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# Quantitative Analysis of Rock Samples by ICP-Quadrupole Mass Spectrometer (QMS)

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ICP-Quadrupole Mass Spectrometers (QMS) can analyze multi-element quickly with high sensitivity. One problem is the interference by polyatomic molecules. For example, polyatomic molecules, such as ArO and ArCl, obstruct the analysis of Fe and As, respectively. In order to remove polyatomic molecules, ICP-QMSs using the collision gas was developed. For collision gas, generally inert gas such as He gas has been used. In this study, we try to analyze major and trace elements of standard rocks and volcanic rocks of Cameroon Volcanic Line by a ICP-QMS with He collision cell.

The iCAP-Q (ThermoScientific Inc) was selected for study. The plasma was operated at 1.7 kW and 27 MHz. The flux of Ar was about 16 L/min. The sampling cone can be removed easily without any tools and cleaning procedure is simple. The plasma gas, which is injected to vacuum system, is bended to 90 degree by an ion lens and reach to He Collision Cell. Neutral molecules are removed efficiently by the ion lens. Helium collision cell has a function as small QMS, removing interfering ions lighter than target element. The polyatomic molecules are also removed due to the reduction of their kinetic energy with He collision. The ions passing He collision cell go to the main QMS and their signals are detected by analog or pulse detections.

We used three standard rocks (JA-2, JB-2, and JB-3) and volcanic rocks at Borombi Mbo Volcano, Cameroon. The 50 mg of rock powder was put into 100 mL Teflon digestion vessel with 2.0 mL of 35 wt% HCl, 1.0 mL of 60 wt% $HClO_4$, and 0.5mL of 50 wt% HF. The vessel was set in microwave heating system (Multiwave 3000, Parkin Elmer Inc.). The microwave power was increased to 500 W by 50 W/min and kept over 60 min. After heating, the digestion vessel was cooled down to 50 ℃. In the cooled vessel, 2.5 mL of saturated H3BO3 water and 2.5 mL of pure water were added, and the vessel was heated by microwave heating system again. The micro wave power was increased to 1400W by 280 W/min and kept for 20 min. After cooling, pure water was added to the sample solution and total volume was adjusted to 50 mL.

Yields of major elements in standard rocks, except for Si, were almost more than 70 %. In case most of trace elements, those were also more than 70%. Furthermore, there was no significant difference in the yield of most elements when we analyzed several times for a common sample. It is found that major elements, except Si, and most of trace elements of volcanic rocks can be analyzed by using a single ICP-QMS. In case of volcanic rock samples of Cameroon, type of these samples were identified to be an alkali basalt based on Nb/Y versus $Zr/TiO_2$ diagram. This result is consistent to the previous study on Cameroon Volcanic Line (A. Marizoli et al., 2000).

Keywords: ICP-QMS, microwave digestion, volcanic rock, quantitative analysis, Cameroon