

Collaborative education on "Geochemical Experiment" and "Geological Survey" for undergraduate students in Earth Science department

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Department of Earth and Planetary Sciences of Nagoya University was the first integrated Earth Science department in Japan. It has strived to provide all of the department undergraduate students with core competences in geology, geophysics, and geochemistry. The lecture of "Geochemical Experiment" focuses on silicate rock analyses by classical wet chemistry. The rock samples are prepared during the lecture of "Geological Survey". All the undergraduate students learn geological mapping in two-week field as a compulsory subject, and during the fieldwork each student collects one rock sample to desire for chemical analyses. The collected rock types are various: igneous, sedimentary, and metamorphic rocks. In the first lecture of the experiment, to specify their objectives of geochemical analyses, the students hold debates: "Why did you choose the rock samples for chemical analyses?" "What do you wish to clarify from chemical data?" After the debate, they start chemical analyses of major elements.

The "Geochemical Experiment" contains most ingredients essential to geochemical analyses: *preparation* of rock powder sample, *digestion* of rock powder by HF treatment and alkali fusion, *gravimetric analysis* of SiO₂, *chemical separation* of hydroxide of Fe, Al, and Ti, *volumetric analysis* of Fe and Ca (EDTA titration) and *instrumental analysis* (atomic absorption analysis) of Na, K, Mg, Ca, and Mn. In the instrumental analysis, the students also learn preparation method of standard solutions. Through a series of experiments, they comprehensively acquire the essentials of geochemical analyses. These classical techniques are critical to more advanced instrumental procedures. Finally, the students make data analysis and discuss their results geologically and geochemically to make out reports.

This collaborative education on "Geochemical Experiment" and "Geological Survey" fosters excellent earth scientists and geo-engineers responsible for challenge to new scientific subjects and new geochemical techniques.