possible to predict the shaking of the ground surface, which is affected by the influence of detailed 'surface soil layers', by means of calculated waveforms on the engineering bedrock, as released by the Earthquake Research Committee. Similarly in the 'Probabilistic Seismic Hazard Maps', the possibility of strong shaking on the ground surface, including the influence from the 'surface soil layers', can be predicted by using the possibility of strong shaking on the engineering bedrock.

6.1.2 Towards integration of the 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults'

With respect to integration of the two maps, study is needed on incorporation of the 'detailed' prediction method for strong ground motions into the 'Probabilistic Seismic Hazard Maps'. In addition, it is important to discuss and agree on their proper use, considering the complementary characteristics of the two maps.

6.2 Technical problems of the Seismic Hazard Maps

For the 'Probabilistic Seismic Hazard Maps', study on the following technical problems is necessary:

- ○ Handling of representative values when the probabilities of occurrence of 'characteristic earthquakes for the 98 major active fault zones' have ranges.
- ○ Evaluation procedures for intensity and its fluctuations
  - Upgrading attenuation relations of earthquake ground motions
  - Handling methods for fluctuations in attenuation relations of earthquake ground motions (setting the size of and cut-off of the fluctuations)
  - Introduction of the 'detailed method' to evaluate strong ground motions
- ○ Improvement of modeling procedures for 'earthquakes without specified source faults'
- ○ Handling of 'earthquakes other than characteristic events occurring on the 98 major active fault zones

- Weighting method in a logic tree (Earthquake Research Committee, 2001c) construction when a range of assumed seismic source regions is considered
- Way of reflecting 'reliability' of long-term evaluations into the Probabilistic Seismic Hazard Maps

For the 'Seismic Hazard Maps for Specified Seismic Source Faults', study on the following technical problems is necessary:

- Improvement of the strong ground motion prediction method (Recipe)
  - Determination method for the characterized source model
  - Modeling subsurface structure
  - Upgrading the calculation procedure of strong ground motions
- Evaluations of strong ground motions for earthquakes on active faults on land and ocean areas, for which evaluations have not been conducted
- Handling methods for earthquakes without specified source faults

Problems to be studied common to both maps:

- Modeling of surface soil layers
- Compilation of databases for data used in map preparation and for evaluated results. Release methods of the databases

The 'National Seismic Hazard Maps for Japan (2005)' were announced to the public and prepared by using the latest information and techniques currently available, however, there are variations in the probabilities of earthquakes caused by the passage of time and occurrences of large earthquakes, in addition to problems in the study that need to be addressed. Accordingly, it is important to re-examine the seismic hazard maps at appropriate times.

References

References in "Long-term Evaluation", "Evaluation of Strong Ground Motion" and "Preliminary studies of Probabilistic Seismic Hazard Map" are listed in the Appendix 2.

Chapter 1

Earthquake Research Committee (1997): "Seismic Activity in Japan - Regional perspective on the characteristics of destructive earthquakes - ", 391pp. （in Japanese）

Earthquake Research Committee (1999): "Seismic Activity in Japan - Regional perspective on the characteristics of destructive earthquakes -" 〈addenda〉 395pp. (in Japanese)

Headquarters for Earthquake Research Promotion (1999): The Promotion of Earthquake Research -Basic Comprehensive Policy for the Promotion of earthquake observation, measurement, surveys and research-, April 23, 1999, 20pp.

Chapter 2

Earthquake Research Committee (1999): "Seismic Activity in Japan-Regional perspective on the characteristics of destructive earthquakes -" 〈addenda〉 395pp. (in Japanese)

Headquarters for Earthquake Research Promotion (1997): The Fundamental Plans for Survey and Observation, August 29, 1997, 38pp. (in Japanese)

Chapter 3

Earthquake Research Committee (2001): Evaluation of the Ikoma fault zone. (published on May 15, 2001). (in Japanese)

Earthquake Research Committee (2003): Long-term Evaluation of seismic activity along Kuril Trench. (published on March 24, 2003). (in Japanese)

Earthquake Research Committee (2004a): Long-term Evaluation of seismic activity along Hyuganada and the vicinity of Nanseishoto Trench. (published on February 27, 2004). (in Japanese)

Earthquake Research Committee (2004b): Long-term Evaluation of seismic activity along Kuril Trench.［Second edition］ (published on December 20, 2004). (in Japanese)

Subcommittee for Utilizing Research Results in Society, Policy Committee, Headquarters for Earthquake Research Promotion (2001): The Report of Subcommittee for Utilizing Research Results in Society – in order to apply the results of long-term evaluation to the society－ , August 22, 2001, 47pp. (in Japanese)

Chapter 4

Aoi, S. and Fujiwara, H (1999): 3D Finite-Difference Method using discontinuous grids, Bull. Seism. Soc. Am., 89, 918-930.

Aomori Prefecture (1969): Documents of large earthquake disaster in Aomori Prefecture. Pp.627. (in Japanese)

Dan, K. and Sato, T. (1998): Strong-motion prediction by semi-empirical method based on variable-slip rupture model of earthquake fault. J. Struct. Constr. Eng., AIJ, 509, 49-60. (in Japanese)

Earthquake Research Committee (2001): Evaluation of the Morimoto-Togashi fault zone. (published on December 12, 2001, revised on May 9 2002 and modified on January 12 2005). (in Japanese)

Earthquake Research Committee (2002): Evaluation of the Futagawa-Hinagu fault zone. (published on May 8 2002).(in Japanese)

Earthquake Research Committee (2003): Evaluation of strong ground motion for the assumed earthquake in Miyagi-Oki. (published on June 18 2003). (in Japanese)

Earthquake Research Committee (2004a): Evaluation of strong ground motion for the assumed earthquake in the north Sanriku-Oki. (published on May 21 2004). (in Japanese)

Earthquake Research Committee (2004b): Evaluation of strong ground motion for the assumed earthquake in the Biwako-seigan fault zone. (published on June 21,2004)

Earthquake Research Committee (2005): Evaluation of strong ground motion for the assumed earthquake in the Yamasaki fault zone. (published on January 31, 2005, revised on February 10, 2005). (in Japanese)

Earthquake Research Committee, Subcommittee for Evaluations of Strong Ground Motion (2002): Verification of strong ground motion evaluation method using the observation record of 2004 Western Tottori Earthquake. (published on October 31, 2002). (in Japanese)

Earthquake Research Committee, Subcommittee for Evaluations of Strong Ground Motion (2004): Verification of strong ground motion evaluation method using the observation record of 2003 Tokachi-Oki Earthquake. (published on December 20, 2004). (in Japanese)

Fujiwara, H. (2004): Personal Communication

Graves, W. R. (1996): Simulating Seismic Wave Propagation in 3D Elastic Media Using Staggered-Grid Finite Differences, Bull. Seis. Soc. Am., 86, 1091-1106.

Honda, R., S. Aoi, N. Morikawa, H. Sekiguchi, T. Kunugi and H. Fujiwara (2004): Ground motion and rupture process of the 2003 Tokachi-oki earthquake obtained from strong motion data of K-NET and KiK-net, Earth Planets Space, 56, 317-322.

Irikura, K. and Miyake, H. (2000): Procedure for characterized of seismic source modeling to prediction of strong ground motion, Grant-in-Aid for Scientific Research (No.08248111) Priority Areas Research (A) Project Research A1 "Strong Motion Estimation for Active Faults with High Earthquake Potential", Appendix in Chapter 7, 128-145. (in Japanese)

Irikura, K. and Miyake, H. (2001): Prediction of Strong Ground Motion for Scenario Earthquakes. Journal of Geography, 110, 849-875. (in Japanese)

Irikura, K. (2004): Recipe for Predicting Strong Ground Motion from Future Large Earthquake. Annuals of Disas. Prev. Inst., Kyoto Univ., No.47A317-322. (in Japanese)

Japan Meteorological Agency (1969): Report on the 1968 Tokachi-Oki Earthquake. Technical report of the Japan Meteorological Agency, No68. (in Japanese)

Kamae, K, Irikura K and Fukuchi Y (1991): Prediction of strong ground motion based on scaling law of earthquake by stochastic synthesis method. Journal of Constr. Engng, AIJ, 430, 1-9. (in Japanese)

Murai I. (1979): (I) 302041. Special research for Natural Disaster, Grant-in-Aid for Scientific Research, Ministry of Education, Fiscal year 1979,89-95.

Pitarka, A. (1999): 3D Elastic Finite-Difference Modeling of Seismic Motion Using Staggered Grids with Nonuniform Spacing, Bull. Seism. Soc. Am., 89, 54-68.

Somerville, P., K.Irikura, R Graves, S. Sawada, D. Wald, N.Abrahamson, Y. Iwasaki, T. Kagawa, N. Smith, and A. Kowada (1999): Characterizing crustal earthquake slip models for the prediction of strong ground motion, Seismological Research Letters, Vol.70, No.1, 59-80.

The Public Works Research Institute, Ministry of Construction (1978): Strong-Motion Acceleration Records from Public Works in Japan. Technical note of the Public Works Research Institute,33. (in Japanese)

Chapter 5

Earthquake Engineering Committee, Japan Society of Civil Engineering (2001): Guidelines for Earthquake-resistance design for Civil Engineering Structure (preliminary report), Earthquake Engineering Committee, Japan Society of Civil Engineering.
(http://www.jsce.or.jp/committee/eec2/taishin/index.html) (in Japanese)

Frankel, A. (2000): USGS national seismic hazard maps, Earthquake Spectra, Vol.16, No.1, 1-19.

Frankel, A., Petersen, M., Mueller, C., Haller, K., Wheeler, R., Leyendecker, E., Wesson, R., Harmsen, S., Cramer, C., Perkins, D., and Rukstales, K. (2002): Documentation for the 2002 update of the national seismic hazard maps, U.S. Geological Survey Open-File Report 02-420.

Headquarters for Earthquake Research Promotion (2001): Regarding review of fundamental earthquake survey and observation plans and establishment of a focused survey and observation system. (August 28, 2001) (in Japanese)

ISO3010 (2000): Bases for design of structures – Seismic actions on structures.

Leyendecker, E., Hunt, R., Frankel, A., Ruksrales, K. (2000): Development of maximum considered earthquake ground motion maps, Earthquake Spectra, Vol.16, pp.21-39.

McGuire, R.K.(2001): Deterministic vs. probabilistic earthquake hazards and risks, Soil Dynamics and Earthquake Engineering, Vol.21, pp.377-384.

Special Committee of Comprehensive Study of Earthquake Disaster Prevention, Architectural Institute of Japan (2004): The Report of Special Committee of Comprehensive Study of Earthquake Disaster Prevention, 107pp.

Study Committee for Engineering Application of the National Seismic Hazard Map (2004): Engineering Application of the National Seismic Hazard Program - Seismic Hazard Information Sharing Bases-. (The Report of Study Committee for Engineering Application of the National Seismic Hazard Map). Technical Note of the National Research Institute for Earth Science and Disaster Prevention No.258, pp.314. (in Japanese)

Survey and study on promotion of earthquake resistance to school facilities cooperators (2003): Survey and Study Report for promotion of earthquake resistance to school facilities. April 15 2003, 38.

Yamada M., Fujiwara H. and Senna S. (2003): Statistical Analysis of Predicted Ground Motions for Scenario Earthquakes. Japan Earth and Planetary Science Joint Meeting, 2004, S-046-009. (in Japanese)

Appendix 1 Terms used in this report

[Earthquake ground motions/strong ground motions]

Movements on the ground surface or subsurface caused by the occurrence of earthquake are called earthquake ground motions. Vibrations that occur at the hypocenter of the earthquake propagate through the Earth as seismic waves, resulting in shaking on the ground surface. Severe earthquake ground motions that can cause damage are particularly called strong ground motions, but this definition is not specific.

*[Supplement] The term 'earthquake' is a common word that often means the ground shaking that people feel, such as when they say, 'Oh, it's earthquake!'. On the other hand, 'earthquake' in the phrase 'distribution of earthquakes', has a different meaning. 'Earthquake' in the latter means the source that causes shaking of the ground, and refers to the rupture (displacement) phenomenon of rocks in the subsurface. In order to distinguish this from the first meaning, the shaking of the ground is referred to as 'earthquake ground motions'.

[Seismic hazard map]

A map predicting the strength of earthquake ground motions that may occur in a target area when an earthquake occurs. The maps are roughly classified into the following two kinds: 'Probabilistic Seismic Hazard Maps' and 'Seismic Hazard Maps for Specified Seismic Source Faults'. 'National Seismic Hazard Maps for Japan (2005)' by Headquarters for Earthquake Research Promotion consist of these two types of maps, which have different characteristics.

[Probabilistic Seismic Hazard Map]

A map that expresses, with probabilities, the strength of earthquake ground motions in the future. The maps are derived by taking into account all earthquakes influencing a target area and evaluating occurrence possibilities and strengths of the earthquake ground motions, with a stochastic procedure.

[Supplement] Among the three parameters: 'time period', 'earthquake ground motion level' and 'probability',two are usually fixed and the remaining parameter is displayed with contours on the map.

(1) Probability map of seismic intensity equal to or larger than 6 Lower, occurring within 30 years from the present (Map showing distribution of 'probabilities' with a fixed 'time period' and at a specific 'earthquake ground motion level')

(2) Regional map of intensity with the 3% probability of exceedance within 30 years from the present. (Map showing the distribution of 'earthquake ground motion levels' with a fixed 'time period' and 'probability')

[Seismic Hazard Map for Specified Seismic Source Faults]

A map expressing the predicted strength of earthquake ground motions in an area of interest, by specifying a particular seismic source fault, and using a strong ground motion prediction method. A seismic source fault is specified and earthquake ground motions are predicted assuming a scenario for the earthquake process. This type of map is also called a 'seismic hazard map for a scenario earthquake' or a 'deterministic seismic hazard map'. The term 'deterministic earthquake hazard map' is used in contrast with the term probabilistic seismic hazard map. The Headquarters for Earthquake Research Promotion has prepared 'Seismic Hazard Maps for Specified Seismic Source Faults' for some potential major earthquakes. They were selected from the active faults on land and subduction-zone earthquakes for which evaluations of the long-term occurrence probabilities were made by considering factors such as their occurrence probabilities.

[Seismic hazard]

The term 'seismic hazard' has several definitions as follows:

1) Earthquakes or phenomena related to earthquakes, such as earthquake ground motions, that possibly cause dangerous situations or destruction (specifically earthquake ground motions, liquefaction, seismic tsunamis). The 'Seismic Hazard Maps for Specified Seismic Source Faults' prepared by the Headquarters for Earthquake Research Promotion corresponds to maps showing the 'hazard' with respect to earthquake ground motions .
2) Occurrence probabilities of earthquakes that possibly give rise to dangerous situations or collapse (of structures). Long-term evaluations of active faults on land and subduction-zone earthquakes announced to the public by the Headquarters for Earthquake Research Promotion corresponds to this definition.
3) Probabilities of strong earthquake ground motions. The 'Probabilistic Seismic Hazard Maps' that have been prepared by the Headquarters for Earthquake Research Promotion fall under this definition.

