Study on fault activity evaluation method (A new attempt to understand fault activities) No.1 - Overall plan and current situation at Shionohira Fault -

*Kazuhiro Aoki[1], Takahiro Watanabe[1], Yukumo Tanaka[1], Kazuyoshi Seshimo[1]

1. Japan Atomic Energy Agency

If there is a "fault that may become active in the future" (hereinafter referred to as “inactive segment”) in the vicinity of a fault that has recently moved (hereinafter referred to as "active segment"), it appears that there is a difference in the stress state and in the "ease of activity" between the two segments. Under the current concept of nuclear regulatory standards, these segments are evaluated as part of the same series of faults due to lack of knowledge about interlocking faults.

Following the April 11, 2011 Fukushima-ken Hamadori Earthquake (4.11 earthquake), co-seismic surface ruptures trending NNW-SSE emerged over a distance of 14km between Nameishi Tabito of Iwaki city and North-west of Tsunaki Ishizumi. The surface rupture was named Shionohira fault by Ishiyama et al. (2011) and is identified to be part of the Itozawa fault (coincides to West trace of Itozawa fault by Tsutsumi and Toda, 2012). According to Imaizumi et al. (2018), the fault is said to continue extending south of the ruptured surface covering the area from Nameishi of Tabito Iwaki city to West of Sakura, Kawabe-cho and from Wakigawa, Yamadama-cho to Kobuki, Sekimoto-cho Kita Ibaraki city. In this study, the area designated as the Shionohira fault which has surfaced after the 4.11 earthquake is called the active segment and the remaining area to the south to be the inactive segment.

The authors aim to develop a fault activity evaluation method in order to clarify whether the inactive segment really moves together with the series of faults including the active section when a fault activity occurs by studying the differences between active and inactive segments in the interlocking of faults.

The authors have been conducting a series of study at the Shionohira fault and its southern extensions, reporting on the outcrop survey results (Kametaka, et al., 2015) and the frictional characteristics of fracture zones (Aoki et al., 2015, 2016). Currently, a fault slip test is carried out to assess the in-situ stress state.
In the fault slip test, a double packer is placed above and below the underground fracture to inject high pressure water from the surface and artificially trigger a slip in the fracture in order to measure the three dimensional deformation amount (micrometer to millimeter) (Guglielmi et al., 2013). This device called the Step-rate Injection Method for Fracture In-situ Properties or SIMFIP probe was designed and manufactured by Guglielmi for underground storage studies of CO_2 in France and was first applied at the underground research facility (LSBB) in the south of France (Guglielmi et al., 2015). Subsequently, in-situ tests have been conducted on faults in underground research facilities such as Tournemire in France, Mont Terri in Switzerland, and the gold mine in South Dakota, USA.

This device allows to quantitatively measure the deviation of the fault by increasing the pore water pressure in the section partitioned by double packers, and to also examine the causes for leakage of groundwater, petroleum, CO_2, and radioactive waste. In addition, it enables to observe fault displacement, pore pressure, and induced seismic waves at the micrometer scale, and to estimate friction and stress state of fault zones. By deepening understanding of the coupled phenomenon of hydraulics and dynamics around the fault, the authors believe the method could be useful in elucidating the mechanism of seismic occurrence. It should be noted that this device is being applied for the first time in Japan, and the first time ever for an in-situ test of active faults.

Keywords: SIMFIP, Shionohira fault, active fault, Fukushima Hama-dori earthquake, fracuter zone characteristics, injection experiment