Clays and Clay Minerals, Vol. 34, No. 5, 612, 1986.

BOOK REVIEW

Shale-Slate Metamorphism in Southern Appalachians by C. E. Weaver and Associates. Developments in Petrology 10, Elsevier, Amsterdam, New York, 1984. 239 pages, hardbound. $69.25 ISBN 0-44-442264-1.

This book represents work completed for four masters theses and independent study problems under the direction of C. E. Weaver over apparently the last six or seven years. For this reason, there is a great coherence in the theme and the method of investigation. It is rare to find such a body of information concerning a given geologic subject, in this case, the Paleozoic sedimentary rocks of the Valley and Ridge Province of Georgia, Tennessee, and Alabama. Further, it is apparent that a large amount of thinking went into deciding what methods were to be used in the study. This has resulted in the use of scanning electron micrographs (SEM), X-ray powder diffraction (XRD) measurements, oxygen isotope and potassium-argon determinations, and bulk chemical analyses of different size fractions of the shales in the province under study.

The problem facing the authors was the following: how can one characterize the transition between the diagenetic facies for phyllosilicates to those of metamorphism. The problem is not simple, and despite the sophisticated tools used, many imprecisions remain in the methods of characterization. No one can fault the authors, however, for not having done their utmost to solve this very important geological problem. It is interesting to note that the publisher chose to place this book in his Developments in Petrology series, because the book actually attempts to define the limit between what is considered clay mineralogy and what is considered to be metamorphism. Neither of the now classical methods of petrology—petrographic microscopy or electron microprobe analyses—are applied or dealt with in detail in the text. The methods and criteria used are primarily those of the clay mineralogist.

The major chapters in the book begin with a description of the texture of the shales as derived from SEM images. This approach is useful, but despite the many excellent micrographs presented, new insights or analytical procedures remain rather vague. The next two chapters deal with the XRD characteristics of illite, chlorite, and low-smectite-content illite/smectite which remain in the shales during the last stages of diagenesis. The Weaver and Kubler XRD indexes of illite crystallinity are compared with other XRD and chemical properties of the illite and accompanying clay minerals. Some new data on the chemistry and stability of clay minerals in acid media are presented, and some new insight is offered into the chemistry of the individual phases; however, little information is presented on the relative stabilities of the different types of clay minerals and on the importance of grain size and crystal structure to mineral stability.

Isotopes of oxygen and argon and potassium/argon values are discussed next. The old problem of validity of the laboratory analytical technique vs. the attainment of mineral-chemical equilibrium in the field reappear. The data appear to be generally consistent, but the scatter in several plots leads one to believe that the heart of the matter has not been reached. The Weaver and Kubler XRD indexes still seem to give a better idea of the stage of diagenesis or metamorphism than do isotope determinations. The next two chapters deal with the chemical characteristics of the several clay minerals as functions of thermal and tectonic (differential pressure) conditions and as a function of the bulk chemistry of the rocks. The eleven-page general summary is useful, and a final chapter on carbonate clay mineralogy indicates that the same reactions which govern the types of phyllosilicates to form in shales operate also in carbonate rocks.

This brief review shows the depth of investigations that the authors carried out on the diagenesis-metamorphism transitions in these shales. The mineralogical characteristics of the phyllosilicates in such environments are important in that future resources of natural gas will undoubtedly be closely associated with these grades of metamorphic change. The development of a coherent means of identifying the attending mineralogical changes is necessary if mineralogists wish to communicate with their petroleum geologist colleagues. On the negative side, it is unfortunate that the authors did not use some of the other modern methods that are currently available, such as electron microprobe analyses, which provide data on the extent of chemical homogeneity of the phases under investigation. Such data might have provided information that could have explained, for example, the scatter in the several isotope-determination diagrams.

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