INTRODUCTION

The crystallization of illite has been recognized as a major and widespread post-sedimentary reaction in detrital sediments (see Środoñ 1999a for a recent review). Consequently, K-Ar dating of illite is an important tool for finding the ages of diagenetic and low-temperature metamorphic events (reviewed by Clauer and Chaudhuri 1995).

K-Ar dating of illitic clays is not much different from dating other K-bearing minerals. Previous concerns about Ar diffusion from small illite particles have been addressed by many authors (e.g., Aronson and Lee 1986; Hunzicker et al. 1986; Clauer et al. 1997 and literature cited therein) and were found to be unimportant in the temperature range of diagenesis and anchimetamorphism. Only the low K content of some clays (randomly interstratified illite-smectite) and the presence of organic material in the clay fraction pose specific analytical difficulties.

The real challenge in dating illite and illite-smectite is in matching the measured dates to the geological events during which the illitization occurred. Two phenomena make such interpretations difficult: (1) The specific nature of the smectite illitization reaction, which, in sediments, usually is not a single event, but is a reaction that continues over a broad temperature range, through burial diagenesis and anchimetamorphism (ca., 70 to 300 °C; reviewed recently by Środoñ 1999a); and (2) The detrital contamination of even the finest clay fractions of common sedimentary rocks (Clauer et al. 1997).

Because the burial of sedimentary rocks often is a long-lasting process, extending over millions or tens of millions of years, the ages of most sedimentary illites, even those free of detrital contamination (e.g., from bentonites), have to be treated as “mixed ages,” i.e., as values intermediate between the ages of end-member events.

Several authors have attempted to extract pure end-member ages from mixed ages (e.g., Aronson and Hower 1976; Mossman 1991; Pevear 1992). This specific aspect of illite dating also has been considered by the present authors (Clauer et al. 1997; Chaudhuri et al. 1999; Środoñ 1999b, 2000). The present contribution offers a more comprehensive treatment of these problems. It is based on an approach to dating mixtures developed by Środoñ (1999b, 2000) and discussed by Ylagan et al. (2000), which recognizes that, for purely mathematical reasons (a ratio and a logarithm in the age equation), a mixed age is not the mean of the end-member ages. Thus the linear technique of extrapolating end-member ages from a series of mixed ages (which is equivalent to considering the mixed age as a mean age) should not be used. Instead, mixed ages can be calculated by putting mean K and mean radiogenic Ar content into the age equation. Using this approach, the effects of long-lasting burial and of detrital contamination are considered separately below.

MODELING K-AR AGES OF DIAGENETIC ILLITE BY GALOPER SIMULATION OF ILLITE CRYSTAL GROWTH MECHANISM

The model

In the simplest case, we ignore detrital contamination and consider only the effects of burial history and of the illitization mechanism on K-Ar dates. According to our current model (Środoñ et al. 2000), illitization is treated as a process of nucle-