

Morphological transition in columnar joint and its characteristics at Takachiho Gorge, Miyazaki Prefecture

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Columnar joint is the fracture of igneous rocks or welded tuff which is formed by volume contraction due to temperature decrease during cooling. There are two types of form: colonnade and entablature. Colonnade has relatively wide and straight columns, in contrast, entablature has relatively narrow and curved columns. The fractures in colonnade are formed perpendicular to the isotherm, but the relationship between fracture and isotherm in entablature as well as the formation mechanics are still unclear. In this study, to understand the formation process of entablature, we focus on the description of its morphology as the first step. We study Takachiho Gorge, Miyazaki Prefecture, as a test field, which typically shows colonnade-entablature structure in welded tuff from Aso Caldera. We obtain their characteristics and try to describe the complex morphology as much as possible in a simple way.

Observing the columnar joint over 150m along Takachiho Gorge and successively sketching the form with photographs, we find that entablature can be mainly divided by three elemental structures, which we name domain structure, radial structure and translational structure. These three types of structures exist repeatedly in a horizontal direction, in addition, they don't be arranged isolatedly but transform continuously from one structure to another. Colonnade below the entablature can be also characterized by three forms, which have the intimate relationships with three elemental structures of entablature. The first is curved deformation near the boundary with entablature and discontinuous with domain structure of entablature. The second is straight columns and discontinuous with domain structure or radial structure. The third has some curved branches and is continuous with translational structure. Integrating these observational facts, we would like to conclude that the whole structure of entablature seems to be formed by the single series of crack propagation with nearly continuous fractures of three different types of entablature.

We also measure the number of sides in polygons in cross sections of columns, the length of sides and the angle between the sides about colonnade and entablature. Comparing the frequency of the number of sides between colonnade and entablature, we find that pentagons and hexagons are dominated in colonnade, and squares and pentagons in entablature. The distribution of the length of sides shows a normal distribution in colonnade with approximate average of 50cm and a skew distribution against the approximate average of 30cm in entablature. Concerning the angle between sides, the average shows no remarkable difference between colonnade and entablature, but the shapes of distribution are different. That is, the value of the average of polygon angle is influenced by not only how many sides of polygons are distributed in cross section, but also how much the polygons deform from regular polygonal shapes.

Keywords: columnar joint, pyroclastic flow deposit, welded tuff, crack, morphology