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Sequence Stratigraphy of Clastic Systems

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The Physical Environment of the City of Greater Sudbury

D.H. Roussel and K. J. Jansons (Editors)
Ontario Geological Survey
Sudbury, Ontario
Special volume 6, 2002, 228 p.
Hardcover $33
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Sudbury is one of the most famous mineral producing areas of Canada, with more than 120 years of dependence on its geological resources. According to the editors, this book represents more than 10 years of effort to assemble a summary of the hydrogeology, Quaternary geology and hydrology of the area and the impact that mining has had on the physical environment and urban development. This information, as pointed out in a preface by the Mayor of Sudbury, has hitherto been unavailable but is key to the city reinventing itself as a major urban hub of Northern Ontario with decreased dependency on mining. Ironically, as its mineral wealth becomes of decreasing importance to the city's long term future, there is greater pressure to put geoscience information into the public domain to guide future land-use planning.

There are ten chapters in the volume, which opens with a substantial review of the physical environment of the Sudbury area and its influence on urban development. It is a long story from the inception of Sudbury as a small Canadian Pacific Railway village in 1883, the first shipment of ore in 1886, the formation of Falconbridge Nickel Mines Ltd in 1928 and the opening of new company towns (largely unplanned and poorly serviced) rooted by their mines below. The narrative includes the influx of french speaking settlers taking advantage of the agricultural potential of the area's glacial sediments, the construction of the famous Inco stack, at Copper Cliff, at 155 m the then highest in the British Empire; and on to the development of the infamous Sudbury 'moonscapes' of the 1970's consisting of more than 1000 km^2 of barren and impacted land. This story is well told and a good introduction to the rest of the volume. A second chapter provides a tightly written overview of the bedrock geology and mineral deposits of the area, and though clearly derived in large measure from the two-volumed 1992 Ontario Geological Survey publication, *Geology of Ontario*, is superior in that it contains thumbnails of the geology of the principal mines and up-to-date models for mineralization. Subsequent chapters review the area's Quaternary geology and the geotechnical properties and hydrogeological conditions in such sediments, and of the bedrock. An excellent well-illustrated chapter reviews the effects of mining and smelting on Sudbury's landscape; this and the following chapter on the impact on area lakes, principally Kelly Lake, underscores the effectiveness of government emission control initiatives implemented under various acid rain programs. The release of sulphur dioxide and particulate emissions from Sudbury smelters for example, was more than halved between 1970 and 1980, defining a turn-around decade for the environment of the city and its inhabitants.

With a single exception, such as the brief and exceptionally bland chapter written by two city planners that concludes the volume, all contributions to *The Physical Environment of the City of Greater Sudbury* provide very useful overviews and lengthy lists of references and as such represent major additions to public knowledge. Overall, the volume provides ample confirmation of the efficacy of federal and provincial environmental initiatives in moderating environmental impacts from mining and smelting; this volume is an attempt to ensure that good geoscience information is available for sound policy and land-use planning at the municipal level. The volume is well produced and edited, makes a valuable contribution to the geoscience literature of the Sudbury area and as such is a welcome addition to libraries.

Sequence Stratigraphy of Clastic Systems

by Octavian Catuneanu
Geological Association of Canada
Short Course Notes, Volume 16
2003, 248 pages, $ 85

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Research, exploration and understanding of the stratigraphic controls on sedimentary successions and their enclosed resources, has progressed rapidly in the last quarter-century, although the real roots of the discipline date to Barrell (1917). The more recent realization that the internal architecture of sedimentary successions and the links between sedimentation, unconformities, time relationships and base-level changes can lead to novel resource exploration models and interpretations, fuelled an enormous international effort to understand the processes involved and the variety of resultant geometries. As the author of this book states, *Sequence Stratigraphy of Clastic Systems* is an attempt to "provide an in-depth coverage and critical assessment of all current ideas and models in the field of sequence stratigraphy", in order to "build a bridge between the various sequence models currently in use, facilitating communication among its practitioners and demonstrating that sufficient common ground exists to promote a unifying theory". These are grand aspirations for a set of Short Course Notes! Does the publication measure up?

