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Chapter 1 : Cambrian Period - Cambrian rocks | theinnatdunvilla.com

About this Book Catalog Record Details. Pre-Cambrian fossils especially in Canada: abstract of a paper Dawson, John William, Sir,

Localities of the Vendian: Mistaken Point, Newfoundland In , geologist S. Misra, who at the time was a graduate student at Memorial University of Newfoundland, discovered and began to document some unusual fossils of late Precambrian age, found in great numbers on exposed rock surfaces along the southern coast of the Avalon Peninsula in Newfoundland Anderson and Misra ; Misra The most famous locality where these fossils can be seen is at Mistaken Point, a wave-swept crag virtually at the southernmost tip of the Avalon Peninsula. Mistaken Point got its name, incidentally, from the difficulty of navigating in the treacherous waters surrounding the point; over fifty ships are known to have been wrecked in the area. The slabs that Misra saw contained numerous imprints of soft-bodied organisms, some of of which resembled those found at other late Precambrian sites, such as the White Sea coast of Russia and the Ediacara Hills of southern Australia. Most, however, had not been found anywhere else in the world, and defied identification with any known living organism. Large, lumpy disc-shaped fossils were also found to be abundant. Today, Mistaken Point is known world-wide for its remarkably preserved fossils, unique in several ways. The Mistaken Point fossils were preserved by being blanketed with layers of fine volcanic ash. The volcanic ash has preserved large numbers of fossils on individual bedding planes, creating "snapshots" of what the sea floor looked like. This has allowed scientists to study the ecology of these organisms in ways that are not possible anywhere else. Study of the surrounding sedimentary rocks has shown that the Mistaken Point organisms lived in a deep-water environment, far below the depth to which sunlight or surface waves could have reached. This contrasts strongly with most "Ediacaran" fossil assemblages, which were laid down in relatively shallow water. Finally, the affinities of most of the fossils remain obscure. While some of the Newfoundland fossils are similar or identical to others that have been described from Charnwood Forest in England Boynton and Ford , others have not yet received scientific names. Their evolutionary relationships and modes of life are still poorly understood. While a few of these fossils at least outwardly resemble living animals, notably the Pennatulacea or "sea pens," most appear radically different from any known living animal. The Mistaken Point fossils have inspired a good deal of controversy, with some scientists assigning them to a completely separate kingdom of multicellular life e. In June of , a group of scientists visited Mistaken Point and nearby sites on a field trip under the auspices of the Geological Asociation of Canada, led by Dr. Guy Narbonne and Dr. Jim Gehling of the South Australian Museum. UCMP alumnus Ben Waggoner , author of this web page, participated in the field trip and created this exhibit. You may click on any of the smaller images to bring up a larger, high-quality version. Mistaken Point can be visited by those willing to hike a bit in a rather remote and occasionally hazardous area of Newfoundland. However, the area is an ecological reserve and is protected, both by Canadian law and by the people of the nearby towns, who are committed to preserving their paleontological heritage. Collecting fossils or making replicas in the Mistaken Point reserve is strictly prohibited without a permit. Despite their abundance, the "spindles" have not yet been given an official scientific name, and they have been found nowhere else in the world but southern Newfoundland. The largest "spindles" are about a foot long 30 cm , but most are smaller; small "spindles" have virtually the same shape as larger ones. Running down the middle of each "spindle" is a sediment ridge, but this probably represents a relatively weak point in the fossil, into which the underlying sediment was forced upwards as the organism was buried and compacted. Coming from both sides of the midline are fan-shaped bundles of "ribs," each of which is itself further subdivided. These "bundles" do not appear to have been separate leafy structures, but instead were completely connected to the rest of the whole organism, something like the patternings on a quilt. At the top left is a well-preserved "spindle;" at the bottom is a close-up of another "spindle," showing the fan-shaped bundled structure of the fossil. Frondlike fossils are also common at Mistaken Point. These have a bulb-shaped or disc-shaped "holdfast" which was attached to the sea floor, and a leaf-shaped main body that probably was held up in the water column. At left, the top two are specimens of Charniodiscus: A third specimen is visible on the larger image, along with some "spindles". The volcanic ash that buried these specimens flattened all of them in the same direction; this explains why the stalks of all of them point in the same direction. Another specimen of what is probably Charniodiscus is depicted in the center; note that the "frond" on this specimen extends into a long, pointed tip. At the bottom is a well-preserved specimen of a frondlike fossil with a small holdfast on the left but no stalk. This specimen has been figured before, but not named Seilacher and is currently thought to represent a new species of the genus Charnia. Both Charnia and Charniodiscus were first described from the late Precambrian rocks of Charnwood Forest, England, but have since been found at several other localities worldwide, notably the White Sea and the Ediacara Hills. This specimen, which is located very close to the Charniodiscus figured above left, is not oriented parallel to the current. This may reflect the fact that in life this organism lay nearly flat on the sediment, rather than sticking up into the water column. In the middle you can see an unnamed fossil with a stalk and holdfast like Charniodiscus, but with an unusual feathery shape. This form is also very much like a Charnwood Forest fossil named Ivesia. All three of these forms are closely associated with "spindles;" in fact the specimen of Ivesia shown here appears to have been lying on top of a "spindle" as it was buried. It is interesting that the Mistaken Point fossil assemblage has a number of members in common with the Charnwood Forest assemblage from central England Waggoner In the late Precambrian and for some time afterwards, eastern Newfoundland and southern Britain,along with what is now the east coast of the United States as far south as Florida, were located near each other, along what is now the northwest coast of Africa. These "bits and pieces" made up a "microcontinent" known as the Avalonian terrane. They were not connected to the continents that they are now part of; this would not happen until about million years ago, as the supercontinent Pangaea was beginning to form. This explains, at least in part, the similarity of the Precambrian assemblages of east Newfoundland and England. It also explains the fact that later fossil assemblages, such as Cambrian trilobites, are also much more similar between eastern Newfoundland and England than, say, between east Newfoundland and the rest of North America. A review, with descriptions of four unusual forms, of the soft-bodied fauna of the Conception and St. Fossils found in pre-Cambrian Conception Group of southeastern Newfoundland. Geological Society of America Bulletin Stratigraphy and depositional history of late Precambrian coelenterate-bearing rocks, southeastern Newfoundland. Journal of the Geological Society, London Early life on Earth: Late Proterozoic fossils and the Cambrian explosion. Early Life on Earth. Columbia University Press, New York. Biogeographic analyses of the Ediacara biota:

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Chapter 2 : Precambrian - Wikipedia

*Pre-Cambrian Fossils Especially In Canada () [John William Dawson] on theinnatdunvilla.com *FREE* shipping on qualifying offers. This scarce antiquarian book is a facsimile reprint of the original.*

