Detection Accuracy of Active Fault Based on Seismic Reflection Method Data

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The Japan Nuclear Energy Safety Organization (JNES) has been conducting the development of methodology for evaluating the exceedance probability spectra of seismic motion occurred by the blind fault.

As a part of the evaluation of detection accuracy for the blind faults, in order to estimate the detection accuracy of active faults by the seismic reflection method, JNES examined the accuracy using active faults data.

JNES also examined the relationship between the fault displacement and the fault length obtained by trenching, boring and outcrop investigation, etc.
The active fault data of Headquarters for Earthquake Research Promotion (HERP), and National Institute of Advanced Industrial Science and Technology (AIST) were used to examine.

HERP’s data are the displacement data obtained by the seismic reflection method, and fault length and average slip rate data etc. obtained by other investigation methods that are the trench, boring and outcrop, etc.

In the same way, AIST’s data are also the displacement data obtained by the seismic reflection method, and fault length and average slip rate data etc. obtained by other investigation methods that are the trench, boring and outcrop,
Results of seismic reflection method for Kyoto-Nara basin fault zone

Profile location

Result of seismic reflection method

- Obitoke fault
- Tenri flexure
- Sanbyaku fault
- Takai fault

Basement
Example of seismic reflection method for Tonami west plain fault zone

Faults location

Result of seismic reflection method with columnar by boring
### Examples of Active fault data of HERP

<table>
<thead>
<tr>
<th>Active fault name</th>
<th>Seismic reflection method</th>
<th>Fault characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Displacement at basement (m)</td>
<td>Displacement at sedimentary Layer (m)</td>
</tr>
<tr>
<td>Ishikari-teichi-toen fault zone</td>
<td></td>
<td></td>
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<tr>
<td>Kitakami-teichi-seien fault zone</td>
<td></td>
<td></td>
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<tr>
<td>Nagamachi-Rifusen fault zone</td>
<td></td>
<td></td>
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<tr>
<td>Motoarakawa fault zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isehara fault</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Kurehayama fault zone</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Morimoto &amp; Togashi fault zone</td>
<td></td>
<td>50-100</td>
</tr>
</tbody>
</table>

! : The type of active fault could not be decided.  Blank: Not description  
Dip: Dip-slip fault, Strike: Strike-slip fault, Dip & strike: Dip & strike-slip fault  
*** : Confidence of decision for dip and strike- fault- High  
** : the above confidence- Middle  
* : the above confidence- Low
Histograms of displacement at sedimentary layer or basement detected by seismic reflection method.

- National Institute of Advanced Industrial Science and Technology (AIST)
- Headquarters for Earthquake Research Promotion (HERP)
Detection accuracy of active fault by seismic reflection method (SRM)

Classification of data

<table>
<thead>
<tr>
<th>Number</th>
<th>Contents</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>Fault can be detected and its displacement is also estimated by SRM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Fault can be detected but its displacement can not be estimated by SRM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Fault can not be detected by SRM but that can be detected by other</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>methods, trench investigation and outcrop etc.</td>
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<td></td>
</tr>
</tbody>
</table>

Percentage of Detection by SRM

The detection percentage of Case 1 & 2 is about 90%.
The active faults that could not be detected by SRM are about 10%.

Reason:  - The application of SRM to the strike-slip faults is not suitable.
         - Since the decision of the fault segmentation is difficult,
           the profile location predicted by SRM is not always suitable.
Relationship between displacement by seismic reflection method and fault length by other geological investigation methods

Vertical resolution value (VRV)

Length of wave=$V_p$ (2000m/s)/$W_in$ (20Hz) =100 m
$V_p$: Primary velocity at sedimentary layer
$W_in$: Frequency of input wave by seismic reflection method

Low of $1/4$ wave length by Rayleigh

$VRV=100 \text{ m}/4=25 \text{ m}$

$\log L=0.6M-2.9$ (M:6.2-8.4)
- When the seismic reflection method was applied suitably against the active faults under sedimentary layer, it was demonstrated that the possibility of their detection was quite large and the detection percentage was about 90%.

- It may well be that the active fault over about fault length of 6 km will be detected by seismic reflection method.
In order to obtain high quality data concerning geophysical prospecting, the main issues are as follows:
- To accumulate the related geophysical prospecting data with the deep boring data
- To examine the detection accuracy of blind faults using the various geophysical prospecting data

In order to realize these plans, it is important that the deep boring data are accumulated.