

Earth History

Precambrian Continents and Plate Tectonics

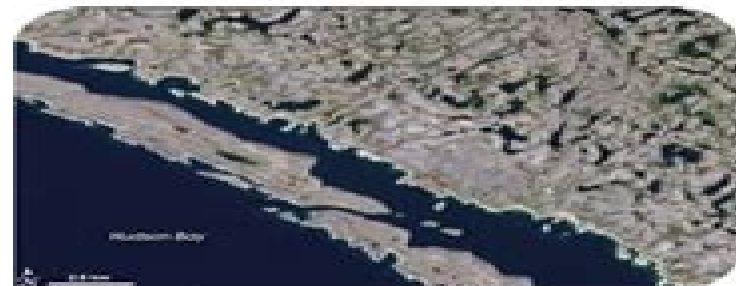
Content of Cratons

Little is known about the **paleogeography**, or ancient geography, of early Earth. The earliest continental crust is found in **cratons**, which are the ancient cores on continents. They also contain all three types of rocks that each tells their own story about the Precambrian era.

- Felsic igneous rocks are the remains of the first continents.
- Rounded sedimentary grains show that early rivers and seas existed and that erosion occurred.
- **Greenstone**, a metamorphic volcanic rock, shows the location of subduction zones because they are found in ocean trenches

Study Tip

The forming of continents was similar to the forming of our planets: Many small pieces (microcontinents) collided to create bigger pieces.



Notice the greenstone lining the Canadian shield, which has been exposed by the scraping of glaciers.

Formation from Cratons

Shields are where cratons crop out at the surface. Many Precambrian shields are about 570 million years old. Cratons covered by younger rocks are called **platforms**. When these platforms undergo erosion, the Precambrian craton is exposed.

Early Crustal Plates

Early crustal plates were small due to faster mantle convection and stronger plate tectonics processes. These processes also created more subduction zones.

Plate Tectonics

Plate tectonics: Smaller **microcontinents** collided to create bigger **supercontinents**, which resulted in the formation of massive mountain ranges. An active period of convergence was between 1.5 million and 1.0 million years ago. Cratons collided with microcontinents and oceanic island arcs to form Laurentia, which is part of the supercontinent Rodinia. Around 750 million years ago, oceans began forming in between continents as the result of Rodinia's disintegration.



The supercontinent Rodinia 1.1 billion years ago

Precambrian Plate Tectonics Developments In Precambrian Geology 4

Andrew Miall



Precambrian Plate Tectonics Developments In Precambrian Geology 4:

Developments in Precambrian geology , **Principles of Sedimentary Basin Analysis** Andrew D. Miall, 2013-06-29

Over the past five years there have been many advances in the field of basin analysis. Developments such as the publication of new stratigraphic codes, new research in fission track dating, evolution of thought regarding the importance of tectonic versus eustatic controls of regional and global cycles, and refinements of geophysically based basin subsidence models have necessitated the publication of a second edition of *Principles of Sedimentary Basin Analysis*. Like the first edition, this book emphasizes the stratigraphic evidence which geologists can actually see in outcrops, well records, and core samples, and can gather using geophysical techniques. *Principles of Sedimentary Basin Analysis* is both an excellent text for students and a practical handbook for professional geologists.

Principles of Sedimentary Basin Analysis Andrew Miall, 2013-04-17 This book is intended as a practical handbook for those engaged in the task of analyzing the paleogeographic evolution of ancient sedimentary basins. The science of stratigraphy and sedimentology is central to such endeavors, but although several excellent textbooks on sedimentology have appeared in recent years, little has been written about modern stratigraphic methods. Sedimentology textbooks tend to take a theoretical approach, building from physical and chemical theory and studies of modern environments. It is commonly difficult to apply this information to practical problems in ancient rocks, and very little guidance is given on methods of observation, mapping, and interpretation. In this book, theory is downplayed and the emphasis is on what a geologist can actually see in outcrops, well records, and cores, and what can be obtained using geophysical techniques. A new approach is taken to stratigraphy, which attempts to explain the genesis of lithostratigraphic units and to de-emphasize the importance of formal description and naming. There are also sections explaining principles of facies analysis, basin mapping methods, depositional systems, and the study of basin thermal history, so important to the genesis of fuels and minerals. Lastly, an attempt is made to tie everything together by considering basins in the context of plate tectonics and eustatic sea level changes.