Cambrian rocks Types and distribution Cambrian rocks have a special biological significance, because they are the earliest to contain diverse fossils of animals. These rocks also include the first appearances of most animal phyla that have fossil records. Cambrian evolution produced such an extraordinary array of new body plans that this event has been referred to as the Cambrian explosion. The beginning of this remarkable adaptive radiation has been used to divide the history of life on Earth into two unequal eons. The Precambrian also includes the first appearance of life on Earth, which is represented by rocks with mainly bacteria , algae , and similar primitive organisms. The younger, approximately half-billion-year-old Phanerozoic Eon , which began with the Cambrian explosion some million years ago and continues to the present, is characterized by rocks with conspicuous animal fossils. Rocks of Cambrian age occur on all of the continents, and individual sections may range up to thousands of metres thick. The most fossiliferous and best-studied deposits are principally from marine continental-shelf environments. Among the thicker and better-documented sections are those in the Cordilleran region of western North America , the Siberian Platform of eastern Russia, and areas of central and southern China. Other well-documented fossiliferous but thinner sections are located in Australia especially in western Queensland , the Appalachian Mountains of eastern North America, Kazakhstan, and the Baltic region most notably in Sweden. Quartzite slope breccia of Cambrian age from Ardennes, Belg. Courtesy of Ernst ten Haaf Lateral changes in the composition of Cambrian rocks resulted from regional differences in environments of deposition. Nearshore deposits are commonly composed of siliceous sandstone. This usually grades seaward into siltstone and shale , which formed by accumulation of finer-grained sediment in deeper water where the seafloor was less affected by wave action. Extensive carbonate platforms, analogous to the present-day Bahama Banks, developed along some continental shelves that were in low latitudes during Cambrian time. Rapid production of carbonate sediment in this warm, shallow-water environment resulted in massive deposits of Cambrian limestone and dolomite. Few Cambrian rocks from land environments have been documented, and most of those are of limited areal extent. They mainly represent deposits of floodplains and windblown sand. Without plants or animals, the desolation of Cambrian landscapes must have rivaled that of any present-day desert. In the absence of plants with roots to hold soil in place, Cambrian lands in general probably eroded more rapidly than they do now. Relative sea level rose significantly during the Cambrian, but with fluctuations. This is indicated by both the geographic distribution and the stratigraphic layering of sedimentary deposits. In North America, for example, marine deposits from earlier in the period covered only marginal areas, whereas later marine deposits covered much of the continent. Similar distributions of marine rocks are present on other continents. In stratigraphic sections from continental shelves that were located in low latitudes, it is common for a basal nearshore sandstone to be overlain by layers of more seaward shale and carbonate rocks deposited during times of high sea level. Shelf sections from high latitudes may be mostly or entirely sandstone, or a basal sandstone deposit may grade upward into shale, but most of these sections contain evidence of marine transgression. Exceptions to the general Cambrian sea-level pattern are commonly attributable either to local tectonism or to different rates of sediment accumulation. The most likely explanation for the general rise in Cambrian sea level seems to be increased thermal activity and related swelling of spreading ridges between lithospheric plates, which would displace vast quantities of seawater. It has been suggested that these periods of marine inundation exerted an influence on adaptive radiation the proliferation of organic lineages by greatly increasing the area of shallow seas where life was most abundant. It contains a thick and continuous marine succession of mostly shale, siltstone, and sandstone. The stratotype point, representing a moment in time, is in the lower part of the Chapel Island Formation. It coincides with the base of the remnant burrows of the fossil Trichophycus pedum and marks the first occurrence of well-developed, fairly complex metazoans group of animals composed of multiple, differentiated cells. This is currently regarded as the most useful benchmark on which to characterize both the lower boundary of Cambrian time and the beginning of the Phanerozoic Eon. Cambrian Period in geologic timeThe Cambrian Period and its subdivisions. International Commission on Stratigraphy ICS While there is general agreement on the point in time picked for the beginning of the Cambrian Period, the ensuing 55â€"56 million years of Cambrian time has yet to be completely settled. The ICS has divided the period into four epochs. Only two, the Terreneuvian and Furongian, have been named. The boundaries of additional subdivisions are approximate. The lower boundary of the Ordovician System indirectly defines the upper boundary of the Cambrian System. A formal boundary stratotype coincides with the first appearance of the conodont Iapetognathus fluctivagus. This boundary marks the base of the Tremadoc Series in the Ordovician System. British geologists have traditionally assigned rocks and fossils of Tremadoc age to the Cambrian, whereas many others have assigned them to the Ordovician. Rocks in the Cambrian-type area in Wales are so poorly exposed, structurally complicated, and sparsely fossiliferous that they have had little influence on development of modern concepts of the Cambrian and its subdivisions. In fact, many rocks in the Cambrian-type area have been reassigned to either the Precambrian or the Ordovician. Economic significance of Cambrian deposits Cambrian rocks are of moderate economic importance, as they provide a variety of resources. For example, ore bodies rich in such metals as lead, zinc, silver, gold, and tungsten have secondarily replaced Cambrian carbonate rocks , especially in parts of North America and Australia. Other carbonate rocks have been widely used as building stone and for making lime and portland cement. Large Cambrian phosphorite deposits are major sources of agricultural fertilizer in northern Australia, southwestern China, and southern Kazakhstan. Other Cambrian resources in China are mercury , uranium , and salt. Eastern Russia also has salt deposits of Cambrian age, as well as those of bauxite , the chief commercial source of aluminum. Some oil fields in southern Siberia produce oil from Lower Cambrian rocks. Correlation of Cambrian strata Time correlation of Cambrian rocks has been based almost entirely on fossils. The most common fossils in Cambrian rocks are trilobites , which evolved rapidly and are the principal guide fossils for biostratigraphic zonation in all but rocks below the Atdabanian Stage or those of equivalent age. Until the mids, almost all trilobite zones were based on members of the order Polymerida. Such trilobites usually have more than five segments in the thorax, and the order includes about 95 percent of all trilobite species. Most polymeroids, however, lived on the seafloor, and genera and species were mostly endemic to the shelves of individual Cambrian continents. Therefore, polymeroid trilobites are useful for regional correlation but have limited value for intercontinental correlation, which has been difficult and subject to significant differences in interpretation. From the s, investigators began to recognize that many species of the trilobite order Agnostida have intercontinental distributions in open-marine strata. These trilobites are small, rarely exceeding a few millimetres in length, and they have only two thoracic segments. Specialized appendages, which were probably useful for swimming but unsuitable for walking on the seafloor, suggest that they were pelagic living in the open sea. Agnostoids make up less than 5 percent of all trilobite species, but individuals of some agnostoid species are abundant. This fact, together with their wide geographic distribution and rapid evolution, makes them valuable for refined intercontinental correlation. Agnostoids first appear in upper Lower Cambrian rocks but did not become common or diversify significantly until the middle of the Cambrian. Therefore, agnostoids have their greatest biostratigraphic value in the upper half of the Cambrian System. A comprehensive trilobite zonation in Sweden has frequently been cited as a standard for correlation. Other kinds of fossils have had more limited use in Cambrian biostratigraphy and correlation. Among them are the archaeocyathan sponges in the Lower Cambrian and brachiopods moss animals throughout the Cambrian, but use of both groups has been hampered by problems of endemism. Small mollusks and other small shelly fossils, mostly of problematic affinities , have been employed for biostratigraphy in the Tommotian Stage a Russian designation for the pretrilobite portion of the Cambrian explosion , but their utility is also limited by endemism. Conodonts appear in the uppermost Precambrian but are rare in most Cambrian rocks except those of latest Cambrian age, when adaptive radiation of conodont animals accelerated. Wide species distributions, rapid evolution, and abundance make conodonts excellent indexes for global biostratigraphy in uppermost Cambrian to uppermost Triassic rocks. Since roughly the s, trace fossils have been used with limited precision to correlate uppermost Precambrian and basal Cambrian strata. Although the biostratigraphic use of such fossils has many problems, they nevertheless demonstrate progressively more complex and diverse patterns of locomotion and feeding by benthic bottom-dwelling marine animals.

Chapter 3 : Mistaken Point Fauna - The Discovery of Late Precambrian Fossils in Southeastern Newfoundl

Caption title "Reprinted from the Canadian Record of Science, July, " "Read in the Geological Section of the British Association, Liverpool Meeting, September ".

