New Concept of Earthquake Scale Evaluation by Integrated Active Fault Survey from Earthquake Source to Surface

Background

Earthquake safety evaluation of each nuclear facility has been conducted since the revision of the "Regulatory guidelines for seismic design of nuclear facilities in Japan" in 2006. The following new geological concepts in the guidelines are included: 1) Active faults are redefined as moved after late Pleistocene (80-130KA); 2) Active faults should be evaluated using tectonic landform processes; and 3) Strong motion should be simulated based on a finite fault model. In addition, recent large (~M7) earthquakes showed that the length of surface rupture was not suitable for the earthquake scale and there was little obvious active tectonic evidence around the area. In order to keep the reliability of earthquake scale evaluation based on the active fault survey, it is necessary to improve each investigation technique by adopting new technology and integrating existing technology, for reconstructing the evaluation scheme.

Objectives

The purpose of this study is to propose an advanced concept for the evaluation of earthquake scale by means of the adoption of new technology and integration of scientific investigation techniques.

Principal Results

1. Proposal of an integrated method for earthquake scale evaluation

An investigation flow for the earthquake scale evaluation is proposed, that introduces not only new observation techniques such as micro-earthquake in deep underground, airborne LIDAR at the subsurface etc., but also a basic verification through model experiment and numerical analysis (Fig.1). In order to apply this integrated method to a target site, it is inevitable to combine among geomorphologic, geological, and geophysical methods appropriately responding to the geological setting of the site.

2. An evaluation of earthquake source fault in the region without an obvious active fault - the 1984 Western Nagano Prefecture Earthquake

Through a case study in the source region of the 1984 Western Nagano Prefecture Earthquake (MJ6.8) where an obvious active fault has not been found, we found the possibility to recognize an active geological structure by a geomorphologic analysis using DEM (digital elevation model) acquired from airborne LIDAR. The combination of the micro-earthquake observation and the seismic reflection survey supported the correlation between the geological structure and the above surface manifestation (Aoyagi and Abe, 2009).

3. Estimation of the source faults from the short active faults at the surface

Geomorphologic and geological properties of short active faults found in the fore-arc region of Japan were characterized as follows: 1) Displacement per an earthquake event is far larger than that deduced from length of the active fault; 2) Recurrence interval of the short active fault is far longer than that of the large interplate earthquake; and 3) Displacement of the short active fault is accumulated. When the earthquake motion is simulated from these active faults, it is important to evaluate using the plate boundary earthquakes or the branched seismogenic fault from plate boundary (Sasaki et al., 2009).

4. Fundamental study through model experiment and numerical analysis

The model experiment and the numerical simulation technique for modeling the rupture progress of strike-slip fault in the bedrock were developed. The shape of the subsurface fault depends on physical properties and the fault movement such as direction, speed etc. of the bedrock (Ueta 2009, Sawada and Ueta, 2009).

Future Developments

The evaluation method for successive rupture of multiple active faults will be further studied through a comparison of fault properties such as fracture, deformation, orientation etc. along the fault line.

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Reference

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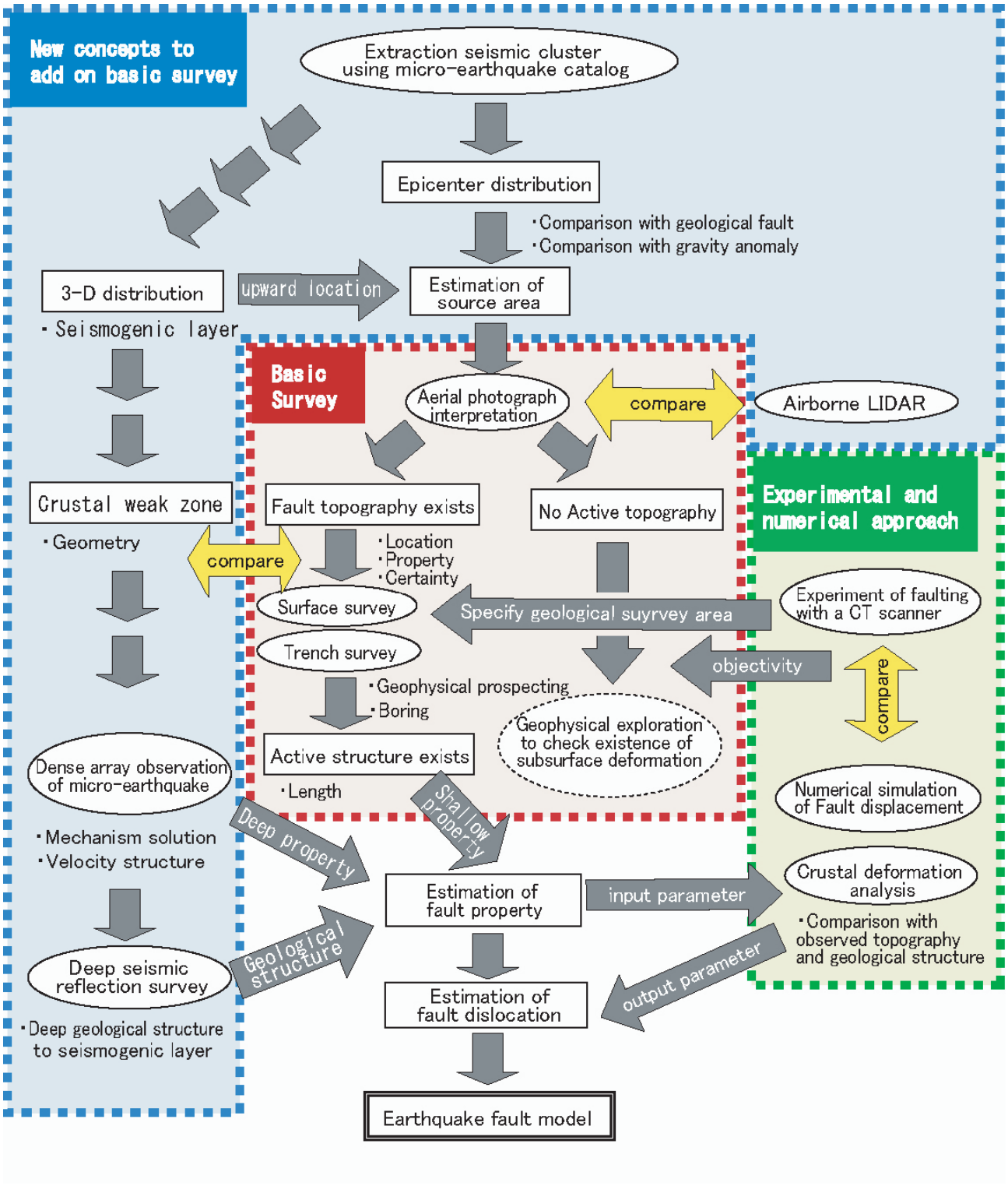

Fig.1 An investigation flow to evaluate earthquake scale by integrated active fault survey