[Supplement] According to the United Nations Disaster Relief Organization (UNDRO) (1979), 'natural hazard' has been defined as the occurrence probability of natural phenomena that will potentially cause damage in assumed areas within a limited period. The Mt. Fuji Volcano Disaster Management Conference has used 'volcanic hazard' in a broad meaning, without including the probabilities, of 'volcanic eruptions or related events that possibly cause dangerous situation or destruction'.

[Seismic Hazard Map]

Map that shows the 'seismic hazard'. There are several types of maps, according to the definition of 'seismic hazard' (Refer to 'seismic hazard').

[Degree of seismic risk]

Because the term 'degree of seismic risk' is vague and can have several meanings, a precise definition must be given for use in quantitative discussions. The degree of seismic risk can be divided into the 'seismic hazard' and 'seismic risk', which have different meanings (Refer to the meaning of each term).

*[Supplement] The term 'degree of seismic risk' is often used with the same meaning as 'seismic hazard'.

[Seismic risk]

Harm, damage and loss possibly caused by earthquakes or related events.

[Supplement] Expected values of loss from earthquake ground motions, are a function of the 'seismic hazard', 'vulnerability for earthquakes' and 'exposure of physical structures exposed to the danger of earthquakes'. Although seismic hazard maps have been developed, risk maps have not been prepared by the Headquarters for Earthquake Research Promotion.

Appendix 2 Lists of public announcements for long-term evaluation, evaluation of strong ground motion and preliminary studies for probabilistic Seismic Hazard Map

Attached Table 2-1 List of public announcements for long-term evaluation (Major Active faults)

Editor	Publication date		Subject
	1996	Sep.11	Evaluation for Itoigawa-Shizuoka-kozosen active fault system
	1997	Aug. 6	Evaluation for Kannawa/Kozu-Matsuda fault zone
	1998	Oct. 14	Evaluation for Fujikawa-kako fault zone
	2000	Aug. 9	Evaluation for Suzuka-toen fault zone
		Aug. 9	Evaluation for Motoarakawa fault zone
		Nov. 8	Evaluation for Tokyo-wan-hokuen fault zone
	2001	Jan. 10	Evaluation for Gifu-Ichinomiya fault zone
		May. 15	Evaluation for Ikoma fault zone
		Jun. 13	Evaluation for Hakodate-heiya-seien fault zone
		Jun. 13	Evaluation for Kitakami-teichi-seien fault zone
		Jun. 13	Evaluation for Arima-Takatsuki fault zone
		Jul. 11	Evaluation for Kyoto-bonchi - Nara-bonchi fault zone nanbu (Nara-bonchi-toen fault zone)
		Nov. 14	Evaluation for Shinanogawa fault zone (Nagano-bonchi-seien fault zone)
		Nov. 14	Evaluation for Yoro-Kuwana-Yokkaichi fault zone
		Dec. 12	Evaluation for Morimoto-Togashi fault zone
	2002	Feb. 13	Evaluation for Nagamachi-Rifu-sen fault zone
		May. 8	Evaluation for Yamagata-bonchi fault zone
		May. 8	Evaluation for Futagawa-Hinagu fault zone
		May. 8	Evaluation for Ise-wan fault zone
		Jul. 10	Evaluation for Shinjo-bonchi fault zone
		Jul. 10	Evaluation for Inadani fault zone
		Sep. 11	Evaluation for Kushigata-sanmyaku fault zone
		Sep. 11	Evaluation for Tsukioka fault zone
		Oct. 9	Evaluation for Miura-hanto fault group
		Dec. 11	Evaluation for Tonami-heiya/Kurehayama fault zone
	2003	Feb. 12	Evaluation for Chuo-kozosen fault zone (Kongo-sanchi-toen - Iyonada) fault zone
		Mar. 12	Evaluation for Mikata/Hanaore fault zone
		Apr. 9	Evaluation for Takayama-Oppara fault zone
		Jun. 11	Evaluation for Biwako-seigan fault zone
		Jun. 11	Evaluation for Kohoku-sanchi fault zone
		Jun. 11	Evaluation for Nosaka/Shufukuji fault zone
		Jul. 14	Evaluation for Mashike-sanchi-toen/Numata-Sunagawa Area fault zone
		Aug. 7	Evaluation for Tachikawa fault zone
		Sep. 10	Evaluation for Kikukawa fault zone
		Sep. 10	Evaluation for Nagao fault zone
		Nov. 12	Evaluation for Ishikari-teichi-toen fault zone
		Nov. 12	Evaluation for Tobetsu fault
		Dec. 10	Evaluation for Yamasaki fault zone

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2004	Jan. 14	Evaluation for Yanagase-Sekigahara fault zone
	Feb. 12	Evaluation for Itsukaichi fault zone
	Feb. 12	Evaluation for Iwakuni fault zone
	Mar. 10	Evaluation for Isehara fault
	Mar. 10	Evaluation for Uemachi fault zone
	Apr. 14	Evaluation for Aomori-wan-seigan fult zone
	Apr. 14	Evaluation for Nunobiki-sanchi-toen fault zone
	Apr. 14	Evaluation for Oritsume fault
	Apr. 14	Evaluation for Tsugaru-sanchi-seien fault zone
	May. 14	Evaluation for Sekiya fault
	Jun. 9	Evaluation for Mino fault zone
	Jun. 9	Evaluation for Kamogawa-teichi fault zone
	Aug. 11	Evaluation for Arakawa fault zone
	Aug. 11	Evaluation for Nagaragawa joryu fault zone
	Sep. 8	Evaluation for Suzuka-seien fault zone
	Sep. 8	Evaluation for Shokawa fault zone
	Sep. 8	Evaluation for Atotsugawa fault zone
	Sep. 8	Evaluation for Tongu fault
	Sep. 8	Evaluation for Kizugawa fault zone
	Oct. 13	Evaluation for Izumi fault zone
	Oct. 13	Evaluation for Nagaoka-heiya-seien fault zone
	Oct. 13	Evaluation for Byoubuyama-Enasan-Sanageyama fault zone
	Nov. 10	Evaluation for Kiso-sanmyaku-seien fault zone
	Dec. 8	Evaluation for Atera fault zone
	Dec. 8	Evaluation for Yamada fault zone
	Dec. 8	Evaluation for Nishiyama fault zone
	Dec. 8	Evaluation for Fukui-heiya-toen fault zone
2005	Jan. 12	Evaluation for Sakaitoge-Kamiya fault zone
	Jan. 12	Evaluation for Osaka-wan fault zone
	Jan. 12	Evaluation for Nobi fault zone
	Jan. 12	Evaluation for Rokko-Awajishima fault zone
	Feb. 9	Evaluation for Mitoke/Kyoto-Nishiyama fault zone
	Feb. 9	Evaluation for Nagai-bonchi-seien fault zone
	Feb. 9	Evaluation for Aizu-bonchi-seien/-toen fault zone
	Feb. 9	Evaluation for Kitaizu fault zone
	Mar. 9	Evaluation for Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone
	Mar. 9	Evaluation for Yokote-bonchi-toen fault zone
	Mar. 9	Evaluation for Kanto-heiya-hokuseien fault zone
	Mar. 9	Evaluation for Ushikubi fault zone
	Mar. 9	Evaluation for Ochigata fault zone
	Mar. 9	Evaluation for Beppu-Haneyama fault zone
	Mar. 9	Evaluation for Unzen fault group
	Mar. 9	Evaluation for Kannawa/Kozu-Matsuda fault zone (Partial revision)

		Mar. 9	Evaluation for Suzuka-toen fault zone (Partial revision)
		Apr. 13	Evaluation for Shibetsu fault zone
		Apr. 13	Evaluation for Tokachi-heiya fault zone
		Apr. 13	Evaluation for Furano fault zone
		Apr. 13	Evaluation for Kuromatsunai-teichi fault zone
		Apr. 13	Evaluation for Noshiro fault zone
		Apr. 13	Evaluation for Kitayuri fault
		Apr. 13	Evaluation for Shonai-heiya-toen fault zone
		Apr. 13	Evaluation for Fukushima-bonchi-seien fault zone
		Apr. 13	Evaluation for Futaba fault
		Apr. 13	Evaluation for Tokamachi fault zone

Attached Table 2-2 List of public announcement for long-term evaluation (Subduction-zone earthquakes)

Editor	Publication date		Subject
Earthquake Research Committee	2000	Nov. 27	Evaluation of the Miyagi-ken-Oki Earthquake
	2001	Sep. 27	Evaluation of earthquakes along the Nankai Trough
	2002	Jul. 31	Evaluation for seismic activity from Sanriku-Oki to Boso-Oki
	2003	Mar. 24	Evaluation for seismic activity along the Kuril Trench
		Jun. 20	Evaluation for seismic activity along Nihonkai-toenbu
	2004	Feb. 27	Evaluation for seismic activity in Hyuganada and the vicinity of Nanseishoto Trench
		Aug. 23	Evaluation for seismic activity along the Sagami Trough
		Dec. 20	Evaluation for seismic activity along the Kuril Trench (2nd. edtion)

Attached Table 2-3 List of public announcements for evaluation of strong ground motion

Editor	Publication date		Subject
Earthquake Research Committee	2002	Oct. 31	Evaluation of strong ground motion for the Itoigawa-Shizuoka-kozosen active fault system (North and Central segments)
	2003	Mar. 12	Evaluation of strong ground motion for the Morimoto-Togashi fault zone
		Jun. 18	Evaluation of strong ground motion for the Miyagi-ken-Oki Earthquake
		Jul. 31	Evaluation of strong ground motion for the Futagawa-Hinagu fault zone
		Oct. 28	Evaluation of strong ground motion for the Miura-hanto fault group
		Nov. 25	Evaluation of strong ground motion for the Yamagata-bonchi fault zone
	2004	Mar. 22	Evaluation of strong ground motion for the Tonami Heiya fault zone
		May. 21	Evaluation of strong ground motion for the Sanriku-Oki hokubu
		Jun. 21	Evaluation of strong ground motion for the Biwako-seigan fault zone
		Sep. 27	Evaluation of strong ground motion for the Takayama-Oppara fault zone
		Nov. 29	Evaluation of strong ground motion for the Ishikari-teichi-toen fault zone
	2005	Jan. 31	Evaluation of strong ground motion for the Yamasaki fault zone

Earthquake Research Committee, Subcommittee for Evaluations of Strong Ground Motion	2001	May. 25	Evaluation of strong ground motion for the Itoigawa-Shizuoka-kozosen as the source fault zone (Northern and Central segments) (Interim report)
		Dec. 7	Evaluation for the fault plane along the Nankai Trough (Interim report)
	2002	Oct. 15	Evaluation of strong ground motion for the Miyagi-ken-Oki Earthquake (Interim report)
		Oct. 31	Verification of strong ground motion prediction method using the observation records of the 2000 Western Tottori Earthquake
	2004	Dec. 27	Verification of strong ground motion prediction method using the observation record of the 2003 Tokachi-Oki Earthquake

Attached Table 2-4 List of public announcements Preliminary studies for Probabilistic Seismic Hazard Map

Editor	Publication date		Subject
Earthquake Research Committee, Subcommittee for Long-term Evaluations, Subcommittee for Evaluations of Strong Ground Motion	2002	May. 29	Preliminary study for Probabilistic Seismic Hazard Map (Specific Area)
	2003	Mar. 25	Preliminary study for Probabilistic Seismic Hazard Map (Specific Area-Northern Japan)
	2004	Mar. 25	Preliminary study for Probabilistic Seismic Hazard Map (Specific Area-Western Japan)

Note that all the publications listed above are in Japanese.

Appendix 3 Lists of long-term evaluation result

Attached Table 3-1 (Part 1) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence			Rank for Probability of occurrence	Mean recurrence interval (years) The latest event (years ago)
			within 30 years	within 50 years	within 100 years		
36	Kannawa/Kozu-Matsuda fault zone (Note 1,2)	7.5	0.2－16%	0.4－30%	1－50%	High probability	800-1300 the 12th century－the first half of the 14th century
41	Itoigawa-Shizuoka-kozosen fault zone (Note 1) (Segment including Gofukuji Fault) (Note 3)	71/2－81/2	14%	20%	40%		1000 1200
46	Sakaitoge-Kamiya fault zone (Main part) (Note 4)	7.6	Nearly 0－13%	Nearly 0－20%	Nearly 0－40%		1800-5900 4900－the 3rd century
52	Atera fault zone (Main part/*Northern segment*)	6.9	6－11%	10－20%	20－30%		1800-2500 3400-3000
37	Miura-hanto fault group (Main part/*Takeyama fault zone*)	6.6 or above	6－11%	10－20%	20－30%		Approx. 1600-1900 2300-1900
43	Fujikawa-kako fault zone (Note 1)	8 ± .5	0.2－11%	0.4－20%	1－30%		1500-1900 2100-1000
65	Biwako-seigan fault zone	7.8	0.09－9%	0.2－20%	0.3－30%		1900-4500 2800-2400
18	Yamagata-bonchi fault zone	7.8	Nearly 0－7%	Nearly 0－10%	Nearly 0－20%		Around 3000 after 6000
25	Kushigata-sanmyaku fault zone (Note 5)	6.8－7.5	Nearly 0－7%	Nearly 0－10%	Nearly 0－20%		3000-18000 Approx. 6600-300
51	Inadani fault zone (Note 6) (*Boundary fault*)	7.7	Nearly 0－7%	Nearly 0－10%	Nearly 0－20%		Approx. 3000－ 12000 6500-300
6	Ishikari-teichi-toen fault zone (Main part)	7.9	0.05－6% or lower	0.09－10% or lower	0.2－20% or lower		3300-6300 5200-3300 or after
51	Inadani fault zone (Note 6) (*Frontal fault*)	7.8	Nearly 0－6%	Nearly 0－10%	Nearly 0－20%		Approx. 4000－20000 28000－7500
93	Futagawa-Hinagu fault zone (*Central segment*)	7.6	Nearly 0－6%	Nearly 0－10%	Nearly 0－20%		3500-11000 7500－2200
19	Shonai-heiya-toen fault zone	7.5	Nearly 0－6%	Nearly 0－10%	Nearly 0－20%		Approx. 2400-4600 3000－the end of the 18th century
56	Tonami-heiya/Kurehayama fault zone (Eastern part)	7.3	0.05－6%	0.09－10%	0.2－20%		Approx. 3000-7000 4300-3700
7	Kuromatsunai-teichi fault zone	≧7.3	2－5% or lower	3－9% or lower	7－20% or lower		≧3600－5000 5900-4900
82	Yamasaki fault zone (Main part/*Southeastern segment*)	7.3	0.03－5%	0.06－8%	0.1－20%		Approx. 3000 3600－the 6th century
81	Chuo-kozosen fault zone (Note 7) (*Kongo-sanchi-toen - Izumi-sanmyaku-nan'en*)	8.0	Nearly 0－5%	Nearly 0－9%	Nearly 0－20%		2000-12000 the 1st－the 4th century
75	Kyoto-bonchi - Nara-bonchi fault zone (Nara-bonchi toen fault zone)	7.4	Nearly 0－5%	Nearly 0－7%	Nearly 0－10%		5000 11000－1200
57	Morimoto-Togashi fault zone	7.2	Nearly 0－5%	Nearly 0－9%	Nearly 0－20%		2000 2000－200

