

## Active fault and seismic safety evaluation: comments from experience of active fault assessment for nuclear power plants

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During the period from 2001 to 2012, when the author was participating in active fault evaluation for nuclear power plants, 1) judging whether the faults in the vicinities of the plants concerned are active or not, 2) evaluating the extent of multi-segment rupturing on the fault system concerned were major issues imposed on active fault researchers. Whether faults in nuclear power plants or beneath nuclear facilities are active became a new point of controversy after the submission of reevaluation reports in March, 2008, based on the new regulatory guide; especially after an on-site inspection of the Tsuruga power plant in April, 2012.

Concerning the faults in the vicinities of the nuclear power plants, opinion was not divided on the faults which everyone could judge active based on the latest knowledge of active fault. On the other hand, we had faults for which opinions were divergent even on each individual data, in addition to faults showing inconsistency among the conclusions from geomorphic, geologic and geophysical data. For the Yokohama fault, one of such difficult faults, on the west coast of Shimokita Peninsula, its characteristics as active fault were unveiled by additional surveys. From such experiences, the author thinks we should make every effort to acquire reliable data as many as possible and listen to different opinions before making the final decision.

Regarding multi-segment rupture, the author was impressed by negative attitudes of the power companies toward this issue. While the governmental HERP made efforts to evaluate the largest earthquake on every major active fault zone in Japan using "5-km rule" based on Matsuda (1990), the companies seemed to try to shorten active fault segments as much as possible and evaluated only single-segment rupturing or ruptures involving a small number of segments. Although this is the case before the revision of the regulatory guide in 2006, similar evaluations of multi-segment rupture appeared even after that.

As the 3.11 earthquake was generated by a successive rupture of many source areas, multi-segment ruptures on active faults in the vicinities of nuclear power plants were reevaluated. The reevaluation has reminded the author that the distant-ward extension of multiple rupture has minor influence on short-period ground motion, and underestimate of near-site heterogeneous rupture and seismic wave amplification is more fatal. For the maximum ground motion, it is necessary to make continuous efforts to reach unique evaluation, neither underestimate nor overestimate, through digging out paleoseismic data hiding in history and under the ground, as well as promoting theoretical research and observation.

Is the fault concerned active? What properties does it have? Where does it stand in the cycle of activity? Replies to these questions are not necessarily the truths. We should keep in mind that scientific evaluations are hanging around the truths, and occasionally far away from them. We also must realize that we are affected by our own experiences and way of thinking, being constrained by social, cultural, and the times background inclusive of earthscience paradigms. It is also necessary to digest data in the fields adjoining our own, and examine them impartially. Only the data of a restricted field sometimes lead to a wrong conclusion.

Seismic safety evaluation of nuclear power plants must be done based upon the above scientific assessment of active faults, but should be done at another place with a wider view. The revision of regulatory guide for reviewing seismic safety in 2006 gave power companies an opportunity to modify their active fault evaluations. Future revisions of regulatory guide must not merely enhance the regulation, but should motivate the companies to ensure higher nuclear safety, and promote deepening of the scientific knowledge and technical innovation indispensable for more advanced active fault evaluation.

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