This summary volume is divided into two parts, the first dealing with basic concepts and the ubiquitous jargon (including 9 chapters, 175 pages), and the second presenting practical applications of sequence stratigraphy to several clastic depositional systems (including 4 chapters, 55 pages), with a short 2-page Conclusion. The extravagant difference in page content between theory and application sections may in itself be telling us something important about one of the prime problems with

sequence stratigraphy at present: too much emphasis on competing theoretical models and jargon systems (although these certainly have their place as initial hypotheses or final syntheses) and too little emphasis on the real practicalities of commonplace usage at a modestly exposed outcrop or on a small-scale well log (which geologists are actually faced with each day). Part I provides a review of the history, concepts, evolution, misconceptions, benefits and pitfalls of sequence stratigraphy, and should be required reading for all practitioners because it cautions against blind trust in any of the various methods. There is a thorough effort here to fully detail all the rival methods and jargon systems proposed so far, but with lesser critical evaluation of these different approaches, or effort to sort through all the competing terms to streamline the nomenclature. In some ways it is really an exposition on the astounding plethora of nomenclatural jargon with which sequence stratigraphy has grown up (rather than matured) and reads more like a Glossary of Geological Terms than a true summary. The point of all stratigraphic studies should be to reduce apparent chaos to a more manageable, simplistic and easily interpretable framework, rather than make it more mysterious. Having gathered everything together in one place, Catuneanu provides an excellent opportunity to sift, sort, toss out and recast this material, to create that simplified and eminently practical synthesis. But, I believe that that process requires further critical assessment than is presented here. Perhaps the discipline requires more distillation before that process can be properly undertaken. However, the final discussion of Chapter 9 of Part I (5 pages) acknowledges the central (dominant?) role of tectonics in ultimately controlling stratigraphic cyclicity, and the key concept of "shifts in depositional trend at the shoreline" as the central element in practical sequence stratigraphic analysis. Here the author provides much firmer ground for laying the foundations of synthesis, and perhaps, points the way to the future. As Embry and Catuneanu (2002) said, "The current consensus is that sequence stratigraphy has a lot to offer but that the discipline is burdened by an unwieldy and overblown jargon, and that it is long on theory but short on practical application".

Part II provides a review of well-known facies concepts, as often summarized elsewhere, and treatments of the application to three separate depositional systems. The first, on non-marine clastic systems, discusses the difficult application of sequence stratigraphy to fluvial systems, but gives very little information on lacustrine and aeolian systems, although there are relevant studies available. The sections on coastal/shallow marine, and deep marine systems are actually simply reviews of facies material (all available in more useful forms elsewhere) and lots of photos of sedimentary structures, with very little discussion of sequence stratigraphy. Although Part II was meant to help geologists apply all that theory from Part I in every-day situations, this unfortunately ends up as the weakest portion of the book, with little practical demonstration of methods at all. Disappointingly, none of these sections use real outcrop photos, measured sections or well log cross sections to demonstrate principles or techniques. I'm not sure a student or professional would come away from this volume, as it stands, with a better idea of how to actually identify any of the truly important surfaces or systems tracts at an isolated outcrop, or how to correlate an ambiguous subsurface cross section. However, it is possible that exercise material presented in-class, but not included here, was more successful.

So, *Sequence Stratigraphy of Clastic Systems* does provide encyclopaedic, in-depth and unbiased coverage of all current ideas and models in the field, and I commend the author for this effort. It certainly gives us the opportunity to try to sort out and improve the sequence stratigraphy mess. However, it is less expansive on critical assessment, analysis or synthesis of those theoretical concepts and jargon-filled models. Overall, this book presents more detail on the theoretical side and copious terminology of the rival model systems than we can absorb, but less useful demonstration of the practical applications. Here, in microcosm, we have the classic duel between the seductiveness of jargon-filled, model-driven science (which might lead the enthusiastic initiate into boundless over-interpretation beyond the real data) vs. the drab actualistic data-driven science (which, conversely, might lead the cautious practitioner to miss extending standard interpretations to the next, perhaps more valuable and imaginative, level). This may be, unfortunately, an encapsulated commentary on the state of sequence stratigraphy today. The next step of providing a clear, concise theory and methodology perhaps can be a major goal of a later edition: as yet, the hoped-for "Unifying Theory" is not well articulated here.

I can recommend this book as a stand-alone guide, but with some reservations. Catuneanu has covered the ground in excruciating detail, more than most people could comfortably absorb, but provided less guideline information on the real threads of logical truth that matter, or on the realistic application in the less-than-ideal real world most geologists toil in. How do we *unequivocally* identify each of the various surface types on a well log or outcrop, and in fact, which surfaces are truly crucial to most workers' practical needs? Which of the numerous systems tracts touted by various authors will really help us map out an important facies? This voluminous outpouring of contending theoretical postulates, giving each researcher's system its fair due, is commendable but, ultimately, confusing. There is some critical evaluation buried here and there, but finding it requires wading through a sea of subtly different concepts. It certainly provides a baseline record of where we are and how we got here (muddled as that may be), but is less successful in pointing the way to the future. In the end, we are left with the advice to use our common sense in each different situation - a state of mind most of us had already adopted, waiting for the dust to clear. For those interested in an encyclopaedic catalogue of every theoretical idea and term of jargon which has yet been proposed, this is your dream come true; for those

interested in one workable practical application of a "quick-and-dirty" methods approach, utilizing real examples from the real world, I would recommend Embry and Catuneanu (2002). However, I repeat my previous caveat, that taking the classroom short course itself likely provided much more "hands-on" experience.

