Carbon sequestration using asbestos-containing slate waste: detoxification of asbestos and carbonate mineralization

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Introduction

One of the representative asbestos-containing waste materials is a slate used as a roofing material. Asbestos-containing slate waste consists of chrysotile asbestos (10~20%) and cement (80~90%). As time goes by, calcium hydroxide which forms a constituent part of cement dissolves in water and chrysotile asbestos harmfully remain in the environment. Generally, asbestos-containing slate waste is dumped in controlled waste sites in Korea. However, this cannot be regarded as an ultimate solution because dispersion of asbestos fibers in the air is an intrinsic risk during dumping operations and in the long term management. An alternative solution is thermal transformation of asbestos-containing material into non-hazardous phase [1, 2]. Also, chrysotile is one of the raw materials to form carbonate mineral for CO_2 sequestration in previous studies [3, 4]. Therefore, the aims of the study were to detoxify chrysotile asbestos in slate waste via heat treatment and to sequester CO_2 using asbestos-containing slate waste via carbonate mineralization.

Materials and Methods

Two steps of experiments were designed: (1) transformation of fibrous asbestos into non-fibrous material through heat treatment after pulvering the slate waste and (2) synthesis of carbonate mineral, calcite ($CaCO_3$), via the physicochemical reactions of heat treated slate waste with CO_2. Chemicophysical properties of slate wastes before and after the treatment were investigated by TG-DTA and XRF analyses. And mineralogical characteristics of the slate waste and byproducts after treatments were examined by PLM, XRD, SEM, TEM and EDS analyses.

Results and Conclusion

Mineral characterization showed minerals such as chrysotile [$Mg_3Si_2O_5(OH)_4$], calcium hydroxide [$Ca(OH)_2$] and calcite ($CaCO_3$) in the slate waste were transformed to magnesite ($MgCO_3$), fosterite (Mg_2SiO_4), and calcium oxide (CaO) by heat treatment. PLM, SEM and TEM analyses showed that chrysotile fibers were transformed into rod-shaped forsterite. Calcite ($CaCO_3$) was formed after reaction of heat treated slate with CO_2. These results indicate that thermal treatment of asbestos-containing slate combined with physicochemical reactions with CO_2 can detoxify chrysotile asbestos in slate waste and sequester CO_2 by forming carbonate mineral.

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Geological Environmental assessment of Lakes Shinji-ko and Nakaumi by stream sediment, Shimane Prefecture, Japan.

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Lakes Shinji-ko and Nakaumi

Lakes Shinji-ko and Nakaumi are the continuous brackish water lakes representing Japan, located Japan seacoast side over Shimane and Tottori prefectures. These lakes had many brackish resources and sightseeing, and many researches have mainly been done water quality or an ecosystem. It is because declining of water quality and the influence on brackish products are becoming serious by human life in recent years [1]. In this research, we investigated the sediment from the river, which flows into lakes. It is because sediment is an basically very important for the ecosystem of the bottom of a lakes. Moreover, it is expected that the rate of an influence to a lakes will be estimatable.

Results and discussion

In this research, we observed the mineral composition of sediment by using of XRD-method and mode counting of minerals and rock fragments under the microscope. All sediment mainly consists of Quartz, feldspars and rock fragment, and accompany with hornblende, biotite, pyroxene, olivine and magnetite. There are no difference between Lakes Shinji-ko and Nakaumi. However, rivers which flow in from south of lakes show high ratio in "granite origin-mineral and fragment". This result is concordant with geological feather surrounding the lakes. That is Thertiary sandstone and mudstone is mainly consisting of Shimane peninsula, which closes the north of a lakes. The granite is widely distributed to the south of lakes. That is, it became clear that the chemical influence according to the geology of the basin is brought to a lake through each river. Importance of this is that the rate of the chemical influence in natural became calculable with the basin area of each river.

It makes clear that Hii river has most affected the lakes Shinji-ko and Nakaumi, as a preliminary report. And Iinashi river has also large affected the lake Nakaumi as well as Hii river. Matsumoto (2009) has reported the same result using a heavy metal element concentration [2, 3, 4]. Our preliminary report is concordant with the result and idea of Matsumoto (2009). In addition, Matsumoto (2009) show only Hii and Iinashi rivers, however we can show the almost all river surrounding the lakes. We are going to study these results in details further and to perform the environmental impact assessment to the lakes Shinji-ko and Nakaumi from viewpoints of a nature and a human life.

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