Impacts from space and mass extinction events

Entertainment, Games

Describe concept of faunal succession and use of fossils in correlation and in the subdivision of Earth history. -Principle of Faunal Succession: Strata of Eke age can be recognized by the fossils they contain even if the outcrops of strata are separated by large distances geographically, this only works because species have evolved through time C] older forms of life die out and new forms develop -using the appearance and disappearance of fossils to subdivide geological time Is thescienceof physiotherapy

D. Recognize the qualities that make fossils useful in physiotherapy. -Physiotherapy: each fossil species is said to have a range through geological time 0 it exists in the geological record from the point that it evolves to the point that it becomes extinct E. Identify important historical figures in the development of stereography and physiotherapy. Archbishop of Armada, James Usher (1581-1665) calculated the Earth to be 6000 years old by adding up all the dates mentioned in the Bible and arrived at a date of October 22, 4004 BC as the creation of planet Earth (hard to accept by many people) -Late asses and asses scientists started to conclude that the Earth Is ancient and had undergone much change throughout Its history. This George Xavier (1769-1832) examined the remains of mammoths in Europe concluding they were a once living species that had become extinct F.

Appreciate the scale of changes that can occur over geological time scales. -Geological time scale - to represent the changing character of the Earth through time, fossils were used to correlate between different regions and characterize particular periods of Earth's history -Today we have a time scale that divides and bedsides Earth's 4. 6 billion years into various time periods

G. List some of the major subdivisions/ ages of the geological time scale and appreciate the relative scale between the Phonetics and the Precambrian.

This is due to an extraordinary proliferation of fossils at the base of the Phonetics in a period called the Cambrian. -Most creatures with hard parts like shells, teeth, and internal skeletons evolved here as they fossil much more readily than soft-bodied creatures -In addition to an increasing biodiversity as new species evolved, many of the new " hard part creatures" would more readily form fossils. H. Understand how extinction events are linked to the structure of the geological time call. Eras are broad subdivisions that are particularly significant as they represent a grouping of geological periods. They represent times when there has been a major change in the Earth's biosphere. -The base of the Phonetics is defined by the emergence of creatures with hard parts. -The base of the Mesozoic and the Cenozoic is based on the emergence of new species following a mass extinction at the top of the Paleozoic and Mesozoic respectively. -The base of all periods is defined on the emergence of radiation of new species l.

List some of the major developments in the history of life on Earth.) At least 30% of Earth's species must be lost 2) It must be across a broad range of geologies, not restricted to any one niche. 3) It must have short/sudden duration (around 1 million years maximum) K. List the " Big Five" mass extinction events and their order through time. 1) Cretaceous / Polygene (Tertiary) (K/Peg), 65 Ma 2) Late -errant's, 205 Ma 3) Perm / Triassic, 251 Ma 4) Late Devotion, 360-375 Ma 5. Late Ordination, 440-450 Ma L. Distinguish between broad extinction-producing phenomena.) Biological causes:

Organisms being brought together that once lived in isolation can cause mass extinctions (ex. Many of the New Zealand ground dwelling bird fauna were devastated when human hunters and then later European mammals (cats, rats, dogs) were introduced) -The three main modes of biologically induced extinctions: a. Competition between creatures occupying the same ecological niche b. (Excessive) Predation: Predators do not have to do the whole Job, Just drive a population to a low enough level then " random extinction" can complete the extinction.

The idea behind a random extinction is that, although the number of individuals in a species may grow and the species may spread over a wide area, thing ensures the permanent survival of a species. C. Pathogens: disease being introduced to an area by incoming plants or animals 2) Earth-based causes: Extinctions influenced by Earth-based tectonic processes may be caused by changes in continental configuration or changes in atmospheric composition a. Changes in continental configuration: changes in the distribution of continents can have a profound effect.