The Precambrian fossil record is poorer than that of the succeeding Phanerozoic , and fossils from the Precambrian e. There is only one other eon: As of [update] , the United States Geological Survey considers the term informal, lacking a stratigraphic rank. Origin of life and Earliest known life forms Landmass positions near the end of the Precambrian A specific date for the origin of life has not been determined. Carbon found in 3. Well-preserved microscopic fossils of bacteria older than 3. However, there is evidence that life could have evolved over 4. Excluding a few contested reports of much older forms from North America and India, the first complex multicellular life forms seem to have appeared at roughly Ma, in the Mesoproterozoic era of the Proterozoic eon. A very diverse collection of soft-bodied forms is found in a variety of locations worldwide and date to between and Ma. These are referred to as Ediacaran or Vendian biota. Hard-shelled creatures appeared toward the end of that time span, marking the beginning of the Phanerozoic eon. By the middle of the following Cambrian period, a very diverse fauna is recorded in the Burgess Shale , including some which may represent stem groups of modern taxa. The increase in diversity of lifeforms during the early Cambrian is called the Cambrian explosion of life. The supercontinent, known as Rodinia , broke up around Ma. A number of glacial periods have been identified going as far back as the Huronian epoch, roughly â€” Ma. One of the best studied is the Sturtian-Varangian glaciation, around â€” Ma, which may have brought glacial conditions all the way to the equator, resulting in a " Snowball Earth ". The atmosphere of the early Earth is not well understood. Most geologists believe it was composed primarily of nitrogen, carbon dioxide, and other relatively inert gases, and was lacking in free oxygen. There is, however, evidence that an oxygen-rich atmosphere existed since the early Archean. This radical shift from a chemically inert to an oxidizing atmosphere caused an ecological crisis, sometimes called the oxygen catastrophe. After the supply of oxidizable surfaces ran out, oxygen would have begun to accumulate in the atmosphere, and the modern high-oxygen atmosphere would have developed. Evidence for this lies in older rocks that contain massive banded iron formations that were laid down as iron oxides.

Chapter 4 : Is This A Precambrian Fossil? - Fossil ID - The Fossil Forum

Precambrian Life. Although the Precambrian contains some seven-eighths of Earth's history, its fossil record is poor, with the majority of fossils being the stromatolites that are often heavily metamorphosed or deeply buried.

Evolution had been busy for billions of years before the first fossils of multicellular creatures are recorded in the sediments. Although in , the International Subcommission on Cambrian Stratigraphy formalized the Precambrian-Cambrian boundary at the first appearance of the horizontal burrow Trichophycus pedum in the reference section at Fortune Head, Newfoundland age million years ago, or mya , this corresponds in practicality to the appearance of a widespread, diverse fauna possessing easily fossilizable hard parts the traditional beginning of the Cambrian. Scientists as far back as the nineteenth century, including Charles Darwin, recognized that something special marked the onset of the Cambrian; life, in all its fabulous diversity, seemed to spring almost magically and instantaneously from the vast void of the Precambrian. Until the advent of radiometric dating, there was no way of knowing how long ago that was, or how much time the Cambrian Period represented. The earliest radiometric dates indicated that the Cambrian began shortly after mya and spanned almost million years. More accurate dates obtained in the last two decades have resulted in a revision of the chronology and a compression of the length of time the Cambrian Period represents. The overall timeframe has been shifted towards the recent in the process. In the Cambrian-Ordovician Boundary Working Group adopted a biostratigraphical definition of that boundary with an age of mya. Thus the current definition of the Cambrian encompasses an interval of 53 million years. This was a really big tectonic episode occurring around a billion years ago that had ramifications for all the continents, not just North America. Dont confuse this supercontinent with the familiar Pangea of Triassic timesâ€"this was a much earlier precursor. By around mya, this supercontinent was breaking up and some of the fragments, including Laurentia which consisted of most of North America and Greenland, along with portions of what are now Great Britain, France, and Scandinavia drifted northward into more equable climes. Sea levels were high and much of North America, especially the lands which comprise the southern and western United States today, lay underwater. Parts of modern Newfoundland, Nova Scotia, and New England had not yet docked with the remainder of North America, instead forming a submarine portion of the continent of Avalonia, which was located near the South Pole. Calm, shallow seas occupied shelf environments marginal to Laurentia, and were ideal for the formation of extensive limestones and reef deposits. Slumping and mudslides along the scarp of one of these reefs in what is now British Columbia formed the spectacular fossil deposits of the Burgess Shale about mya. The climate during the Cambrian is not well known, although there are no indications of any glaciations occurring during this time. Without large continental landmasses located in the high latitudes of either hemisphere, oceanic currents would have been able to circulate freely and distribute heat relatively well between the equator and the poles. Thus, it is likely that worldwide climates were fairly equable, being neither overly hot nor terribly cold. Early in the Cambrian there is evidence of aridity over much of the North American continentâ€"consistent with its positioning underneath the southern subtropical dry belt created by the persistent high pressure of the convergence zone between the equatorial and midlatitude Hadley cells of atmospheric circulation. Later on in the Cambrian, Laurentia had drifted further northwards such that Alaska straddled the equator. Tropical climates probably existed along the modern western ancient northern margin of the continent, and warm-temperate ones along the modern eastern ancient southern shore. What was happening on land? Microbes may have colonized continental hot springs, but other than that, the land surfaces were pretty much barren. Although plants had diverged from animals possibly as much as 2 billion years ago or so, there is little, if any, evidence to indicate that they had yet begun to colonize the land. A single report, in Russian, of a supposedly Cambrian land plant Aldanophyton has been published, but this occurrence is questionable and lacks substantiation from any other fossil evidence uncovered thus far. In the seas, however, it was quite another story. We have seen previously that during the Vendian latest Precambrian , there is ample fossil evidence of a diverse and abundant array of soft-bodied lifeforms, the so-called Ediacaran biota. These, however, were preserved only under the most unusual of circumstances because of their lack of hard parts. The traditional definition of the onset of the Cambrian cites the sudden appearance of almost all the modern phyla of animals, complete with easily-fossilizable shells. In other words, was there really an explosion of evolution, or is the sudden plethora of fossils a preservational artifact? And if the former, what could have driven it? Let us begin with the assumption that the explosion is realâ€"that all the modern phyla with readily fossilizable hard parts, i. Contained within this assumption is the further postulate that those modern phyla without any hard parts, and thus possessing low preservation potential e. Arthropods especially trilobites, but also crustaceans and other weird forms , molluscs, echinoderms, corals, annelids segmented worms , brachiopods, graptolites, tunicates, and chordates are all