Potential hazardous elements release from coal reservior into undergroud water during the CO_2 geosequestration

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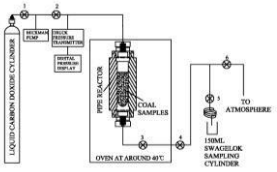
1. **Introduction –** Carbon dioxide is a major greenhouse gas (GHG) which causes global warming. The CO_2 geosequestration is one of the attractive way to reduce the concentration of CO_2 in the atmosphere. Coal reservoir is an important media which provide storage spaces for CO_2. However, the reaction between the injected CO_2, water and coal might influence the occurrences of elements in coal. Trace elements can be associated with either the inorganic or the organic matter of coal [1]. The injected CO_2 will react with react with the minerals in the coal, especially calcite [2]. As the reaction proceeds, more minerals are involved and the occurrence and content

of trace elements in the coal are consequently changed [3] resulting in some elements entering the underground water system. This paper presents the findings of trace elements (especially hazardous elements) release characteristics during the CO_2 geosequestration process.

Image 1. Sketch of the HP-$ScCO_2$ geochemical reactor



2. **Experimental –** We selected 2 coal samples for CO_2 geosquestration simulation experiment with a selfdesigned "High pressure $ScCO_2$ geochemical reactor" (Image 1). Water, CO_2 and coal samples were put into the reactor for 120 h at about 40 °C and 9.8 MPa. The coal samples before and after the $ScCO_2$ treatment were analysed with Inductively Coupled Plasma Mass Spectroscopy.

3. **Results and Discussion** – Table 1 shows the mobile rate calculation from the treated and untreated coal samples. According to the United States National Research Council, these harmful elements can be classified into three categories: the first category includes: As, B, Cd, Mo, Hg, Pb and Se, the second category includes: Cr, Cu,

Tabla I. Mobile rates of trace elements in treated and untreated coal samples (μg/g)

Samples	Sr	Zr	V	As	Be	Mn	Co	Cu	Zn	Pb	Mo	Ba	Cr	Ni	Cd
Anthracite	38.02	10.23	31.03	33.28	4.76	46.04	51.97	35.22	53.79	47.07	21.90	47.80	20.18	28.51	13.95
High volatile bituminous	40.43	18.18	21.42	31.10	12.73	37.03	62.89	30.37	49.11	57.14	20.51	37.31	18.26	27.02	3.77

F, Ni, V and Zn; and the third category includes: Ba, Sb, Sr, Na, Mn, Co, Li and Br [4].
Among the 15 trace elements in this paper, those with a high content in coal are Sr, Zr, S, As, Mo and Cd; and those with significant mobilization are Co, Zn, Mn, Sr, Ba, Cu and As. These elements might possibly enter the groundwater and cause environmental problems. Based on the mobilization, among the first category of elements, As has the highest mobility which is 33.28%, then Mo and Cd. The mobility of Pb cannot be calculated accurately as it was contaminated by the container, however, based on the background value, Pb should have a high mobility. Among the second category of elements, the mobilities of Zn and Cu are 53.79% and 35.22% respectively, and then Ni, V and Cr. Among the third category of elements, Co, Mn, Sr and Ba show greater mobilities of 62.89%, 46.04%, 40.43% and 47.80% respectively. Most of the trace elements show significant mobilization due to the reaction between $ScCO_2$+H_2O and minerals in the coal. Although the states of the elements existing in water are different after release from coal, most of the elements will occur in water as free ions, hydroxides or polyatomic acids. This means we should monitor the groundwater systems in coal mining areas to avoid environmental issues caused by trace elements (especially Pb, As, Cu, Cr and so on).

4. **Conclusions -** In this paper, we discussed the environmental effects of trace elements in coal during the CO_2 geosequestration process. It is reasonable to believe that during the CO_2 geosequestration, the environmental monitoring of trace elements in groundwater is very necessary and important, especially for elements that pose an environmental hazard such as Pb, As, Cu and Cr.