Attached Table 3-1 (Part 2) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence within 30 years	Probability of occurrence within 50 years	Probability of occurrence within 100 years	Rank for Probability of occurrence	Mean recurrence interval (years)	The latest event (years ago)
48	Takayama-Oppara fault zone (Kokufu fault zone)	7.2	Nearly 0−5%	Nearly 0−7%	Nearly 0−10%	High probability	3600-4300	4700−300
92	Beppu-Haneyama fault zone (Oita-heiya - Yufuin fault zone part/*Western segment*) (Note 8)	6.7	2−4%	3−7%	6−10%		700-1700	2 events during 2000−the beginning of the 18th century
92	Beppu-Haneyama fault zone (Oita-heiya - Yufuin fault zone/*Eastern segment*)	7.2	0.03−4%	0.06−7%	0.1−10%		2300-3000	2200−the 6th century
95	Unzen fault group (Southwestern part)	7.5	Nearly 0−4%	Nearly 0−7%	Nearly 0−10%		2500-4700	2400−the 11th century
45	Kiso-sanmyaku-seien fault zone (Main part/*Southern segment*)	6.3	Nearly 0−4%	Nearly 0−7%	Nearly 0−10%		4500-24000	6500−3800
56	Tonami-heiya/Kurehayama fault zone (Western part)	7.2	Nearly 0−3% or higher	Nearly 0−6% or higher	Nearly 0−10% or higher		5000-12000 or shorter	6900−2700
80	Uemachi fault zone	7.5	2−3%	3−5%	6−10%		Approx. 8000	28000−9000
37	Miura-hanto fault group (Main part/*Kinugasa/Kitatake fault zone*)	6.7 or above	Nearly 0−3%	Nearly 0−5%	Nearly 0−10%		Approx. 1900-4900	the 6th−the 7th century
92	Beppu-Haneyama fault zone (Noinedake-Haneyama fault zone)	7.3	Nearly 0−3% (Max. 2.6%)	Nearly 0−4%	0.001−9%	Fairly high probability	Approx. 4000	3900−the 6th century
55	Ochigata fault zone (Note 9)	7.6	2%	3−4%	5−8%		Approx. 1200-1900	3200−the 9th century
27	Nagaoka-heiya-seien fault zone	8.0	≦2%	≦4%	≦9%		1200-3700	after the 13th century
34	Tachikawa fault zone	7.4	0.5−2%	0.8−4%	2−7%		Approx. 10000−15000	20000−13000
88	Iwakuni fault zone	7.6	0.03−2%	0.05−3%	0.1−6%		9000−18000	11000−10000
53/54	Byobuyama/Enasan-Sanageyama fault zone (Note 10) (Enasan-Sanageyamakita fault zone)	7.7	Nearly 0−2%	0.001−3%	0.001−6%		7200-14000	7600−5400
5	Tobetsu fault	7.0	Nearly 0−2%	Nearly 0−4%	Nearly 0−8%		Approx. 7500−15000	11000−2200
39	Tokamachi fault zone (Western part) (Note 11)	7.4	1%	2%	3−5%		Approx. 2000-3000	Unspecified
17	Shinjo-bonchi fault zone (Note11)	6.6−7.1	0.7−1%	1−2%	2−5%		Approx. 2000-4000	Unspecified
9	Aomori-wan-seigan fault zone (Note11)	7.3	0.5−1%	0.8−2%	2−3%		Approx. 3000-6000	Unknown
8	Hakodate-heiya-seien fault zone	7.0−7.5	Nearly 0−1%	Nearly 0−2%	Nearly 0−3%		13000-17000	after 14000
71	Nunobiki-sanchi-toen fault zone (Western part)	7.4	Nearly 0−1%	Nearly 0−2%	Nearly 0−4%		Approx. 17000	28000−400
96	Izumi fault zone	7.0	Nearly 0−1%	Nearly 0−2%	Nearly 0−4%		Around 8000	7300−2400
70	Tongu fault	7.3	≦1%	≦2%	≦4%		≧10000	10000−the 7th century

Attached Table 3-1 (Part 3)　Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence within 30 years	Probability of occurrence within 50 years	Probability of occurrence within 100 years	Rank for Probability of occurrence	Mean recurrence interval (years)	The latest event (years ago)
20	Nagamachi-Rifu-sen fault zone (Note 11)	7.0－7.5	≦1%	≦2%	≦3%	Fairly high probability	≧Approx. 3000	Unspecified
56	Tonami-heiya/Kurehayama fault zone (Kurehayama fault zone) (Note 11)	7.2	0.6－1%	1－2%	2－3%		Approx. 3000-5000	Unspecified
83	Chuo-kozosen fault zone (Note 7) (*Kitan-kankyo--Naruto-Kaikyo*)	7.7	0.005－1%	0.009－2%	0.02－4%		4000-6000	3100－2600
26	Tsukioka fault zone	7.3	Nearly 0－1%	Nearly 0－2%	Nearly 0－3%		≧7500	6500-900
82	Yamasaki fault zone (Main part/*Northwestern segment*)	7.7	0.08－1%	0.2－2%	0.4－4%		1800-2300	AD.868 Harimanokuni Eq.
79	Rokko-Awajishima fault zone (Main part/*Rokko-sanchi-nan'en--Awajishima-togan segment*)	7.9	Nearly 0－0.9%	Nearly 0－2%	Nearly 0－5%		Approx. 900-2800	the 16th century
97	Ise-wan fault zone (Shirako－Noma fault)	7.0	0.2－0.8%	0.3－1%	0.7－3%		Approx. 8000	Around 6500－5000
78	Mitoke/Kyoto-Nishiyama fault zone (Kyoto-Nishiyama fault zone)	7.5	Nearly 0－0.8%	Nearly 0－1%	Nearly 0－3%		3500－5600	2400－the 2nd century
16	Kitayuri fault	7.3	≧0.7%	≧1%	≧2%		≦Approx. 4000	after 4200
48	Takayama/Oppara fault zone (Takayama fault zone) (Note 11)	7.6	0.7%	1%	2%		Approx. 4000	Unspecified
53/54	Byoubuyama-Enasan-Sanageyama fault zone (Note10) (Byoubuyama fault zone) (Note11)	6.8	0.2－0.7%	0.4－1%	0.8－2%		Approx. 4000－12000	Unspecified
39	Tokamachi fault zone (Eastern part) (Note11)	7.0	0.4－0.7%	0.6－1%	1－2%		Approx. 4000-8000	Unknown（Note 12）
67	Yoro-Kuwana-Yokkaichi fault zone	8	Nearly 0－0.6%	Nearly 0－1%	Nearly 0－3%		1400-1900	the 13th－the 16th century
73	Mikata/Hanaore fault zone (Hanaore fault zone/*Central southern segment*)	7.3	Nearly 0－0.6%	Nearly 0－1%	Nearly 0－2%		4200-6500	2800－the 6th century
78	Mitoke/Kyoto-Nishiyama fault zone (Mitoke fault) (Note 11)	7.2	0.4－0.6%	0.7－1%	1－2%		Approx. 5000-7000	before the 3rd century
3	Furano fault zone (Eastern part) (Note 11)	7.2	0.1－0.6%	0.2－1%	0.5－2%		Approx. 5000－20000	Unknown
4	Mashike-sanchi toen/Numata-Sunagawa area fault zone (Mashike-sanchi-toen fault zone) (Note11)	7.8	≦0.6%	≦1%	≦2%		≧ Approx. 5000	Unspecified
58	Fukui-heiya-toen fault zone (Main part) (Note 11)	7.6	0.2－0.4% or higher	0.3－0.7% or higher	0.6－1% or higher		Approx. 7000－18000 or shorter	Unknown
2	Tokachi-heiya fault zone (Kochien fault) (Note 13)	7.2	0.1－0.4%	0.2－0.7%	0.5－1%		Approx. 7000－21000	2 events after 21000
85	Chuo-kozosen fault zone (Note 7) (*Sanuki-sanmyaku-nan'en--Ishizuchi-sanmyaku-hokuen-tobu*)	8.0 or above	Nearly 0－0.3%	Nearly 0－0.6%	Nearly 0－2%		1000-1600	the 16th century
86	Chuo-kozosen fault zone (Note 7) (*Ishizuchi-sanmyaku-hokuen*)	7.3－8.0	Nearly 0－0.3%	Nearly 0－0.6%	Nearly 0－2%		1000-2500	the 16th century
89	Chuo-kozosen fault zone (Note 7) (*Ishizuchi-sanmyaku-hokuen-seibu － Iyonada*)	8.0 or above	Nearly 0－0.3%	Nearly 0－0.6%	Nearly 0－2%		1000-2900	the 16th century

Attached Table 3-1 (Part 4) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence			Rank for Probability of occurrence	Mean recurrence interval (years) / The latest event (years ago)
			within 30 years	within 50 years	within 100 years		
2	Tokachi-heiya fault zone(Note 11) (Main part)	8.0	0.1－0.2%	0.2－0.3%	0.5－0.6%	Fairy high probability	Approx. 17000－22000 / Unknown
69	Suzuka-seien fault zone(Note 11)	7.6	0.08－0.2%	0.1－0.3%	0.3－0.6%		18000－36000 / Unspecified
53/54	Byoubuyama-Enasan-Sanageyama fault zone(Note 10) (Kagiya fault zone)(Note 11)	7.4	0.1%	0.2%	0.3%		Approx. 30000 / Unspecified
82	Yamasaki fault zone (Nagisen fault zone)(Note 11)	7.3	0.07－0.1%	0.1－0.2%	0.2－0.3%		30000－40000 / Unspecified
77	Ikoma fault zone	7.0－7.5	Nearly 0－0.1%	Nearly 0－0.2%	Nearly 0－0.6%		3000-600 / 1600-1000
68	Suzuka-toen fault zone(Note 1,2)	7.5	Nearly 0－0.07%	Nearly 0－0.1%	Nearly 0－0.2%		6500-12000 / 3500-2800
92	Beppu－Haneyama fault zone (Beppu-wan--Hijiu fault zone/*Western segment*)	7.3	Nearly 0－0.05%	Nearly 0－0.08%	Nearly 0－0.2%		Approx. 13000－25000 / 7300－the 6th century
3	Furano fault zone (Western part)(Note 11)	7.2	Nearly 0－0.03%	Nearly 0－0.05%	Nearly 0－0.1%		Approx. 4000 / the 2nd century－AD.1739
22	Nagai-bonchi-seien fault zone	7.7	≦0.02%	≦0.04%	≦0.1%		Approx. 5000－6300 / after 2400
76	Arima-Takatsuki fault zone	7.5	Nearly 0－0.02%	Nearly 0－0.05%	Nearly 0－0.3%		Approx. 1000-2000 / AD.1596 Keicho-Fushimi Eq.
31	Kanto-heiya-hokuseien fault zone (Main part)	8.0	Nearly 0－0.008%	Nearly 0－0.01%	Nearly 0－0.03%		13000－Approx. 30000 / 6200-2500
98	Osaka-wan fault zone	7.5	≦0.004%	≦0.007%	≦0.02%		3000-7000 / after the 9th century
35	Isehara fault	7.0	Nearly 0－0.002%	Nearly 0－0.005%	Nearly 0－0.01%		Approx. 4000-6000 / the 5th century － the beginning of the 18th century
97	Ise-wan fault zone (Main part/*Southern segment*)	6.9	Nearly 0－0.002%	Nearly 0－0.003%	Nearly 0－0.008%		Approx. 5000－10000 / Around 2000－1500
71	Nunobiki-sanchi-toen fault zone (Eastern part)	7.6	0.001%	0.002%	0.005%		Approx. 25000 / 11000
63	Nosaka/Shufukuji fault zone (Nosaka fault zone)	7.3	Nearly 0% or higher	Nearly 0% or higher	Nearly 0% or higher		5600-7600 or shorter / the 15th－the 17th century
47	Atotsugawa fault zone	7.9	Nearly 0%	Nearly 0%	Nearly 0%		2300-2700 / AD.1858 Hietsu Eq.
50	Shokawa fault zone	7.9	Nearly 0%	Nearly 0%	Nearly 0%		3600-6900 / the 11th－the 16th century
13	Kitakami-teichi-seien fault zone	7.8	Nearly 0%	Nearly 0%	Nearly 0%		16000－26000 / 4500
52	Atera fault zone (Main part/*Southern segment*)	7.8	Nearly 0%	Nearly 0%	Nearly 0%		1700 / AD.1586 Tensho Eq.
21	Fukushima-bonchi-seien fault zone	7.8	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 8000 / 2200－the 3rd century
40	Shinanogawa fault zone (Nagano-bonchi-seien fault zone)	7.4－7.8	Nearly 0%	Nearly 0%	Nearly 0%		800-2500 / AD.1847 Zenkoji Eq.

Attached Table 3-1 (Part 5) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence within 30 years	Probability of occurrence within 50 years	Probability of occurrence within 100 years	Rank for Probability of occurrence	Mean recurrence interval (years)	The latest event (years ago)
53/54	Byoubuyama-Enasan-Sanageyama fault zone (Sanage−Takahama fault zone)	7.7	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 40000	14000 or so
49	Ushikubi fault zone	7.7	Nearly 0%	Nearly 0%	Nearly 0%		5000-7100	the 11th−the 12th century
92	Beppu-Haneyama fault zone (Beppu-wan--Hijiu fault zone/*Eastern segment*)	7.6	Nearly 0%	Nearly 0%	Nearly 0−0.004%		1300-1700	AD.1596 Keicho Bungo Eq.
61/62	Yanagase-Sekigahara fault zone (Main part/*Northern segment*)	7.6	Nearly 0%	Nearly 0%	Nearly 0%		2300-2700	the 17th century or so
30	Sekiya fault	7.5	Nearly 0%	Nearly 0%	Nearly 0%		2600-4100	the 14th−the 17th century
45	Kisosanmyaku-seien fault zone (Main part/*Northern segment*)	7.5	Nearly 0%	Nearly 0%	Nearly 0%		6400-9100	the 13th century
23	Futaba fault	6.8−7.5	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 8000−12000	2400−the 2nd century
74	Yamada fault zone (Gomura fault zone)	7.4 or above	Nearly 0%	Nearly 0%	Nearly 0%		10000-15000	AD.1927 Kitatango Eq.
92	Beppu-Haneyama fault zone (Kuenohirayama-Kameishiyama fault zone)	7.4	Nearly 0%	Nearly 0%	Nearly 0%		4300-7300	after the 13th century
60	Nobi fault zone (Main part/*Umehara fault zone*)	7.4	Nearly 0%	Nearly 0%	Nearly 0%		14000-15000	AD.1891 Nobi Eq.
24	Aizu-bonchi-seien/-toen fault zone (Aizu-bonchi seien fault zone)	7.4	Nearly 0%	Nearly 0%	Nearly 0%		7600-9600	AD.1611 Aizu Eq.
38	Kitaizu fault zone	7.3	Nearly 0%	Nearly 0%	Nearly 0%		1400-1500	AD.1930 Kitaizu Eq.
60	Nobi fault zone (Main part/*Neodani fault zone*)	7.3	Nearly 0%	Nearly 0%	Nearly 0%		2100-3600	1891 Nobi Earthquake
72	Kizugawa fault zone	7.3	Nearly 0%	Nearly 0%	Nearly 0%		4000-25000	AD.1854 Iga-Ueno Eq.
94	Minou fault zone	7.2	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 14000	AD.679 Tsukushii Eq.
15	Yokote-bonchi-toen fault zone (*Northern segment*)	7.2	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 3400	AD.1896 Rikuu Eq.
64	Kohoku Sanchi fault zone (Northwestern part)	7.2	Nearly 0%	Nearly 0%	Nearly 0%		3000-4000	the 11th−the 14th century
73	Mikata/Hanaore fault zone (Mikata fault zone)	7.2	Nearly 0%	Nearly 0%	Nearly 0%		3800-6300	Eearthquake in 1662 AD.
93	Futagawa/Hinagu fault zone (*Northeastern segment*)	7.2 ± .2	Nearly 0%	Nearly 0%	Nearly 0%		11000-27000	1500−1200
97	Ise-wan fault zone (Main part/*Northern segment*)	7.2	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 10000−15000	Around 1000 −500
12	Noshiro fault zone	≧7.1	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 1900-2900	AD.1694 Noshiro Eq.
79	Rokko-Awajishima fault zone (Main area/Awajishima-seigan *segment*)	7.1	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 1800-2500	AD.1995 Hyogo-ken nanbu Eq.

