Introduction to

Clastic Sedimentology

(Notes for a University level, second year, half-credit course in clastic sedimentology)

by

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Acknowledgements

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Mike Lozon (Department of Earth Sciences, Brock University) is thanked for preparing several of the figures.

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CHAPTER 1. INTRODUCTION TO CLASTIC SEDIMENTOLOGY

Clastic sedimentology is the branch of geology that studies sediment and sedimentary rocks that are made up of particles that are the solid products of weathering at or near the Earth's surface. Thus, clastic sedimentology is concerned with gravel, sand and mud and the rocks that form by the induration (formation into rocks) of these particulate materials (rudites, sandstones and shales; see Chapter 3). The goal of this book is to introduce the terminology and fundamental concepts that are necessary for the description and interpretation of sediment and sedimentary rocks.

WHY STUDY CLASTIC SEDIMENTOLOGY?

There are at least two good reasons for studying clastic sedimentology. The first is because humans, and most other species on the planet, interact with the Earth largely at its surface. Sedimentary rocks make up only 7.9% of the total crust of the Earth which is dominated by igneous and metamorphic rocks (Fig. 1-1). However, the **surface** of the Earth is dominated by sedimentary rocks and almost 50% of that surface is made up of clastic sedimentary rocks (predominantly shale and sandstone). Humans are not uniformly distributed over the Earth's surface and if we were to further consider the proportion of the human population that lives immediately on clastic sediments we would find that almost all of us interact with the Earth's surface through a cover of clastic sediments and/or sedimentary rocks. We interact with this sedimentary surface in a variety of ways. We grow food within it and raise livestock on it so that it is crucial to global food requirements. We build our homes on it and take water and other resources from it. At the same time we hide our garbage in it and we modify its physical and chemical properties in such a way as to render it unsuitable for many of our needs. Thus, given our uses and abuses of the Earth's surface it is particularly important that we understand the various properties of sediments and have systematic methods of describing these properties.

A second reason for studying clastic, and all other, sedimentary rocks is because they preserve the record of changing environmental conditions at or near the Earth's surface over almost the whole of geologic time. All sediment and sedimentary rocks were deposited at the Earth's surface, either in the oceans or on the continents. As such, these deposits were influenced by processes that were acting on the Earth's surface, in their environments of deposition. A large part of clastic sedimentology is devoted to the development of criteria for the recognition of the action of various processes on sediments in their environment of deposition. By developing tools for the recognition of the signature of these processes in a sediment we can unravel the history of environmental change that is preserved in the stratigraphic sequence of rocks that has been laid down over geologic time.

