

Influence of hydrothermal transformation of amorphous silica on amino acid adsorption capacity

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Silica is the major component of the earth's crust and changes its structure with different crystallinity during diagenesis. Silica has been suggested to assist the chemical evolution of life because of its adsorption and catalytic capacities for organic matter (Bujdak and Rode, 1997). However, it is not known how these properties change with diagenesis. In this study, amorphous silica was hydrothermally transformed and its adsorption capacity for amino acid (Lysine) was investigated.

Methods

Silica gel (WakoSil-25SIL) was heated at 180°C until 48 hours with de-ionized water. The infrared (IR) absorption peak height ratio (Si-OH/Si-O-Si) was used as a measure of dehydration/polymerization degree (Ito and Nakashima, 2001). After this treatment, the silica was mixed with Lysine solution. Adsorbed Lysine was determined by Ion chromatography.

Results and Discussion

With increasing heating time of silica, the Si-OH/Si-O-Si ratio and the adsorbed Lysine gradually decreased (Fig. 1). The adsorption capacity of silica decreased by dehydration/polymerization. However, the adsorbed Lysine per specific surface area remains almost unchanged (Fig. 2). If the surface concentration of amino acid is the main factor for the chemical evolution of life, a variety of amorphous silica with different surface structures might be available for the amino acid adsorption process.

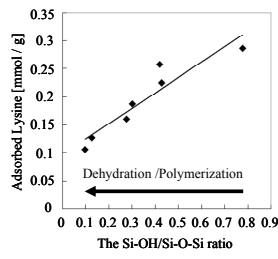


Fig. 1. The relationship between the Si-OH/Si-O-Si ratio and adsorbed Lysine [mmol/g]

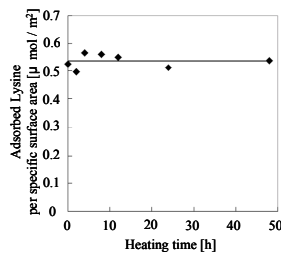


Fig. 2. Changes with time of adsorbed Lysine per specific surface area [$\mu\text{mol}/\text{m}^2$]

References

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Detecting the origin of saline solutions in salt deposits of the German Zechstein basin

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Considering the fact that salt is soluble in water, the problem that salt mines intruded by external water encounter the risk of flooding is obvious. However, the chance that liquids were inclosed in salt deposits during or after compaction is also known, but poses a considerably lower risk. The distinction of these internal and external inflows is vital for salt companies to avoid the loss of a mine by taking appropriate preventive actions.

One method to distinguish between open and closed inflows is the comparison of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ of the saline solutions to the global meteoric water line (e.g. Müller & Papendieck 1975). However, this method is indistinct when used stand-alone.

So far, we have analyzed 106 samples from 25 sites in 12 German mines and 11 groundwater wells for $^{87}\text{Sr}/^{86}\text{Sr}$ and the Sr concentration in addition to $\delta^2\text{H}$ and $\delta^{18}\text{O}$. One approach is the comparison of $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$ versus the stratigraphic position of the intruded salt rock. The isotopic oscillations of those saline solutions which are -for several reasons- considered to be of salt internal origin show approximately the same pattern. Since the two main processes -hydrothermal convection and continental runoff- that control both isotopic systems in seawater should generate anti-correlations for Sr and O isotopes in marine deposits, the genesis of the saline solutions has to be more complex. However, a link between the evolutions of $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$ must exist.

Regarding the Sr concentrations in the internal solutions, the Sr content of <3 ppm is comparatively low. In contrast, the samples from most of the open system solutions show much higher amounts between 15-240 ppm, probably absorbed from detrital clays deposited in the beginning of each evaporitic cycle. In addition, their $\delta^{18}\text{O}$ values of -12 to -10 ‰ resemble those of the groundwater in the vicinity of the mines. The internal solutions cover a wide range of -12 to +3 ‰. Their main ingredient is MgCl_2 which almost impedes the presence of Ca. Since the chemical attributes of Sr are similar to those of Ca, this could be one reason for the absence of Sr in salt internal solutions.

Based on the isotopic information, a distinction between open and closed system solutions is yet quite complex. However, the apparent usefulness of the Sr concentrations as a fast distinction tool is further to be evaluated.

References

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