Extraction of features of strata using borehole data of geothermal area by multivariate analysisExtraction of features of strata using borehole data of geothermal area by multivariate analysis

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The quartz index is defined as the percentage of the strongest X-ray intensity of a certain mineral in the sample and the intensity of the pure quartz measured under the same experimental conditions. We have developed a method to classify the strata by multivariate analysis and extract the features, in particular the difference in alteration degree, and verified effectiveness of the method in comparison with usual geological analysis. First, applying the principal component analysis data was dimensionally compressed and characteristics were emphasized. and Then classification of the strata by the clustering based on the Gaussian mixture model. In addition, the classification results obtained by this method compared with electric logging and temperature logging data.

In this study, we used the quartz index data obtained from wells in Hachimantai geothermal area of Iwate prefecture. The geology of this area consists of andesite tuff and dacite tuff. The quartz index means the content (% by weight) in the sample for quartz and the relative quantity ratio for the other minerals. To verify the validity of this method, the principal component analysis was performed on the quartz index data of standardized clay minerals and compared with the results of existing geological classification by geological interpretation. As a result of the comparison, the classification results were similar, and this method was verified.

Next, in order to ascertain the effect of dimensional reduction by the principal component analysis, (i) we performed clustering without dimension reduction for all quartz index, and (ii) after the dimensional reduction is applied to all quartz index, we compared the results of clustering. In dimension reduction, we used up to the principal components whose contribution total is 95%. As a result of the comparison, the optimal classification number of the strata was 6 in the case where dimension reduction was not performed (case (i)), but in the case of dimensional reduction (case (ii)), the optimum classification number was 10. As a result, it was found that more detailed features can be extracted from the formation by dimension reduction. In particular, the classification in the depth range from 0 to 1000 m, especially the correspondence between clay minerals and zeolite minerals, became clearer.