Attached Table 3-1 (Part 6)　Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence within 30 years	within 50 years	within 100 years	Rank for Probability of occurrence	Mean recurrence interval (years) / The latest event (years ago)
84	Nagao fault zone	7.1	Nearly 0%	Nearly 0%	Nearly 0%		Around 30000 / the 9th－the 16th century
14	Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone (Mahiru-sanchi-toen fault zone/*Northern segment*)	6.7－7.0	Nearly 0%	Nearly 0%	Nearly 0%		6300－31000 / AD.1896 Rikuu Eq.
64	Kohoku-sanchi fault zone (Southeastern part)	6.8	Nearly 0%	Nearly 0%	Nearly 0%		Around 7000 / the 15th－the 17th century
60	Nobi fault zone (Nukumi fault/*Northwestern segment*)	6.8	Nearly 0%	Nearly 0%	Nearly 0%		2200-2400 / AD.1891 Nobi Eq.
82	Yamasaki fault zone (Kusatani fault)	6.7	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 5000 / the 5th－the 12th century
79	Rokko/Awajishima fault zone (Senzan fault zone)	6.6	Nearly 0%	Nearly 0%	Nearly 0%		Approx. 5000－10000 / the 11th century －the beginning of the 17th century
1	Shibetsu fault zone	≧7.7	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
24	Aizu-bonchi-seien/-toen fault zone (Aizu-bonchi-toen fault zone)	7.7	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
90	Kikukawa fault zone	7.6 or above	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified / Approx. 8500－2100
61/62	Yanagase/Sekigahara fault zone (Main part/*Southern segment*)	7.6	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Approx. 4900－the 15th century
4	Mashike-sanchi-toen fault zone/Numata-Sunagawa-area fault zone (Numata-Sunagawa-area fault zone) (Note 16)	7.5	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
45	Kiso-sanmyaku seien fault zone (Seinaiji toge fault zone)	7.4	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
74	Yamada fault zone (Main part)	7.4	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / before Approx. 3300
95	Unzen fault group (Northern part) (Note 17)	≧7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / after Approx. 5000
60	Nobi fault zone (Mugigawa fault)	7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified / Unknown
59	Nagaragawa-joryu fault zone	7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified / Unspecified
52	Aterea fault zone (Shirakawa fault zone)	7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
91	Nishiyama fault zone	7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Around 12000-2000
15	Yokote-bonchi-toen fault zone (*Southern segment*)	7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / after 6000－5000
10	Tsugaru-sanchi-seien fault zone (Note 18) (Southern part)	7.1－7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified / Earthquake in 1766 AD.
10	Tsugaru-sanchi-seien fault zone (Note 18) (Northern part)	6.8－7.3	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified / Earthquake in 1766 AD.
29	Kamogawa-teichi fault zone (Note 19)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown

Attached Table 3-1 (Part 7) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence			Rank for Probability of occurrence	Mean recurrence interval (years) / The latest event (years ago)
			within 30 years	within 50 years	within 100 years		
46	Sakaitoge-Kamiya fault zone (Mutoyama-Narai fault zone)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
52	Atera fault zone (Sami fault zone)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
61/62	Yanagase-Sekigahara fault zone (Urazoko-Yanagaseyama fault zone)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
73	Mikata/Hanaore fault zone (Hanaore fault zone/*Northern segment*) (Note 20)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Earthquake in 1662 AD.
78	Mitoke/Kyoto-Nishiyama fault zone (Kanbayashigawa fault)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
93	Futagawa/Hinagu fault zone (*Southwestern segment*)	7.2	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown 7500－2200
6	Ishikari-teichi-toen fault zone (Southern part)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
58	Fukui-heiya toen fault zone (Western part) (注21)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown AD. 1948 Fukui Eq.
60	Nobi fault zone (Ibigawa fault zone)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified the 1st－the 10th century
95	Unzsen fault group (Southeastern part) (Note 17)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified After 7300
53/54	Byoubuyama-Enasan-Sanageyama fault zone (Note 10) (Ako fault zone)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
31	Kanto-heiya-hokuseien fault zone (Hirai－Kushibiki fault zone)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
48	Takayama/Oppara fault zone (Inohana fault zone)	7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
14	Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone (Mahiru-sanchi-toen fault zone/*Southern segment*)	6.9－7.1	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
60	Nobi fault zone (Nukumi fault zone/*Southeastern segment*)	7.0	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
60	Nobi fault zone (Main part/*Mitabora fault zone*)	7.0	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
87	Itsukaichi fault zone (Itsukaichi fault zone)	7.0	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified the 7th－the 12th century
14	Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone (Shizukuishi-bonchi-seien fault zone)	6.9	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown 2800－the 14th century
61/62	Yanagase/Sekigahra fault zone (Main part/*Central segment*)	6.6	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown 7200-7000
87	Itsukaichi fault zone (Koi－Hiroshima-seien fault zone)	6.5	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified before 2300
63	Nosaka/Shufukuji fault zone (Shufukuji fault zone)	6.5	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown Unknown
37	Miura-hanto fault group (Southern part)	6.1 or above	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unspecified 2600-2200

Attached Table 3-1 (Part 8) Summary of long-term evaluations for the 98 major active fault zones

NO.	Fault zone name (seismogenic fault/*segment*)	Estimated Magnitude	Probability of occurrence			Rank for Probability of occurrence	Mean recurrence interval (years) / The latest event (years ago)
			within 30 years	within 50 years	within 100 years		
11	Oritsume fault (Note 22)	(Max. 7.6)	Unknown (Note 15)	Unknown (Note 15)	Unknown (Note 15)		Unknown / Unknown
32	Motoarakawa fault zone	Divided into North segment and South segment at the border around Ageo City, and only North segment is regarded as an active fault					
28	Tokyo-wan-hokuen fault	Regarded as not active fault					
66	Gifu-Ichinomiya fault zone	Regarded as not active fault					
33	Arakawa fault	Regarded as not active fault					

Each value has an uncertaity to some extent.
In the above table, 'Nearly 0% 'expresses probability value less than 0.001%.

Note 1:

With respect to the Itoigawa-Shizuoka tectonic line fault zone and Fujikawa-kako fault zone, probabilities were not given when the long-term evaluation was presented. Probabilities of these fault zones are shown with 2 significant digits in 'On methods for evaluating long-term probability of earthquake occurrence' (June 8, 2001). The values indicated in this table were determined with only one significant digit since January 12, 2005. However, the probabilities are written with 2 significant digits when the 30-year probabilities are at the level of 10%.

The probability values given with 2 significant digits are as follows:

- Itoigawa-Shizuoka tectonic line fault zone: 30-year probability is 14%, 50-year probability is 23%, and 100-year probability is 41%.
- Fujikawa-kako fault zone: 30-year probability is 0.21-11%, 50-year probability is 0.39-18%, and 100-year probability is 0.93-33%.

In addition, the Kannawa/Kozu-Matsuda fault zone and Suzuka-toen fault zone, were deleted from the above because the past history of activity and earthquake occurrence probabilities changed with recent investigations (March 9, 2005, Note 2).

Note 2:

For the Kannawa/Kozu-Matsuda fault zone and Suzuka-toen fault zone, long-term evaluations were released in the past, but subsequent surveys of the active faults were conducted, and more data on the past history were obtained, so that the evaluation was reexamined.

The former evaluations of the fault zones were as follows:

- Kannawa/Kozu-Matsuda fault zone: 30-year probability is 3.6%, 50-year probability is 6.0%, and 100-year probability is 12%.
- Suzuka-toen fault zone: 30-year probability is under 0.50%, 50-year probability is under 0.83%, and 100-year probability is under 1.7%.

Note 3:

In classification of the 98 major fault zones across the country by the Headquarters for Earthquake Research Promotion (1997), the Itoigawa-Shizuoka tectonic line fault zone was divided into three segments consisting of the northern area (44), central area (41) and southern area (42). The Gofukuji fault is in the central area and the long-term evaluation stated that it cannot be judged where the 'segment including the Gofukuji fault' ends. The northern and southern segments were simultaneously active at the time of the latest event (about 1200 years ago).

Note 4:

The latest event on the main part of the Sakaitoge-Kamiya fault zone(main part) was possibly after the period from about 4900 years ago to the 3rd century, the previous event was about 7600 to 6700 years ago, and the mean recurrence interval (about 1800 to 5900 years) has been derived from the interval between the past two events. However, the period range of the latest event is large, about 3000 years, so that the mean recurrence interval could not be sufficiently determined. Accordingly, the elapse time rate after the earthquake (0.3-2.7) and the future earthquake occurrence probability (30 years from the present: 0-13%) calculated from these values has a large uncertainty.

Note 5:

The largest value of the earthquake occurrence probability for the Kushigata-sanmyaku fault zone is for a mean recurrence interval of about 3000 years, with the latest event occurring about 6600 years ago, with a magnitude of about 6.8. For a magnitude of about 7.2 or less, the occurrence probability within 30 years is 3%, or higher. For the case of a magnitude 7.5, earthquake, the occurrence probability within 30 years from the present is under 0.5%.

Note 6:

The Inadani fault zone has been separated into two sections, the boundary fault and the frontal fault, as indicated by the respective values in the table. However, there is the possibility that the two sections may be activated simultaneously as a single fault zone. In this case the earthquake has a magnitude of about 8.0, and its long-term probability does not exceed the case when the boundary fault and frontal fault are activated individually.

Note 7:

The Chuo-kozosen (Median Tectonic Line) fault zone has been evaluated as consisting of five separate segments, and the respective values are shown in the table. However, it is possible that all the segments are simultaneously activated in a single earthquake, which corresponds to an earthquake with a magnitude equal to or larger than 8.0. Its long-term probability does not exceed that for the case when the five segments are activated individually.

Note 8:

For the Beppu-Haneyama fault zone (Oita-heiya - Yufuin fault zone/western segment) there is no accurate information on the latest event, and mean recurrence interval cannot be derived with the conventional methods. Here, it has been derived from the past history, assuming events occurred twice during the time from about 2000 years ago through the 18th century. In calculation of the earthquake occurrence probability, a Poisson model was used because of the limited reliability in using the conventional BPT distribution.

Note 9:

For the Ouchigata fault zone there is no accurate information on the latest event, so the mean recurrence interval cannot be derived. The mean recurrence interval has been derived based on activity that three events occurred during the time from about 4900 years ago through the 9th century. In calculation of the earthquake occurrence probability, a Poisson model was used because of the limited reliability in using the conventional BPT distribution.

Note 10:

Matsuda (1990) had initially divided the Byobuyama-Enasan and Sanageyama fault zones into the separate Byobuyama-Enasan fault zone and Sanageyama fault zone. The Headquarters for Earthquake Research Promotion (1997) also treated them to be separate fault zones in the 'Fundamental Plans for Surveys and Observations'. However, the two fault zones were evaluated together because of their close locations. In accordance with Nakata and Imaizumi (2002), the Otaka-Obu fault and Takahama flexure, located in Okazaki Plain, were also determined to be included in this evaluation because the fault traces are shown to be connected to the Sanageyama fault zone. In the evaluation, we divided this fault zone into the Byobuyama, Enasan-Sanageyama-kita fault zone and Sanage-Takahama fault zone, based on the definition of seismogenic faults by Matsuda (1990).

Note 11:

For the following fault zones, the long-term probabilities have not been derived with the normal evaluation procedure (in which earthquake probabilities with time), but under the assumption that earthquake occurrence probabilities remain unchanged with time, because the time of the latest event has not been specified: Tokamachi fault zone (western and eastern parts), Shinjo-bonchi fault zone, Aomori-wan-seigan fault zone, Nagamachi-Rifu-sen fault zone, Tonami-heiya fault zone/Kurehayama fault zone (Kurehayama fault zone), Takayama-Oppara fault zone (Takayama fault zone), Byobuyama-Enasan-Sanageyama fault zone, (Byobuyama fault zone, Kagiya fault zone), Mitoke/Kyoto-Nishiyama fault zone (Mitoke fault), Furano fault zone (western and eastern parts), Mashike-sanchi-toen/Numata-Sunagawa area fault zone (Mashike-sanchi-toen fault zone), Fukui-heiya-toen fault zone (main part), Tokachi-heiya fault zone (main part), Suzuka-seien fault zone, and Yamasaki fault zone (Nagisen fault zone).

Note 12:

The Tokamachi fault zone (eastern part) has unconfirmed activity from about 3900 to 3300 years ago, causing uncertainty.

Note 13:

For the Tokachi-heiya fault zone (Kochien fault), there is no accurate information on the latest event, so the mean recurrence interval cannot be obtained. The mean recurrence interval has been derived from past activity, assuming that two events occurred in the last 21,000 years. In calculation of earthquake occurrence probabilities, a Poisson model was used because of the limited reliability in using the conventional BPT distribution.

