

Andesitic magmatic water which generated Matsushiro Earthquake Swarm and S reflector

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1. Introduction

When the Matsushiro earthquake swarm occurred between August 1965 and October 1967, large amounts of groundwater were released. Even at present, groundwater being released in this area, accompanied by the free gases. The water is characterized by high concentration of Cl⁻ and Na⁺ ions. It is assumed that the water triggered the earthquake swarm.

2. The origin of the water

Yoshida et al.(2002) measured the isotope ratios of d18O and dD of the Matsushiro groundwater. They plotted their isotope ratio data on the d18O vs. dD diagram. The linear regression line passes through the range for andesitic magmatic water named by Giggenbach, d18O ranging between +5 and +10 per-mil and dD between -30 and -10 per-mil. Further, the isotope ratio of d13C of CO₂ indicates that CO₂, which was the major component of the gas, originated from the mantle. These mean that the Matsushiro groundwater came from magma and was probably responsible for the earthquake swarm.

3. Mechanism for great amounts of water release while the earthquake swarm

It is known that there is a seismic S wave reflective layer 15 km beneath the Matsushiro earthquake swarm area. We propose that this layer is made of aquifer. A Quaternary volcano of Mt. Minakamiyama erupting about 35 Ma situated in the Matsushiro earthquake swarm area. Fluid squeezed out of solidified magma of Mt. Minakamiyama must have been accumulated under the impermeable layer. When the impermeable sheet broke and high-pressure water with CO₂ rose into the upper crust, the crust was weakened, causing the Matsushiro earthquake.

4. Other examples

Hot spring waters from the Arima spa (Rokko Mountains) and the Kashio spa (on Median Tectonic Line, Ohshika-mura, Nagano Pref.) have a similar characteristic to the Matsushiro groundwater in chemical composition of high concentration of Cl⁻ and Na⁺ ion, and isotope ratio of heavy d18O and dD. The S reflector has been observed under the Arima spa but not under the Kashio spa. Earthquake swarm has been observed under the Arima spa but not under the Kashio spa. These mean that the S wave reflector is closely related to earthquake swarm.

Reference

Yoshida, Okusawa and Tsukahara, 2002, Zisin55,207-216