represented in Cambrian sediments. What might have driven such a burst of evolution, and why has the pace slowed since? Many reasons have been proposed over the years, some more and some less robust in the face of intense scrutiny. For example, the breakup of the late Precambrian supercontinent would have resulted in an increase in continental shelf area and a corresponding increase in habitat for benthic and shallow-water marine creatures. Why wasnt a burst of evolution associated with those events? Another suggestion has been that evolution was spurred on to refill econiches that were vacated by extinctions related to the late Precambrian glaciations. Both of these suggestions have merit, but similar circumstances occurred later on in the geologic record e. I suspect that they were, at most, contributing factorsâ€¦and that we must look elsewhere for the primary cause s. Another intriguing suggestion is that the Cambrian Explosion corresponds with the invention of sexual reproduction. Evolution suddenly could create variety far more quickly and easily than it could through mutation alone. This certainly sounds plausible, but is difficult, if not impossible, to test. It is true that trace fossilsâ€"which indicate vagile animalsâ€"are rare prior to the Cambrian, which lends some credence to this possibility. Also, Ediacaran fossils showing clear evidence of defensive adaptations are unknown, whereas the Burgess Shale is full of critters sporting spines, horns, and other structures which could have been used for protection. Obvious predators, notably anomalocarids and conodonts, abound. Arthropods in the Burgess Shale are particularly diverse, and show that trilobites, while the dominant fossils of the Cambrian, were merely a minor branch of the arthropod family tree at the time. In fact, the finest lesson of the Burgess Shale may be to show us how incomplete and skewed the Cambrian fossil record really is. Perhaps the hard parts which exponentially increased the preservation potential of Cambrian organisms were a necessary defensive response to the evolution of active predators. What about the proposition that the Cambrian Explosion is an illusionâ€"that complex metazoan life existed far back into the Precambrian, and is only revealed to us by fossils when hard parts, and greatly increased preservation potential, evolved? If true, the number of mutations separating the DNA of two organismsâ€"or genetic difference between themâ€"provides an estimate of the time since they diverged from a common ancestor. It has been pointed out that such studies reveal that evolution at the molecular genetic level frequently proceeds much more quickly than at the level of morphology which is all the fossil record can reveal. Two organisms that differ greatly in their genetic sequence may not appear that far apart morphologically. Prior to genetic sequencing, Bacteria and Archea were classified together because of their strong physical resemblance. DNA sequencing reveals that they differ from each other as much as do ostriches and liverwortsâ€"and therefore obviously have been on separate evolutionary paths for a very long time. Fossil evidence cannot reveal this disparate history. Proponents of this point of view point out that molecular genetic studies place the common ancestors of the modern phyla deep within the Precambrian. However, I have my doubts about this analysis. The reverse is often true: This is especially true when the mutations occur in homeobox Hox genesâ€"those which control the timing and trajectory of developmental processes rather than the synthesis of proteins. A minor mutation in a developmental gene can result in as significant a change in morphology as a bird growing teeth or not. Additionally, I find the assumption that genetic mutations accumulate at a constant rate, especially over the expanses of geologic time and across diverse lineages, rather tenuous. A small difference in the rate of mutation between two lineages can have a tremendous effect on the divergence dates calculated. This is not to say that I do not believe that various phyla diverged from one another far back in the Precambrian. They well may haveâ€"but I am skeptical of putting too much faith in molecular clock studies as evidence of this. One fairly robust piece of data indicating that there was nowhere near the diversity of metazoans during the Late Precambrian as later is the paucity of trace fossils found in the older sediments. Had there been a diversity of vagile movement-capable animals, even soft-bodied ones, one would expect to find an abundant and varied trace fossil record during the Late Precambrian. This is not the case. Horizontal burrows do not occur in sediments older than about mya, and vertical burrows before mya. This is clear evidence that many econiches were not filled during the latest Precambrian, and circumstantial evidence that the basic types of organisms â€”possibly the phyla themselvesâ€”capable of exploiting those niches had not yet evolved. So what can we conclude from all of this? Likely many lineages had embarked on widely disparate trajectories long before the Cambrian began, yet evolution itself also spun into high gear during the interval from to mya. Ok, a little explanation is called for. Envision a graph shaped more or less like a forward-slanting S, flat on the top and the bottom at the beginning and ending of the stroke and almost vertical, rather than backwardly diagonal, in the middle. Height is population or diversity could be number of individuals, number of species, or number of archetypes and increasing distance to the right represents time. Say you have bacteria dividing in a petri dish or organisms giving rise to new species. Say every minute or million years they doubleâ€”give rise to two daughter cells or species. Each of those progeny doubles during the next unit of time, etc. Try it on a calculator, starting with 1 and multiplying by 2 each time. Youll have a million in less time than you think. But this cant go on foreverâ€”those organisms need resources food, living space and those resources are finite. So at some point, some of them begin to starve or die off for whatever reason , and you dont have the entire lot of them doubling their population with each iteration. The longer you go, the more of them cant compete, and the slower the growth rate gets until its effectively zero and the population is limited by the carrying capacity of the environment; you are at the top of the Sâ€”time goes on, but your population or number of new species fails to increase with it. This may have been what happened during the Cambrian. New taxa evolved at an ever-increasing rate until the limits of ecospace began to impinge on their partying. Why have no new archetypes or phylum-level body plans appeared subsequent to this interval with the exception of the Bryozoa, which didnt lag by much? Perhaps ecomorphospace was filled and no one new could squeeze in. Perhaps the necessary early-stage mutations were all lethal. Suffice it to say that by the end of the Cambrian, the blueprint for the next half billion years of life on earth had been laid. Ok, enough about the explosion. What did a Cambrian seafloor look like? If all the modern phyla of animals were present, would it have appeared very different from a tropical reef today? Well, yes, there were the first reefs, but they werent formed by coralsâ€”they were created by skeletonized sponges called archaeocyathids, which had conical, cup-like forms and grew in dense colonies. But the Burgess Shale and other lagerst otten teach us that whereas yes, arthropods were the dominant phylum, trilobites themselves were relegated to a minor role compared with non-trilobite arthropods. It would have been amazing enough to be transported back to a trilobite reef, but one populated by the bizarre variety of arthropods revealed in the Burgess Shale would have been even more awesome. Although the other modern phyla were present, their numbers and ecological importance paled in comparison with that of the arthropods. Anomalocaridsâ€”considered by some to be arthropods, by others to be a separate phylumâ€”preyed on the trilobites and their kin.

