

Siliciclastic Diagenesis and Fluid Flow: Concepts and Applications

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Review by Christopher G. Kendall

It is aimed at geologists with an interest in the interaction between siliciclastic diagenesis and interstitial fluids. It provides an understanding of how the mineralogy, texture, and geochemistry of the original minerals forming siliciclastic sediments interact with formation waters to produce the fabrics that we see in rocks today. The book is broken into two parts. Part one deals with the concepts related to variations in fluids, the composition of the rocks and how these two interact on a theoretical and practical basis. Part two focuses on applications of these concepts to real world examples.

The book begins with a paper which discusses how chlorides interact with siliciclastics driving them towards a metastable equilibrium, in which multi-phase silicate and carbonate minerals form and describes how these can be modeled using simple mass balance techniques. The next two papers investigate how variations in hydrologic regime can effect sandstone diagenesis. One deals with the influx of fresh waters into the San Joaquin Basin and the other deals with marine fresh water interactions in the cyclic Cretaceous sediments of the Western Interior of the USA. This is followed by a paper which reports on how deeply sourced basin waters of offshore Texas have affected the Miocene reservoirs there. Then there is a paper on the use of geothermometers in petroleum environments. The next three papers deal with more impermeable sediments in the rock record, looking at fluid flow regimes in the Powder River Basin; how organic matter affects authogenic illite/smectite inversions in the Devonian black shales of Michigan and Illinois Basins; and another on sources of silica from illite to muscovite during late stage diagenesis of shales.

Part Two deals with applications and focuses on implications of diagenetic processes with respect to reservoir quality and hydrocarbon production. The first of these papers considers layered fluids in the South Brae Oilfield in the North Sea, reporting on the relationship between the oxygen isotopes in the quartz overgrowths in the South Brae reservoir sandstones. In the next paper the effect of early siderite cementation on reservoir quality of submarine fan sandstones in the Val Verdi Basin is examined and it is demonstrated that early siderite has inhibited later porosity loss through compaction of the sediment. The next paper deals with how compaction can be quantified and how pressure solution and quartz cementation is driven in the moderately and deeply buried quartzose sandstone of the Greater Green River Basin in Wyoming. Then there is a paper on the early diagenesis and development of paleosol features of ancient desert sediments in the Permian Basin of West Texas and New Mexico in which the authors have developed criteria for the separation of marine vs. paleosol diagenesis. Next is a paper on organic and authogenic mineral chemistry of the Delaware Mountain Group in which a model is developed for the mobilization of organic matter and the authogenic minerals of this group of rocks. The interpretation of the porosity of the sandstones is that it is largely secondary in origin and is related to the dissolution of calcite cements. It is proposed that organic matter was in part responsible for the development of this dissolution and so enhances porosity. Then there is a paper on the origin and timing of carbonate cements in the St. Peter Sandstone of the Illinois Basin which proposes the carbonate cementation of these sediments is related to the Mississippi type mineralization. The last paper in the book deals with diagenesis induced during thermal heavy oil recovery. The grain size is used as a predictor of

reservoir alteration. The paper records that fine grain materials continue to alter as the reservoir produces hydrocarbons while smectite transforms to illite.

This elegant volume is beautifully illustrated with many photographs, beautiful line drawings, and some photomicrographs of various petrographic fabrics. The book is well produced, well edited and contains abundant information on a great number of new and intriguing fields of studies, including bacterially induced cementation vs. the alteration of rocks during hydrocarbon production.

The book ties the petrology and alteration of the siliciclastic rocks to the movement of fluids through their fabrics relating this to sequence stratigraph or more classical interpretations of the geology. Those of you who have an interest in siliciclastics and diagenesis will find that this is a book you should probably purchase. It is beautifully illustrated, clearly written, and a book that you should have in your personal library if you are at all active in this field. If you plan to work in siliciclastics in the future, you should try and encourage your university or company to acquire this book for their library. An elegant production, well worth buying.