Problems associated with the active fault assessments and analyses of the destructive 2016 Kumamoto earthquake

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The 2016 Kumamoto earthquake occurred with the activity of a known active fault. Although it could be possible that the latest long-term predictions by the Headquarters for Earthquake Research Promotion are correct, there are still unresolved problems regarding 1) the earthquake mechanism itself, 2) the extent of damages caused by strong ground motion, and 3) the emergence of unknown earthquake faults.
The active fault was assessed two times in 2002 and 2013. According to the evaluation in 2002, the faults extending from Aso to the Yatsushiro Sea were regarded as a series of active faults, which were collectively referred to as the Futagawa-Hinagu fault. In contrast, the evaluation in 2013 divided the Futagawa and Hinagu faults into separate systems by taking into account underground geology within the Kumamoto plane. This later assessment concluded that the Futagawa fault extends from Aso toward the Uto Peninsula, and furthermore, that the Hinagu fault extends from Togawa in Mashiki to the Yatsushiro Sea. However, the “Active Fault Map in Urban Area” regards the Futagawa fault as continuing further south of Togawa because the tectonic landforms were smoothly traced. Among the several estimations mentioned above, we should check which one is more appropriate. On the basis of the 2002 evaluation, it is possible to say that the earthquakes on April 14th and 16th occurred continuously along the northeastern part of the Futagawa-Hinagu fault. On the other hand, based on the 2013 evaluation, the two earthquakes appear to have occurred irregularly on different parts of the different faults. According to the 2002 evaluation, the former earthquake on April 14th should be regarded as a “one size smaller earthquake” than the expectations, whereby the possible occurrence of a bigger one was mentioned.
The locality of the Futagawa-Hinagu fault had already been indicated on the large-scale active fault map, and the earthquake faults appeared on the fault line. However, several secondary faults emerged at other places. In particular, an earthquake fault with a total length of 4 km appeared, and it produced extensive damage in the town of Mashiki. We should thus carefully check the reason why this fault was not identified prior to the 2016 earthquakes.
Within the vicinity of the Futagawa fault, severe damage occurred. Especially, in the town of Mashiki where high seismic intensities were recorded on April 14th and 16th, numerous buildings collapsed during the earthquake on April 16th. The “severely damaged zone,” which was approximately 1 km in width, trended in the east–west direction. In the village of Minami-Aso, several traces of earthquake faults were discovered, and almost all of the buildings located on these faults collapsed. At least five cars overturned onto their sides in the northward direction. Such phenomenon had not been observed before in Japan. These events are estimated to have been the result of an S wave in the orthogonal direction along strike-slip faults.
There is a need to re-examine the segmentation and groupings of the faults. The 2016 earthquakes indicate that the fault should not be divided if the tectonic landform is smoothly continued. There is also a need to explain why such high seismic intensity of 7 occurred along the Futagawa-Hinagu fault. Although the present theory of strong ground motion postulates that a shallow portion of the crust never generated strong motion, the narrow distribution of damage seems to imply some contribution from breaks at the shallow portion of the crust. In regard to this issue, the distribution of seismic intensity of 7 will need to be officially mapped by the Japan Meteorological Agency. In the field of disaster prevention awareness, it is often heard that strong

earthquakes can happen anywhere, but this could misleading. It will be necessary to specify the areas where the seismic intensity could reach 7 for disaster prevention. It will also be important to verify the reason why the branch faults could not be identified before the 2016 earthquakes. Needless to say, active fault assessments for regions harboring nuclear power plants require further rigor. Although the Nuclear Regulation Authority may say that they can identify the potential active branch faults prior to the earthquake, it is essential to verify this assessment.

Keywords: Active fault, Earthquake disaster prevention, Earthquake fault, Strong ground motion