Not surprising in a set of Short Course Notes, there are a number of minor spelling/grammatical/editing errors (eg. "Walter's Law" appears several times instead of Walther's Law), which will likely be rectified in later editions. Although the volume is well-illustrated and the photographs are of high quality, there is a preponderance of sedimentological photos that don't effectively demonstrate the principles of sequence stratigraphy, and of model-driven line drawings. The spiral-bound, soft-cover format is convenient, low-cost and appropriate for a publication that could receive daily use for a few years (particularly by students), later to be replaced by updated versions (already planned) as the content evolves.

The author states in his Preface "This volume should therefore be seen as work in progress, and comments from the readership will be most welcome". I encourage professionals and students alike to read carefully, sift, absorb, and analyse the contents, then take the author up on his offer for comments. Not only this book, but also sequence stratigraphy itself, is still a work in progress.

Barrell, J. 1917. Rhythms and the measurements of geological time. Geological Society of America Bulletin, v. 28, p. 745-904.

Embry, A.F. and Catuneanu, O. 2002. Practical Sequence Stratigraphy: Concepts and Applications. Canadian Society of Petroleum Geologists, Short Course Notes, 147p.

The Age of the Earth: from 4004 BC to AD 2002

by C.L.E. Lewis and S.J. Knell (Editors)
Geological Society Publishing House
Unit 7, Brassmill Lane
Bath, BA1 3JN, United Kingdom
Geological Society Special Publication No. 190, 2001, 288 p. Hardcover $US 117.00, GSL Members $US58.00, AAPG Members $US70.00

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This volume resulted from the Geological Society's William Smith Millennium Meeting, convened on 28-29 June 2000 at Burlington House on behalf of the History of Geology Group. The book is dedicated to the memory of John Thackray, archivist at the Natural History Museum and the Geological Society who passed away in 1999.

A debate about the Age of the Earth has raged for centuries and absolute dates have been postulated and revised countless numbers of times. The discovery of the concept of deep geologic time was the cornerstone to the development of the modern concepts of geology and biology. It provided Hutton and Lyell with the mechanism to explain the history of the Earth and to formulate the modern principles of geology and Darwin with the time required to explain the transmutation of species. With apologies to plate tectonics it probably represents the most important concept to come out of geology. The volume contains 19 contributions from some of the best-known historians of geology and documents the development of the concept of determining the Age of the Earth over a span of some 350 years from 1650 to 2002. It provides valuable insights both on the techniques and the scientists involved in this enquiry. Although the author list is a bit top heavy with contributors from Great Britain (11 of the 21 contributors), the editors have tried to make it cosmopolitan with authors from Italy, the United States, Canada, Ireland, Australia, Sweden and Germany. This provides a more even handed treatment of the subject from a number of points of view.

The book opens with an introductory essay on "*Celebrating the age of the Earth*" by the editors Simon Knell and Cherry Lewis where they summarize the key developments for the quest of determining the Age of the Earth. The remaining 18 contributions are arranged in more or less chronological order, beginning with the work on biblical chronology in the 1660's and ending with the radiometric dating chronologies of the present day. Specific contributions on the role of fossils as geological clocks, time and life, dating humans, and the abstraction of cosmic time are also included.

I particularly enjoyed the contributions by Ken Taylor (on Buffon and Desmarest), Martin Rudwick (on Jean-André de Luc), Hugh Torrens (on William Smith), Patrick Wyse Jackson (on John Joly), and Cherry Lewis (on Arthur Holmes). The Torrens essay was brilliant and in spite of all of the recent work on Smith managed to cover new ground. On the other hand, I was disappointed with the essay by John Fuller on the early biblical chronologies especially the lack of discussion on the impact of the work by James Ussher and John Lightfoot. This is especially odd given that the title specifically mentions the 4004 BC date. This date became the rallying point from which geology began its dramatic separation from religious orthodoxy and established itself as a viable science. The contribution on the American perspective by Ellis Yochelson and Cherry Lewis was also disappointing as it was superficial. It could have used some of the verve given by Ezio Vaccari on his excellent treatment on the European views on the subject as exemplified by Descartes, Leibniz, Kirchner, Steno, Swedenborg, De Maillet and Scheuuchzer among others.

One disappointing aspect of the volume is the lack of illustrative