

Improvement of hydrogeological X-ray CT experiments using K absorption edges

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【Outline】

We performed computer simulations and experiments of the X-ray computed tomography (CT) using polychromatic X-ray sources. Effects of the K absorption edges of heavy elements on the beam hardening artifact were analyzed quantitatively to obtain the following two results: (a) and (b).

【Details】

(a) A CeCl_3 aqueous solution (0.55 mol/L) sample was imaged by medical CT. The atomic number and molar concentration were estimated by reproducing the degree of the beam hardening (the sample center is darker than the sample rim) of the experimentally obtained CT image by systematic computer simulations (Fig. 1).

(b) Two homogeneous sand pack samples (56 mm diameter) saturated with an iodine-bearing or tungsten-bearing contrast agent were imaged by medical CT. The obtained images demonstrated that the latter significantly suppressed undesirable beam hardening compared with the former, which is conventionally used in hydrogeological experiments (Fig. 2).

- Y. Nakashima and T. Nakano (2012) Japanese Patent (Appl. No. 2012-267612).
- Y. Nakashima and T. Nakano (2013) Presentation at the 69th annual scientific congress of Japanese Society of Radiological Technology (awarded the CyPos prize (bronze)).
- Y. Nakashima (2013) J. Hydrol. Hydromech. Vol.61, pp.347-351.

【Application of research results】

Item (a) is applicable to the nondestructive screening of hazardous geomaterials such as soil cores contaminated with heavy elements. Item (b) is useful for the more accurate determination of relative permeability curves that are necessary for CO_2 underground storage and for enhanced oil recovery.

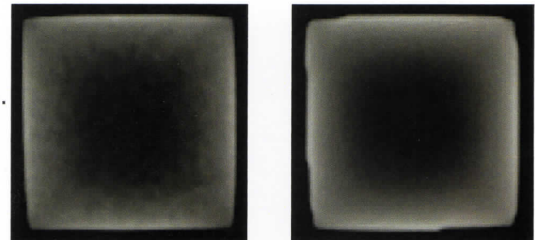


Fig. 1 CT images of a CeCl_3 solution in a plastic container (28 mm inside diameter) exhibiting beam hardening: (left) experimental and (right) simulated.

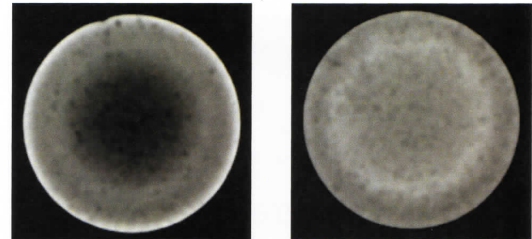


Fig. 2 CT images of sand pack samples with a different contrast agent: (left) KI 9.16 wt.%; (right) $\text{Na}_6\text{H}_2\text{W}_{12}\text{O}_{40}$ 8.80 wt.%.