ELASTIC MODELLING OF MAGMA INTRUSION:
EXAMPLE OF THE 2000 ERUPTION OF USU
VOLCANO, HOKKAIDO, JAPAN

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After 23 years of dormancy, Usu Volcano (Hokkaido, Japan) erupted on 31st of March, 2000. Many observations (seismicity, deformation rates, gravity observations, groundwater level monitoring) show that the period of intense activity was short, starting abruptly, and continuing for ca. 5 months with a decreasing rate. Uplift was observed at two successive and separate locations at the time of the eruption. We obtained GPS and microgravity data at Usu Volcano for two intervals, first from August 1996 to July 1998, once every 2 to 4 months, and second in November 2000, 2 months after the end of the eruption. Between July 1998 and November 2000, the displacements and gravity variations are among the largest ever recorded on an active volcano in association with an eruption. We review three different elastic models commonly used in volcano-geodesy (sphere, fault system, fissure zone) and invert the high quality data using each of these models. The combined inversion of GPS and microgravity data leads to the best solution in the least-squares sense. It is compatible with the intrusion of approximately $5 \times 10^{11}$ kg of new magma into the western part of Usu Volcano. This appears to have occurred in a subvertical fracture zone (about 2.4 km length, 0.1 km width) aligned in the East-West direction. The fracture zone is between 0.4 and 3.3 km depth with an extension of about 30 m. The fractures are likely to be filled with material having a density slightly higher than the density of old products of Mount Usu, i.e., about 2400 kg m$^{-3}$. This model is consistent with the locations and magnitudes of the earthquakes recorded during the period of the intense seismic activity in April and May 2000. These earthquakes correspond to the boundaries of the intruded magma body. The model suggests that the two locations of uplift are not independent.