A joint analysis of groundwater changes and crustal deformation related to earthquake swarms off the east coast of Izu Peninsula, Japan

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Izu Peninsula is situated at the collision zone of Eurasian, Philippine Sea, and North American plates. Earthquake swarms have been repeatedly recorded off the east coast of Izu Peninsula since June 1978 (Fig.1). Shimazaki(1988) suggested magmatic dike intrusion mechanism as possible source of the swarms in this region. Because of the frequent seismic activities and tectonic importance of this area, many kinds of observations have been conducted by various institutions. For example, groundwater observation by Geological Survey of Japan (GSJ), AIST, earthquake and tilt observation by National Research Institute for Earth Science and Disaster Prevention (NIED), GPS observation by Geospatial Information Authority of Japan(GSI) and earthquake and strain observation by Japan Meteorological Agency (JMA) have been conducted. Related to the repeated earthquake swarms, changes in groundwater, tilt, strain and position were frequently observed (Okada et al., 2000; Koizumi et al., 2004). Those changes should be explained by the fault which was produced by the magmatic dike intrusion. In this presentation we will suggest a joint analysis of groundwater changes and crustal deformation for making the comprehensive fault model which can explain all these changes and deformation.

Firstly we assumed the model is an inclined tensile fault model (Fig.2) because the source is considered to be the magmatic dike intrusion. Secondly we decided the fault parameters which minimized the sum of the weighted and non-dimensional residuals ($\Sigma WiRi^2$) through a grid search method, where Ri is Ci-Oi, Ci a calculated value from the model, Oi an observed value, Wi is a weight and equal to $1/\sigma i^2$ and σi is a noise level. The form and position of the initial model was decided in consideration of the hypocenter distribution. The result for the case of the swarms in December 2009, which is the largest in recent several years, is shown in Fig.3. The residuals of GPS was relatively larger than those for the other observations because the S/N ratio was worse in GPS than in the other observations. We will make the models for the other swarms and check and improve the models and the parameters of them.

References

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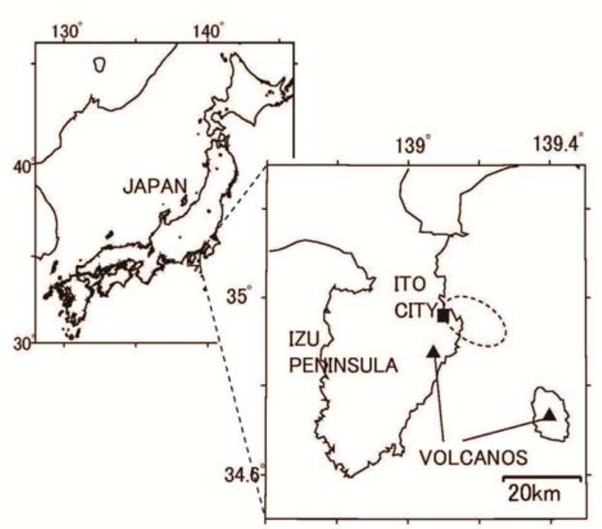

Fig.1 Map of Izu Peninsula.The earthquake swarms frequently occur in the dotted area.

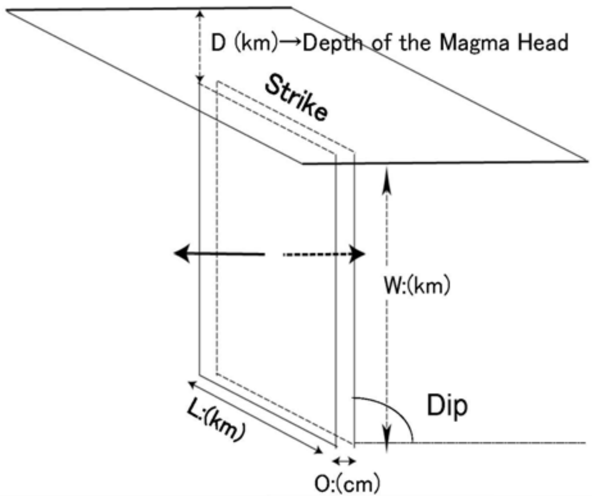

Fig.2 Schematic figure of the tensile fault model.

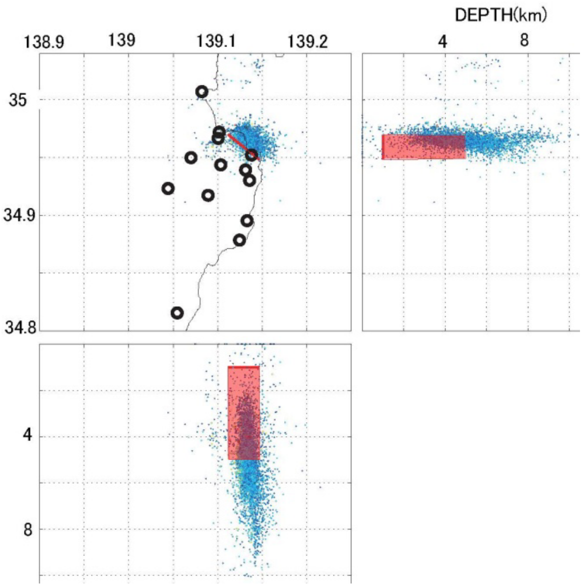

Fig.3 The blue dots and open circles show the hypocenters and observation station, respectively. The red rectangle is a final model for the swarms in December 2012. The depth, length, width, strike and dip of the fault is 1km, 4km, 4km 307 degree and 88 degree, respectively. The opening is 95 mm.

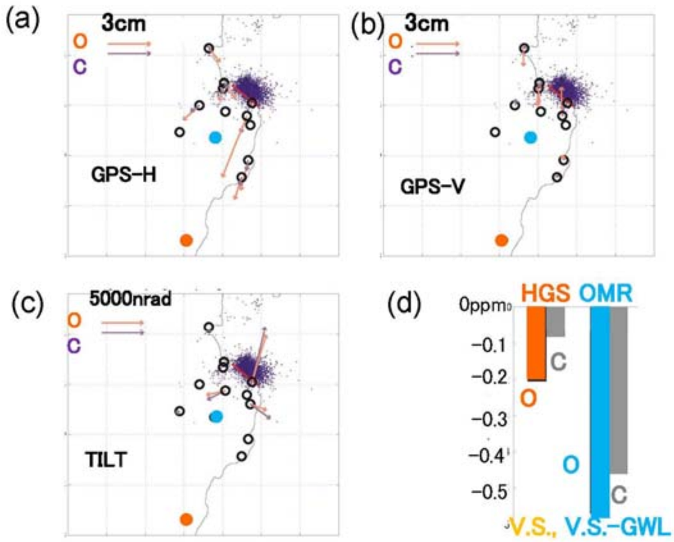

Fig.4 Comparison of the calculated data (C) to the observed data(O) for the swarms in December 2012. The blue and orange circles are the groundwater observation station of GSJ, AIST and volumetric strain observation station of JMA.

(a) Horizontal displacement (GPS) by GSI.
(b) Vertical displacement (GPS) by GSI.
(c) Crustal tilt by NIED.
(d) Volumetric strain by JMA and groundwater level by GSJ, AIST.