Study for development of geothermal exploration technique using thermoluminescence of feldspar

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Japan has abundant geothermal resources, and geothermal development is important in energy strategies, but its development is not progressing. This is because geothermal power development costs are expensive, and lead times are long. As a solution to these problems, a simple geothermal exploration method using mineral thermoluminescence has been proposed. Thermoluminescence (TL) is a phenomenon in which energy is accumulated inside a mineral crystal by radiation, and this energy is released as luminescence by thermal stimulation. Light emission due to energy accumulated by natural radiation is called as natural thermoluminescence (NTL), and light emission due to energy accumulated by irradiation of artificial radiation is called as artificial thermoluminescence (ATL). Tsuchiya et al. (2000) and Saito et al. (2017) showed that Geothermal exploration using TL of quartz has effectiveness. Feldspar also emits TL like quartz, but few studies have been conducted on geothermal exploration methods using TL of feldspar. Feldspar is a ubiquitous mineral at the crust, if a geothermal exploration method using feldspar TL can be developed, TL geothermal exploration can be applied to areas without quartz. In addition, it is thought that the accuracy of the geothermal exploration method using the TL can be improved by using it in combination with the quartz TL. In this study, the basic properties of TL of feldspar were studied.

The geothermal exploration method using TL of quartz utilizes the difference in NTL intensity due to geothermal influence. This utilizes the property that accumulated energy is released by heat and utilizes the phenomenon that the intensity of light emission (NTL) decreases as it approaches the heat source, that is, as the geothermal temperature increases. An isothermal decay experiment was performed using K-feldspar in pegmatite to examine whether the same method can be applied to feldspar. As the heating environment conditions, three patterns were prepared: a sample only heated, a sample immersed in acidic water (Tamagawa hot spring water) and heated, and a sample immersed in neutral water (distilled water). These samples were reacted at temperature of 90, 125, 150, 200 and 250 ºC, and 24, 168 and 672 hours. The total number of samples is 45. To evaluate thermoluminescence, first observe the glow curve. Glow curve is obtained by subtracting background luminescence intensity (mainly infrared radiation from heater) from thermo luminescence intensity of mineral crystals. After that, integrate the glow curve from 50ºC to 350ºC and define that integrated value as the TL intensity. Regarding the relationship between the TL intensity and the heating temperature/time, the decay of TL intensity was observed as the heating temperature was higher and the heating time was longer. Regarding the relationship between the TL intensity and the heating environment, no change was observed in the tendency of the TL intensity decay even when the heating environment was changed. Therefore, it is considered that the decay of TL intensity depends more on the influence of temperature than on the influence of hydrothermal alteration. These results of the TL intensity decay were kinetically interpreted, and fitting was performed assuming a fifth-order reaction. As a result, the apparent activation energy was 1.25 eV. This value is in good agreement with the quartz results calculated in previous studies, indicating the possibility of geothermal exploration using NTL of feldspar.

In the poster presentation, feldspars collected from rocks such as tuff and granite will also be discussed.

Keywords: thermoluminescence, feldspar, geothermal exploration

