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Detrital illite crystals identified from crystallite thickness measurements in siliciclastic sediments

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Abstract

Illite crystals in siliciclastic sediments are heterogeneous assemblages of detrital material coming from various source rocks and, at paleotemperatures >70 °C, of superimposed diagenetic modification in the parent sediment. We distinguished the relative proportions of $2M_1$ detrital illite and possible diagenetic $1M_d$ + 1M illite by a combined analysis of crystal-size distribution and illite polytype quantification. We found that the proportions of $1M_d$ + 1M and $2M_1$ illite could be determined from crystallite thickness measurements (BWA method, using the MudMaster program) by unmixing measured crystallite thickness distributions using theoretical and calculated log-normal and/or asymptotic distributions. The end-member components that we used to unmix the measured distributions were three asymptotic-shaped distributions (assumed to be the diagenetic component of the mixture, the $1M_d$ + 1M polytypes) calculated using the Galoper program (Phase A was simulated using 500 crystals per cycle of nucleation and growth, Phase B = 333/cycle, and Phase C = 250/cycle), and one theoretical log-normal distribution (Phase D, assumed to approximate the detrital $2M_1$ component of the mixture). In addition, quantitative polytype analysis was carried out using the RockJock software for comparison. The two techniques gave comparable results ($r^2 = 0.93$), which indicates that the unmixing method permits one to calculate the proportion of illite polytypes and, therefore, the proportion of $2M_1$ detrital illite, from crystallite thickness measurements. The overall illite crystallite thicknesses in the samples were found to be a function of the relative proportions of thick $2M_1$ and thin $1M_d$ + 1M illite. The percentage of illite layers in I-S mixed layers correlates with the mean crystallite thickness of the $1M_d$ + 1M polytypes, indicating that these polytypes, rather than the $2M_1$ polytype, participate in I-S mixed layering.