Preparation of Active Fault Maps in Urban Area

Hiroshi MASAHARU[1], Hidetoshi NAKAJIMA[2], Masuo TAGUCHI[3],
Tatsuo SEKIGUCHI[4] and Satoko ODAGIRI[5]

ABSTRACT

The Geographical Survey Institute, Japan made "Active Fault Map in Urban Area" which delineates position of active faults around urban area. The scale of these maps is 1:25,000 and they cover major urbanized area and cities in 45 map sheets. They are the most detailed maps on the position of active faults in Japan. The maps show active fault traces and their directions of movement as well as classification of landforms related to judgment of active faults. The specifications and symbols of these maps as well as the process for preparing the maps are explained in this paper. The aim and the role of these maps in earthquake disaster mitigation measures are also discussed.

Keywords:
Active Fault, Earthquake, Landform, Map

1. INTRODUCTION

After 1995 Hyogoken-nanbu earthquake (the Great Hanshin-Awaji Earthquake Disaster) which killed more than six thousand people and was caused by movement of faults just under the ground of urbanized area, the danger of active faults near urbanized area has become widely recognized. An active fault is a fault which is judged to move again in future with intervals of a thousand to several ten thousand years, from landforms showing repeated movements in recent several hundred thousand years. Intensive surveys on active faults are now carried out in Japan as a national project to evaluate risks of earthquakes and thus to mitigate hazards.

Geographic Department of the Geographical Survey Institute (GSI) has carried out geographic surveys and research works about neotectonic landforms. The existence and location of active faults can at first be surveyed by investigating landforms. With this background, the Geographic Department decided to make and publish maps describing the locations of active faults and other neotectonic landforms around urban area at very detailed scale of 1:25,000. As the survey of active faults requires much expert skills and knowledge, the survey work was carried out under collaboration with expert researchers at universities who are regarded as representatives in this research field. The map was named "Active Fault Map in Urban Area."

There already exists a book which shows active faults in whole Japan comprehensively. The book "Active Faults in Japan," first published in 1980 and the revised edition in 1991, uses 1:200,000 topographic maps as base maps. Much detailed information about the location of active faults especially around urban area has been required for disaster mitigation planning and for detailed investigation such as trenching of each active fault. Responding to the requirement, the GSI made "Active Fault Map in Urban Area" and by adopting the scale of 1:25,000, the positional accuracy are greatly improved compared with "Active Faults in Japan."

[1] Head, Third Geographic Division, Geographic Department, Geographical Survey Institute, Ministry of Construction, Kitasato-1, Tsukuba-shi, 305 Japan E-mail: masaharu@gsi-mc.go.jp
[2] Deputy Head, ditto
[3] Assistant Technical Officer, ditto
[4] Chief, Section of Disaster Prevention Geographic Information, Third Geographic Division, ditto
[5] Section of Disaster Prevention Geographic Information, ditto
Titles above written are those in Japanese fiscal year 1996 (April 1996-March 1997).

2. CONTENTS OF THE MAP - MAP SPECIFICATIONS AND SYMBOLS

This map expresses not only neotectonic landforms such as active faults but also other landforms made in Late Quaternary such as terraces or alluvial lowlands.

Active faults are grouped into four classes by their forms and reliability of locations; namely "Active Fault Trace," "Active Fault Trace (site indistinct)," "Active Flexure" and "Active Fault Trace (concealed)." These traces are drawn in red solid, broken or dotted lines respectively with some auxiliary symbols when necessary. But "Active Flexure" needs to be expressed with their width. Therefore we adopted an areal representation with small red dots pattern and arrows showing the downward direction of the flexure. In addition to these classes, the landform features which cannot be specified as active faults clearly under present conditions are grouped as "Presumed Active Fault" and they are expressed in black broken line.

Terraces are grouped into three classes by their formative period; namely "Higher Terrace," "Middle Terrace" and "Lower Terrace." These terraces are painted in orange color using dot screen. Deeper color is used for higher terraces. The newest landforms which were formed in recent thousands years are classified as "Alluvial Lowland," "Fan" and "Filled-up Land or Reclaimed Land." These landforms are painted in green color. Dot pattern is used for "Fan" and line pattern is used for "Filled-up Land or Reclaimed Land."

"Active Fault Map in Urban Area" is printed in five colors. Base topographic map is expressed in one color (gray). Two colors (red and black) are used for active faults etc. and other two colors (orange and green) are used for landform classification. The area expressed in one map sheet is 10 minutes in latitude and 15 minutes in longitude. This corresponds to four map sheets of 1:25,000 Topographic Maps published by the GSI. The Active Fault Map is printed on paper of the size of 788mm×1091mm.

Up to now, 45 map sheets in total of the Active Fault Map in Urban Area are published for the area of three large urban areas in Japan, namely the Metropolitan area, Cyukyo area and Kinki area, and special big cities which are designated by a government ordinance. The maps cover about 15,000 km^2 in total.