Note 14:

Matsuda (1990) divided the Yanagase-Sekigahara fault zone into the separate Yanagase fault zone and Sekigahara fault zone, and the Headquarters of Earthquake Research Promotion (1997) also regarded them as independent active faults in the 'Fundamental Plans for Surveys and Observations'. According to Okada and Togo (2000), and Nakata and Imaizumi (2002), however, the Yanagase fault zone and the Sekigahara fault zone are shown to have a nearly connected trace, and the two faults both can be regarded as a single seismogenic fault, based on the definition of Matsuda (1990). Accordingly, the Yanagase and Sekigahara fault zones were grouped together and evaluated as the Yanagase-Sekigahara fault zone (main part). Further distributed to the west are successive northwest-southeast running faults, which can be included in this fault zone, based on the definition by Matsuda (1990). Therefore, the northwest-southeast running faults are tentatively called the 'Urazoko-Yanagaseyama fault zone', and evaluated together with the Yanagase-Sekigahara fault zone (main part).

Note 15:

For the following fault zones, we cannot derive the earthquake occurrence probability because the mean recurrence interval is not clear: Shibetsu fault zone, Aizu-bonchi-seien/-toen fault zone (Aizu-bonchi-toen fault zone), Kikukawa fault zone, Yanagase- Sekigahara fault zone (main part/southern segment, Urazoko-Yanagaseyama fault zone), Mashike-sanchi-toen fault zone (Numata-Sunagawa area fault zone), Kiso-sanmyaku-seien fault zone (Seinaiji-toge fault zone), Yamada fault zone (main part), Unzen fault group (northern and southeastern parts), Nobi fault zone (Nukumi fault /southeastern segment, Nobi fault zone (main part)/Mitabora fault zone(segment), Mugigawa fault, Ibigawa fault zone), Nagaragawa-joryu fault zone, Atera fault zone (Shirakawa fault zone, Sami fault zone), Nishiyama fault zone, Yokote-bonch-toen fault zone (southern segment), Tsugaru-sanchi-seien fault zone (northern and southern parts), Kamogawa-teich fault zone, Sakaitoge-Kamiya fault zone (Mutoyama-Narai fault zone), Yanagase-Sekigahara fault zone (main part/central segment, Urazoko-Yanagaseyama fault zone), Mikata/Hanaore fault zone (Hanaore fault zone, northern segment), Mitoke/Kyoto-nishiyama fault zone (Kanbayashigawa fault), Futagawa-Hinagu fault zone (southwestern segment), Ishikari-teichi-toen fault zone (southern part), Fukui-heiya-toen fault zone (western part), Byobuyama-Enasan-Sanageyama fault zone (Ako fault zone), Kanto-heiya-hokuseien fault zone (Hirai-Kushibiki fault zone), Takayama-Oppara fault zone (Inohana fault zone), Shizukuishi-bonchi-seien/Mahiru-sanchi-toen fault zone (Mahiru-sanchi-toen fault zone, southern segment, Shizukuishi-bonchi-seien fault zone), Itsukaichi fault zone (Itsukaichi fault, Koi/Hiroshima-seien fault zone), Nosaka/Shufukuji fault zone (Shufukuji fault), Miura-hanto fault group (southern part) and Oritsume fault.

Note 16:

The Mashike-sanchi-toen fault zone has been evaluated together with a fault zone near Numata- Sunagawa area fault zone, which Ikeda et al. (2002) first reported. The latest events and mean recurrence intervals are unknown for both faults, so that the earthquake size was derived from the fault length (about 38 km) when assuming that the whole fault moved as a single earthquake.

Note 17:

Earthquake occurrence probabilities of the Unzen fault group (northern and southeastern parts) are unknown because the mean recurrence intervals have not been obtained (Note 15).

However, the average slip rate of these fault zones is thought to reach 1 m/1000 years, although the information is of low reliability. Note that the mean recurrence interval is possibly shorter than the elapsed time from the latest event.

Note 18:

The Tsugaru-sanchi-seien fault zone has been evaluated as being divided into the northern and southern parts. As mentioned in Note 15, although the earthquake occurrence probability cannot be derived because the mean recurrence interval is unknown, the probability in the near future is considered to be extremely small, because the latest event is in 1766 and the elapsed time after the earthquake is short. The earthquake size has been set at a value with a range, because the estimated earthquake size of the latest event is large compared with the length of the fault zone.

Note 19:

For the Kamogawa-teich fault zone, clear evidence for whether or not this is an active fault is scarce, and there are survey results that report doubts about an active fault. Thus, it is necessary, at the present, to obtain clear data on the active period and activity of this zone.

Note 20:

For the northern segment of Hanaore fault zone, the earthquake occurrence probability cannot be obtained because the mean recurrence interval is unknown. However, the earthquake occurrence possibility in the near future is considered small, because the latest event is possibly the earthquake in 1662.

Note 21:

For the Fukui-heiya-toen fault zone (western part), the earthquake occurrence probability cannot be obtained because the mean recurrence interval is unknown. However, the earthquake occurrence probability in the near future is considered extremely small, because the latest event is in 1948 and the elapsed time after the earthquake is short.

Note 22:

For the Oritsume fault, there is not sufficient data to clarify the future activity. Although it is considered near certain that the fault was active in the Quaternary, because Pliocene strata have been largely deformed, clear evidence showing repetitive activity in the Late Quaternary has not been discovered, so far, and activity by the Late Quaternary had possibly declined, particularly on the Tatsunokuchi flexure in the north. Although the largest value has been used for the sake of convenience, this value is a trial value for the earthquake size for when whole fault is activated.

'Nearly 0%' in the table indicates probability values of less than 10^{-3}%.

References

Edited by Ikeda,Y., Imaizumi, T., Togo, M., Hirakawa, K., Miyauchi, T., Sato, H. (2002): Atlas of Quaternary Thrust Faults in Japan, University of Tokyo Press, 254p.

Headquarters for Earthquake Research Promotion (1997): The Fundamental Plans for Survey and Observation, 38p.

Matsuda, T. (1990): Seismic zoning map of Japanese islands, with maximum magnitudes derived from active fault data, Bulletin of Earthquake Research Institute, 65. 289-319.

Nakata, T. and Imaizumi, T. (2002): Digital Active Fault Map of Japan. University of Tokyo Press, DVD-ROM and a Map, 60p.

Okada, A. and Togo, M. (2000): Active Faults in the Kinki Area, Central Japan: Sheet Maps and Inventories, University of Tokyo Press, 408p.

Attached Table 3-2 (Part 1) Outline of long-term evaluation for Subduction-zone earthquakes

Region	Sea area or Specific earthquake name	Estimated Magnitude	Probability of occurence (Note 1) within 10 years	within 30 years	within 50 years	Mean recurrence interval (Note 1) (years)	The latest event (Except for Poisson model) (years ago)
Earthquakes along the Nankai Troungh (Note 7)	Nankai Earthquake	8.4 (whole area 8.5)	About 10%	About 50%	About 80%	114.0 (optimum estimation for the next event (Note 2) 90.1)	58.0
	Tonankai Earthquake	8.1 (whole area 8.5)	10－20%	About 60%	About 90%	111.6 (optimum estimation for the next event (Note2) 86.4)	60.1
Earthquakes from Sanriku-Oki to Boso- Oki along the Japan Trench	Adjucent region of the trench: Tsunami earthquakes	Mt8.2	About 7% (About 2%) *	About 20% (About 6%) *	About 30% (About 9%) *	Approx. 133.3 (Around 530 for specific regions) *	—
	Adjucent region of the trench: Earthquakes of normal faults type	8.2	1－2% (0.3－0.6%) *	4－7% (1－2%) *	6－10% (2－3%) *	Around 400－750 (Around 1600－3000 for specific regions) *	—
	Northern Sanriku-Oki	8.0	Nearly 0% －0.1%	0.04－7%	20－40%	Approx. 97.0	36.6
	Northern Sanriku-Oki: Earthquakes at plate boundary except for characteristic earthquakes	7.1－7.6	About 60%	About 90%	—	Approx. 11.3	—
	Miyagi-ken-Oki	7.5 (whole area 8.0)	About 50%	99%	—	37.1	26.6
	Close to the trench in southern Sanriku-Oki	7.7 (whole area 8.0)	30－40%	70－80%	≧About 90%	Approx. 105	107.4
	Fukushima-ken-Oki	7.4 (some earthquakes occur in succession)	≦About 2%	≦About 7%	≦About 10%	≧400	—
	Ibaraki-ken-Oki	6.8	About 50%	About 90%	—	Approx. 15.5	—
Earthquakes along the Kuril Trench (2nd Edition)	Tokachi-Oki	8.1 (whole area 8.3)	Nearly 0%	0.02－0.5%	9－20%	72.2 (Note 3)	1.3
	Nemuro-Oki	7.9 (whole area 8.3)	1－5%	30－40%	About 70%	72.2 (Note 3)	31.5
	Shikotanto-Oki	7.8 (Mw8.2) (Note 4)	3－8%	About 40%	About 80%	72.2 (Note 3)	35.4
	Etorofuto-Oki	8.1 (Mw8.5) (Note 4)	8－10%	About 50%	80－90%	72.2 (Note 3)	41.2

Attached Table 3-2 (Part 2) Outline of long-term evaluation for Subduction-zone earthquakes

Earthquakes along the Kuril Trench (2nd Edition)	Relatively small interplate earthquakes	Tokachi-Oki/ Nemuro-Oki	7.1	About 40%	About 80%	About 90%	17.5	—
		Shikotanto-Oki/ Etorofuto-Oki	7.1 (Mw7.7) (Note 4)	About 60%	About 90%	≧About 90%	10.5	—
	Relatively shallow earthquakes within subducted plate		8.2	about 10%	About 30%	About 50%	82.8	—
	Intermediate depth earthquakes within subducted plate		7.5	About 30%	About 70%	About 80%	27.3	—
Earthquakes in eastern margin of Japan Sea	Northwestern Hokkaido-Oki Eq.		7.8	0.002−0.04%	0.006−0.1%	0.01−0.2%	Around 3900	Around 2100
	Western Hokkaido-Oki Eq.		7.5	Nearly 0%	Nearly 0%	Nearly 0%	Around 1400−3900	64.4
	Southwestern Hokkaido-Oki Eq.		7.8	Nearly 0%	Nearly 0%	Nearly 0%	Around 500−1400	11.5
	Western Aomori-ken-Oki Eq.		7.7	Nearly 0%	Nearly 0%	Nearly 0%	Around 500−1400	21.6
	Akita-ken-Oki Eq.		7.5	≦About 1%	≦About 3%	≦About 5%	≧Around 1000	—
	Yamagata-ken-Oki Eq.		7.7	Nearly 0%	Nearly 0%	Nearly 0%	≧Around 1000	171.1
	Northern Niigata-ken-Oki Eq.		7.5	Nearly 0%	Nearly 0%	Nearly 0%	≧Around 1000	40.5
	Northern Sadogashima-Oki Eq.		7.8	1−2%	3−6%	5−10%	Around 500−1000	—
Earthquakes in Hyuganada and the vicinity of Nanseishoto Trench	Intraplate earthquakes in Akinada-Iyonada-Bungosuido		6.7−7.4	About 10%	About 40%	About 50%	Approx. 67	—
	Interplate earthquakes in Hyuganada		7.6	About 5%	About 10%	About 20%	Approx. 200	—
	Relatively small interplate earthquakes in Hyuganada		7.1	30−40%	70−80%	80−90%	Approx. 20−27	—
	Shallow earthquakes at the vicinity of Nanseishoto (Note 5)		—	—	—	—	—	—
	Intermediate depth earthquakes from Kyushu to the vicinity of Nanseishoto (Note 5)		—	—	—	—	—	—
	Earthquakes at the vicinity of Yonakunijima		7.8	About 10%	About 30%	About 40%	Around 100	—

Attached Table 3-2 (Part 3) Outline of long-term evaluation for Subduction-zone earthquakes

Earthquakes along the Sagami Trough	Kanto Earthquake of "1923 Taisho" type	7.9	Nearly 0－0.05%	Nearly 0－0.9%	Nearly 0－5%	200－400 81.3
	Kanto Earthquake of "1703 Genroku" type (Note 6)	8.1	Nearly 0%	Nearly 0%	Nearly 0%	Around 2300 301.0
	Other M7 scale earthquakes in the Southern Kanto	6.7－7.2	About 30%	About 70%	About 90%	23.8 －

Each value has an uncertaity to some extent.
In the above table, 'Nearly 0% 'expresses probability value less than 0.001%.
Mt is the scale of an earthquake that measures by a tsunami height

Note 1:

The start date of the calculation for the occurrence probability is January 1, 2005. A renewal process was applied in the calculation based on the start date. A Poisson model was applied to the following events: Earthquakes in the trench side region from Sanriku-Oki to Boso-Oki, the smaller earthquakes in northern Sanriku-Oki, the earthquakes in Fukushima-ken-Oki, the Ibaraki-ken-Oki Earthquake, the smaller earthquakes in the subducted plate along the Kuril Trench, the Akita-ken-Oki Earthquake along the eastern margin of Japan Sea, the Northern Sadogashima-Oki Earthquake, the earthquakes in the vicinities of Hyuganada and the Nanseishoto Trench, and other about M7 earthquakes in Southern Kanto along the Sagami Trough.

Note 2:

Estimation based on the time-predictable recurrence model.

Note 3:

It was assumed that interplate earthquakes of about M8 repeatedly occur on each segment along the Kuril Trench, and that occurrence intervals are nearly the same for each region. Thus, differences in earthquake occurrence intervals in each region (Tokachi-Oki: 108.9 and 51.6 years; Nemuro-Oki: 79.2 years; Shikotanto-Oki: 76.2 years; and Etorofuto-Oki: 45.1 years) are regarded as fluctuations, and the average value of 72.2 years, was determined as the value of the average occurrence interval.

Note 4:

Because there is a large difference between M and Mw for past earthquakes, Mw was shown for reference. Mw is the ‘moment magnitude’. Magnitude (M), which represents the earthquake size, is calculated by using the distribution of the amplitude of seismic waves at stations, whereas, Mw is calculated by using a quantity called seismic moment, which representing physical size of the source. Because Mw reflects the size of the seismic source region, it can avoid the saturation of magnitude (a phenomenon where the calculated magnitude does not grow in proportion to increase of earthquake size), and has a clear physical meaning.

Note 5:

For these regions, we do not have enough information to determine the general location of the earthquakes, so we do not know the characteristics of the earthquakes, and cannot evaluate the mean recurrence intervals.

Note 6:

The Kanto Earthquakes of 1703 Genroku-type are regarded as a Kanto Earthquake of 1923 Taisho-type of Kanto, with a source area that extends to the southern and southeastern offshore regions of the Boso Peninsula, so the occurrence probabilities of the Genroku-type and Taisho-type are not considered here to be independent.

Note 7:

For the Tokai Earthquake, which is one of the earthquakes occurring along the Nankai Trough, the Central Disaster Management Council has published a national evaluation, 'Report of the Special Survey Committee for the Tokai Earthquake' (2001), in which the Council has regarded that the Tokai Earthquake may occur at any time. Because there is no historical example for a Tokai Earthquake seismic source region that ruptures independently, the occurrence probability cannot be obtained with the normal procedures for long-term evaluations, which estimates occurrence intervals based on past case examples.