Paleomagnetism of the Early Proterozoic Sioux Quartzite, Southwestern Minnesota--implications for Correlating Quartzites of the Baraboo Interval Val W. Chandler, G. B. Morey, 1993 Paleomagnetic studies were conducted on the Early Proterozoic Sioux Quartzite, one of the so-called Baraboo interval red bed sequences of the Lake Superior region. A total of 158 samples were collected from 17 sites scattered across four basins: Cottonwood County, New Ulm, northern Pipestone, and southern Pipestone in southwestern Minnesota. Alternating field and thermal demagnetization studies indicate that the magnetization is dominantly single component and that the magnetic carrier is hematite. Hematite occurs both as a diagenetic mineral whose long paragenetic history began shortly after deposition and as veinlets that formed during a strain event possibly related to regional tilting. The magnetization is tentatively interpreted to have occurred before regional tilting, although a definitive fold test is difficult because dips are low. Measured paleomagnetic directions at both site and basin levels show good clustering, and the average directions obtained

from each of the four basins are not significantly different at the 95 percent confidence level. The good clustering at all levels of sampling indicates that the Sioux Quartzite was magnetized either within a short time interval or during a period of subdued apparent polar wander. The structurally corrected paleomagnetic directions from the four basins yield a combined paleopole location at 1 01° W and 16° N, $k = 65$, $\alpha_{95} = 11^\circ$. Dated paleopoles for Early Proterozoic rocks in North America and age dates of rocks interpreted to underlie the Sioux Quartzite imply that its age is 1 700 ± 1 650 Ma. This interval corresponds in part with the age of 1 800 ± 1 630 Ma of the Central Plains orogen which lies some 200–300 kilometers south of the Sioux Quartzite outcrop. Quartzite may reflect a tectonic pulse related to the Central Plains orogen. Preliminary paleomagnetic data on Baraboo interval quartzites from Wisconsin indicate that the Sioux paleopole cannot be distinguished at the 95 percent confidence level from that of the Barren Quartzite but that it differs from that of the Baraboo Quartzite which on the basis of existing apparent polar wander data could be as much as 100 million years older. The paleomagnetic data support previously raised cautions that some Baraboo interval quartz arenites may have been deposited in separate basins at significantly different times.

Hydrothermal Mineral Deposits Franco Pirajno, 2012-12-06 This book is intended primarily for exploration geologists and post graduate students attending specialist courses in mineral exploration. Exploration geologists are engaged not only in the search for new mineral deposits but also in the extension and re-assessment of existing ones. To succeed in these tasks the exploration geologist is required to be a generalist of the Earth sciences rather than a specialist. The exploration geologist needs to be familiar with most aspects of the geology of ore deposits and detailed knowledge as well as experience play an all important role in the successful exploration for mineral commodities. In order to achieve this it is essential that the exploration geologist be up to date with the latest developments in the evolution of concepts and ideas in the Earth sciences. This is no easy task as thousands of publications appear every year in an ever increasing number of journals, periodicals and books. For this reason it is also difficult at times to locate appropriate references on a particular mineral deposit type although this problem is alleviated by the existence of large bibliographic data bases of geological records, abstracts and papers on computers. During my teaching to explorationists and indeed during my years of work as an explorationist the necessity of having a text dealing with the fundamental aspects of hydrothermal mineral deposits has always been compelling. Metallic mineral deposits can be categorised into three great families namely: 1 magmatic, 2 sedimentary and residual, 3 hydrothermal.

The Web of Geological Sciences: Marion E. Bickford, 2017-09-29 The web of geological sciences. Special papers 500 and 523 written in celebration of the 125th anniversary of the Geological Society of America.

