多変量解析による地熱地域の坑井データを用いた地層の特徴の抽出
Extraction of features of strata using borehole data of geothermal area by multivariate analysis

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In geothermal development, geological characteristics are often estimated qualitatively based on logging data of geothermal wells. On the other hand, the quartz index (QI) has quantitative information on minerals, and the index enables to objectively extract features of the geological formation using a statistical method. Therefore, in this study, from the QI obtained from the core cuttings in a geothermal field, we developed and examined a method to classify and extract geological features along with a well by multivariate analysis (in particular the difference in alteration degree). Specifically, we first carried out a principal component analysis to extract and emphasize the features of the data through dimensionality reduction. Then, their lithological features were classified by clustering using a Gaussian mixture model. In addition, the classification results by our method were compared with electric logs and temperature logs. In this study, we used the data obtained from wells in a geothermal area at Iwate prefecture. The geology of this area consists of andesite tuff and dacite tuff. The QI is defined as the percentage of the strongest X-ray intensity of a certain mineral in the sample from the strongest X-ray intensity of pure quartz measured under the same experimental conditions. This value means the content (weight percentage) in the sample for quartz and the relative quantitative ratio for the other minerals. In order to verify our proposed method, the principal component analysis was performed on the standardized QI data of clay minerals and compared with the results of existing geological classification based on geological interpretation. As a result of the comparison, our classification results agree with the results of existing geological classification, thus the classification of the strata by our method is valid. Next, in order to examine the effect of the dimensionality reduction by a principal component analysis, we compared the following cases: (i) clustering without dimension reduction for all QI, and (ii) clustering after applying the dimensionality reduction to all QI. In the case of dimensionality reduction, we used the principal components with a total contribution total over 95%. As a result of the comparison, the optimal classification number of the strata without the dimensionality reduction (case (i)) was 6. On the other hand, in the case of dimensional reduction (case (ii)) the optimal classification number was 10. The number of the optimal class indicates that more detailed features can be extracted using dimensionality reduction by principal component analysis. Notably, the classification in the depth range from 0 to 1000 m became detailed, highlighting the correspondence between clay, zeolite minerals and the geological formation.

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