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Modeling and Visualization of Faulted Geologic Structure

In this study, we propose a method using the GRASS GIS environment, which incorporates faulting into the theory and algorithm based on the computer processing for geologic structures formed through the sedimentation and the erosion. The geologic structures formed through the sedimentation and the erosion can be expressed by the surfaces surround the distributed areas of geologic units, and the logical relation between the distribution of geologic units and surfaces are termed logical model of geologic structure. When we regard the changeable process of geologic structure formed through sedimentation and erosion as the relations between the distribution of geologic units and the surfaces, there is a definite rule of its formative process corresponds with the logical model of geologic structure, and it is expressed as a recursive definition. Concerning the faulting we define the rule which suggests the surface of fault divides a three-dimensional geologic unit and the open space into two areas, and the geologic structures of each area can be preserved. Therefore, faulting can be reasonably included into the recursive definition, which leads logical model of geologic structures formed through the sedimentation and the erosion, and the faulted geologic structure can be expressed as recursive definition. In addition, this recursive definition can lead a logical model of geologic structure cut by plural faults. With introducing a logical model of faulted geologic structure, we propose the faulted geologic map can be generated without any changes of the existent processing system based on a logical model of geologic structure. Further, the example of application for the logical model of faulted geologic structures is shown using a 3-D visualization tool "Nviz" in GRASS GIS.

Geologic information plays an important role in the fields of civil engineering, construction and environmental preservation. Various studies have been proceeding to construct a three-dimensional (3-D) model of geologic structure using the GRASS GIS environment for practical use. 3-D modeling of geologic structure is composed of two elements; the logical model of geologic structure and the gridded surfaces (DEM: Digital Elevation Model). If the two elements are given, the geologic function that assigns the geologic unit to every point in space A can be defined uniquely. Based on this geologic function, the distribution of geologic units can be visualized on an objective surface including the topographic surface and the vertical section by classifying them with different colors. i.e. it is possible to

visualize the 3-D model of geologic structure. The geologic structure formed through sedimentation and erosion is formulated as a recursive definition and it can be derived by a technical procedure. However, the formulation of faulted geologic structure has been left as an unresolved problem.

The present study proposed a mathematical formulation of geologic structure formed by faulting. We assume that fault surface divides the preexisting geologic units into two parts; the foot wall and hanging wall. If the relation between the geologic units and the surfaces in each part is preserved, the logical model of geologic structure on both sides is expressed in the same form as the case of the geologic structure before the faulting. Focusing on this rule, we define a new recursive definition to derive the logical model of geologic structure that involves fault movements as well as sedimentation and erosion. The recursive definition provides a powerful tool to derive the logical model of complex geologic structures formed by the sedimentation, erosion and faulting through a simple mechanical procedure.

It is expected that this study would advance the computer processing of the faulted geologic structure and activate the application of such geologic information in various fields.

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