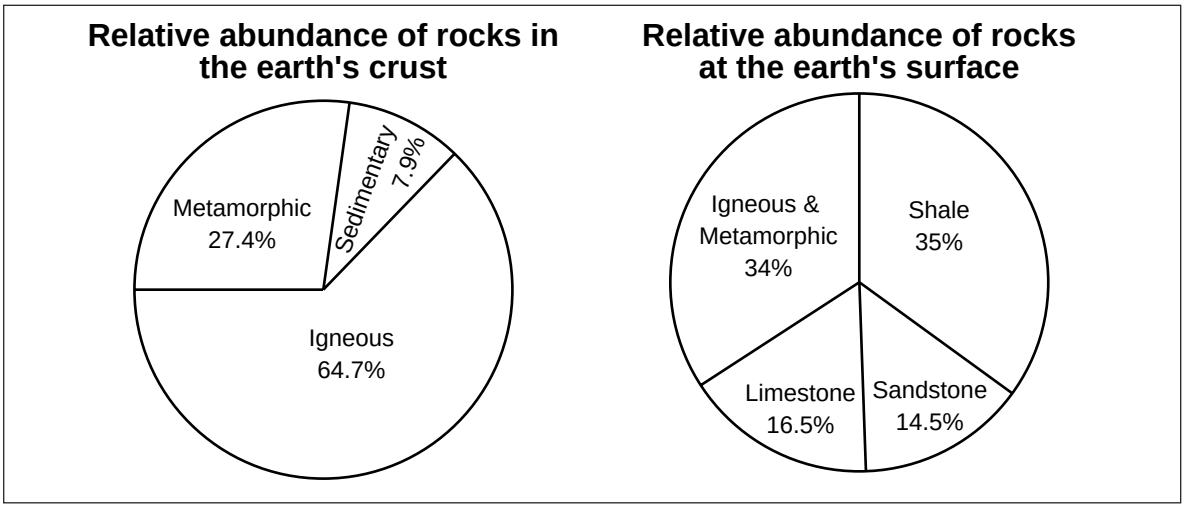

Figure 1-1. Relative abundance of rock types in the Earth's crust and at the Earth's surface.

About these notes

These notes were first compiled in 1992 from the author's lecture notes that were prepared over six years of teaching Clastic Sedimentology at the Junior Undergraduate level, first at Brandon University and later at Brock University, and are meant to provide an inexpensive "text" to support this half-credit second year course. Sedimentologists will notice that these notes contain material similar to that in some of the "classic" sedimentology textbooks but also includes much of my own bias and understanding. I was fortunate enough to have been (and will likely always be) a student of Gerry Middleton at McMaster University and a significant proportion of Chapters 2, 3 and 4 are derived from an understanding (or perhaps misunderstanding in some cases) of the great experiences that I have had with one of the father's of modern sedimentology. At McMaster I was also provided the opportunity to learn much from Roger Walker, another Canadian sedimentologist of significant stature. Despite these opportunities, any shortcomings within these notes reflect my own limitations and are certainly despite the input of these two great educators.

These notes do not aim to cover all of the important aspects of clastic sedimentology but only those that the author has decided to stress in this one semester, introductory course. A list of more comprehensive texts is given at the end of this introductory chapter. Some of the examples and figures in these notes were modified from these texts and they will provide a more detailed treatment of several topics that are covered in this course. These notes are expected to evolve with time as new sections are added and old ones dropped, although sections that are removed from the course will remain in the notes, provided that the cost to students remains reasonable. In an earlier addtion of these notes I added several colour plate. Unfortunately these plates resulted in a doubling of the cost of the notes. For that reason I have not included the plates here.

In 2005 I began to put Power Point lecture presentations that I created for the course onto the World Wide WEB. I subsequently added the full course notes to the Web in the hope that they would provide a resource for students at other Universities. These notes, and the Power Point presentations are available free of charge to anyone who wants to download them; they are available at *www.brocku.ca/sedimentology*. In some cases the notes may be downloaded and provided to students by a third party. My condition for such downloading and reproduction is that under no circumstances will a profit be added to the cost of the notes to students, other than a charge of up to 20% of reproduction costs for distribution by a University book store or similar service that prints the notes for sale to students. There will be no charge that incurs a profit to any other person or group, including myself. The reason for these notes is to provide an inexpensive but useful resource for students. If your school would like to reproduce these notes for sale to students I ask that I be approached for permission to do so. Please direct such requests to me at rcheel@brocku.ca with the subject line "SedNotes Request" and include the per unit reproduction costs and the proposed sale price. I will respond to such requests promptly.

The notes begin with a section on the most fundamental properties of clastic sediments, those properties that collectively make up the "texture" of a sediment. The next section reviews the criteria for classifying sediment and sedimentary rocks, criteria that are commonly based on the texture of the rocks. The remainder of the notes focus on the behaviour of sediments in response to processes in subaqueous settings, the most common settings in which sediments are deposited. This begins with an examination of some of the important characteristics of unidirectional fluid motion (like the currents in a river) and the manner in which sediment is moved by such fluid motion. This is followed by a section that examines the bulk response of a sediment to unidirectional fluid motion (i.e., bedforms) and the criteria for interpreting hydraulic condition on the basis of the internal structure of sediments and sedimentary rocks (i.e., internal stratification and cross-stratification). The final chapter briefly considers all of these aspects of fluid motion and sediment response but for currents that reverse in direction over relatively short periods (seconds to tens of seconds) and are generated by water surface waves that are common in many marine and lacustrine environments.