3. PROCESS OF PREPARATION OF THE MAP

A committee for preparation of Active Fault Map in Urban Area composed of 16 researchers at universities and staff of the GSI was organized. The committee held several meetings to discuss map specifications including adopting criteria of active faults and representation as map symbols of each feature, areas to be covered by the maps, assignment of survey area to each researcher, and results of survey. Intensive cross-check was done among researchers. Final results of checking were adopted and delineated on the map. As these maps have a characteristic of research result, the names of researchers in charge of respective map sheet is printed on the map.

The maps were made through aerial photo interpretation. Reference materials and research papers are also used. Aerial photos in 1940's and 1960's on a scale of 1:10,000 were used for the survey. The reason of using such old aerial photos is to observe original landforms before development activity. Due to artificial land development, it is becoming hard especially in urban areas of Japan to identify natural landforms created by fault movements. With these large scale photographs, geomorphologic features of active faults were newly discovered in some places.

4. CONCERNS BEFORE PUBLICATION AND RESPONSES TO THE MAPS AFTER PUBLICATION

Because these maps provide information on potential risks of earthquake hazards, cautious consideration was necessary before publishing

them to the open public. In order to avoid misunderstanding on the contents of the maps, brief explanation on the characteristics of the map is printed at lower right corner of each map sheet as "Attention in use." It explains that only the positions of active fault traces are shown in the map and it is not shown when each active fault moved in the past and will move in future. Therefore, the earthquake occurrence risk of each active fault cannot be understood from these maps. More detailed investigations on the activeness, history and other characteristics of each fault are necessary to evaluate the risk of the earthquake occurrence. This evaluation is still very difficult at the present level of science and technology. Furthermore not only information on active faults but also on peripheral ground such as structures are needed to evaluate the strength of ground motion caused by an earthquake.

The Active Fault Maps in Urban Area were published in October, 1996. The maps caught much attention of general public and were sold well as such maps meant for professional use. The responses to these maps were rather positive. Most inquiries on the maps to the GSI were asking where the maps were sold and whether there was an active fault map covering a certain town or city. We hope the maps would contribute to raising awareness of potential earthquake risks among citizens and be useful for disaster mitigation planning.

5. THE ROLE OF "ACTIVE FAULT MAPS IN URBAN AREA" IN EARTHQUAKE DISASTER MITIGATION MEASURES

For earthquake disaster mitigation planning, evaluation of potential risks of earthquake occurrence is required. It is now clear that earthquakes are destruction phenomena of underground rocks at fault planes. Therefore to investigate the existence and the precise positions of active faults is needed first of all for the evaluation of earthquake occurrence.

This can be carried out by geomorphologic study using aerial photo interpretation. This method has advantage that comprehensive survey of active faults is possible although it does not show us underground structures and precise history of previous activities (i.e. earthquakes). The "Active Fault Map in Urban Area" is the result of this effort. It shows the position of active faults around urbanized area in detailed positional accuracy.

It goes without saying that more detailed investigations are necessary for the evaluation of earthquake occurrence. Geophysical prospecting such as seismic prospecting is necessary to clarify underground structures of strata and faults. In some cases, the positions of active faults on the Active Fault Maps were corrected based on the results of seismic prospecting. Trenching of a fault provides detailed information of the activity of the fault including activeness and recent history of its activity. In order to carry out these investigations, information on precise position of active faults is needed. Active faults maps are meant to provide this fundamental information for all the research and survey work relating to active faults.

If potential of earthquake for each active fault were clarified, there still remain problems of evaluation of earthquake vibration at specific position and seismic design of buildings and infrastructures reflecting such knowledge. Preparation of active fault map is one of the efforts for earthquake disaster mitigation which is now carried out as a national project. Active fault map provides information of only the existence and position of active faults as mentioned in the previous section but it is the information that is firstly required for other research and surveys on active faults.

These maps are published to the public because information disclosure of governmental bodies are strongly required nowadays. This would also help to increase awareness on earthquake disaster of citizens who have key role in disaster mitigation.

6. FUTURE WORK AND CONCLUSION

The GSI plans to continue the preparation of the "Active Fault Map in Urban Area" for major urbanized areas such as capitals of prefectures in case that there exist major active faults. To make digital data of active faults and other features from these maps is now under consideration for the use in GIS.

The investigation concerning active fault is now being executed by several governmental organizations in Japan. We hope the Active Fault Maps in Urban Area are used effectively in these active fault investigation projects.