Chapter 5 : Michigan Precambrian Stromatolite #23 â€“ Indiana9 Fossils

Anderson and Misra 1 have described new fossils from the Pre-Cambrian of Newfoundland and ascribe them to impressions of soft-bodied Metazoa, but they do not discuss why they consider the structures to be undoubtedly organic in origin, though the Pre-Cambrian age is beyond dispute.

The oldest rocks in the world occur in the Canadian Shield. Their ages have been calculated from precisely measured ratios of the radioactive decay of trace amounts of certain isotopes in the rock sample. The ratio ofâ€¦ The Precambrian environment Several rock types yield information on the range of environments that may have existed during Precambrian time. Evolution of the atmosphere is recorded by banded-iron formations BIFs , paleosols buried soil horizons , and red beds, whereas tillites sedimentary rocks formed by the lithification of glacial till provide clues to the climatic patterns that occurred during Precambrian glaciations. Paleogeography One of the most important factors controlling the nature of sediments deposited today is continental drift. This follows from the fact that the continents are distributed at different latitudes, and latitudinal position affects the temperature of oceanic waters along continental margins the combined area of the continental shelf and continental slope ; in short, sedimentary deposition is climatically sensitive. At present, most carbonates and oxidized red soils are being deposited within 30 degrees of the Equator, phosphorites within 45 degrees, and evaporites within 50 degrees. Most fossil carbonates, evaporites, phosphorites, and red beds of Phanerozoic age dating back to the Cambrian have a similar bimodal distribution with respect to their paleoequators. If the uniformitarian principle that the present is the key to the past is valid meaning the same geologic processes occurring today occurred in the past , then sediments laid down during the Precambrian would have likewise been controlled by the movement and geographic position of the continents. Thus, it can be inferred that the extensive evaporites dating to 3. It can also be inferred that stromatolite-bearing dolomites of Riphean rock, a sedimentary sequence spanning the period from 1. Riphean rock is primarily located in the East European craton , which extends from Denmark to the Ural Mountains, and in the Siberian craton in Russia. Today, phosphate sediments are deposited primarily along the western side of continents. This is the result of high biological productivity in nearby surface waters due to the upwelling of nutrient-rich currents that are moving toward the Equator. The major phosphorite deposits of the Aravalli mountain belt of Rajasthan in northwestern India, which date from the Proterozoic Eon , are associated with stromatolite-rich dolomites. They were most likely deposited on the western side of a continental landmass that resided in the tropics. Paleoclimate Evolution of the atmosphere and ocean During the long course of Precambrian time, the climatic conditions of the Earth changed considerably. Evidence of this can be seen in the sedimentary record, which documents appreciable changes in the composition of the atmosphere and oceans over time. Oxygenation of the atmosphere Earth almost certainly possessed a reducing atmosphere before 2. The minerals uraninite UO_2 and pyrite FeS_2 are easily destroyed in an oxidizing atmosphere; confirmation of a reducing atmosphere is provided by unoxidized grains of these minerals in 3. However, the presence of many types of filamentous microfossils dated to 3. The presence of fossil molecules in the cell walls of 2. Oceans of the Archean Eon 4. The oxygen that combined the ferrous iron was provided as a waste product of cyanobacterial metabolism. A major burst in the deposition of BIFs from 3. This enabled the atmospheric oxygen level to increase appreciably. By the time of the widespread appearance of eukaryotes at 1. These relatively high concentrations were sufficient for oxidative weathering to take place, as evidenced by hematite-rich fossil soils paleosols and red beds sandstones with hematite-coated quartz grains. A second major peak, which raised atmospheric oxygen levels to 50 percent PAL, was reached by million years ago. It was denoted by the first appearance of animal life metazoans requiring sufficient oxygen for the production of collagen and the subsequent formation of skeletons. These sediments, which include abraded detrital zircon grains that indicate water transport, are interbedded with basaltic lavas with pillow structures that form when lavas are extruded under water. The stability of liquid water that is, its continuous presence on Earth implies that surface seawater temperatures were similar to those of the present. Differences in the chemical composition of Archean and Proterozoic sedimentary rocks point to two different mechanisms for controlling seawater composition between the two Precambrian eons. During the Archean, seawater composition was primarily influenced by the pumping of water through basaltic oceanic crust , such as occurs today at oceanic spreading centres. In contrast, during the Proterozoic, the controlling factor was river discharge off stable continental margins, which first developed after 2. The present-day oceans maintain their salinity levels by a balance between salts delivered by freshwater runoff from the continents and the deposition of minerals from seawater. Climatic conditions A major factor controlling the climate during the Precambrian was the tectonic arrangement of continents. At times of supercontinent formation at 2. This relative shortage of volcanoes resulted in low emissions of the greenhouse gas carbon dioxide CO2. This contributed to low surface temperatures and extensive glaciations. In contrast, at times of continental breakup, which led to maximum rates of seafloor spreading and subduction at 2. These latter conditions also applied to the Archean Eon prior to the formation of continents. Temperature and rainfall The discovery of 3. The presence of 3. Extreme greenhouse conditions in the Archean caused by elevated atmospheric levels of carbon dioxide from intense volcanism effusion of lava from submarine fissures kept surface temperatures high enough for the evolution of life. They counteracted the reduced solar luminosity rate of total energy output from the Sun , which ranged from 70 to 80 percent of the present value. Some limited evidence has been provided by well-preserved rain pits in 1. Worldwide glaciations The presence of tillites glacial sediments indicates that extensive glaciations occurred several times during the Precambrian. Glacial deposits are not necessarily limited to high latitudes. In general, they are complementary to the carbonates , evaporites , and red beds that are climatically sensitive and restricted to low latitudes. The oldest known glaciation took place 2. The most extensive early Precambrian Huronian glaciation occurred 2. It can be recognized from the rocks and structures that the glaciers and ice sheets left behind in parts of Western Australia, Finland, southern Africa, and North America. The most extensive occurrences are found in North America in a belt nearly 3, km 1, miles long extending from Chibougamau in Quebec through Ontario to Michigan and southwestward to the Medicine Bow Mountains of Wyoming. This probably represents the area of the original ice sheet. Most details are known from the Gowganda Formation in Ontario, which contains glacial deposits that are up to 3, metres 9, feet thick and that occupy an area of about 20, square km 7, square miles ; the entire glacial event may have covered an area of more than 2. Paleomagnetic studies indicate that the Gowganda glaciation occurred near the paleoequator. Similar, roughly contemporaneous glacial deposits can be found in other parts of the world, suggesting that there was at least one extensive glaciation during the early Proterozoic. The largest glaciation in the history of the Earth occurred during the late Proterozoic in the period between 1 billion and million years ago. It left its mark almost everywhere. One of the best-described occurrences is in the Flinders Range of South Australia , where there is a sequence 4 km 2. Detailed stratigraphy and isotopic dating show that three worldwide glaciations took place: What is the explanation for all these occurrences of glacial deposits? Some paleomagnetic studies have shown that the tillites in Scotland, Norway, Greenland, central Africa , North America, and South Australia were deposited in low or near-equatorial paleolatitudes. Such conclusions are, however, controversial, because it has also been suggested that the positions of the northern and southern magnetic poles may have migrated across the globe, leaving a record of glaciations in both high and low latitudes. There is the possibility that floating ice sheets could have traveled to low latitudes, depositing glacial sediments and dropstones below them. Whatever the answer, the existence of such vast quantities of tillites and of such extensive glaciations is intriguing. The earliest signs of life on Earth are in western Greenland where apatite calcium phosphate grains within a 3. The presence of organic hydrocarbon droplets in kerogenous sediments has been found in the 3. These are small amounts of oil that date to the Archean Eon which lasted from about 4. The first fossil evidence of terrestrial life is found in the early Archean sedimentary rocks of the greenstone-granite belts metamorphosed oceanic crust and island arc complexes of the Barberton craton in South Africa and in the Warrawoona Group, which are both roughly 3. There are two types of these early, simple, biological structures: Microfossils and stromatolites The microfossils occur in cherts and shales and are of two varieties. One type consists of spherical carbonaceous aggregates , or spheroids, which may measure as much as 20 mm 0. These resemble algae and cysts of flagellates and are widely regarded as biogenic produced by living organisms. The other variety of microfossils is made up of carbonaceous filamentous threads, which are curving hollow tubes up to micrometres 0. Most likely, these tubes are the fossil remains of filamentous organisms. Hundreds of them have been found in some rock layers. The oldest microfossils, and possibly the oldest known evidence of life on Earth, comes from the Apex chert deposit in Western Australia. The chert dates to 3. Some of these species were early photosynthesizers , whereas others had metabolic processes that relied on methane cycling. Such diversity suggests that the first forms of life were much older than the chert in which they were discovered, possibly as old as 4 billion years. A much younger, but no less fascinating, collection of microfossils occurred in the 2. These beds are notable because they contain carbonaceous columnar microfossils up to 7 mm slightly less than 0. They probably extracted gold from their environment in much the same way that modern fungi and lichens do. Stromatolites are stratiform, domal, or columnar structures made from sheetlike mats precipitated by communities of microorganisms, particularly filamentous blue-green algae. The early Archean examples form domes as tall as about 10 cm 4 inches. Stromatolites continued to form all the way through the geologic record and today grow in warm intertidal waters, as exemplified by those of Shark Bay in Western Australia. They provide indisputable evidence that life had begun on Earth using algal photosynthesis in complex, integrated biological communities by 3. These Archean organisms were prokaryotes that were incapable of cell division. The prokaryotes were predominant until about 1. The latter made use of oxygen in metabolism and for growth and thus developed profusely in the increasingly oxygen-rich atmosphere of the early Proterozoic the Proterozoic Eon extended from 2. The eukaryotes were capable of cell division, which allowed DNA deoxyribonucleic acid , the genetic coding material, to be passed on to succeeding generations. By early Proterozoic time both microfossils and stromatolites had proliferated. The best-known occurrence of microorganisms is in the 2-billion-year-old stromatolite-bearing Gunflint iron formation in the Huronian Basin of southern Ontario. These microbial fossils include some 30 different types with spheroidal, filamentous, and sporelike forms up to about 20 micrometres 0. Sixteen species in 14 genera have been classified so far. Microfossils of this kind are abundant, contain beautifully preserved organic matter, and are extremely similar to such present-day microorganisms as blue-green algae and microbacteria. These microbiota lived at the time of the transition in the chemical composition of the atmosphere when oxygen began accumulating for the first time.

Chapter 6 : Precambrian ichnology | Life Traces of the Georgia Coast

A partial anything from the Precambrian isn't worth much, especially when you consider something complete looks like a blob or a fingerprint even in the most complimentary lighting. If you have one of the old Natural Canvas catalogues, that might help give you some idea of a retail price range.