Two major effects of continental configurations: -Changes in climate, ocean cyclist, sea level. Weather patterns and the movement of the oceans are directly linked to the distribution of continents. The Late Ordination extinction -The greater the landmass the lower the diversity. At the moment we have a relatively high biodiversity. This is in part due to the number of continents that are in effect isolated from one another. In times when there is a high degree of continental fragmentation, evolution can proceed in isolation to produce many different species on different landmasses.

If plate tectonics cause the formation of a large interconnected land mass there will be more competition between species and lower biodiversity. 0 The Perm/ Triassic Extinction b. Changes in the atmosphere: volcanic activity can also have severe effects. Gases such as carbon dioxide can cause greenhouse warming and aerosols may cause climatic cooling. These can significantly affect thehealthof the biota c. Extraterrestrial impacts d. Combination of many factors: it is very unlikely that any one factor would be responsible for a global crisis in the biosphere.

M. Describe the late Ordination and Perm-Triassic extinction. -Late Ordination: Australia, moves towards the South Pole during the late Ordination causing a severe ice age. As water was locked up in the form of glaciers at the Southern Pole, sea level fell. This may have had a severe effect on creatures that live in the shallow water, lose to the continental margins. As the sea retreated off the continental shelf and into the ocean basis shallow marine ecosystems would have been devastated. The Perm / Triassic Extinction (the WORST day for the Biosphere, 251 Ma): At the end of the Permian, plate tectonics had brought all the continents together to form the super continent of Pangaea -Between 95-98% of all species would go into extinction -It hit both ocean- and land-based ecosystems and was less than 1 million years in duration -Many of the common Paleozoic marine creatures would suffer badly through this extinction including trilobites, barbershops, and crinoids.

On land, large amphibians and mammal-like reptiles would be badly effected. -Potential causes of the Perm / Triassic extinction (involves a

number of events happening at the same time): 1) Continental configuration: drop in biodiversity. The greater the landmass the greater the competition between species. At the end of the Permian, the superscription of Pangaea or " all lands" would have brought many species into direct competition. 2) Sea level fall: less ocean ridge activity.

Sea floor spreading slowed its pace during the Permian, resulting that the oceanic ridges were smaller in size and displaced less water. Consequently oceans retreated from shallow areas into the deeper basin causing problems for creatures that lived in any remaining shallow marine environments. 3) Oceanic stagnation: The close of the formation of Pangaea saw the end of an ice age. Cold polar waters probably disappeared and ocean circulation slowed or stopped. This would have reduced ventilation of deep ocean waters killing off many deeper marine species.

In addition occasional overturn of stagnant water could have brought oxygen poor waters to shallower marine communities as well. 4)Climate change: Due to the formation of a large landmass, limited would have been much drier and subject to drought. 5) Siberian Traps: massive volcanic activity in Russia: Around 2-3 million kamala basaltic lava were produced within a million years. Carbon dioxide from the volcanic activity and methane caused by melting of gas hydrates would have resulted in greenhouse warming of the planet.

In addition, gas emission from volcanoes would have also produced acid rain effects. 6) Possible impacts: Although still very controversial, it is possible that the Earth suffered impacts from space during this time as well. N. Describe the character of extinctions at the K/Peg boundary. Just as the end

of the Permian extinction marked the beginning of a new grouping of periods (the Mesozoic) the end of the Cretaceous extinction is likewise so distinct that it marks the beginning of the latest grouping of periods, the Cenozoic. Characteristics: 1) Over 50% of all species on the planet would go into extinction during the k/Peg extinction event 2) One land, few creatures over 25 keg in weight would survive 3) In general, the extinction was even more severe in the oceans with around 80-90% of marine species including the ammonites and marine reptiles going into extinction -A ether and son scientific team, Louis and Walter Olivarez brought the K/Peg extinction crosses the K/Peg boundary in Gobi, Italy.

The I-CM clay layer lies directly on top of the latest Cretaceous rocks and was found to be enriched in the element iridium (very rare at the Earth's surface and yet in this layer was enriched over xx above background 0 has now been recorded in many other sections around the world that straddle the Cretaceous. Polygene boundary) -Iridium is known to exist in higher concentrations in extra-terrestrial objects such as asteroids. Olivarez suggested that he clay layer enriched in iridium has been produced by a meteor or comet over 10 km in diameter impacting the Earth.

