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Implications of crustal fluids for regional variation of cutoff depth of shallow seismicity and generation of inland eqs

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Japan islands are densely covered by the integrated seismic observation network (Kiban network). High quality data obtained from this network and analyzed by Japan Meteorological Agency (JMA) were utilized to obtain 3D velocity structure and relocate earthquake hypocenters. This was done in order to decrease the effect of heterogeneous structure of the study area, which was disregarded in the hypocenter location procedure by JMA in the Ichigenka Catalogue. Relocated earthquakes were used to determine the cutoff depth of shallow seismicity, or so-called D90. Tomography method by Zhao et al. (JGR, 1992) was applied to arrival time data from local earthquakes with depths down to 50 km located beneath the land area during 2001-2009. The study area was divided into partially overlapped 4x4 degree size 8 sub-areas for calculation. Obtained 3D velocity structure images are generally in agreement with the previous results. Spatial variation of D90 shows a negative correlation between D90 and heat flow (HF). Locally shallow seismogenic layer is extended belt-like along the volcanic front in eastern Japan from Hokkaido to Kanto area. This area has high HF. Similarly, locally shallow seismogenic layer is extended belt-like along the volcanic front in western Japan from the Chubu Mountain Range to Kyushu along the coast of the Japan Sea through the Chugoku region. HF in this area is also high. A belt-like zone with locally shallow seismogenic layer is also distributed along the Median Tectonic Line (MTL) in the western Japan fore-arc area from the central part of Kii Peninsula to western Shikoku.
Moreover we observe both volcanic and non-volcanic low-frequency earthquakes occur beneath the above area with shallow D90. Locally shallow D90 is probably caused by heating and increase in pore fluid pressure by the crustal fluids supplied from the deeper part. Crustal fluids weaken ambient crustal rocks. It seems that large inland earthquakes are generated in the shallow areas of D90.
On the other hand, remarkable deep D90 is also seen on the Pacific Ocean side in eastern Japan. These areas have for low HF values. Deep D90 is possibly caused by cooling due to the cold Pacific Plate. It is obvious that temperature, crustal fluids and pore fluid pressure play key roles in lateral variation of the bottom of the seismogenic layer in this region and generation of the crustal earthquakes.

Keywords: inland earthquakes, seismogenic layer, shallow seismicity, crustal fluids, heat flow, pore fluid