Enhanced desorption of cesium from vermiculitized biotite by treatment with cations

*Xiangbiao Yin [1], Hideharu Takahashi [1], Toshihiko Ohnuki [1], and Kenji Takeshita [1]
[1] Tokyo Institute of Technology, 2-12-1, Ookayama, Meguro-ku, Tokyo 152-8550.

Abstract:
The objectives of present study are to clarify how Cs fixation on vermiculite is influenced by structure change caused by Cs sorption at different loading levels and how Cs desorption is affected by various replacing cations induced at different treating temperature. As a result, more than 80% of Cs was readily desorbed from vermiculite with loading amount of 2% saturated Cs (5.49×10^{-3} mmol g^{-1}) after four cycles of treatment of 0.01M Mg^{2+}/Ca^{2+} at room temperature, but less than 20% of Cs was desorbed from saturated vermiculite. These distinct desorption patterns were attributed to inhibition of Cs desorption by interlayer collapse of vermiculite, especially at high Cs loadings. In contrast, elevated temperature significantly facilitated divalent cations to efficiently desorb Cs from collapsed regions. After five cycles of treatment at 250°C with 0.01M Mg^{2+}, ~100% removal of saturated Cs was achieved. X-ray diffraction analysis results suggested that Cs desorption was completed through enhanced diffusion of Mg^{2+} cations into collapsed interlayer space under hydrothermal condition resulting in subsequent interlayer decollapse and readily release of Cs^+. The results were expected to provide new insights to explore available decontamination technology for Fukushima Cs-contaminated soils.

Keywords: Cesium desorption, hydrothermal treatment, volume reduction, ion exchange

After the Fukushima accident, radioactive Cs was widely dispersed and contaminated the north-eastern district of Japan, thus the topsoil has been stripped within the top 5 cm which is now just being stored in temporary storage sites because of its difficulty of decontamination. So it is urgently essential to develop more environmental friendly and efficient techniques performing desorption of Cs^+ ions from the clay soils.

The hydrothermal treatment (HTT) process is a newly testing method to desorb Cs from the vermiculite using the subcritical water (SCW) at high temperature. This process is much attractive because of its safety, accessibility, no any secondary waste and low cost. In our study, we clarified the effect of cation species and temperature dependence on the Cs desorption from the (un-)collapsed interlayer regions of a 2:1 phyllosilicate clay mineral, elucidated the corresponding desorption process and discussed the mechanism.

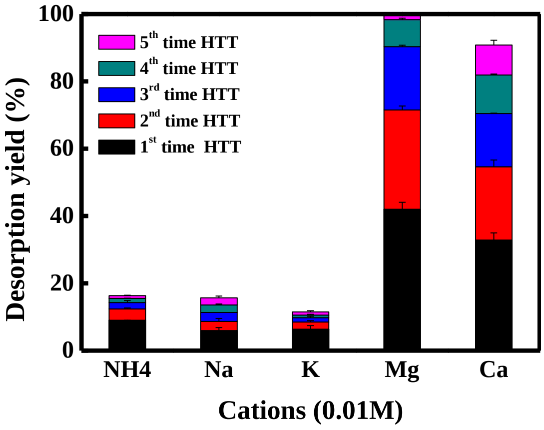

Fig. 1 HTT effect of seawater on the Cs desorption

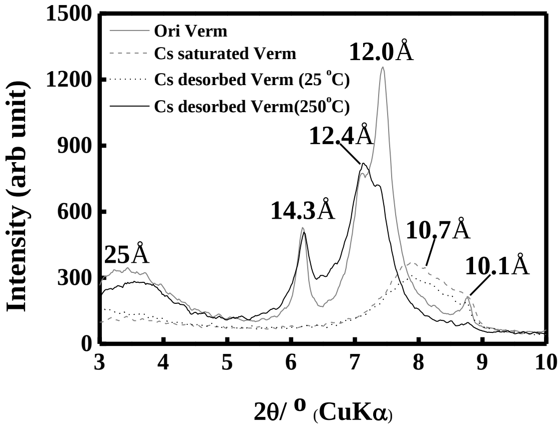

Fig. 2. The XRD profiles of samples

References

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