He suggested further that this impact may have also been responsible for the extinction at the end of the Cretaceous. O. Discuss the evidence used to support the K/Peg impact. 1) Fern spores vs.. Pollen: Ferns are often the first plants to colonize a landscape that has been devastated by fire. In the earliest Polygene (part of what was formerly called the Tertiary), many areas show an increase in fern spores relative to pollen. This suggests that global

forest fires may have raged at the end of the Cretaceous paving a landscape open for ferns to spread.

This is further supported by high concentrations of soot found around the K/Peg boundary. 2) Tektites: they are thought to be produced during an impact event and they are composed of natural gas. During impact, rock is melted and ejected form the crater. As it travels through the air and cools, it forms characteristic aerodynamic shapes. Many tektites are found at the K/Peg boundary in many different locations, suggesting a massive impact event. 3) Shocked quartz: In many sections around the K/Peg boundary, fragments of the mineral quartz show evidence of multiple fractures.

These fractures are thought to be produced when rock is shattered during a high-energy impact. The fragments are called shocked quartz. 4) Tsunami deposits: Tsunami waves leave characteristic sedimentary deposits on inundated shores and as far inland as the waves reach. This feature was found in Mexico, Texas, New Jersey, and the Carolinas suggesting the passage of an enormous wave, far larger than could have been produced by standard tectonic processes.

Such a wave could have been generated if an impact had occurred in the ocean. P. Describe the location and probable nature of the K/Peg impact. The distribution of tektites, iridium, shocked quartz, and other potential impact related features was pointing towards a possible centre of activity in the Yucatan Peninsula of Mexico. An oil company had drilled wells in the area and encountered unusual fractures and even melted rock suggesting the area had been subjected to some form of extremestress. The presence of a

crater was finally confirmed when geophysical data revealed a large circular disturbance over km in diameter, the Clubbing Impact Crater -The object responsible for this crater had a shallow angle of entry around 0-30 degrees and is estimated to have been at least 10 km across. -As an analogy, you can think of something the size of Mount Everest hitting the surface of the planet. The energy released by the impact was equivalent to 6. Axes tons of TNT. An estimated 100 kamala of rock was vaporized and released to the atmosphere. Material that wasn't instantly vaporized was thrown out of the crater (the ejects) and Q.

Describe the initial and long-term effects of the impact and their environmental consequences. 1) Initial effects (seconds to days) of the impact in the area of the Yucatan Peninsula were significant a. Everything close by would have been vaporized b. The intense heat form the blast and the hot debris (including tektites) would have started massive forest fires as suggested by the fern and pollen data c. As the impact occurred partly in the ocean, a massive tsunami would have been generated 2) Longer-term effects (months to decades) of the impact were numerous.

Two significant effects were on global temperature and on atmospheric composition. A. Global temperature changes -Dust thrown into the atmosphere would have shut off sunlight for weeks or perhaps months generating a period of cold (a " Cold House", lasting weeks to months. The lack of sunlight would also have had severe consequences for plants and photosynthetic algae. -After the dust had settled, water vapor would have remained in the atmosphere acting as a blanket, preventing heat from

escaping the Earth. This would have created a greenhouse effect and caused a rise in global temperature. Eventually the excess water vapor would be removed by rainfall. However, the temperature of the Earth would continue to rise due to the release of greenhouse gases during impact (a " Hot House"), lasting years to decades. In particular, carbon dioxide would have been liberated when large quantities of limestone (calcium carbonate, Cacao) would have vaporized during the impact. -The Mesozoic had in general been a warm equableenvironment. These swings in temperature would have laced a lot of stress on creatures more used to stable climatic conditions. . Acid Rain -High-energy blasts can cause oxygen to combine with nitrogen to form oxides of nitrogen. When these are dissolved in water (ex. Rainfall), it becomes nitric acid. -In addition to the vaporization of limestone as described in (a) above, rocks called evaporates were also vaporized in the blast. Evaporates form when salts precipitate out of solution as the sun evaporates a body of water. This can occur on a vast scale, for example in the Mediterranean Sea, which is closed off at the Strait of Gibraltar.

