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Introductory Remarks

M. L. Coleman

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Introductory remarks

By M. L. Coleman

The following papers resulted from a Discussion Meeting held on 26 and 27 January 1993. Preoccupation with sedimentary diagenesis is not an activity new to the Royal Society. The first volume of *Philosophical Transactions* includes reference by an anonymous author (1665) to work on diagenetic concretions. This volume arguably evolved from that work, but a much more direct link can be traced to another Discussion Meeting, 'Geochemistry of buried sediments', held in June 1984 (Eglinton *et al*. 1985). At that time it helped to codify many of the collected observations of the previous years into an understanding of general, underlying processes, as demonstrated by Brassell (1985). In addition, novel techniques were reported which allowed new observations to be made, as shown by Lewan (1985).

The aims of the meeting reported here were (*a*) to appraise these qualitative understandings by reviewing their quantitative constraints; (*b*) to help progress towards an holistic understanding of diagenesis. Juxtaposing the quantitative results from disciplines, which separately contribute to the subject area, we hoped to identify which pieces of the scientific jigsaw puzzle do not fit. This will help focus future research effort to resolve the apparent anomalies. Again, we included descriptions of newly understood processes, relevant novel techniques and their results, which will contribute to the next generation of understanding.

Most aspects of the subject, from controls on sediment input to its deep burial, were considered. Climatic change is a plausible control on composition and rate of sediment supplied to a basin (Degens 1989). Release and redistribution of stored sediment (within a catchment) is a major factor which controls accumulation rates in modern systems. However, there are dangers in the unrigorous application of palaeoclimate indicators to old rocks. The present, recently postglacial climate may not be a suitable geological model (Johnson & Baldwin 1986) and thus the present is not necessarily the key to the past. This iconoclastic concept recurs throughout the following papers; however, it is not always clear that the relatively recent climatic changes are the cause.

A key question in clastic sediment diagenesis is: how much material has moved into or out from the system (Gluyas & Coleman 1992) and how much has just been locally redistributed? (Bjørlykke 1983). The same question is pertinent to limestones. Careful, quantitative observations now show that much carbonate produced in shallow shelf environments is dissolved (an indirect effect of microbial processes), leaving only a variable, small proportion to form rocks subsequently. Although carbonate mineral fabrics may be ascribed to specific diagenetic environments (Bathurst 1975), molecular dynamics modelling now shows how crystal form can be related directly to conditions of origin (via process rather than empiricism).

Microbial processes too are now better understood by modelling. Too often previously, bacterial effects were explained by reference to observations of selected, laboratory-cultured strains. Understanding the complex interactions within microbial communities can be achieved by computer simulation; however, novel biochemical methods have been developed for *in situ* quantification of microbial

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community structures and nutritional status (White 1988). Diagenetic concretions result from microbial activity (Curtis 1977) and may focus diagenetic products from a larger sedimentary section into one bed, differentiated by its mineral composition. This allows a plausible connection between climate and cyclicity in the sedimentary record. Climate might control mineral composition of sedimentary input, which in turn might allow diagenetic amplification of that signal via microbial processes (e.g. Fe(III) reduction in iron-rich beds).

Despite the significance of the topic, quantification (by mass balance) of the chemically most active parts of the system reveals the shortcomings in our understanding of the interactions of iron, sulphur and organic matter. Even attempting mass-balance of organic carbon diagenesis alone reveals the gaps in our knowledge. Numerical tests of conceptual models give a powerful method for their validation or constraint. Quantitative description of timing, temperature and source of components for burial diagenetic products in sandstones has revealed a damaged paradigm and exposed unexpected processes. The amount of silica introduced to sandstones seems to exceed reasonable models for its transport (Robinson & Gluyas 1992), while the process of simultaneous petroleum-emplacement and porosity-loss by quartz precipitation has been observed recently but not yet understood. New techniques (particularly for noble-gas geochemistry) allow analysis, and thereby characterization, of fluid sources from minute samples. Noble gas results on fluids produced from hydrocarbon fields give surprising results on large-scale fluid movement in basis. The accumulation of natural gas in one field in a sedimentary basin (Ballentine *et al.* 1991) contained radiogenic noble gases swept from a large proportion of the sedimentary fill of the basin. Such focusing of flow was unexpected. Recently developed models interactively couple flow and fluid properties. This is an improvement over an earlier generation of models and allows more realistic simulation of hydrological observations made in sedimentary basins. More general, powerful approaches give models which couple flow with chemical reaction. Components of the sediment may be dissolved, carried by the flow and re-precipitated, thereby modifying porosity and permeability, and thus altering flow rate. Modelling this complex process allows understanding and prediction of diagenetic self-organisation on a number of scales.

It is clear that the genetic trait inherited from the previous Discussion Meeting is expressed in this one. The debt to earlier research is apparent, and we trust that this work will serve similarly to act as part of the foundation for future research directions.

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