Evolution of Archean Crust and Early Life Yildirim Dilek, Harald Furnes, 2013-11-26 This book presents an integrated approach to the study of the evolution of the Archean lithosphere, biosphere and atmosphere and as such it is a unique contribution to our understanding of the early Earth and life. The structural and geochemical make up of both the oceanic and continental crust of the Archean Earth is documented in some case studies of various cratons and the

implications of the Phanerozoic plate and plume tectonic processes for the Archean geology are discussed in several chapters in the book All chapters are process oriented and data rich and reflect the most recent knowledge and information on the Archean Earth The interdisciplinary approach of examining the evolution of the Archean crust oceans and life that we adopt in this book sets it apart from previous publications on Precambrian geology The book will be attractive to researchers in academia and in industry and to senior undergraduate students graduate students and faculty in earth and natural sciences

U.S. Geological Survey Bulletin ,1983

Patterns of Change in Earth Evolution H.D. Holland,A.F.

Trendall,2012-12-06 3 of the experience of the last few generations The group of happily unexperienced events includes large bolide impacts with the Earth The evidence for the occurrence of such impacts at intervals of some tens of millions of years is quite convincing and Lyell stands admonished by Hamlet There are more things in heaven and earth Horatio than are dreamt of in your philosophy The role of bolide impacts on the history of life during other portions of the Phanerozoic Eon is less clear see Raup and Fischer both this volume and catastrophic changes unrelated to extraterrestrial processes may have been important see Holser this volume Changes in the later Precambrian biota are still difficult to interpret in part because the preservation of soft bodied animals from this period of Earth history is so unusual see Seilacher this volume During the past billion years or so bolide impacts have exerted a significant effect on the Earth s surface and its inhabitants but not on its interior The 3800 Ma rocks at Isua in West Greenland are the oldest terrestrial rocks that are currently available for inspection see Dymek this volume They contain abundant evidence for the operation of chemical and physical processes that are similar to those of the present day This situation could not have prevailed during the entire 700 Ma preceding the formation of the Isua rocks **A History of the Earth** John J. W. Rogers,1993-11-18 This book surveys the history of the

Earth and the nature of the processes that controlled its history Integrating information from many fields the book focuses on fundamental processes the geological record historical topics and specific areas such as the development of modern ocean basins and the nature of cratonic sedimentary cover sequences *Canadian Inland Seas* I.P. Martini,2011-09-22 The various chapters of this book have been written by researchers who are still working in the Canadian Inland Seas region The chapters synthesize what is known about these seas yet much still is to be learnt It is hoped that this collection of information will serve as a springboard for future much needed studies in this fascinating diverse region and will stimulate comparative analyses with other subarctic and arctic basins of the world The Canadian Inland Seas are the only remnants albeit cold of the ancient cratonic marine basins which occupied central North America throughout the Paleozoic and part of the Mesozoic Precambrian rocks and gently dipping Paleozoic sedimentary rocks underlie the seas The area is also close to the centers of Pleistocene glaciations The coastal areas represent an emerged landscape of the post glacial Tyrrell sea as the region has been isostatically uplifted to about 350 meters since glacial times A total of 56 fish species inhabit Hudson Bay and James Bay Seals whales and one of the largest and southernmost populations of polar bears inhabit the seas as well The coastal

areas are important habitats for migratory bird populations some of which migrate from as far away as Southern Argentina The ostic environment has preserved these regions relatively unchanged by man with only a major harbour at Churchill Manitoba which is active for part of the year and a second large rail terminal settlement in the south at Moosonee Ontario A few small native Indian and Inuit villages dot the coasts The seas are being affected indirectly by the damming of rivers for the generation of hydroelectric power and by drainage diversions towards the man made reservoirs A major project is being completed in Quebec east of James Bay but other rivers in Ontario and Manitoba have been dammed as well Undoubtedly freshwater is one of the more important resources of the area however its exploitation needs careful thought because of the possible long range effects on the environment particularly the coastal marshes which sustain much of the eastern American intercontinental migratory avifauna Other resources occur in the regions primarily minerals and perhaps petroleum For the most part however such resources remain to be discovered