With virtually no input of water from the Atlantic Ocean, high rates of evaporation resulted in the Sea being converted into a vast sultan. This process had also occurred in the Yucatan area. The effect of high-energy blasts on sulfate-rich evaporates is the release of large amounts of sulfur gases. These gases, when dissolved in rainwater, fall to Earth as sulfuric acid. Although the acidity of the nitric- and sulfuric- containing rain was weak and could probably not affect any large animals directly, they would have been affected the acidity of soil and surface ocean.

This would have had a devastating effect on plant life and plankton. Thus, the effects from acid rain on the organisms that form the base of thefoodchain or food web had serious repercussions for all the creatures at higher atrophic levels. R. Consider other potential causes of the K/Peg environmental consequences. -Some scientists remain convinced that another impact at the K/Peg boundary (perhaps not loud have been significantly larger than the Clubbing impact, but impacts would NOT have been the only cause.

Some factors may be: -During the late Cretaceous, the superscription of Pangaea was starting to fragment. This would have caused changes in oceanic circulation and climate. -Even more significantly, global climate would have been affected by an increase in volcanic activity, in particular, during the formation of the Decca Traps in India, which were highly active at this time. Like the Siberian Traps that occurred at the end of the Permian, this activity would have reduced vast quantities of gases that could have seriously affected the Earth's climate.

S. Describe the type and location of potential impostors and rate of meteor influx. 1) Comets are essentially material left over from the formation of the Solar System and are composed of icy material and other debris - effectively " dirty snowballs" in space. As comets travel towards the Sun, the ices vaporize producing the comet's tail. -Two examples of comets are comet Halley, which comes into view of the Earth every 74-79 years, and comet Hale-Bop that was last seen in the night sky in 1997 and will turn in 2380 years. An annual event is the Leonie Meteor Shower, which is visible in

Canadian skies in November. This rain of " shooting stars" is produced as the Earth passes through the debris left behind by comet Temple-Tuttle as it orbits around the sun -There are two comet " stores" in the Solar System: a) The Keeper belt exists in an area from about the orbit of Neptune to about 50 auk's out (1 AU = 150 million km) -May contain 1 billion (1 x IOWA) comets that are greater than km in diameter.) The Root cloud is a cloud of comets that exists way beyond the Keeper belt and is only Oakley associated with our sun -May have more than 200 comets with a diameter greater than 500 km with many smaller but still significant in size -It is interesting to note that comets may have been responsible for bringing much of the water and perhaps some of the organic compounds that would lead to the development of life of Earth 2) Asteroids are mostly found in a belt between the orbit of Mars and Jupiter.

It is speculated that they may represent the material that might have formed another planet early in the history of the Solar System if it were not for the gravitational effects of Jupiter. Some asteroids are solid, rocky to metallic while others are little more than " rubble piles" in space. Collisions between asteroids could potentially cause them to be redirected into Earth-crossing orbits. Of those so far mapped, a few are over km in diameter, about 1000 have diameters greater than 30 km and 1 million (alexia) with diameters over 1 km T.

List some of the major impact features preserved on the Earth's surface and explain why impact craters appear to be rare on Earth. -Around 100 billion (IXIA 1) objects enter our atmosphere every rush 0 most of these are burned

out at a distance of km above the Earth's surface. These objects are commonly traveling around 11-km/ second. At such speeds, the atmosphere acts like a brick wall. If an object enters at a shallow angle, it may skip like a stone being skipped across a pond and fly back out to space -Early in Earth's history, our planet probably suffered on our planetary neighbors' like Mercury.