However, because an occurrence probability of the Tokai Earthquake is necessary for preparation of the probabilistic seismic hazard maps, the Headquarters for Earthquake Research Promotion derived the value with the following method:

- The mean recurrence interval was set as 118.8 years, which is an average of four earthquakes: 1498 Meio Tokai Earthquake, 1605 Keicho Earthquake, 1707 Hoei Earthquake and 1854 Ansei Tokai Earthquake. In the 'Long-term evaluation for earthquakes along the Nankai Trough', it has been described that the total or partial area of the seismic source region of the assumed Tokai Earthquake was activated.
- The latest event was set as the 1854 Ansei Tokai Earthquake.
- The value 0.20 was adopted as the parameter for the fluctuation of the mean recurrence interval. This is the same to the Tonankai Earthquake, for which a long-term evaluation was conducted.
- The same occurrence interval was assumed for cases where the earthquake occurs together with adjacent regions and cases where it occurs alone.

Because the mechanism of the Tokai Earthquake linked with adjacent regions is not known, the above assumptions are needed, to derive the occurrence probability. Therefore, the degree of reliability is less than those of other subduction-zone earthquakes, released in the long-term evaluations.

Probability of assumed Tokai Earthquake used in probabilistic seismic hazard maps

Earthquake name	Size	Probability of occurrence	Mean recurrence interval
	Magnitude	Within 30 years	
Tokai Earthquake	About 8	86% (for reference)	118.8 years (for reference)

Appendix 4 Release of data for seismic hazard maps and their uses

All documents and drafts of this report are released on the home page of the Headquarters for Earthquake Research Promotion (http://www.jishin.go.jp). Large figures that have resolutions of about 1 km square can be downloaded in PDF format. With software to read PDF files, the user can expand the figures to see the details.

Data, conditions for the calculations and the preparation process used for preparing figures of the results in this report are also available from the Independent Administrative Institution (IAI) National Research Institute for Earth Science and Disaster Prevention, through the 'Seismic hazard map release system' (http://www.j-map.bosai.go.jp).

Seismic hazard maps shown in this report have been prepared on the basis of results in the 'Study of the preparation procedures for the seismic hazard maps', a special project of the (IAI) National Research Institute for Earth Science and Disaster Prevention. Data have been released jointly as products of the Headquarters for Earthquake Research Promotion and the (IAI) National Research Institute for Earth Science and Disaster Prevention. Mentioned here are the types of data and notes on the use of the data release.

The release system also includes the data derived by the (IAI) National Research Institute for Earth Science and Disaster Prevention on the process of preparing the seismic hazard maps and evaluated results. These have also been released as products of a special project of the (IAI) National Research Institute for Earth Science and Disaster Prevention.

(1) Data

(a) **Probabilistic Seiemic Hazard Maps**

○Maps and data

Period	Maps	Numerical data	Remarks
30 years	Distribution maps of probability	Probability value of ground motions equal to or larger than seismic intensity 6 Lower, occurring	Note 1
		Probability value of ground motions equal to or larger than seismic intensity 5 Lower, occurring	
	Maps of ground motions of equal to or larger than seismic intensity for a 3% probability of exceedance occurring	Instrumental seismic intensity on the ground surface	Note 2
		Peak velocity on the ground surface	
		Peak velocity on the engineering bedrock	
50 years	Maps of ground motions of equal to or larger than seismic intensity for a 5% probability of exceedance occurring	Instrumental seismic intensity on the ground surface	
		Peak velocity on the ground surface	
		Peak velocity on the engineering bedrock	
	Maps of ground motions of equal to or larger than seismic intensity for a 10% probability of exceedance occurring	Instrumental seismic intensity on the ground surface	
		Peak velocity on the ground surface	
		Peak velocity on the engineering bedrock	
	Maps of ground motions of equal to or larger than seismic intensity for a 39% probability of exceedance occurring	Instrumental seismic intensity on the ground surface	
		Peak velocity on the ground surface	
		Peak velocity on the engineering bedrock	

Note 1: In addition to maps and numerical data for all earthquakes, include are those by earthquake classification (the 98 major active fault zones, subduction zone earthquakes and other earthquakes), maps in the maximum case when the 98 major fault zones have ranges of occurrence probabilities, the map before the occurrence of 2003 Tokachi-Oki Earthquake, and maps dealt in Chapter 3 of Separate Vol. 1.

Note 2: Maps of parameters other than those shown here are prepared by the (IAI) National Research Institute for Earth Science and Disaster Prevention.

○Data on degree of influence from earthquakes at specified sites

Period	Sites	Numerical data	Remarks
30 years	Prefectural government seats (Subprefectural government seats in Hokkaido)	Hazard curve for peak velocity on the ground surface	Note 1
		Hazard curve for peak velocity on the engineering bedrock	
		Data on degree of influence from earthquakes	

Note 1: Data other than those shown here are prepared by the (IAI) National Research Institute for Earth Science and Disaster Prevention.

○In addition, the following numerical data are released as those obtained on the process of map preparation by (IAI) National Research Institute for Earth Science and Disaster Prevention.

Numerical data	Remarks
Amplification factor of the surface soil layers	Note 1
Evaluation model data for seismic activity	
Seismic source model (Location, geometry, seismic size)	

Note 1: Figure 2. 3-1 is joint fruits of the Headquarters for Earthquake Research Promotion and the (IAI) National Research Institute for Earth Science and Disaster Prevention.

(b) Seismic Hazard Maps for Specified Seismic Source Faults

○Map and data

	Maps to release	Numerical data	Remarks
Detailed method	Distribution maps of seismic intensity for selected earthquakes	Instrumental seismic intensity on the ground surface	Note 1
		Peak velocity on the ground surface	
		Peak velocity on the engineering bedrock in the detailed method	
		Calculated waveforms on the engineering bedrock in the detailed method	

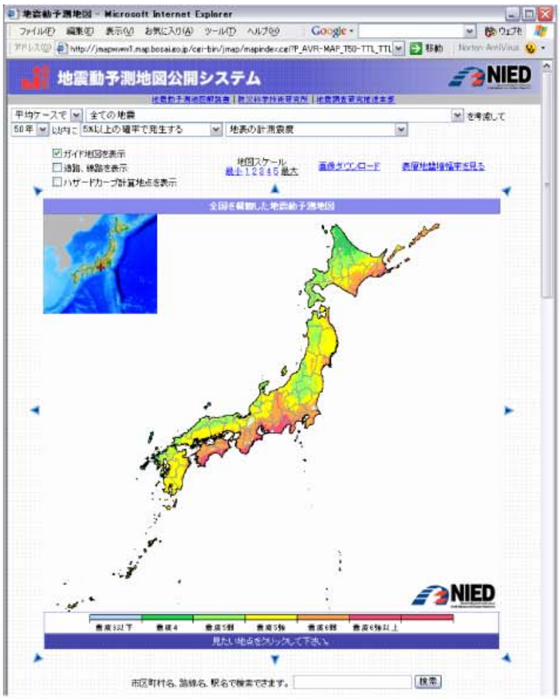
Note 1: Maps for the 98 major fault zones and subduction-zone earthquakes with specified source faults in the conventional method are located in reference figures. Figures are joint fruits of the Headquarters for Earthquake Research Promotion and the (IAI) National Research Institute for Earth Science and Disaster Prevention. Related numerical data are prepared by the (IAI) National Research Institute for Earth Science and Disaster Prevention.

○In addition, the following numerical data are obtained on the process of map preparation by the (IAI) National Research Institute for Earth Science and Disaster Prevention.

Method	Numerical data	Remarks
Detailed method	Characterized source model (Location and geometry of faults, large and small-scale parameters)	
	Subsurface structural data	Note 1
	Amplification factor on the surface soil layers	
Conventional method	Seismic source model (Location, geometry, seismic size)	Note 2
	Amplification factor on the surface soil layers	

Note 1: Release method is studied hereafter.
Note 2: The model used in probabilistic seismic hazard maps

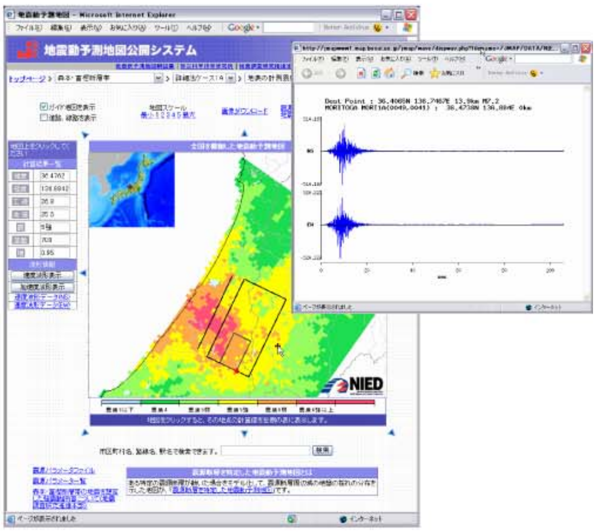
(2) Notation example for the ‘seismic hazard map release system’



First page of the ‘Seismic hazard map release system’

Probabilistic seismic hazard map
(Enlarged example)

Calculated values of the clicked spot are displayed in the table on the left.



Seismic hazard map for specified seismic source fault

In addition to showing the calculated values of the clicked spot in the table on the left, calculated waveforms on engineering bedrock can also be displayed.

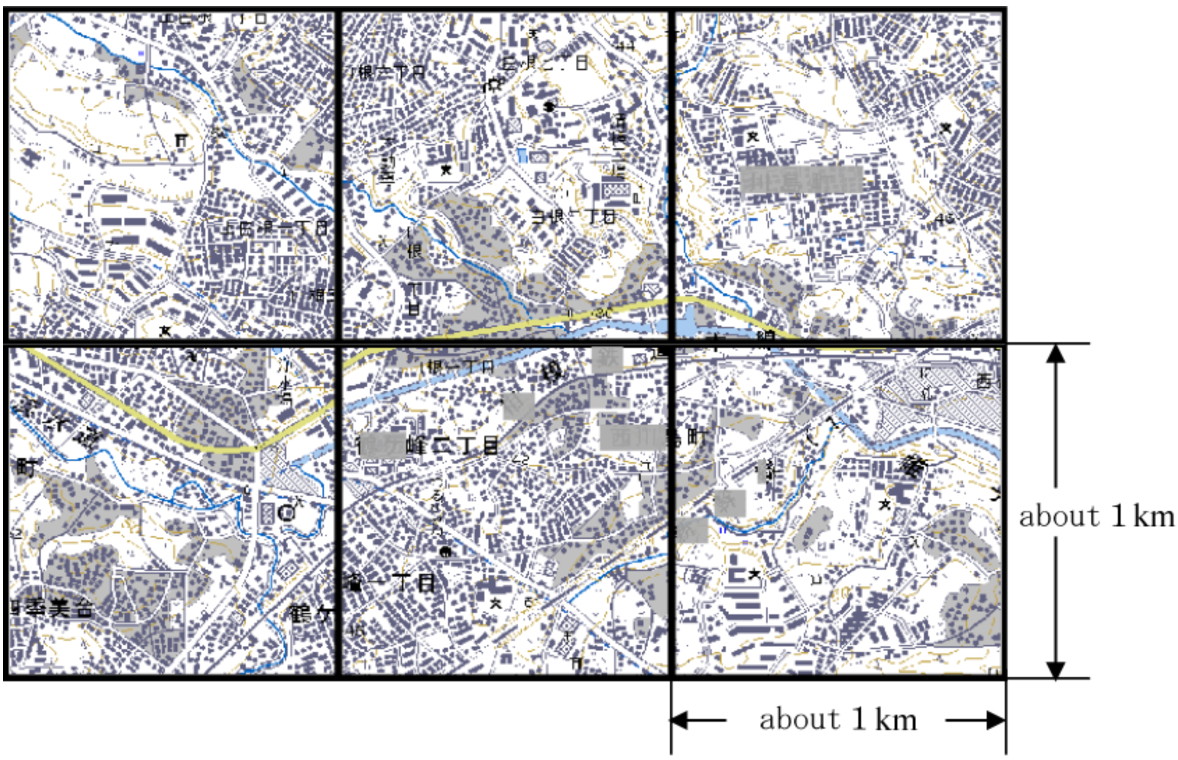
(3) Points to be kept in mind upon utilization

In evaluating the influence of surface soil layers, a ‘conventional method’ has been used because of the limited available data. When evaluating an area of about 1 km square, there may sometimes be differences from the predicted intensity within the area, because the amplification factor of surface soil layers, is given by a representative value for a wide region, as shown in the figure below.

There are limitations in the ‘Seismic Hazard Maps for Specified Seismic Source Fault’, due to uncertainties of the subsurface structure and setting of the small scale seismic source parameters, used for calculations of the earthquake ground motions with the ‘detailed method’. Also in the ‘Probabilistic Seismic Hazard Maps’, modeling of the seismic activity, prediction of the intensity with the ‘conventional method’ and evaluation of the uncertainties, all have limitations in accuracy . In consequence, numerical values of the calculated earthquake ground motions, contain a corresponding level of uncertainty.

Also, in maps released by the Headquarters for Earthquake Research Promotion, seismic intensities 6 Upper and 7 have been expressed as ‘seismic intensity equal to or larger than 6 Upper’. This is because the accuracy of the empirical formula to convert peak ground velocity into instrumental seismic intensity, has limitations due to the scarcity of observed seismic intensity 7, as well as difficulties in accurately including the effects of the surface soil layers with the ‘convenient’ procedure , as mentioned above.

For disaster prevention studies of individual areas, it is important to consider these points, along with considering detailed data on the regional surface soil layers to account for the influence of the surface structure.



Attached Fig. 4-1 Comparison of sizes between a map and evaluation area of about 1 km square

Appendix 5 Explanation Table of the JMA Seismic Intensity Scale

Evaluated results shown in the seismic hazard maps are composed of many kinds of distribution maps, as shown in **Sections 3** and **4**. The most representative is the map of seismic intensity. Seismic intensity represents the strength of the earthquake ground motion, and was originally determined by a scale using human perception and the damage conditions. Since April 1996, the intensity has been determined based on instrumental intensity obtained from acceleration waveforms recorded on seismometers. Since that time, ‘seismic intensity 5’ and ‘seismic intensity 6’ have been both divided into two levels: ‘seismic intensity 5 Lower’, ‘seismic intensity 5 Upper’, ‘seismic intensity 6 Lower’ and ‘seismic intensity 6 Upper’. This split was done because it was thought that the range of earthquake damage was too large (for the old 7 level system), and 10 levels of the seismic intensity scale were needed. **Table 5-1** shows an explanation of the JMA Seismic Intensity Scale. This table shows the correspondence between traditional human perception and damage conditions to values of seismic intensity scale and instrumental seismic intensity.

