

Spike-like Emission of Methane from Groundwater at Omaezaki 500m Well

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We report a temporal change of the methane concentration in groundwater monitored at the 500m-depth well of the Omaezaki observation station from October 17, 2005 to December 7, 2005.

Observation

The 500m-depth well of the Omaezaki observation is located at N34.62 and E138.23, Shizuoka prefecture. The diameter of the casing of the well is 200 mm. Two plastic tubes were coaxially installed into the strainer depth. Groundwater was directly pumped up from the aquifer by the inner tube, and returned to the aquifer by the outer tube after concentration measurements of a dissolved gas. The dissolved gas was separated by a gas-water separator and introduced into a quadrupole mass spectrometer (Standam:ULVAC). A mass spectrum was recorded every 20 seconds. Associated data measured every 10 seconds were the water level, the water temperature, the ambient temperature, the atmospheric pressure, and the pumping rate.

Results and discussion

Spike-like changes of the methane concentration were frequently observed in this period. On the other hand, the concentration of the main constituents of the air such as N₂, O₂, ⁴⁰Ar and CO₂ were fairly stable. Here we assumed that the methane generation by a reaction of an ionized fragment of carbon dioxide with a hydrogen plasma in the spectrometer is negligible.

The seismic activity was very silent around the observation station in this period, and the maximum magnitude was 2.9 (November 2, 2005, JST 21:18, N 34.34, E 138.62, D 226.8). The profile of an exponential of magnitude was different from that of the methane concentration.

The water level calculated by the BAYTAP program, the water temperature, the ambient temperature and the pumping rate were stable after October 23, 2005. These parameters therefore do not affect on the methane concentration.

By contrast, the methane concentration was synchronized with the atmospheric pressure. It was significant that the spike-like emission of methane is occurred when the rate of atmospheric pressure change is large under the low atmospheric pressure condition. Then we supposed a mathematical model

$$C_i^{methane} \propto \Delta p_i \cdot \dot{p}_i, \quad (1)$$

where i , $C_i^{methane}$, Δp_i , and \dot{p}_i are time, the methane concentration, the differential pressure between a standard value and a current pressure, and the rate of pressure change, respectively. It is expected that parameters Δp_i and \dot{p}_i are related to the expansion degree of micro-cracks and the degree of micro-crack growth.

Conclusion

We observed the spike-like change of the methane concentration in groundwater monitored at the 500m-depth well of the Omaezaki observation station. The temporal change of the methane concentration was well described by a preliminary model that the concentration is proportional to the product of the differential pressure between a standard value and a current pressure, and the rate of pressure change.