The evidence of this early bombardment is missing on Earth due to processes of erosion and active plate tectonics. -Until recently (sass's) the possibility of impact on Earth's surface was regarded as improbable. -Craters such as Meteor Crater in Arizona and even the craters on the non were held by some to represent extinct volcanoes and not impact craters at all. U. Describe some of the features and processes of crater formation. Gene Shoemaker was to change this view by studying features such as the material thrown out of a crater (ejects), shocked quartz, and chemical anomalies, which demonstrated extra-terrestrial origins for these features. -With the aid of satellite imagery, we are now beginning to identify more craters on the surface of our planet. V. Provide examples of Canadian Impact Craters. -Manicuring impact crater (Northern Quebec) - formed about 214 Ma in the Late Triassic. It is km in diameter but was probably as wide as km before glacial erosion stripped away the upper levels. This impact even is thought to be associated with 4 others including Saint Martin Crater (Manitoba) - 40 km in diameter and Architecture Crater (France) - 25 km in diameter. -When the continents are reassembled into their locations during the late Triassic all these craters line up along 22. 8 degrees North latitude over a distance of 462 km. -It is thought that this almost improbable

alignment may actually represent a fragmented body that generated several impacts. It is interesting to note that although the effects of this impact would have been severe, it is not associated with a major mass extinction event W. Describe the hypothesis proposed by Rap and Sheepskin. -They analyzed the number of mass extinctions during the Phonetics and concluded that every 25 million years there was severe stress on the biosphere, sometimes associated with a mass extinction event -There is no known terrestrial geological process that could cause this frequency of problems for the biosphere.

So it was suggested that an extraterrestrial source may be to blame 0 comets in the Root cloud were cited as being the most likely culprit -Rap and Sheepskin's hypothesis suggests that every 25-26 million years, something shifts the Root cloud, which causes some comets to fall in towards the Sun and a possible impact with the Earth 0 for this to work, we need to identify a gravity source that can cause disturbances in the cloud on a regular 25 million year basis: 1) Nemesis - Companion Star: This hypothesis proposes that our Sun has a companion star way beyond the outer limits of our Solar System whose orbit brings it close to the Root cloud every 25 million years.

The gravitational effects of this close pass could cause comets to fall into the inner Solar System. If this body was a red dwarf star or even a black hole, it might be difficult to detect, but even though powerful telescopes such as Hubble have the Nemesis hypothesis, this has an astronomical body (Planet X) that causes shifts in the Root cloud as it orbits around the Sun. In this case, the body y is a planet lying within the bounds of the Root cloud but

outside the Keeper belt. Again, no evidence of such a planet has been found. 3) Movement Through the Galactic Plane: In the same way that our planet orbits the Sun, so our Solar System orbits around the center of the Milky Way Galaxy.

Galaxies are not Just flat pancakes of stars, they also have " thickness" -In addition to traveling around our galaxy, our Solar System is also moving up and down through it, Every 25-26 million years we pass through the densest part of the galaxy, which contains a higher number of stars and also the most gravitational effects. It is proposed that it is this movement through the dense part of the galactic plane that is responsible for the shifts in the Root cloud and thereby a potential impact related biosphere crisis every 25 million years or so. X. List and describe some recent impacts and " near misses".) Tunas, Siberia None 30, 1908): A large explosion about km above the surface attributed to an extraterrestrial object breaking up I the atmosphere (which is why no crater was found).

Fortunately, the area was not populated but people and horses km away were knocked off their feet. The shock wave from the blast traveled around the Earth twice. -In Scotland and Sweden, a light appeared in the sky so bright that you could read books at am without the aid of artificial light. It has been suggested that this might have been a fragment of comet Neck, which was passing close by the Earth at hat time -Over 80 million trees were knocked over covering an area about kamala (compare the area of the Tunas devastation to that of the area occupied by Washington, D. C.) 2) Asteroid

near misses: 1989, 1996, 2009, 2011 -March 22, 1989: A mm asteroid misses Earth by 6 hours.