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Mineral Sciences and Fukushima Incident

In March, 2011, the fourth largest recorded earthquake occurred offshore from the Tohoku region of Japan. After the earthquake, the high tsunami waves hit the Fukushima Daiichi Nuclear Power Station (FDNPS) of the Tokyo Electrical Power Company (TEPCO). All electric power was lost to units 1 through 4 in FDNPS within fifteen minutes after the first tsunami wave hit the station, and this led to a blackout of the station, followed by a series of hydrogen explosions in the FDNPS. The series of hydrogen explosion resulted in the negative legacies such as the damaged nuclear power station, melted fuel debris, contaminated water, soils, vegetation and debris, secondary wastes from on-site water treatment, and huge volumes of the Cs-contaminated soil from decontamination operation off-site. The author, as an environmental mineralogist, has been involved in the countermeasure activities against the negative legacies of the accident. In this lecture, the author shows how applied mineralogy has been and will be an important component in the recovery of areas surrounding FDNPS and tries to promote the social and economic impacts of mineralogy based on the author's experiences after the accident.

On site, the contaminated water initially contained high concentrations of non-radiogenic Na, K, Mg, Ca, Sr, and Cl, which originated from seawater, as well as radioactive Sr, Cs, and I, which came from the damaged fuel. TEPCO started operating the treatment system with Cs/Sr removal system including synthetic zeolite and ferrocyanide compound for Cs, and crystalline silicotitanate for Sr due to their high selectivities. Other treatment facilities such as the multi-nuclide removal facility (Advanced Liquid Processing System: ALPS) have also operated to reduce the radioactivity of the 62 nuclides to below the limit specified by the Japanese reactor regulation, the system produces different kinds of spent slurry and adsorbents. Contribution from mineralogists and materials scientists is desired in the selection and optimization of materials used in the above system for efficient and economical treatment of water, as well as the safe storage and disposal of spent adsorbents.

Off site, because of aggressive decontamination efforts, huge volumes of the contaminated soil have been collected and placed under interim storage. The estimated volume of contaminated soils is approximately 22 million m^3. With this volume, it is difficult, both economically and logistically, to find appropriate disposal sites. Thus, the challenge is to reduce the volume of the contaminated soil destined for actual disposal, and to develop technologies to separate highly radioactive materials from bulk soils. In order to meet these challenges, identification of the host mineral and understanding the relationship between Cs and host minerals are necessary. This scientific information would be also useful in the safety assessment of interim storage sites and the reuse of the separated soils with low radioactivity.

The disaster at FDNPS has proven to be technically, politically, economically, and emotionally costly. From the view of commonality, recovery from the accident at FDNPS needs to accelerate to alleviate lingering personal and economic hardships for the people affected by the disaster as well as for the people involved in recovery efforts. Mineralogists must also understand that efforts in the water treatment and the decontamination should not only be conducted in scientifically sound ways but also in ways that are acceptable to the public. If mineralogists do so, they can ensure greater public understanding and support for the work of mineralogists, allowing them to thrive and continue their research.