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On linkage between researches based on observation and of elementary processes

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Cooperative researches of different methods on various aspects of phenomena became more and more important in any field science. Such cooperation seems to be working and will work well in volcanology. The success might be due to the fact that a variety of phenomena occurs at a clear and concentrated target of research (volcanoes and eruption); therefore various methods and type of studies can be applied to the same phenomenon and it is sometimes also possible, in particular for geophysical monitoring, that the monitoring results are modeled based on a single elementary process. However, accumulation of such observational researches and researches on elementary processes can lead the comprehensive understanding of volcanoes or volcanic processes?

Mathematical modeling of volcanic phenomena has be well developed based on individual modeling of elementary processes and evaluation of their non-linear interaction, that reveals us general behavior of the system which could not be expected only from a linear summation of elementary processes (Koyaguchi, 1995; 2008). Such understanding of general behavior of a system will lead us to the comprehensive understanding of volcanoes. In order to realize such understanding, the general behavior of the system should be described in the way that can be tested by scientific clarification, and the description is the important part of the research. Bifurcation mechanism of silicic magma eruptions between explosive and non-explosive is one of the most significant achievement of the modern volcanology. This modeling became possible because of the intuitive description about the similarity of magmas that caused explosive and non-explosive eruptions based on observation and analyses of eruptive products. Such general images of volcanoes or volcanic phenomena extracted from results of monitoring and observations are necessary to bring the related elementary process and their governing rules to the discussion.

Each datum has its own cause and can be modeled. However, not all the causes and their related elementary processes are equally important to understand the general behavior of volcanoes. Further, it is likely that only part of important phenomena could be detected by observation as most magmatic processes occurred underground. It is also likely that different observational methods are measuring signals from different parts the system or caused by different processes. Therefore, a simple accumulation of interpretations of different observation results does not necessarily results in the general image of the volcano or volcanic processes. We need to interpret each result within the framework of general images to test both the data interpretation and the general images by extracting essential phenomena from the pile of data and models.

Geophysical methods measure phenomena commonly caused by a single physical process and their results are relatively well interpreted based on mathematical models and elementary processes. Results of geochemical monitoring are commonly appeared as integrated phenomena of various processes which are hard to be described by a simple mathematical model, resulting in schematic but ambiguous models. Although it is a great advantage of the geophysical monitoring that the results can be directly interpreted based on mathematical models, it is also possible that completeness of the model does not require an effort to construct a general images which may reduce the completeness of their own model. In contrast, schematic models proposed by geochemical data might be schematic but describing movement of substantial materials; therefore each mathematical or elementary process model can be adjoined into the schematic model to test consistency of the models. In order to realize such cross-evaluation of interpretations and models, it is important to provide general images of volcanoes or volcanic processes from different view points even if they are inaccurate.

Keywords: volcano monitoring, elementary process, modeling