Appendix Table 5−1 Explanation Table of Japan Meteorological Agency

Instrumental Seismic Intensity	JMA Scale	People	Indoor Situations	Outdoor Situations	Wooden Houses	Reinforced−Concrete Buildings	Lifelines	Ground and Slopes
0.5	0	Imperceptible to people.						
1.5	1	Felt by only some people in the building.						
2.5	2	Felt by most people in the building. Some people awake.	Hanging objects such as lamps swing slightly.					
3.5	3	Felt by most people in the building. Some people are frightened.	Dishes in a cupboard rattle occasionally.	Electric wires swing slightly.				
4.5	4	Many people are frightened. Some people try to escape from danger. Most sleeping people awake.	Hanging objects swing considerably and dishes in a cupboard rattle. Unstable ornaments fall occasionally.	Electric wires swing considerably. People walking on a street and some people driving automobiles notice the tremor.				

Instrumental Seismic Intensity	JMA Scale	People	Indoor Situations	Outdoor Situations	Wooden Houses	Reinforced-Concrete Buildings	Lifelines	Ground and Slopes
5	5 Lower	Most people try to escape from a danger.Some people find it difficult to move.	Hanging objects swing violently.Most Unstable ornaments fall. Occasionally, dishes in a cupboard and books on a bookshelf fall and furniture moves.	People notice electric-light poles swing. occasionally, windowpanes are broken and fall, unreinforced concrete-block walls collapse, and roads suffer damage.	Occasionally, less earthquake-resistant houses suffer damage to walls and pillars.	Occasionally, cracks are formed in walls of less earthquake-resistant buildings.	A Safety device cuts off the gas service at some houses. On rare occasions water pipes are damaged and water service is interrupted.(Electrical service is interrupted at some houses)	Occasionally, cracks appear in soft ground. and rockfalls and small slope failures take place in mountainous districts.
5.5	5 Upper	Many people are considerably frightened and find it difficult to move.	Most dishes in a cupboard and most books on a bookshelf fall.Occasionally, a TV set on a rack falls,heavy furniture such as a chest of drawers falls,sliding doors slip out of their groove and the deformation of a door frame makes it impossible to open the door.	In many cases ,unreinforced concrete-block walls collapse and tombstones overturn.Many automobiles stop because it becomes difficult to drive. Occasionally, poorly-installed vending machines fall.	Occasionally, less earthquake-resistant houses suffer heavy damage to walls and pillars and lean.	Occasionally, large cracks are formed in walls, crossbeams and pillars of less earthquake-resistant buildings and even highly earthquake-resistant buildings have cracks in walls.	Occasionally, gas pipes and / or water mains are damaged.(Occasionally, gas service and / or water service are interrupted in some regions)	

Instrumental Seismic Intensity	JMA Scale	People	Indoor Situations	Outdoor Situations	Wooden Houses	Reinforced-Concrete Buildings	Lifelines	Ground and Slopes
6	6 Lower	Difficult to keep standing.	A lot of heavy and unfixed furniture moves and falls. It is impossible to open the door in many cases.	In some buildings, wall tiles and windowpanes are damaged and fall.	Occasionally, less earthquake-resistant houses collapse and even walls and pillars of highly earthquake-resistant houses are damaged.	Occasionally, walls and pillars of less earthquake-resistant buildings are destroyed and even highly earthquake-resistant buildings have large cracks in walls, crossbeams and pillars.	Gas pipes and / or water mains are damaged.(In some regions, gas service and water service are interrupted and electrical service is interrupted occasionally.)	Occasionally, cracks appear in the ground, and landslides take place.
6.5	6 Upper	Impossible to keep standing and to move without crawling.	Most heavy and unfixed furniture moves and falls. Occasionally, sliding doors are thrown from their groove.	In many buildings, wall tiles and windowpanes are damaged and fall. Most unreinforced concrete-block walls collapse.	Many,less earthquake-resistant houses collapse. In some cases, even walls and pillars of highly earthquake-resistant houses are heavy damaged	Occasionally, less earthquake-resistant buildings collapse. In some cases, even highly earthquake-resistant buildings suffer damage to walls and pillars.	Occasionally, gas mains and / or water mains are damaged.(Electrical service is interrupted in some regions. Occasionally, gas service and / or water service are interrupted over a large area.)	
	7	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.In some cases, reinforced concrete-block walls collapse.	Occasionally, even highly earthquake-resistant buildings are severely damaged and lean.	Occasionally, even highly earthquake-resistant buildings are severely damaged and lean.	(Electrical service gas service and water service are interrupted over a large area.)	The ground is considerably distorted by large cracks and fissures, and slope failures and landslides take place, which occasionally change topographic features.

*The descriptions given in ( ) of the "lifelines" describe situations concerning electrical, gas and water service in particular for information.

Appendix 6 Nominal List of Committee Members

* Affiliation of the committee member is as of March 2005.Other members are dissolution of the committee or retirement.

Earthquake Research Committee
(August 9,1995 -)

Chairperson

Tsumura, Kenshiro	Counselor, Japan Weather Association	April 2000-

Committee Members

Abe, Katsuyuki	Professor, Earthquake Research Institute, University of Tokyo (Deputy Chairperson April 2000-)	August 1995-
Ando, Masataka	Professor, Disaster Prevention Research Institute, Kyoto University	August 1995-March 2000
Ishida, Mizuho	Research Supervisor, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	July 1996-
Irikura, Kojiro	Vice-President, Kyoto University	March 1998-
Uchiike, Hiroo	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	May 2000-March 2002
Umino, Norihito	Professor, Graduate School of Science, Tohoku University	April 2000-
Umeda, Yasuhiro	Professor, Disaster Prevention Research Institute, Kyoto University	April 2004-
Kaidzu, Masaru	Director, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	July 2000-
Kasahara, Minoru	Professor, Graduate School of Science, Hokkaido University	August 1995-May 2001 March 2002-
Ganeko, Yasuhiro	Director, Planning Division, Hydrographic Department, Japan Coast Guard	August 1995-March 1998
Kikuchi, Masayuki	Professor, Earthquake Research Institute, University of Tokyo	March 2002-October 2003
Kinugasa, Yoshihiro	Chief Senior Researcher, Geological Survey of Japan	August 1995-March 1999
Komaki, Kazuo	Director, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 1999-June 2000
Sakurai, Kunio	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	April 2004-
Sasaki, Minoru	Director, Technology Planning and International Affairs Division, Hydrographic and Oceanographic Department, Japan Coast Guard	April 2002-March 2004
Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	August 1995-
Shimizu, Hiroshi	Professor, Graduate School of Sciences, Kyushu University	April 2000-
Sugiyama,Yuichi	Director, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	April 1999-May 2001 April 2004-
Suzuoki, Tetsuro	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	August 1995-March 1996
Tsukahara, Koichi	Director, Crustal Dynamics Department, Geographical Survey Institute	August 1995-June 1996
Tsukuda, Eikichi	Research Coordinator, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	May 2001-March 2004

Tsuchide, Masakazu	Director, Technology Planning and International Affairs Division,Hydrographic and Oceanographic Department, Japan Coast Guard	April 2004-
Nishida, Hideo	Director, Planning Division, Hydrographic Department, Japan Coast Guard	April 1998-March 2000
Hamada, Kazuo	Director, Solid Earth Science Division, National Research Institute for Earth Science and Disaster Prevention	August 1995-June 1996
Hiraki, Tetsu	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	April 2003-March 2004
Hirasawa, Tomowo	Professor, Graduate School of Science, Tohoku University (Deputy Chairperson)	August 1995-March 2000
Fujitani, Tokunosuke	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	April 2002-March 2003
Hontani, Yoshinobu	Associate Professor, Graduate School of science, Hokkaido University	May 2001-March 2002
Matsuda, Tokihiko	Professor, Department of Literature, Seinangakuin University	August 1995-March 2002
Miyazaki, Yamato	Director General, Japan association of surveyors (Chairperson)	August 1995-March 2000
Mori,James Jiro	Professor, Disaster Prevention Research Institute, Kyoto University	March 2000-March 2004
Mori, Toshio	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	April 1998-April 2000
Yashima, Kunio	Director, Planning Division, Hydrographic Department, Japan Coast Guard	April 2000-March 2002
Yamazaki, Haruo	Professor, Graduate School of Science, Tokyo Metropolitan University	March 2002-
Yamamoto, Koji	Director-General, Seismological and Volcanological Department, Japan Meteorological Agency	April 1996-March 1998
Yoshimura, Yoshimitsu	Director, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	July 1996-March1999

Subcommittee for Long-term Evaluations, Earthquake Research Committee (December 13,1995 -)

Chairperson

Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	December 1995-

Committee Members

Ando, Masataka	Professor, Disaster Prevention Research Institute, Kyoto University	December 1995-September 1997
Iwabuchi, Yo	Deputy Director, Technology Planning and International Affairs Division, Hydrographic and Oceanographic Department, Japan Coast Guard	December 1995-March 2003
Kato, Teruyuki	Professor, Earthquake Research Institute, University of Tokyo	October 2001-
Kawase, Hiroshi	Professor, Graduate School of Human-Environment Studies, Kyushu University	June 2002-March 2004
Kikuchi, Masayuki	Professor, Earthquake Research Institute, University of Tokyo	March 2002-October 2003
Kinugasa, Yoshihiro	Chief Senior Researcher, Geological Survey of Japan	December 1995-March 1999
Kumaki, Yohta	Director, Research Planning Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	August 2000-March 2003
Sugiyama, Yuichi	Director, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	April 1999-
Tada, Takashi	Research Coordinator, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	December 1995-July 2000
Tsuzawa, Masaharu	Director, Research Planning Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 2003-
Tsuji, Yoshinobu	Associate Professor, Earthquake Research Institute, University of Tokyo	October 1997-
Nakata, Takashi	Professor, Graduate School of Letters, Hiroshima University	April 2001-
Nishizawa, Azusa	Principal Ocean Research Officer, Ocean Research Laboratory, Technology Planning and International Affairs Division, Hydrographic and Oceanographic Department, Japan Coast Guard	April 2003-
Hashimoto, Manabu	Professor, Disaster Prevention Research Institute, Kyoto University	October 1997-September 2001
Hirasawa, Tomowo	Director General, Earthquake Research Center, Association for the Development of Earthquake Prediction	December 1995-
Fujiwara, Hiroyuki	Project Director, Special Project Center, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	April 2004-
Maeda, Kenji	Head, The Fourth Research Laboratory, Seismology and Volcanology Research Department, Meteorological Research Institute, Japan Meteorological Agency	April 2004-
Matsuzawa, Toru	Associate Professor, Graduate School of Science, Tohoku University	April 2004-
Matsuda, Tokihiko	Professor, Department of Literature, Seinan Gakuin University	December 1995-February 2002
Matsumura, Shozo	Director, Solid Earth Research Group, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	December 1995-
Yamazaki, Haruo	Professor, Graduate School of Science, Tokyo Metropolitan University	March 2002-

Yoshida, Akio	Director, Kakioka Magnetic Observatory, Japan Meteorological Agency	December 1995-March 2004
Yonekura, Nobuyuki	Emeritus Professor, University of Tokyo	April 2000-March 2001

Subcommittee for Active Fault,
Subcommittee for Long-term Evaluations, Earthquake Research Committee
(February 27, 1996 - June 27, 2001)

Chief Investigator		
Matsuda, Tokihiko	Professor, Department of Literature, Seinan Gakuin University	April 1996-June 2001
Committee Members		
Ikeda, Yasutaka	Associate Professor, School of Science, University of Tokyo	April 1996-June 2001
Ito, Kiyoshi	Associate Professor, Disaster Prevention Research Institute, Kyoto University	April 1996-June 2001
Okada, Atsumasa	Professor, Graduate School of Science, Kyoto University	April 1996-September 1997
Kinugasa, Yoshihiro	Chief Senior Researcher, Geological Survey of Japan	April 1996-June 1998
Sato, Hiroshi	Associate Professor, Earthquake Research Institute, University of Tokyo	April 1996-June 2001
Sugiyama Yuichi	Deputy Director, Active Fault Research Center, Independent Administrative Institution, National Institute of Advanced Industrial Science and Technology	June 1998-June 2001
Suzuki, Yasuhiro	Associate Professor, Faculty of Information Science and Technology, Aichi Prefectural University	April 1996-June 2001
Chida, Noboru	Professor, Faculty of Education and Welfare Science, Oita University	April 1996-June 2001
Matsuzawa, Toru	Associate Professor, Graduate School of Science, Tohoku University	April 1996-June 2001
Yamazaki, Haruo	Professor, Graduate School of Science, Tokyo Metropolitan University	April 1996-June 2001

Subcommittee for Northern Region in Japan ,
Subcommittee for Long-term Evaluations, Earthquake Research Committee
(June 6, 1996 - January 13, 1999)

Chief Investigator		
Hirasawa, Tomowo	Professor, Graduate School of Science, Tohoku University	July 1996-January 1999
Committee Members		
Awata, Yasuo	Senior Researcher, Active Fault Research Section, Earthquake Research Department, Geological Survey of Japan	July 1996-January 1999
Imakiire, Tetsuro	Head, Observation and Analysis Division, Crustal Dynamics Department, Geographical Survey Institute	April 1997-April 1998
Iwabuchi, Yo	Director for Earthquake Research, Planning Division, Hydrographic Department, Japan Coast Guard	July 1996-January 1999
Umino, Norihito	Associate Professor, Graduate School of Science, Tohoku University	July 1996-January 1999
Kasahara, Minoru	Professor, Graduate School of Science, Hokkaido University	July 1996-January 1999
Tanaka, Kazuo	Professor, Faculty of Science, Hirosaki University	July 1996-January 1999
Nogoshi, Mitsuo	Professor, Faculty of Education, Akita University	July 1996-January 1999
Hashimoto, Manabu	Head, Observation and Analysis Division, Crustal Dynamics Department, Geographical Survey Institute	July 1996-March 1997
Hasemi, Akiko	Professor, Faculty of Science, Yamagata University	July 1996-January 1999
Hirakawa, Kazuomi	Professor, Graduate School of Environmental Earth Science, Hokkaido University	July 1996-January 1999
Hirano, Shin-ichi	Associate Professor, Graduate School of Science, Tohoku University	July 1996-January 1999
Maeda, Kenji	Senior Researcher, Second Research Laboratory, Seismology and Volcanology Research Department, Meteorological Research Institute	July 1996-January 1999
Murakami, Makoto	Head, Crustal Deformation Research Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 1998-January 1999

Subcommittee for Central Region in Japan,
Subcommittee for Long-term Evaluations, Earthquake Research Committee
(June 6, 1996 - January 13, 1999)

