

HYDROGEN ISOTOPE SORPTION CAPACITY OF CLAY MINERALS

PUSHKAREVA R.A., LYTOVCHENKO, A.S. & PUSHKAREV, A.V. (State Scientific Center of the Environmental Radiochemistry NAS Ukraine, Kiev, Ukraine)
E-mail: gnc-r@science.kiev.ua

The accumulation of hydrogen isotopes in different structural types of clay minerals is the subject of this work. The dependence of accumulation parameters from the ratio of heavy isotope concentration in the “water–mineral” system and from the time of water–mineral interaction was investigated. IR spectroscopy, β spectroscopy and DTA were used for the determination of the quantitative characteristics of the exchange in perfect and imperfect kaolinite, palygorskite, and montmorillonite.

It was established that the concentration of heavy H isotopes in all structural positions of clay minerals increased with the increase of their concentration in the aqueous medium. The accumulation of H isotopes also depends on the structural type of clay minerals, e.g. greatest absorption ability in all items is characteristic for palygorskite. Three types of hydrogen isotope accumulation capacity within the clay minerals have been discovered: as superficially absorbed water (C_{sur}), as interlayer water (C_{int}) and as structural OH groups (C_{str}). Absorption capacity is: $C_{common} = C_{sur} + C_{int} + C_{str}$, where C_{common} is the full capacity. $C_{sur} = f(N_d, properties)$; $C_{int} = f(cations, properties)$; $C_{str} = f(properties)$; N_d is the number of active centres on the surface of the clay mineral.

Structural peculiarities of clay minerals determine their *properties*. Comparative quantity of the OH groups in clay minerals with 1:1 structure (e.g. kaolinite) is more than with 2:1 structure (montmorillonite). Therefore there are more H bonding positions that can be exchanged to the heavy isotopes in the first structure than in the second. *Cations* denotes the type of exchangeable cations. In some case this item can be zero. There are no exchangeable cations in the structure of kaolinite.

The basic attention in the estimation of absorption capacity of clays has been given to the study of the accumulation of isotopes in structural hydroxyl groups. For the estimation of the quantitative absorption capacity of clay minerals the fractionation factor of hydrogen isotopes α was used, which is calculated according to the formula $\alpha = (H^*/H)_m / (H^*/H)_w$, where H^* is heavy hydrogen isotope (deuterium, tritium), H is hydrogen, $(H^*/H)_m$ in the numerator is the ratio of heavy isotope to hydrogen in mineral, $(H^*/H)_w$ in the denominator is the same ratio in water. Limiting theoretical significance α for montmorillonite is 0.94, and 0.97 for kaolinite. After the accumulation of tritium in the structure of montmorillonite the value of the coefficient α reached 0.6 (initial α was 0.002). Therefore the change of α expresses the levelling of heavy isotope concentration in the “clay mineral–heavy water” system which occurs during the short period time (to 180 days). In the case of kaolinite placed in heavy water α increased from 1.5×10^{-6} to 4×10^{-2} in 40 days.