

# A hot zone disclosed by satellite images as a precursor for the 1995 Northern Niigata Earthquake

# Tameshige Tsukuda[1]; Keinosuke Gotoh[2]

[1] ERI, Univ. Tokyo; [2] Systems Sci., Nagasaki Univ

Crustal deformations and the associated stress changes may induce migration of fluid within the crust. It is hypothetically expected that a volume of interstitial water suddenly pressured by an elevated stress level in some seismogenic zone has a power to intrude up into a crack network and incidentally emerges at the ground. Groundwater changes in temperature, chemical contents, discharge of gasses should be observed at the spot where the upwelling water comes out. If upwelling and discharge of hot water takes place widely in space, then rocks around the ground surface will be heated by the hot water and accordingly some high temperature zones in the ground surface will be detected corresponding to the upwelling zone of hot water. This temperature pattern on the map will be obtained through satellite infrared images.

We used LANDSAT satellite because of its high resolution of an infrared band observation. This satellite turns around the Earth with 99 minutes period. The same place will be visited on every 16 days. In Japan area, it moves from north to south in day time at around 10:00 and from south to north in night time at around 21:00. We selected the data of No.6 band (10.40-12.50 micron m ) of infrared obtained by the sensor TM(Thematic Mapper). In this specification, the resolution is 120m for one dot in the image. In order to monitor the ground surface temperature, cloud over the sky and snow covering on the ground should be avoided. Then, the chance to get the ideal data is consequently at least only once in a year.

The LANDSAT 5 image showing the earth surface temperature distribution on August 10, 1994 over the area of the northern Niigata Prefecture disclosed a lineament of hot zone of 10-20km long and several kilometers wide. The area is about 1 degree higher in temperature than the surrounding area. The temperature should be around 23 degree in centigrade. This value is somewhat higher than the ordinary state of the ground in Niigata region as disclosed through the repetitions of observations. This hot zone lies along the Tsukioka fault system(Research Group for Active Faults of Japan, 1991). Because there are hot springs around the fault, it is reasonable that a hot zone is formed there. Here we should note that a remarkable heat supply occurred in 1994. The above mentioned heating may happen frequently. The image in 1984 also has the same hot zone lineament along the Tsukioka fault.

The hot zone is located near the epicenter of the 1995 Northern Niigata earthquake (M5.5), about 5km apart from the Tsukioka fault. This earthquake occurred on April 1, 1995. Before this destructive earthquake, a swarm activity had been taken place in the same region of the source area of the remarkable shock. It started around October in 1994 and became highly active in December of the same year, and had lasted till just before the time of the major shock of April 1, 1995. The maximum magnitude recorded before the M5.5 shock was M4.3; eleven shocks were greater than or equal to 3 in magnitude. The M5.5 shock was accompanied by many aftershocks; the maximum shock of M5.0 and 47 shocks with magnitudes greater than or equal to 3. The temporary heating of the ground surface possibly arises from intermittent heat transfer by water. Either new paths for upwelling of hot water were created or the rates of upwelling at the preexisted hot springs, or both processes might be realized.