Phanerozoic Evolution of Sedimentary Basins in the Uinta-Piceance Basin Region, Northwestern Colorado and Northeastern Utah Samuel Y. Johnson, Geological Survey (U.S.), 1992 A multidisciplinary approach to research studies of sedimentary rocks and their constituents and the evolution of sedimentary basins both ancient and modern

The Geologic Time Scale 2012 F M Gradstein, 2012-08-14 The Geologic Time Scale 2012 winner of a 2012 PROSE Award Honorable Mention for Best Multi volume Reference in Science from the Association of American Publishers is the framework for deciphering the history of our planet Earth The authors have been at the forefront of chronostratigraphic research and initiatives to create an international geologic time scale for many years and the charts in this book present the most up to date international standard as ratified by the International Commission on Stratigraphy and the International Union of Geological Sciences This 2012 geologic time scale is an enhanced improved and expanded version of the GTS2004 including chapters on planetary scales the Cryogenian Ediacaran periods systems a prehistory scale of human development a survey of sequence stratigraphy and an extensive compilation of stable isotope chemostratigraphy This book is an essential reference for all geoscientists including researchers students and petroleum and mining professionals The presentation is non technical and illustrated with numerous colour charts maps and photographs The book also includes a detachable wall chart of the complete time scale for use as a handy reference in the office laboratory or field The most detailed international geologic time scale available that contextualizes information in one single reference for quick desktop access Gives insights in the construction strengths and limitations of the geological time scale that greatly enhances its function and its utility Aids understanding by combining with the mathematical and statistical methods to scaled composites of global succession of events Meets the needs of a range of users at various points in the workflow researchers extracting linear time from rock records students recognizing the geologic stage by their content

U.S. Geological Survey Bulletin Paul Kibler Sims, Richard W. Ojakangas, S. A. Nachatilo, S. R. Hemming, Theodore J. Bornhorst, Val W. Chandler, William J. Gregg, G. B. Morey, Gilbert N. Hanson, R. L. Bauer, Rodney C. Johnson, Warren C.

Day, Scott M. McLennan, 1983 The Early Proterozoic Michigamme Formation of northern Michigan was deposited in the southeastern part of the Animikie basin The formation conformably overlies the Goodrich Quartzite and comprises three widespread members a lower member of thin bedded shale siltstone and sandstone the Bijiki Iron formation Member and an upper member of turbiditic graywacke siltstone and mudstone and a few local members The Goodrich Quartzite is interpreted as having been deposited in a tidally influenced shallow marine environment The lower member of the Michigamme is interpreted as having been deposited in a tidally influenced environment the iron formation member as having been deposited below wave base in somewhat deeper water and the upper member as having been deposited in still deeper water with turbidity currents being a major depositional mechanism Several lines of evidence including paleocurrents paleogeographic setting and neodymium isotopes suggest that the graywacke of the southern part of the outcrop area was derived from the south Early Proterozoic Wisconsin magmatic terranes Archean miniplates and older Early Proterozoic sedimentary units formed on the continental margin and that the graywacke in the northern area was derived from an Archean terrane to the north The tectonic model that best fits the available data is a northward migrating foreland basin

When Did Plate Tectonics Begin on Planet Earth? Kent C. Condie, Victoria Pease, 2008-01-01 Inspired by a GSA Penrose Conference held in Lander Wyoming June 14 18 2006 this volume discusses the beginning and evolution of plate tectonics on Earth and gives readers an introduction to some of the uncertainties and controversies related to the evolution of the planet In the first three sections of the book which cover isotopic geochemical metamorphic mineralization and mantle geodynamic constraints a variety of papers address the question of when modern style plate tectonics began on planet Earth The next set of papers focuses on the geodynamic or geophysical constraints for the beginning of plate tectonics The volume's final section synthesizes a broad range of evidence from planetary analogues and geodynamic modeling to Earth's preserved geologic record This work provides an excellent graduate level text summarizing the current state of knowledge and will be of interest to a wide range of earth and planetary scientists Publisher's website *Laurentia* Steven J. Whitmeyer, Michael L.

