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Natural Zeolites: Cation Exchange, Cation Arrangement and Dehydration Behavior

Thomas Armbruster

Introduction

Still 50 years ago natural zeolites mainly from vugs and fissures of volcanic rocks were considered a rare curiosity of nature. About 100 years ago chemists recognized that these minerals with a tetrahedral framework structure, characterized by internal porous space in form of cavities and connecting channels, can be used for ion exchange, molecular sieving, and catalytic reactions. Thus in the 1950s the chemical industry became engaged in the synthesis of these minerals. The industry aimed for chabazite but the synthesis failed and instead the most important synthetic zeolite LTA (Linde Type A) was produced. Simultaneously, geologists discovered huge deposits of natural zeolites mainly in altered volcanic tuffs. Whole mountain ranges on all continents consist of clinoptilolite, phillipsite, chabazite, and analcime with zeolite concentrations above 60%. Since this discovery there is a continuous competition between the pure but expensive synthetic products and the "dirty" but inexpensive natural zeolites. About 3.6 Mio tons of natural zeolites are annually produced. In contrast, 1.3 Mio tons of synthetic zeolites are annually consumed for detergents, catalysts, desiccation, and separation. Main applications (Armbruster, 2001) for natural zeolites are as soil conditioner, animal feed addition, ion exchanger for industrial-, agricultural-, and municipal- wastewater treatment, absorber of Sr and Cs radioisotopes in the nuclear industry and for clean up of nuclear accidents (Chernobyl), soil replacement (ZEOPONICS) in horticulture and also as cat litter. Even veterinary and medical applications are under investigation. In general, products from each natural zeolite deposit have a different favorable application depending on structure and chemistry of the zeolite. A sodian zeolite is not good for potable water production or horticultural applications but excellent for ammonia, Cs, Sr, Pb, Cd exchange in wastewater. A potassian zeolite is favorable for soil amendment

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