Comprehensive sedimentology textbooks

ALLEN, J.R.L., 1985, *Principles of physical sedimentology*. George Allen and Unwin, Boston, 272 p.

ALLEN, J.R.L., 1985, *Experiments in physical sedimentology* . George Allen and Unwin, Boston, 63 p.

ALLEN, J.R.L., 1982, *Sedimentary structures: their character and physical basis* (Two volumes) Elsevier, New York, 593 p. (v. 1) and 663 p. (v. 2).

ALLEN, J.R.L., 1970, *Physical processes of sedimentation. An introduction.* George Allen and Unwin, London, 248 p.

BLATT, H., MIDDLETON, G.V., AND MURRAY, R., 1980, *Origin of sedimentary rocks.* (Second Edition) Prentice-Hall, New Jersey, 782 p.

Boggs Jr., Sam, 2001, *Principles of Sedimentology and Stratigraphy* (3rd Edition). Prentice Hall, New Jersey, 770 p.

DAVIS, R.A., 1983, *Depositional systems: a genetic approach to sedimentary geology*. Prentice-Hall, Toronto, 669 p.

HARMS, J.C., SOUTHARD, J.B., AND WALKER, R.G., 1982, *Structures and sequences in clastic rocks.* Society of Economic Mineralogists and Paleotologists, Short Course Number 9, 249 p.

HSÜ, K.J, 1989, *Physical Principles of Sedimentology: a readable textbook for beginners and experts.* Springer-Verlag, New York, 233 p.

LEEDER, M.R., 1982, *Sedimentology: process and product.* George Allen and Unwin, London, 344 p.

MIDDLETON, G.V. AND SOUTHARD, J.B., 1984, *Mechanics of sediment movement.* (Second Edition) Society of Economic Mineralogists and Paleontologists, Short Course Number 3, 394 p.

PETTIJOHN, F.J., 1975, *Sedimentary rocks.* (3rd Edition). Harper and Row, New York, 628 p.

PETTIJOHN, F.J., Potter, P.E., and Siever, R., 1973, *Sand and sandstone*. Springer-Verlag, New York, 618 p.

POTTER, P.E., MAYNARD, J.B., AND PRYOR, W.A., 1980, *Sedimentology of shale*. Springer-Verlag, New York, 306 p.

REINECK, H. -E. AND SINGH, I.B., 1980, *Depositional sedimentary environments, with reference to terrigenous clastics.* (Second Edition). Springer-Verlag, New York, 549 p.

SELLEY, R.C., 1982, *An introduction to sedimentology*. Academic Press, New York, 417 p.

Introduction to Sedimentology 206-12181 â€“ 3 credits Dr. Dorit Korngreen. Syllabus Part I: Physical principles of sedimentation. Facies models; weathering processes, erosion and sedimentation, sorting and grain size change, modes of sediment transport, the connection between bedding morphology, flow and grain size.Â Part 3: Chemical sedimentary rocks - Carbonate rocks- the water-carbonate system, car bonate depositional environments - continental shelves, carbonate ramps and platforms, basinal environments. Exercises: Identification of skeletal and non-skeletal components under the microscope; classification of carbonate rocks. Part 4: Introduction to diagenesis: Definitions, classification, cyclicity, diagenetic environments. Dolomitization, porosity and cementation. Start studying Introduction to sedimentology. Learn vocabulary, terms and more with flashcards, games and other study tools.Â sedimentary rock with a grain size larger than 2mm , very poorly sorted, rounded clasts. Breccia. Clastic, coarse sized grains, usually near-surface faults, angular clasts. Monomict. (of a conglomerate) all have the same lithology and from the same rock type. Introduction. Why study clastic sedimentology? About this book Comprehensive sedimentology textbooks. Chapter 2. Grain Texture. Introduction Grain Size. Volume Linear dimensions. Direct measurement Sieving Settling velocity Stoke's Law of Settling Grade scales Displaying grain size data Describing grain size distributions Median Mean Sorting coefficient Skewness Kurtosis Paleoenvironmental implications Why measure grain size?