

## Earth Science System and Education: Analysis of Concepts about Igneous Rocks

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An effort to catch the earth as a system in earth science education has been made, but it is hard to say that learning of earth science letting students understand Earth science system was enough. In order to clarify a problem, I studied conceptual ideas of students in front of and behind a class about igneous rocks and minerals in two junior high schools and one senior high school about the increase and decrease of conceptual ideas by using Concept Mapping (Novak and Gowin, 1984). I tried to understand the tendency of conceptual changes by examining connections of more than two labels as representative concepts (Fukuoka and Kasai, 1991), Concepts of classification and Concepts of the formation process of igneous rocks.

Consequently, the understanding of concepts of classification increased in junior high schools. It was difficult for students to understand crystallization differentiation in a senior high school, but the concepts of the formation process increased when understanding advanced. As the formation process of igneous rocks might be considered to be a part of earth system, understanding concepts of the formation process of igneous rocks are necessary to understand Earth science system. Before the study of crystallization differentiation in senior high school, it is possible to teach concepts of the formation process of igneous rocks like 'Minerals crystallize from magma first' and 'Minerals gather to form igneous rocks' in a learning plan in accordance with the development of the students. For example, we can teach 'Minerals crystallize from magma first' when volcanic ashes treated in elementary school, and 'Minerals gather to form igneous rocks' when igneous rocks in junior high school. In this way when and how concepts of earth system like concepts of the formation process of igneous rocks should be taught plays important role in education about the Earth science system.