All you have to do to see these fossils is go to Newfoundland, Mistaken Point Ecological Reserve in Newfoundland, Canada, get permission from the Reserve to visit them, have a guide accompany you, and walk minutes to the site from a car park. Incidentally, there will be absolutely no cafes or toilets on the way there. You know, just like how it was in the Precambrian. Photograph by Anthony Martin; scale in centimeters. These discomforting realizations started a little less than two weeks ago, inspired by a field trip to the Ediacaran-Cambrian rocks of eastern Newfoundland, Canada. Why was I in cool, temperate Newfoundland, instead of sweating it out on the summertime Georgia coast? The occasion was a pre-meeting trip associated with the International Congress on Ichnology, simply known among ichnologists as Ichnia. This was the third such meeting, a once-every-four-years event coinciding with years of the summer Olympics. The previous two were in Krakow, Poland and Trelew, Argentina , and thus far these meetings also include fabulous field trips. For Ichnia , upon seeing an announcement of a field trip to Mistaken Point and other localities associated with the Precambrian-Cambrian boundary, I eagerly signed up for it. You see, Mistaken Point is world famous for its extraordinary preservation of more than 1, body fossils of those weird and wonderful fossils known as the Ediacaran fauna, Ediacaran biota, Vendian fauna, or Vendobionts take your pick. Photograph by Ruth Schowalter. Discovered in , these fossils have since proved to be one of the best examples of easily visible body fossils from more than million years ago, and the Newfoundland fossils comprise the only such assemblage that originally lived in deep-marine environments. They evidently died in place when suffocated by a layer of volcanic ash that settled onto the seafloor, hence the fossils reflect a probable sample of their original ecosystem. Bedding-plane exposure at Mistaken Point with many frond-like fossils, broadly referred to as rangeomorphs. Photograph by Anthony Martin, Canadian-themed scale is in centimeters. A close-up of one of the more exquisitely preserved rangeomorphs, which I think is Fractofusus misrai. Photograph by Anthony Martin. Just a few years ago, though, Mistaken Point became paleontologically famous again, and this time for its trace fossils. Researchers from Memorial University in Newfoundland and Oxford University looked at bedding planes near those holding the the body fossils, and were surprised to find a few trails there. At that time, it was the oldest evidence of animal movement from the fossil record , and although these finds have been disputed and others have tried to stake this claim for trace fossils elsewhere, it is still holding up fairly well. The animal moved from left to right, which is indicated by the crescentic ridges inside the trail, which open in the direction of movement. Another surface trail, but this one without the internal structure of the other one, and with levees on either side of the central furrow. It looks like a series of overlapping trails, some looping, but would have taken me several hours to unravel. What made these trace fossils? In short, my ignorance was showing, and these trace fossils were completely out of my realm of experience. And if you squint really hard and have a couple of beers, you might agree that it almost resembles one of the fossil trails from Mistaken Point. Here, have another beer. But if ignorance loves company, I can feel good in knowing that others have grasped at the same straw of actualism and found it far too short. I could tell a few of my ichnological colleagues were likewise a little challenged by what they saw at Mistaken Point, and I knew that for some of them â€" like me â€" they normally deal with trace fossils in much younger rocks. Fortunately, a little more information provided during the meeting after the field trip helped my understanding of the trace fossils we saw at Mistaken Point, and actually connected to modern tracemakers. Alexander Liu, the primary author of the paper that first reported the trace fossils, gave a talk that reviewed the evidence for Precambrian trace fossils, including those from Mistaken Point. In experiments he and his coauthors did with living anemones in a laboratory setting, they were able to reproduce trails similar to the Mistaken Point trace fossil with the internal structure. Thus these researchers were able to use actualism to assist in their interpretation, which also meant that neoichnology was not so useless after all when applied to the Ediacaran. That made me feel a little better. The crecentic ridges in the interior of the trail may represent marks where the basal disc of a anemone-like animal pushed against the surface as it moved. Even more interesting, the arrow points to an oval impression, which may be a resting trace that shows the approximate basal diameter of the tracemaker. What was the tracemaker? For instance, about four years ago, some scuba-diving researchers observed a giant protozoan making a trail on a sediment surface in the Bahamas. Accordingly, they proposed that one-celled organisms â€" not animals â€" could have made similar trails during the Ediacaran Period. Interestingly, this shows how actualism can produce conflicting results when applied to Ediacaran fossils. In the only research article I have ever attempted on Ediacaran fossils, which were much closer to Georgia â€" coming from the Carolina Slate Belt of North Carolina â€" my coauthors and I struggled with exactly that question with some fossils found in that area. In the end, we said they were body fossils, not trace fossils. And as everyone knows, I love trace fossils, and I really wanted these to be trace fossils. But they were not. So surely the Cambrian would be easier to interpret, right? I meanl, after mya, animals started burrowing merrily, to and fro, hither and tither, with uninhibited and orgiastic abandon, and, well, you get the idea. Another part of the field trip involved looking at what happened with the departure of the relatively unbioturbated alien world of the Ediacaran, pre mya, to the more familiar sediment mixing of the Cambrian and Ordovician Periods, post mya. Yet even these rocks and their trace fossils were still not quite like what we see today. This will be the subject of my next post, which will again explore the theme of how we should approach strict actualism like any scientifically based idea: As we bid adieu to Mistaken Point and began our walk back to the car park, we could swear we saw lifeforms emerging from the mist-covered rocks, resurrected from the deep time and deep water of the Avalonian Precambrian. Then we realized those were just some of our group behind us. Further Reading Fedonkin, M. The Rise of Animals: Evolution and Diversification of the Animalia. Johns Hopkins Press, Washington: Giant deep-sea protest produces bilaterian-like traces. Geological Society of London, Special Publication

Chapter 7 : Why aren't there that many fossils from the Precambrian Time? | Yahoo Answers

Stromatolites occur widely in the fossil record of the Precambrian, but are rare today. Very few ancient stromatolites contain fossilized microbes. While features of some stromatolites are suggestive of biological activity, others possess features that are more consistent with abiotic (non-biological) precipitation.