Williams, Dawn A. Kellett, Basil Tikoff, 2023-01-04 This Memoir focuses on 7 turning points that had specific and lasting impacts on Laurentian evolution The Neoproterozoic characterized by cratonization the Paleoproterozoic and the initial assembly of Laurentia the Mesoproterozoic southern margin of Laurentia the Midcontinent rift and the Grenville orogeny the Neoproterozoic breakup of Rodinia the mid Paleozoic phases of the Appalachian Caledonian orogen and the Jurassic Paleogene assembly of the North American Cordillera **U.S. Geological Survey Bulletin** Augustus K.

Armstrong, Christopher J. Schenk, Earl R. Verbeek, Samuel Y. Johnson, Bernard L. Mamet, Marilyn A. Grout, John E. Repetski, 1983 **Scientia Geologica Sinica**, 2000 *Life and death of a rural village in Garamantian Times.*

Archaeological investigations in the oasis of Fewet (Libyan Sahara) Lucia Mori, 2013-12-01 This volume presents the results of the archaeological investigations in the oasis of Fewet SW Libyan Sahara carried out by the Archaeological Mission in the

Sahara of the Sapienza University of Rome Evidences of an ancient rural village were identified under the houses of the modern town of Tan Afella and a large necropolis dated to the Garamantian times spread at the fringes of the modern settlement Until 1997 very little was known on the Garamantian period in the Wadi Tanezzuft area and on the transition from the pastoral to the early historical phase This period witnessed the gradual sedentarisation of human groups in the oases and the development of caravan routes with the flourishing of an intra and trans Saharan trade These processes also influenced by significant alterations in climate which led to the agricultural exploitation of the limited areas where water resources were available the oases were archaeologically unknown as far as settlements were concerned The archaeological surveys and excavations carried out in the area of Fewet were particularly promising and are here analysed in a multidisciplinary perspective which takes into consideration environmental and anthropological studies in the attempt to reconstruct the culture and the life of people inhabiting the Southern Fezzan region in early historical times The historical archaeology of the Sahara remains an underdeveloped field of research especially for the pre Islamic period The most significant exception to this rule has for long concerned the people known as the Garamantes who inhabited the central Saharan region coincident with Libya s south west province Fezzan This volume is a marvelous addition to the small corpus of published research on the Pre Islamic oasis societies of the Sahara and provides a complementary perspective on the world of the Garamantes to the Anglo Libyan work I have directed from their heartlands in the Wadi el Ajal c 400 km to north east of Ghat Prof David J Mattingly University of Leicester UK

Stable Isotopes in High Temperature Geological Processes John W.

Valley, Hugh P. Taylor, James R. O'Neil, 2018-12-17 Volume 16 of Reviews in Mineralogy introduces to high temperature stable isotope geochemistry and should provide an entry into the pertinent literature as well as some understanding of the basic concepts and potential applications The first three chapters focus on the theory and experimental data base for equilibrium disequilibrium and kinetics of stable isotope exchange reactions among geologically important minerals and fluids The fourth chapter discusses the primordial oxygen isotope variations in the solar system prior to formation of the Earth along with a discussion of isotopic anomalies in meteorites The fifth chapter discusses isotopic variations in the Earth s mantle and the sixth chapter reviews the variations in the isotopic compositions of natural waters on our planet In Chapters 7 8 9 and 10 these isotopic constraints and concepts are applied to various facets of the origin and evolution of igneous rocks bringing in much material on radiogenic isotopes as well because these problems require a multi dimensional attack for their solution In Chapters 11 and 12 the problems of hydrothermal alteration by meteoric waters and ocean water are considered together with discussions of the physics and chemistry of hydrothermal systems and the ^{18}O ^{16}O history of ocean water Finally in Chapters 13 and 14 these concepts are applied to problems of metamorphic petrology and ore deposits particularly with respect to the origins of the fluids involved in those processes

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