Experimental studies on radiation of light associated with rock fracture

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Rock fracture accompanies electromagnetic radiation at a wide range of wavelengths. We study electromagnetic radiation at visible bands, or specifically radiation of light. We conduct rock fracture experiments under conditions of a dark room and observe radiation of faint light with fractures. Our aim is to understand how radiation of light occurs in conjunction with rock fractures from photographic records of our experiments.

In studying luminous phenomena, it is usual to use spectrometers, since by spectrometers enable us to obtain precise spectra of the light. However, spectrometers are not suited for our purpose, since radiation of light with rock fractures is faint and a local phenomena. Our methodology is to use a digital single lens reflex camera (Canon EOS10D) to observe the radiation of light. This enables us to obtain information about the wavelengths of the radiated light from color photographs, despite not as much detailed as observations with spectrometers. Additionally, we can get the spatial information about the radiation of light, which is not easy to get with spectrometers. For the rock specimens, we used granite, tonalite, basalt, sand stone, marble and natural quartz crystal. For granite, we used samples from four different places and with different grain sizes. We also used quartz glass and artificial quartz crystal. Variation of specimens is an important aspect of this research.

We observed that granite with high quartz content and large grain size radiated the intense light at fracture. Quartz also radiated strong light. On the other hand, the specimens with low quartz content radiated no or little light at fracture. We could classify the light on the photographs into red light and blue light. For granite specimens, blue light is located in the vicinity of but not exactly on the surface quartz minerals.

We propose two mechanisms for the radiation of light which we could observe with fractures in the experiment. First is local heating as a result of the release of the strain energy with fractures, and second is excitation with air discharge drived by piezoelectricity of quartz crystals. The former causes red light, and the latter causes blue light.