Chief Investigator		
Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	July 1996-January 1999
Committee Members		
Ikeda, Yasutaka	Associate Professor, School of Science, University of Tokyo	July 1996-January 1999
Izutani, Yasuo	Professor, Faculty of Engineering, Shinshu University	July 1996-January 1999
Ito, Kiyoshi	Associate Professor, Disaster Prevention Research Institute, Kyoto University	July 1996-January 1999
Imaizumi, Toshifumi	Professor, Faculty of Education, Yamanashi University	July 1996-January 1999
Iwabuchi Yo	Director for Earthquake Research, Planning Division, Hydrographic Department, Japan Coast Guard	July 1996-January 1999
Ooida, Tooru	Associate Professor, School of Science, Nagoya University	July 1996-January 1999
Kawasaki, Ichiro	Professor, Faculty of Science, Toyama University	July 1996-January 1999
Sugiyama, Yuichi	Chief, Active Fault Research Section, Earthquake Research Department, Geological Survey of Japan	July 1996-January 1999
Tada, Takashi	Research Coordinator, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	July 1996-April 1998
Tsukuda, Tameshige	Associate Professor, Earthquake Research Institute, Tokyo University	July 1996-January 1999
Tsuji Yoshinobu	Associate Professor, Earthquake Research Institute, Tokyo University	July 1996-January 1999
Noguchi, Shin'ichi	Senior Researcher, Intraplate Earthquake Laboratory, Earthquake Research Center, National Research Institute for Earth Science and Disaster Prevention	July 1996-January 1999
Yoshikawa,Sumio	Head, Third Research Laboratory, Seismology and Volcanology Research Department, Meteorological Research Institute, Japan Meteorological Agency	July 1996-January 1999
Furumoto, Muneyoshi	Professor, Faculty of Science, Kanazawa University	July 1996-January 1999
Murakami, Makoto	Head, Crustal Deformation Research Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 1998-January 1999

Subcommittee for Western Region in Japan, Subcommittee for Long-term Evaluations, Earthquake Research Committee (June 6, 1996 - January 13, 1999)

Chief Investigator

Ando, Masataka	Professor, Disaster Prevention Research Institute, Kyoto University	July 1996-January 1999

Committee Members

Ishikawa, Yuzo	Head, Second Research Laboratory, Seismology and Volcanology Research Department, Meteorological Research Institute, Japan Meteorological Agency	July 1996-January 1999
Ishibashi, Katsuhiko	Professor, Research Center for Urban Safety and Security, Kobe University	July 1996-January 1999
Imakiire, Tetsuro	Head, Observation and Analysis Division, Crustal Dynamics Department, Geographical Survey Institute	April 1997-April 1998
Iwabuchi, Yo	Director for Earthquake Research, Planning Division, Hydrographic Department, Japan Coast Guard	July 1996-January 1999
Kimura, Shozo	Associate Professor, Faculty of Science, Kochi University	July 1996-January 1999
Goto, Kazuhiko	Associate Professor, Faculty of Science, Kagoshima University	July 1996-January 1999
Sato, Tadanobu	Professor, Disaster Prevention Research Institute, Kyoto University	July 1996-January 1999
Shimizu, Hiroshi	Associate Professor, Shimabara Institute of Seismology and Volcanology, Faculty of Sciences, Kyushu University	July 1996-January 1999
Tsukuda, Eikichi	Chief, Seismotectonics Section, Earthquake Research Department, Geological Survey of Japan	July 1996-January 1999
Nakamura, Masao	Research Associate, Wakayama Earthquake Observation Center, Earthquake Research Institute, University of Tokyo	July 1996-January 1999
Hashimoto, Manabu	Head, Observation and Analysis Division, Crustal Dynamics Department, Geographical Survey Institute	July 1996-March 1997
Hayashi, Haruo	Professor, Disaster Prevention Research Institute, Kyoto University	July 1996-January 1999
Maemoku, Hideaki	Associate Professor, Faculty of Education, Yamaguchi University	July 1996-January 1999
Murakami, Makoto	Head, Crustal Deformation Research Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 1998-January 1999
Watanabe, Kunihiko	Associate Professor, Disaster Prevention Research Institute, Kyoto University	July 1996-January 1999

Subcommittee for Active Fault in Northern Japan, Subcommittee for Long-term Evaluations, Earthquake Research Committee (November 24, 1999 - March 15, 2005)

Chief Investigator		
Togo, Masami	Professor, Faculty of Social Sciences, Hosei University	March 2000-March 2005
Committee Members		
Awata, Yasuo	Leader, Seismotectonics Research Team, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	August 2001-March 2005
Katsumata, Kei	Research Associate, Graduate School of Science, Hokkaido University	April 2004-March 2005
Suzuki, Yasuhiro	Professor, Graduate School of Environmental Studies, Nagoya University	March 2000-March 2005
Takemura, Keiji	Professor, Beppu Geophysical Research Laboratory, Graduate School of Science, Kyoto University	March 2000-March 2005
Tsukuda, Eikichi	Director, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	March 2000-July 2001
Tsutsumi, Hiroyuki	Associate Professor, Graduate School of Science, Kyoto University	April 2003-March 2005
Matsuzawa, Toru	Associate Professor, Graduate School of Science, Tohoku University	March 2000-March 2004
Yamazaki, Haruo	Professor, Graduate School of Science, Tokyo Metropolitan University	March 2000-February 2002

Subcommittee for Active Fault in Central Japan, Subcommittee for Long-term Evaluations, Earthquake Research Committee (November 24, 1999 - March 15, 2005)

Chief Investigator		
Nakata, Takashi	Professor, Graduate School of Letters, Hiroshima University	March 2000-March 2005
Committee Members		
Ikeda, Yasutaka	Associate Professor, School of Science, University of Tokyo	March 2000-March 2003
Goto, Hideaki	Associate Professor, College of Human Development and Culture, Fukushima University	April 2003-March 2005
Chida, Noboru	Professor, Faculty of Education and Welfare Science, Oita University	March 2000-March 2005
Tsukuda, Tameshige	Associate Professor, Earthquake Research Institute, University of Tokyo	March 2000-March 2005
Miyauchi, Takahiro	Associate Professor, Faculty of Science, Chiba University	March 2000-March 2005
Yoshioka,Toshikazu	Leader, Active Fault Evaluation Team, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	March 2000-March 2005

Subcommittee for Active Fault in Western Japan, Subcommittee for Long-term Evaluations, Earthquake Research Committee (November 24, 1999 - March 15, 2005)

Chief Investigator		
Sato, Hiroshi	Professor, Earthquake Research Institute, University of Tokyo	March 2000-March 2005
Committee Members		
Yonekura, Nobuyuki	Emeritus Professor, University of Tokyo (Chief Investigator)	March 2000-March 2001
Ito, Kiyoshi	Professor, Disaster Prevention Research Institute, Kyoto University	March 2000-March 2005
Imaizumi, Toshifumi	Professor, Graduate School of Science, Tohoku University	April 2001-March 2005
Okumura, Koji	Professor, Graduate School of Letters, Hiroshima University	March 2000-March 2005
Shimokawa, Koichi	Senior Researcher, Geological Survey Planning and Coordinating Office, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	April 2001-March 2005
Sugiyama, Yuichi	Chief, Active Fault Research Section, Earthquake Research Department, Geological Survey of Japan	March 2000-March 2001
Watanabe, Mitsuhisa	Professor, Faculty of Sociology, Toyo University	March 2000-March 2005

Subcommittee for Subduction-zone Earthquake, Subcommittee for Long-term Evaluations, Earthquake Research Committee (March 19, 2001 - March 15, 2005)

Chief Investigator		
Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	April 2001-March 2005
Committee Members		
Abe, Katsuyuki	Professor, Earthquake Research Institute, University of Tokyo	April 2001-March 2005
Ando, Masataka	Professor, Graduate School of Environmental Studies, Nagoya University	April 2001-March 2003
Imakiire, Tetsuro	Head, Crustal Deformation Research Division, Geography and Crustal Dynamics Research Center, Geographical Survey Institute	April 2003-March 2005
Umino, Norihito	Associate Professor, Graduate School of Science, Tohoku University	April 2001-March 2005
Kasahara, Minoru	Professor, Graduate School of Science, Hokkaido University	April 2001-March 2003
Kikuchi, Masayuki	Professor, Earthquake Research Institute, University of Tokyo	April 2001-October 2003
Sagiya, Takeshi	Associate Professor, Graduate School of Environmental Studies, Nagoya University	April 2001-March 2005
Satake, Kenji	Deputy Director, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	April 2001-March 2005
Tanioka, Yuichiro	Associate Professor, Graduate School of Science, Hokkaido University	April 2003-March 2005
Tsuji, Yoshinobu	Associate Professor, Earthquake Research Institute, University of Tokyo	April 2001-March 2005
Noguchi, Shinichi	Senior Researcher, Solid Earth Research Group, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	April 2001-March 2005

Hamada, Nobuo	Director, Seismology and Volcanology Research Department, Meteorological Research Institute, Japan Meteorological Agency	April 2001-March 2005
Yabuki, Tetsuichiro	Deputy Director, Hydrographic Survey Division, Hydrographic and Oceanographic Department, Japan Coast Guard	April 2001-March 2005
Yoshioka, Shoichi	Associate Professor, Graduate School of Sciences, Kyushu University	October 2001-March 2005

Subcommittee for Long-term Probability Evaluation Method, Subcommittee for Long-term Evaluations, Earthquake Research Committee (November 21, 1997 - June 27, 2001)

Chief Investigator		
Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	December 1997-June 2001
Committee Members		
Imakiire, Tetsuro	Assistant Director for Geodesy, Geodetic Department, Geographical Survey Institute	December 1997-June 2001
Imoto, Seijiro	Principal Senior Researcher, Solid Earth Research Group, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	December 1997-June 2001
Ogata, Yoshihiko	Professor, The Institute of Statistical Mathematics, Ministry of Education, Culture, Sports, Science and Technology	December 1997-June 2001
Kumamoto, Takashi	Associate Professor, Faculty of Science, Okayama University	December 1997-June 2001
Satake, Kenji	Leader, Earthquake Hazard Assessment Team, Active fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative	December 1997-June 2001
Suzuki, Yasuhiro	Associate Professor, Faculty of Information Science and Technology, Aichi Prefectural University	December 1997-June 2001
Nishide, Noritake	Seinior Coordinator for Seismological Information, Administration Division, Seismological and Volcanological Department, Japan Meteorological Agency	April 1999-June 2001
Mori, Shigeo	Seinior Coordinator for Seismological Information, Administration Division, Seismological and Volcanological Department, Japan Meteorological Agency	December 1997- March 1999

Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee (August 25, 1999 -)

Chairperson		
Irikura, Kojiro	Vice-President, Kyoto University	October 1999-
Committee Members		
Ito, Hisao	Senior Researcher Group, Institute of Geology and Geoinformation, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	October 1999-May 2001
Kawashima,Kazuhiko	Professor, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology	October 1999-
Kikuchi, Masayuki	Professor, Earthquake Research Institute, University of Tokyo	October 1999-October 2003
Kinoshita, Shigeo	Director, Advanced Technology Research Group, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	October 1999-September 2002
Kudo, Kazuyoshi	Associate Professor, Earthquake Research Institute, University of Tokyo	October 1999-
Kubo, Tetsuo	Professor, Graduate School of Engineering, University of Tokyo	October 1999-
Sasatani, Tsutomu	Associate Professor, Graduate School of Science, Hokkaido University	October 1999-

Sato, Kiyotaka	Senior Research Scientist, Civil Engineering Research Laboratory, Central Research Institute of Electric Power Industry	April 2003-
Shimazaki, Kunihiko	Professor, Earthquake Research Institute, University of Tokyo	October 1999-October 2003
Sugiyama, Yuichi	Director, Active Fault Research Center, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	June 2001-
Takahashi, Michio	Director, Earthquake and Tsunami Observations Division, Seismological and Volcanological Department, Japan Meteorological Agency	April 2001-March 2003
Nakagawa, Koichi	Professor, Graduate School of Science, Osaka City University	October 1999-
Nishide, Noritake	Director, Earthquake and Tsunami Observations Division, Seismological and Volcanological Department, Japan Meteorological Agency	April 2003-March 2004
Hirata, Kazuta	Senior Research Scientist, Abiko Research Laboratory, Central Research Institute of Electric Power Industry	October 1999-March 2003
Fujiwara, Hiroyuki	Project Director, Special Project Center, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	October 2002-
Furuya, Itsuo	Director, Earthquake and Tsunami Observation Division, Seismological and Volcanological Department, Japan Meteorological Agency	October 1999-March 2001
Midorikawa, Saburo	Professor, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology	October 1999-
Yamamoto Masahiro	Director, Earthquake and Tsunami Observations Division, Seismological and Volcanological Department, Japan Meteorological Agency	April 2004-

Subcommittee for Strong Ground Motion Prediction Method, Subcommittee for Evaluations of Strong Ground Motion, Earthquake Research Committee (November 16, 1999 -)

Chief Investigator		
Irikura, Kojiro	Vice-President, Kyoto University	November 1999-
Committee Members		
Iwata, Tomotaka	Professor, Disaster Prevention Research Institute, Kyoto University	November 1999-
Kataoka, Shojiro	Senior Researcher, Earthquake Disaster Prevention Division Research Center for Disaster Risk Management, National Institute for Land and Infrastructure Management	April 2003-
Katsumata, Akio	Lecturer, Meteorological College, Japan Meteorological	April 2003-
Kamae, Katsuhiro	Professor, Research Reactor Institute, Kyoto University	November 1999-
Kawase, Hiroshi	Professor, Graduate School of Human-Environment Studies, Kyushu University	November 1999-
Kumamoto, Takashi	Associate Professor, Faculty of Science, Okayama University	November 1999-
Koketsu, Kazuki	Professor, Earthquake Research Institute, University of Tokyo	November 1999-
Fujiwara, Hiroyuki	Project Director, Special Project Center, National Research Institute for Earth Science and Disaster Prevention, Independent Administrative Institution	November 1999-
Hoshiba, Mitsuyuki	Senior Researcher, Seismological Observatory, Earthquake and Tsunami Observations Division, Seismological and Volcanological Department, Japan Meteorological Agency	November 1999- March 2003
Mori, James Jiro	Professor, Disaster Prevention Research Institute, Kyoto University	November 1999-
Yokoi, Toshiaki	Senior Researcher, International Institute of Seismology and Earthquake Engineering, Building Research Institute, Independent Administrative Institution	November 1999-
Yokokura, Takanobu	Chief Research Scientist, Tectonophysics Group, Institute of Geology and Geoinformation, National Institute of Advanced Industrial Science and Technology, Independent Administrative Institution	November 1999-

Subcommittee for Aftershock Probability Evaluation Method , Earthquake Research Committee (June 11, 1997 - April 8 1998)

Chief Investigator		
Abe, Katsuyuki	Professor, Earthquake Research Institute, University of Tokyo	June 1997-April 1998
Committee Members		
Utsu, Tokuji	Emeritus Professor, University of Tokyo	June 1997-April 1998
Ogata, Yoshihiko	Professor, The Institute of Statistical Mathematics, Ministry of Education, Culture, Sports, Science and Technology	June 1997-April 1998
Koketsu, Kazuki	Associate Professor, Earthquake Research Institute, University of Tokyo	June 1997-April 1998
Hiroi, Osamu	Professor, Institute of Socio-Information and Communication Studies, University of Tokyo	June 1997-April 1998
Yoshii, Hiroaki	Professor, Faculty of Information and Communication, Bunkyo University	June 1997-April 1998
Yoshida, Akio	Director, Earthquake Prediction Information Division, Japan Meteorological Agency	June 1997-April 1998