Some of the oldest fossils in the RBCM collection are over million years old. Some of the youngest fossils in the collection include clams and other invertebrates from the Victoria area that are only a few thousand years old. Paleo Environments Our fossils represent many different ancient environmentsâ€"the oceans, lakes and land where plants and animals once lived and died. We have examples from the deep ocean, where unusual marine reptiles, fishes, invertebrates and single-celled organisms once lived; coastlines, where diverse communities of shelled creatures thrived in the ancient past; lake bottoms and shorelines, where plants provided shelter and food for a myriad of fish and insects; and forests and wetlands full of plants, where small and large vertebrates once skittered and roamed. Geology BC has one of the most complicated geological settings on Earth. Ancient island terranes rising from the ocean floor collided with the North American continent, where they were squeezed upwards to build the mountains of BC. The past life preserved in these rocks is now visible as fossils, which help us understand the deep history of BC and its geologic past. Many fossils contain particular chemicals; change in the character of such compounds can reveal the history of the deposit containing the fossils and give us clues to the location and nature of resource deposits. Fossil layers can also assist us in placing rock layers in relation to each other and figuring out their age. Sites Fossils are primarily found in sedimentary rocks from many basins in the province. Volcanic rocks, such as ash, also may preserve fossils. Many of these were collected by Dr. Charles Newcombe, a notable BC naturalist and historian. Many of the fossils were identified and mentioned in volumes on Mesozoic Fossils by Joseph Frederick Whiteaves, who joined the paleontology branch of the Geological Survey of Canada at Montreal in We still regularly refer to these volumes to initiate identification of fossils from Haida Gwaii, Vancouver Island and the Gulf Islands. These older collections are important to show changes in the original sites as they eroded and revealed different fossils over time. Much growth has occurred over the last ten years, mainly from donations and from research and field collection. One of our goals is to develop the fossil collections through donations and research to more completely represent the diversity of past life found in BC rocks over its long and complex geological history. A second large collection arrived in late The majority of these fossils were collected from Vancouver Island and the Gulf Islands Nanaimo Group rocks and they are about million years old. This second large collection was declared a National Treasure. The anonymous donor had collected the fossils over 35 years. The largest fossil is about 1 metre across and the smallest less than 1 cm. Examples of the marine fossils include ammonites, bivalves, gastropods, crustaceans crabs and lobsters and vertebrate bones e. The fossils represent offshore marine and near-shore life that existed when the dinosaurs lived on land to the east on the North American continent. The climate was warmer than today, and some of the vegetation included palms and cycads. Citizens of British Columbia play an important role in donating fossils to BC museum and institutions. Many new species and rare specimens have been collected by the public. To date, most of the fossil collection has been donated by the public. Type Specimens Over type specimens are stored separately in the fossil type cabinet. This is a great honour for a collector. Some examples of recent additions to the type collection include: Graham Gwawinapterus beardi gen. Hofmann and Mountjoy, holotype, Ediacaran fossil , collected by P. Graham Specimen Identifications Fossil identifications are completed by staff, research associates, visiting researchers and expert volunteers. Important to the collection is research literature and web information. We compile current information and old literature to assist with identifications. Some of the literature is from the nineteenth century, and this needs to be properly conserved but while remaining accessible for future reference. In paleontology, original species descriptions and illustrations are frequently referred to for identifications, and therefore this information needs to be archived. Sometimes the literature has been scanned and can be read on the computer, but this does not match the quality seen in an original publication. To further assist with identifications, we are building keys that organize and prioritize diagnostic characteristics and features of fossils that can be used to differentiate species. Collections Storage The research fossil collection is organized according to geologic age, the name of the rocks group and formation containing the fossils, the location where the fossils were found and their biological classification. A separate and small paleontology teaching collection is used for public programs at the museum. Fossils are stored in metal cabinets or on shelving, in plastic fossil trays or Durphy boxes padded with conservation high-quality foam. A catalogue number is applied to each fossil matrix which provides a link to data files about each matrix and specimen. Imaging and Illustrating Fossils The quality of digital imaging has improved greatly. Today, it is very easy to photograph a fossil and have an instant image result. An image is useful to assist with identifications and building identification catalogues. To describe and image a new fossil species in research literature, higher quality images are needed that may require special preparation of the fossil and techniques to enhance the details of the fossil. Plans for paleontology preparation and image labs are underway. Drawing fossils is still an important part of paleontological science. Artists work with paleontologists to provide evidence-based interpretations on the biology of an organism that once lived. For example, mobility, colour and group behavior may be added to create an image of what life might have been like in the past. Sometimes the interpretation involves several specimens to view parts preserved on one fossil but not another and then create a composite image. Currently, we have a volunteer artist working on specimen illustrations of fossils from the Cambrian Burgess Shale site. Two stunning paintings of ancient landscapes in the Natural History galleries were imagined on the basis of our fossils collections. One shows the reconstruction of the late Cretaceous shoreline of Vancouver Island covered in palms, cycads and subtropical plants such as breadfruit. Fossils of these plants are in our collections. Opposite the Woolly Mammoth, the ice age landscape is covered in beautiful wildflowers. We know what grew at this time from the study of tiny fossil pollen grains in our collections. Volunteers Volunteers are vital to the successes of all aspects of the paleontology program. They are involved in research, field programs, specimen identifications, applying catalogue numbers and mounting specimens, preparing specimens, compilation of data and information, data entries, illustration of fossils, photography and editing, literature compilation and lists, public programs and tours, and education activities. Strengths Our collection has wonderful exhibit-quality specimens for displays and use in public programs. Researchers from all over North American visit and study our specimens on a regular basis. We store and conserve our fossils to a high standard either secured and sealed in metal cabinets or stored on closed shelving. Many specimens rest snugly in secure acid-free foam in closed inert plastic boxes. We accept only well documented collections primarily from BC or nearby regions. Key information includes the location of the collection, name of the collector, and the geological setting of the specimen. We keep comprehensive records for all specimens adding greatly to their scientific and educational value. The Royal BC Museum collections contain some very old fossils representing early life during the Proterozoic Ediacaran and the Cambrian periods. Our Burgess Shale collection is small but contains good examples of these experimental early life forms. Interesting trilobites are in the collections from early donations that were collected on Mt. Stephen and others from thesis research completed by Lisa Bohach. Exquisite fossil fishes in our collections from the Early Triassic period about Ma from rocks near Wapiti Lake show coelacanths, sharks, and a full array of bony fishes that lived along the shorelines of continental North America called Pangaea at the eastern margin of massive ocean called Panthalassa. This was proto-BC, before the island terranes collided and the mountains of BC were formed. There are many new species and specimens that have yet to be discovered and described in the collections. This is especially true for Upper Cretaceous fossils from Nanaimo Group rocks where there are many mollusks and plants that are not well understood and are from changing shallow and deep water biofacies and sequences in the Georgia Basin. The collection is very large and provides many unique opportunities for researchers to study in detail species variability in mollusks especially ammonites because of the large number of individual specimens. During the Eocene, about 50 million years ago, the climate was warmer and common volcanic activity was linked to the accretion of terranes at the western margin of the continent. A series of lakes and water courses in the BC interior from the Princeton area north to Driftwood Canyon near Smithers preserved excellent plants, insects, fishes, birds and other vertebrates. Examples of plants include conifers such as Metasequoia, similar to the redwoods in

California; water plants such as Azolla water fern ; Equisetum horsetail , which is the only living genus of an entire class of ancient Paleozoic plants; Ginkgo, another sole survivor of an extinct class of trees; rare flowers of angiosperms and many other plants such as birch, alder, maple, cedar and pine. Considerable diversity is observed in these fossils undoubtedly representing different micro-climates in mountainous and valley regions. Younger Cenozoic rocks of the Sooke Formation along coastal Vancouver Island about 25 million years old contain common mollusks clams, snails and rare vertebrates that are well-represented in the Royal BC Museum collections. The former is a type species with examples in the collections and the other is probably a new species currently being studied. Pleistocene climate change and glaciers have dramatically shaped BC in the last two million years. Mammoths, mastodons, bison and other mammals have been recovered from gravel pits and other sediments on Vancouver Island. Pollen and marine shells provide clues to understanding climate and sea level changes as glacial cycles waxed and waned. The mammoth is an icon at the Museum and there are excellent examples of teeth and tusks in the collections. A globally exceptional collection of wood sections and cores from Heal Lake spanning 9, years records year to year climatic variation for northwest North America. Areas of Opportunity Our collections received little attention between the early s and the s. During this time, however, the Geological Survey of Canada, the staff of the provincial geological survey and university researchers collected widely. Many collections were made by experts outside of the province and found homes in institutions in Canada, United States and Europe. As a result, our collections have limited material from famous sites such as the Burgess Shale. In the s, the museum recognized how important fossil were in British Columbia, and in the mids, many paleontological societies formed in the province. People got really excited about fossils and excellent collections were made at many sites. Our fossil collections began to grow rapidly and researchers around the world realized their tremendous value. The rapid growth and strong scientific interest has posed challenges: We are moving forward with an interim plan to accommodate this collection growth until new storage and workspaces are available. Our geological history is complex and long and is represented by tens of thousands of fossil sites.

Chapter 8 : CRITERIA FOR RECOGNIZING PRE

Microscopic fossils and traces of fossils are found throughout Australian Precambrian rocks, and new finds of fossil soft-bodied animals are regularly being made. In the USA, Canada, Mexico, China, Russia, Africa and India the story is the same.