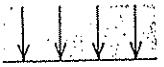
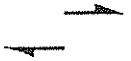
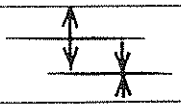
REFERENCES

Sekiguchi, T., Nakajima, H., Tsuzawa, M., Yoshitake, K., Masaharu, H., Taguchi, M. and Odagiri, S.: Preparation of Active Fault Map in Urban Area, Kokudochiri'in Jiho (Report of the GSI) No.86, Geographical Survey Institute, 1996. (in Japanese)

Ikeda, Y., Shimazaki, K. and Yamazaki, H.: A Primer on Active Faults in Japan, University of Tokyo Press, 1996. (in Japanese)

Research Group for Active Faults of Japan: Active Faults in Japan - revised edition, University of Tokyo Press, 1991. (in Japanese)

Table 1 Legend of Active Fault Map in Urban Area (part)

Active Fault Trace		red
Active Fault Trace (site indistinct)		red
Active Flexure		red
Active Fault Trace (concealed)		red
Strike Slip		red
Dip Slip		red
Earthquake Fault		black
Presumed Active Fault		black
Presumed Active Fault (by prospecting data)		black
Active Fold		black
Tilting Surface Direction		black

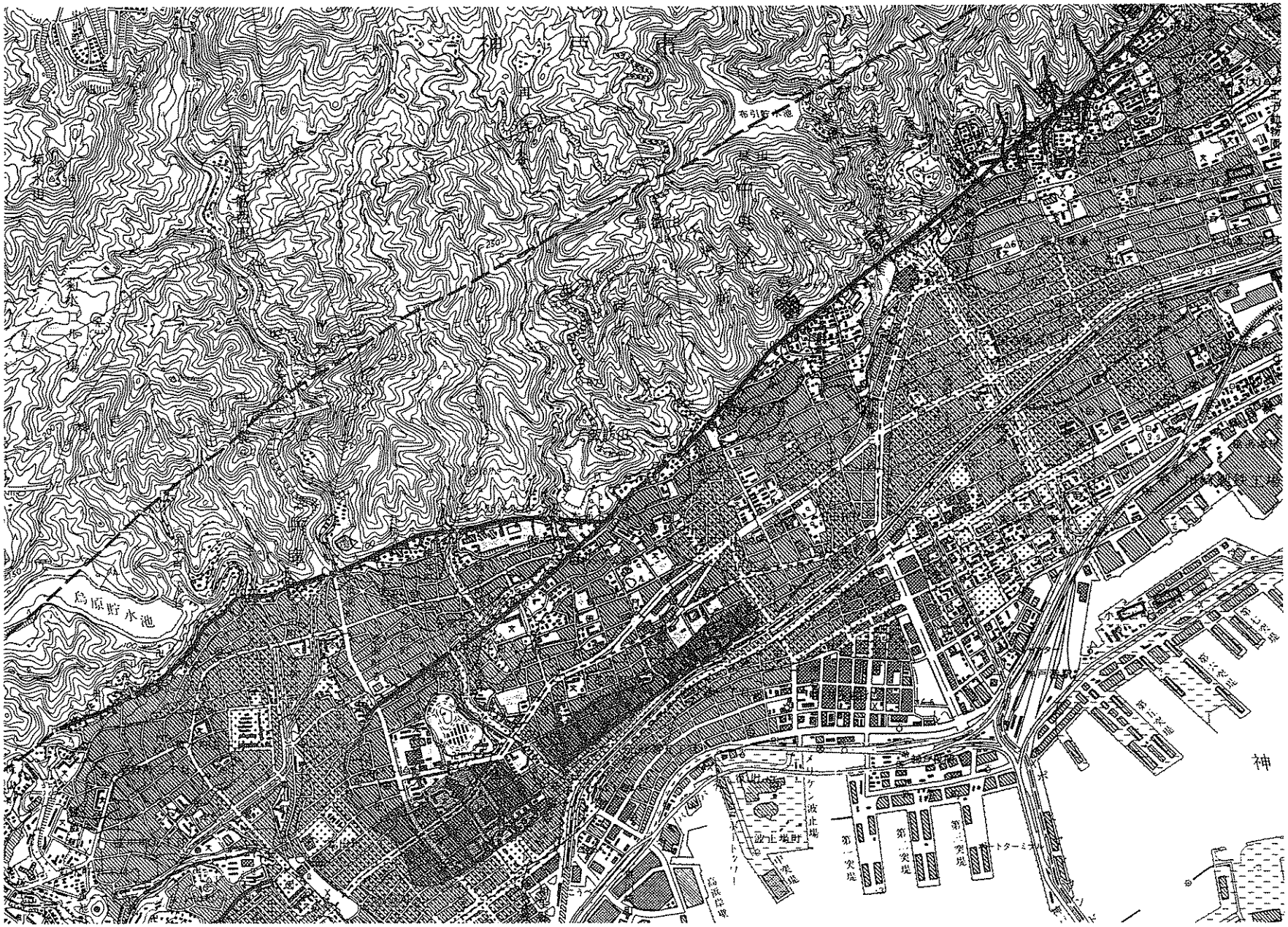


Figure 1 A portion of an Active Fault Map in Urban Area "Kobe" as an example ("Suwayama Fault" can be seen in the middle.)