5–5 Development of a Metal Adsorbent Using Bone Waste
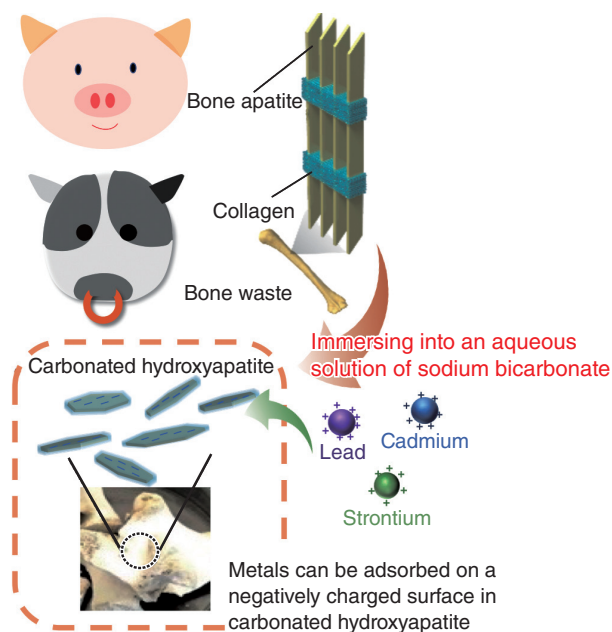## －A Low-Cost and High-Performance Metal Adsorbent Prepared from Food Waste－

Fig.5-10 Schematic of metal adsorbents using bone waste
Carbonated hydroxyapatites prepared from bone waste-adsorbed metal ions such as strontium and cadmium with high efficiency.

Fig.5-11 Distribution coefficients (K_d) of C_x-NHAPs, natural bone, synthesized HAPs, clinoptilolite, and mordenite
x in C_x-NHAPs corresponds to the concentration of $NaHCO_3$ (wt%) in the immersion solution.

Decontamination of a wide range of pollutants has been identified as a key challenge for building a sustainable and safe society, especially after the accident at TEPCO's Fukushima Daiichi NPS in 2011. The development of effective methods for removing pollutants from the environment remains an important research topic.

Biological hydroxyapatite (HAP) that can be extracted from animal bone is an interesting material because it exhibits greater adsorptivity for cadmium (Cd), strontium (Sr), and uranium (U) than those exhibited by synthetic HAPs. However, the ion-adsorption performance is lower than that of other conventional materials. The ion adsorptivity of biological HAP has been considered to depend on its highly substituted carbonate ions, but the adsorption mechanisms have not yet been fully elucidated.

This study aims to use bone waste to develop low-cost effective metal adsorbents that can adsorb ^{90}Sr and heavy metals (Fig.5-10). In this study, we focused on the correlation between the high carbonation substitution ratio, which is the most c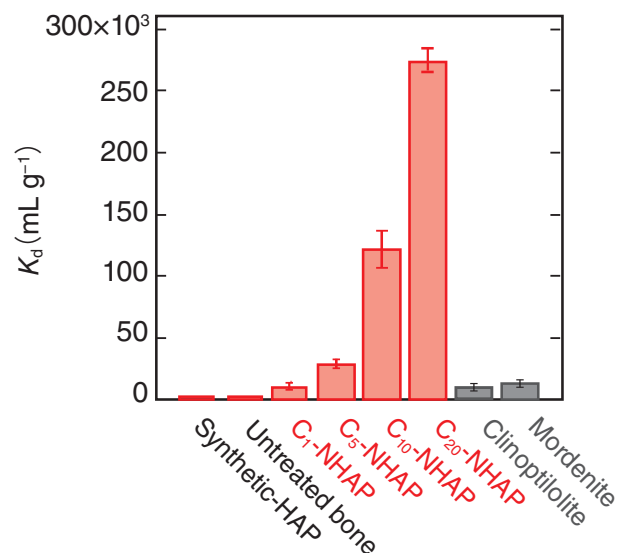haracteristic property of biological HAP, and adsorption performance. First, bulk pig bone was immersed in water and autoclaved to eliminate the residual organic compounds. Then, the heat-treated bone was immersed in aqueous sodium bicarbonate ($NaHCO_3$) solutions to obtain highly carbonated nanohydroxyapatites (C-NHAP). We investigated its performance with respect to the adsorption of Sr^{2-} and Cd^{2-}. The distribution coefficient (K_d) of the C-NHAP for Sr^{2-} was approximately 20 and 250 times greater than those of clinoptilolite and the untreated bone, respectively (Fig.5-11). The K_d value of the C-NHAP for Cd^{2-} was approximately 370 and 23 times greater than those of the untreated bone and clinoptilolite, respectively. The amount of introduced CO_3^{2-} into C-NHAP increased with the increasing $NaHCO_3$ concentration in the immersion solution. With the increasing amount of CO_3^{2-} ions introduced into the C-NHAP, it exhibited a greater ion-adsorption performance.

The CO_3^{2-} substitution approach presented in this study would be a useful strategy for the development of high-performance HAP adsorbents for toxic ions, especially ^{90}Sr, by efficiently using waste bones.

(Yurina Sekine)

Reference
Sekine, Y. et al., Carbonated Nanohydroxyapatite from Bone Waste and Its Potential as a Super Adsorbent for Removal of Toxic Ions, Journal of Environmental Chemical Engineering, vol.9, issue 2, 2021, 105114, 12p.