Insights into earthquake generation and topographic evolution in and around the Kurikoma geothermal area

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We have studied the 1996 Onikobe Earthquake swarm and the 2008 Iwate-Miyagi Nairiku Earthquake by thoroughly integrating various kinds of observations (seismology, geology, geomorphology, geodesy, etc.). By integrating those two events (potentially more), we gained some insights into the characteristics of volcanic geothermal areas.

The hypocentral distribution for those two events has common gap and common belt of seismicity. This may imply that the elastic stress is transferred to the isolated seismogenic area surrounded by high temperature region from outside through very limited structures. Careful comparison between different data sets show that the seismicity belt connecting the Onikobe geothermal area and the epicentral area of the Iwate Miyagi Earthquake very well coincides with the remnant of the past caldera rims. The transferred elastic stress would be released by earthquakes in the isolated area involving the considerable amount of aseismic slip along the boundary between high-temperature and low-temperature areas (Takada and Furuya, 2009).

From the view point of geomorphology, we found that the low topographic slopes are dominant in high-heat-flow areas, which is well evidenced by a clear contrast between northern half of the Onikobe caldera and the southern half of it. This could be caused by a decrease in the upper crustal strength under high temperature and water-rich environment. Steeper slopes require stronger strength of the material (e.g., Davis et al., 1983).

Finally, we found the different sequences of the earthquake swarms in and around the Onikobe caldera during the 1996 earthquake swarm which seems to be characterized by a mainshock-aftershock sequence. In the western part of the Onikobe caldera, however, another swarmy earthquake sequence took place, which did not indicate the mainshock-aftershock sequence and was long-lasting relative to its magnitude (e.g., Vidale and Shearer, 2006).

We have to admit that our piecewise findings raised above are still not beyond the speculation and/or already pointed out by the pioneers (e.g., Umino et al., 1998). However, the physical relationship between those findings has not been revealed. We are on the way to combine those into one scenario with the aid of newly developed techniques like space geodesy. The scenario should be tested against the physical modeling and further observations.

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