Correlation Study Between Fracture Zone and Geophysical Logging Data in Crystalline Rock

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1. Introduction

Geophysical logging is the conventional investigation method for understanding the chemical and physical environment in the subsurface area. Though some logging methods can be applied to detect fracture in the bedrock, they are generally used for identifying a relatively large-scale open fracture and fracture zone. Also, the fracture and fracture zone from the geophysical method is very difficult to consider as deterministic features because of the lack of fracture geometry data. Thus, the relation study between fracture data, which are used for fracture network modeling, and geophysical logging data were needed.

In this paper, we aimed to understand the relation between statistically obtained fracture zone and geophysical logging data.

2. Study area

2.1 Geology

The study area is located at a northern part of Dae-jeon city. The topography of the site is well characterized as rolling hills surrounded by upland of EL. 300-500 m and the lowland of about EL. 50 m. The geology of the study area is mainly composed of Mesozoic plutonic rock, Precambrian metamorphic rock and a dike. The geologic formation of the Mesozoic plutonic rock is Jurassic schistose granite and two mica granite. The Cenozoic alluvium is distributed over a wide area through the surface basin system in research area with a 3-11 m depth. So, the geological unit of the study area below the surface soil layer is defined as crystalline rock which includes fractures and a fracture zone.

2.2 Boreholes

Total 3 boreholes (AH1, AH2 and AH6) were used for the correlation study in this paper. These boreholes, drilled in 2014 and 2015 around KURT(KAERI Underground Research Tunnel), are for an understanding of the deep geologic environment with a depth of -400～-500 m (GL.) (Table 1, Fig. 1). Statistics of fracture data were applied to define the fracture zone intersecting boreholes such as fracture spacing and frequency analysis. And, fracture data were obtained in the boreholes by borehole acoustic televiewer.

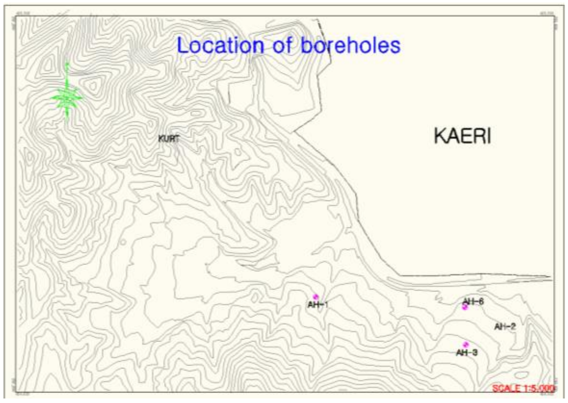

Fig. 1. Location of boreholes (All borehole are located at south-eastern area from KURT).

Table 1. Summary of boreholes around study area

AH-1	424745.4	232989.1	400	89.8	3 in.	Vertical
AH-2	424648.7	233489.6	450	74.8	3 in.	Vertical
AH-6	424718.2	233385.5	400	73.5	3 in.	Vertical

2.3 Geophysical logging method

To compare borehole logging data with fracture zone, we used total 5 logging data including 4 geophysical data which are temperature, electric conductivity, self-potential and gamma lay, and 1 borehole diameter data by caliper logging. Because fracture frequency is defined by number of total fractures each meter, geophysical data also obtained at same interval.

3. Result

Total 3498 fractures were obtained from the borehole acoustic televeiwer and projected to a stereo net. The results showed that main orientation of fractures has a tendency of the NS direction. Also, NW and EW trend fractures could be found around the study area (Fig. 2).

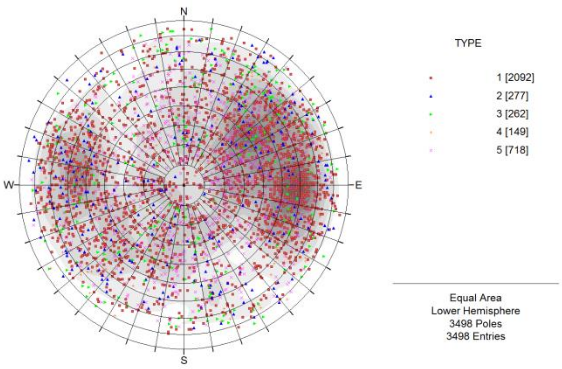

Fig. 2. Orientation of fractures in the boreholes.

Based on the fracture spacing analysis, the fracture zone in the boreholes was determined below the 0.33m of fracture spacing, which is identical to the 3 fractures per meter of the fracture frequency.

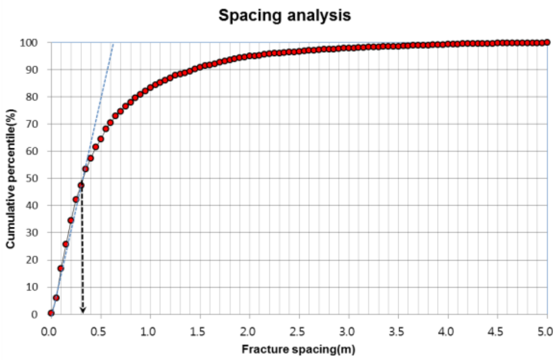

Fig. 3. Result of fracture spacing analysis.

The correlation study between fracture frequency data and geophysical logging data were performed. Furthermore, fracture zone data were also compared with geophysical logging data. Table 2 and 3 showed that self-potential logging data were related to the fracture frequency data and fracture zone. And, it seems that there is a little relation between caliper data and fracture frequency. Because the values of correlation coefficient were very low, it was difficult to suggest that SP logging was most significant logging method for identifying the fracture zone.

Table 2. Correlation coefficient between fracture frequency data and geophysical logging data

	SP	Caliper	Gamma	EC	Temp
AH1	0.27	0.10	-0.01	-0.06	-0.09
AH2	0.34	0.18	0.10	0.02	0.04

Table 3. Correlation coefficient between fracture zone and geophysical logging data

	SP	Caliper	Gamma	EC	Temp
AH1	0.23	0.08	-0.02	0.05	-0.04
AH2	0.32	0.17	0.06	0.01	0.06
AH6	0.21	0.16	-0.04	0.07	-0.09

4. Conclusion

Geophysical logging data and statistically obtained fracture data were compared to understand their relation. The result explained that the self-potential logging and borehole diameter (caliper) data were more related to fracture data than other logging method such as Gamma, EC, Temperature logging data. Because the value of correlation coefficient is about 0.2-0.3, it is difficult to suggest that SP and caliper logging is most effective logging technique to recognize the fracture zone. Nevertheless, the result from the comparison with other geophysical logging data is about zero, so we could conclude that there is a little relation between fracture data and SP, caliper data.