Introduction - Hadean Eon - Archean Eon - Proterozoic Eon - Links og literature - Introduction Visible tangible life in the form of trilobites and other animals appeared for the first time in Cambrian. That is why the traditional boundary between the distant geological past and the period of life on Earth, is defined at the start of Cambrian. Cambrian is the first part of Phanerozoic, which traditionally denotes the era, where life has existed on Earth. This article is about the climate during the whole period before Phanerozoic that often is referred to as Precambrian. The first rocks, that we know about, were formed in Archean, water vapor condensed, and an atmosphere of nitrogen and methane was created. Proterozoic was the eon when cyanobacteria produced oxygen, iron and methane were oxidized, and life emerged in the late of the period on the bottom of the sea. Several very severe ice ages occurred in Proterozoic that is the Huronian, Sturtian, Marinoan and Gaskiers ice ages. Phanerozoic denotes the period of life on earth. The period started with the formation of Earth 4,56 billion years ago and ended 3,8 billion years ago. There have not been found any rocks from this period on Earth. Earth and probably most of the other planets were formed prior to the Hadean period out of a giant cloud of matter. Thanks to its mass and the resulting gravitational force it grew constantly by attracting still more matter from outer space. This huge mass of rock and other materials rotated around its center of gravity as a giant disk. Within this disk, matter collected into larger clumps, which again attracted even more matter due to its mass. The sun was formed first in the center of the disc, and later the Earth and other planets were created. In the beginning, everything was a glowing inferno. The pressure created by the matter, that was brought together, was together with radioactive decay causing an intense heat. An artistic reconstruction of the clash between Theia and Earth. It is assumed, that while Earth was still in this hot liquid state, it was hit by a planet, by some called Theia, that was of the size of the planet Mars. Caused by the collision most of Theias mass was hurled out into orbit around Earth together with some initial mass of Earth. During the following 10 to 15 million years, the escaped matter in orbit around Earth slowly collected itself to the Moon. It was originally about 16, kilometers closer to Earth, than it is now, and it must have appeared much larger in the sky than we presently see it. Also, other planets show evidence of dramatic collisions with large celestial bodies. Venus rotates in the opposite direction of all other planets. Artistic reconstruction of Earth seen from Space in the early Hadean period. Again and again, they sank into the molten magma and were remelted as a homogeneous mass. At the same time, magma solidified elsewhere and formed new pieces of crispy crust. The initial thin crust was constantly broken and remelted by volcanoes and new meteoroid impacts. But however many of the early surfaces have been preserved on the Moon. Moon rocks have namely not been eroded by wind and water, and there has been much less volcanism on the Moon than on Earth. The Apollo expeditions to the Moon brought rocks back to Earth that were dated to be just 4. However, the lack of heat input from sunlight was amply compensated by geothermal heat from the liquid magma just beneath the thin crust and from radioactive decay. Artistic reconstruction of a landscape in the Hadean period. One can only speculate on the atmospheric composition of Hadean, as there are no rocks preserved from this period. One can imagine that during the first million years the high temperatures led to degassing from the rocks that together with widespread volcanism created an atmosphere consisting of methane, hydrogen, nitrogen, water vapor and small amounts of CO2 and inert gases. The sky was constantly dark and cloudy because of sulphurous clouds and dust that was thrown up by the numerous meteoroid impacts. The atmospheric pressure was most likely very high, about atm. The atmosphere was probably highly electrically charged and ravaged by violent storms. The light hydrogen molecules gradually escaped to space. In the early part of Hadean, water vapor did not condense, as it was still too hot. Analysis of zirconium silicate found in Western Australia shows that it has been exposed to liquid water as early as 4. Perhaps some of the water condensed in low-lying areas due to the high pressure. Artistic reproduction of Late Heavy Bombardment Right: The moon sea Mare

Imbrium with crater Plato. As we can see with a small telescope on a clear night with full moon, there are on the Moon large flat areas, called "moon seas". This indicates that the meteors were simply gigantic. Moon craters may be up to kilometers in diameter. It has been stated that between 4. But it is logical that Earth must have been subjected to exactly the same devastating bombardment, only the craters no longer exist, because they have been destroyed by new volcanic eruptions and erosion by wind and water. Moreover, as mentioned before, there are no longer rocks on Earth from the Hadean period. It is the traditional and still prevailing view that the LHB was all-destructive. All, that existed of rocks and possibly life on the surface of the planet, were destroyed and devastated, and everything started all over again, perhaps several times. Archean Eon Examples of fossils of stromatolites from Archean: The name Archean comes from Greek and means "beginning" or "origin". In later years it is commonly believed that life on Earth began in this period. Original rocks from this period can today be found as smaller parts of greater continental plates. But continents, as we know them today, with continental plates and plate tectonics, did not show up before in the very last part of the Archean. Start of Archean about 3. The Archean Eon lasted 2. Present stromatolites at Shark Bay in Western Australia. Comparison of modern cyano-bacteria with fossils from Archean. The two green ones at the top are micro photos of living cyano-bacteria; the below shown fossils have been found in the Apex Chert rock formation in Western Australia. Maybe it contained minor amounts of ammonia and CO2, but however little or no oxygen, and can thus be regarded as a chemically reducing atmosphere. CO2 was largely dissolved in the oceans. This is in contrast to, for example, the thin atmosphere on Mars, which consists mainly of CO2, precisely because Mars have no oceans that it can be dissolved in. The sky on the Achean Earth was orange caused by the high concentration of methane. Throughout Archean, the general cooling, that started at the end of the Hadean period, continued due to the decrease in the radioactive decay and the reduced meteor bombardment. The initial drop in temperature caused a further decrease in the atmospheric content of important greenhouse gases that were water vapor, CO2 and methane. A piece of frozen methane hydrates brought up from the seabed off the American state of Oregon. The new cyanobacteria took up carbon from CO2 in the atmosphere using their photosynthesis, and some of the newly created organic materials sank to the bottom of the oceans, and thereby decreased the concentration of CO2 in the atmosphere. It was also oxidized in Archean, but it lasted probably longer time. Part of the methane was deposited on the seabed as frozen methane hydrates. Many believe that also a large proportion of methane disappeared into space. Earth was mostly covered by water, with volcanoes and volcanic islands sticking up here and there. The seas were acidic and green because of dissolved iron compounds. Start of Archean happened 3. Suns luminosity, radius and temperature as a function of time in billions of years - after Ignasi Ribas: There was a significant geothermal activity. Most likely most of the very first organisms did not use photosynthesis but could have used perhaps methane, ammonia or sulfates to their energy needs. Photosynthesis began with cyano-bacteria, also called blue-green algae, perhaps 3. These bacteria are a sort of cross between plants and living organisms; They can grow up to 0. At shallow muddy shores, cyano-bacteria can live in symbiosis with other "organisms and together form moss-like cushions with a few centimeter thick calcareous crust; such pads are called stromatolites. These ancient organisms can still be found at the coasts of the Bahamas, Australia and Mexico. However, the oxygen that the stromatolites produced immediately reacted chemically with oxidizing rocks on land and iron compounds in the oceans, and therefore there was no increase in atmospheric oxygen for a very long time. The oxygen content in the atmosphere did not begin to rise significantly until billions of years after the beginning of photosynthesis. It is obvious that, as there was little or no oxygen in the atmosphere, there could not be created the protective ozone layer in the stratosphere, which today protects life on Earth from ultraviolet radiation. It made it extra difficult for life to get a foothold on land. In modern time it is commonly believed that life on Earth began in Archean. Among the oldest fossils of living organisms from Archean are the 3. Proterozoic Eon In Proterozoic blue-green algae continued to produce ever more oxygen. An artist imagines long coastlines full of stromatolites, which are made up of blue-green algae also known as cyanobacteria. The name Proterozoic comes from Greek and means "former life". It was a period of intense volcanic activity, where many mineral-rich volcanic rocks were created. The sun was weaker than it is now. Large continental land masses were formed for the first time around mid-Proterozoic. They were composed of smaller sub-continents. When the contingents pressed against each other, it caused the buildup of mountains. As the mountains began to erode, the sediments washed into the shallow parts of the oceans, creating marine environments, where life could flourish and spread. The Supercontinent Rodinia was formed 1.

Chapter 9 : Cambrian explosion - Wikipedia

The Cambrian explosion or Cambrian radiation was an event approximately in the Cambrian period when most major animal phyla appeared in the fossil record. [2] [3] It lasted for about 20 [4] [5] [6] [7] million years.