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INTERPRETATION OF K-AR DATES OF ILLITES AIDED BY TECHNIQUES OF QUANTIFYING CLAYS AND THEIR PROPERTIES

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K-Ar dates of illitic clays from sedimentary rocks may be "mixed ages", i.e., may be ages that are intermediate between the ages of end-member components. Two phenomena that may cause mixed ages are: (1) long-lasting reaction during the burial illitization of smectite, and (2) physical mixing of detrital and diagenetic components.

The first type of the mixed age can be modelled using thermal history data and fractions of illite crystallized at different stages of the thermal history. The fractions of illite can be obtained by modelling of the illitization path with the use of the computer program GALOPER, which simulates the evolution of crystal size in the course of illite nucleation and growth. Results of such modelling indicate that if burial is long-lasting, the resulting mixed age strongly depends on the burial history. Distribution of K-Ar ages with respect to crystal thickness is indicative of the illitization mechanism and the duration of the reaction.

The challenge offered by the second type of mixed ages is in extracting pure end-member ages of the detrital and the diagenetic component. This is done by the extrapolation of K-Ar data of subsamples, containing the two components in different proportions (grain size fractions). Any type of extrapolation requires a possibly accurate measurement of the proportion of the two components. If the detrital component is exclusively $2M_1$, the polytype ratio can be applied. A feasible alternative , insensitive to polytypes, is a decomposition of illite crystal size distribution into detrital and diagenetic component. This can be attempted using data from MudMaster, a computer program measuring crystal size distributions of clay minerals by Bertaut-Warren-Averbach analysis of 001 XRD reflections.

Dating of artificial mixtures confirms a non-linear relation between mixed ages and the proportions of the components, which makes the extrapolation technique based on K-Ar dates much more difficult to apply. It is advantageous than to apply the extrapolation technique to K and radiogenic Ar separately, because these values offer a linear relation with the proportions of the components. Both ages can be calculated from the extrapolated K and Ar values. This technique can be applied, if all non-illitic components of the sample have been quantified.

A quantitative XRD technique has been designed, which applies an internal standard (ZnO), random preparations, and idividual selected reflections, least sensitive to structural and chemical variations of minerals (060 reflections for clays). The technique has been automated recently using evolutionary programming. It keeps the main advantage of the original method: the use of "trusted" reflections, but avoids a disadvantage of operator-biased and time consuming manual decomposition of the overlapping peaks. A promissing complementary FTIR technique uses KBr pellets and also applies evolutionary programming to cope with the problem of background, of the scaling of reference spectra, and of fitting the spectra of mixtures with the spectra of pure standards. The FTIR technique is particularly accurate in quantifying kaolinite and quartz admixtures.

Using available quantitative mineralogical data, the classic vertical variation of K-Ar mixed ages from the Gulf Coast shales can be modelled by assuming diagenetic illitization that overprints a subtle vertical trend (presumably of sedimentary origin) in detrital mineral content.

ZUM CHEMISMUS VON 2:1-TONMINERALEN IN DER RINGVERSUCHSPROBE „TON STOOB“ ALS DATENBASIS ZUR NORMATIVEN ERFASSUNG DER MINERALOGISCHEN ZUSAMMENSETZUNG

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Zusammenfassung:

Mit den Ergebnissen der elektronenmikroskopischen Untersuchungen an der Ringversuchsprobe „Ton Stoob“ hinsichtlich des Auftretens und der Beschreibung der chemischen Zusammensetzung der einzelnen smektitischen und illitischen Phasen (KASBOHM et al. 2002) wurde unter Anwendung der modifizierten CIPW-Norm die normative mineralogische Zusammensetzung an der Tonprobe Stoob (<2 µm) erneut berechnet.

Aus den TEM-EDX-Resultaten in KASBOHM et al. (2002) lässt sich ein eher beidellitischer Charakter für die Smektite in der Probe Stoob ableiten. Die Vielzahl der mittels TEM-Untersuchungen differenzierten Phasen und ihre qualitativ chemisch ähnliche Zusammensetzung erschwert jedoch die Festlegung von Leitelementen für die Anwendung der modifizierten CIPW-Norm. Das Erstellen von Szenarien hinsichtlich der Art und Weise der Zusammenfassung chemisch ähnlicher Phasen für die Berechnung der normativen mineralogischen Zusammensetzung kann hier einen Lösungsweg darstellen.

Es werden zwei Szenarien mit insgesamt sechs Optionen vorgestellt. Das Szenario I, „Strukturformeln gemäß CIPW-Mineralverteilungsmuster”, ist identisch mit den Vorschlägen aus TARRAH et al. (2001). Für das Szenario II, „Strukturformeln gemäß TEM-EDX-Analytik“, wird aus Plausibilitätsgründen Option 3 (Orthoklas: 5 %, Beidellit+Fe-Beidellit: 19 %, mögliche 50:50 Übergangsstruktur Montmorillonit-Beidellit: 28 %, illitische Strukturen: 29 %, Kaolinit 12 % sowie Quarz: 4%) favorisiert. Im Vergleich zu Angaben entsprechend Szenario I (aus TARRAH et al., 2001) wird neben einer Spezifizierung der smektitischen Komponenten nun auch ein höherer Anteil an Dreischichtsilikaten und eine wesentlich geringere Kaolinit-Menge prognostiziert.

Zur Verifizierung der eingesetzten Szenarien können weitere phasenanalytische Verfahren herangezogen werden, z.B. Differential-Simultan Thermoanalyse (DTA/TG) zur Überprüfung der zu erwartenden Masseverluste durch Dehydroxylation der Schichtsilikate. Bei der Berücksichtigung der DTA/TG-Ergebnisse bedarf es noch einer Überprüfung des Anteils organischer Substanz in der Probe Stoob.