FACTORS AFFECTING THE REACTION PROGRESS OF PHYLLOSILICATES IN LOW-TEMPERATURE METAMORPHIC CONDITIONS

ÁRKAI, P.

Laboratory for Geochemical Research HAS [MTA Geokémiai Kutatólaboratórium], Budaörsi út 45., Budapest, 1112, Hungary
E-mail: arkai@geochem.hu

Certain phyllosilicate parameters such as the calibrated full width at half maximum (FWHM) values of the X-ray powder diffractometric (XRPD) basal reflections of illite-muscovite and chlorite have been widely and successfully used for determining diagenetic and metamorphic zones of rocks devoid of diagnostic or metamorphic facies-indicating minerals or mineral assemblages. These empirical parameters express the stage that was reached by a series of inequilibrium type structural and chemical transformations of clay minerals, i.e. the stage in inequilibrium processes called reaction progress.

Integrated XRPD, TEM, EMP, AEM, FTIR and other studies demonstrated that regular changes in proportion of swelling interstratifications (especially at lower grades), increase of mean crystallite thickness, change in shape of crystallite thickness distribution, and decrease of mean lattice strain (especially at higher grades) control these FWHM values formerly called "crystallinity" indices.

Temperature is generally regarded as the main, decisive factor that determines the reaction progress of phyllosilicates. In spite of this, "crystallinity" indices could never be used as geothermometers, and efforts aiming at the quantitative, overall valid correlations of these indices with other indicators of metamorphic grade (coal rank, mineral facies, etc.) failed because of

a) the inequilibrium nature of the reaction progress of phyllosilicates, and because

b) there are numerous additional factors that may influence considerably the processes mentioned above.

Some of these additional factors are: lithology, chemistries of bulk rocks and fluids, porosity and permeability of rocks, mineral chemistry, and various types of pressure (lithostatic, fluid, tectonic deviatoric) and strain, as well as the time derivatives of these factors (kinetic parameters).

At present, data and conclusions available in the literature on the effects of these factors are in part sporadic, and—to a great extent—controversial. This can be explained mostly by the fact that various, often extremely differing combinations of these factors may act in natural systems in function of geotectonic settings. Thus, additive or subtractive (extinctive) interrelations of these factors may result in strongly differing apparent diagenetic-metamorphic grades.

The lecture presents selected examples of case studies carried out with contributions of many colleagues from the Alpine and Carpatho-Pannonian regions in the past several years.

The effects of lithology and bulk rock chemistry on phyllosilicate assemblages, dioctahedral white mica and chlorite chemistries and "crystallinity" indices are discussed using characteristic formations from the Helvetic domain of the Swiss Central Alps, the Graz and Sausal Palaeozoic of the Upper Austroalpine Nappe System, Eastern Alps, the Palaeozoic of the Transdanubian Central Range and the Mesozoic of the Meliata unit (Western Carpathians).

Contrasting effects of tectonic shear strain on phyllosilicate characteristics in thin-skinned compressional settings are demonstrated by profiles cross-cutting the main nappe boundaries of the Helvetic domain, by profiles representing meso- (outcrop-) scale tight folds (Helvetic domain) and post-peak metamorphic mylonitisation in the Bükk Mountains (NE Hungary).

The effects of post-diagenetic fracturing on clay mineral behaviours are demonstrated on the example of a thick, monotonous albitic claystone formation from the Mecsek Mountains, Southern Hungary, which was selected for disposal of high-level radioactive wastes.

For complex interactions of the various factors could be proved in most of the investigated geological objects, only multi-methodological approach using petrographic (microstructural) observations, clay mineralogy, phyllosilicate "crystallinity" indices and organic maturity data may provide realistic results for petrogenetic interpretations.