Earth Engineering Technology Learnt from Low Temperature Serpentinization

*Tsutomu Sato[1]

1. Faculty of Engineering Hokkaido University

For our sustainable development, engineering technology in 21st century should be in safety, low-cost and environmentally friendly for human living together with the Earth. In such technology, not rare earth and platinum group elements but rather ubiquitous elements such as Si, Al, Mg, Fe should be used. Natural process is a physical, chemical and biological process existing in nature without the intent of human beings. Therefore, products and technology learnt from natural processes are available with low-cost and safety. In the natural processes, of course, ubiquitous elements play a key and major role. Not only civil and geological engineers but also engineering chemists and biologists are interested in natural processes for sustainable engineering technology. Especially, chemical processes at extremely alkaline environments have been attracted their attention for sustainable management of waste disposal used huge amount of concrete, recycling of alkaline materials such as cement, slag and fly ash, and so on. However, an understanding of the processes at such a hyperalkaline condition is not enough for safety assessment of the waste disposals and the recycling. In addition to this, many engineering chemists and biologists are also interested in the hyperalkaline processes for safety CO_2 geological storage, application of Fisher-Tropsch type reaction to natural system, and so on. Therefore, there are many contents to make lessons and be learnt from natural processes at hyperalkaline conditions. Fortunately, we can have the lessons at some ophiolites where occur low temperature present-day serpentinization.
Serpentinization has unambiguously been recognized as important geophysical and geochemical processes in mantle wedge and oceanic lithosphere. Serpentinized peridotite generally forms at reaction temperatures of 100–500˚C as indicated by chemical, mineralogical and isotopic data. On the other hand, temperatures of present-day serpentinization observed at ophiolites and Lost City vents are considerably lower (40–75˚C). This is in strong contrast to other known serpentinization systems. Thus, the temperature variability expressed by vent fluids from ultramafic-hosted hydrothermal systems on or slightly removed from mid-ocean ridge, is not altogether surprising. The low temperature hydrothermal field is characterized by a combination of extreme conditions never before seen in the marine environment. These conditions include venting of hyperalkaline and metal-poor hydrothermal fluids with high concentrations of dissolved H_2, CH_4. Huge amount of CO_2 gas is fixed into carbonate minerals observed in chimneys at the hyperalkaline vents and fissure filling of ultramafic rocks at the ophiolites.
In this context, the previous studies on low temperature present-day serpentinization will be reviewed from the engineering points of view (hazardous anion migration, CO_2 geological storage, hydrogen and methane generation, abiogenic hydrocarbon production) in this presentation with introduction of our studies (lessons) at Oman ophiolite.

Keywords: Serpentinization, Hydrogen, Methane, Carbon dioxide storage, Hyperalkaline