

Natural Disasters

Lecture 27

Ch #17 – The Great Dyings (Mass Extinctions)

Text Source Today:

Chapter #17 (p. 10-16)

#17.2: Ch. #17 – The Great Dyings (Mass Extinctions)

♦ Possible Causes of Mass Extinctions:

- **Plate Tectonic Causes:** the rate of **seafloor spreading** varies, the number and size of **continents** differ over time, and the rise and fall of **sea level** changes the **percentage of land versus sea**.

- Today, the oceans cover about **71%** of Earth's surface and the land the remaining **29%**. A sea level **drop** could increase the percentage of land up to **40%**, whereas a sea level **rise**, could decrease the percentage of land to only **17%**.

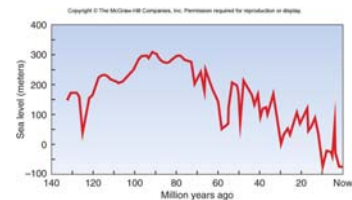
(Fig. #17.21)

- ♦ **1 Changes in Seafloor Spreading Rates:** during times of **high** seafloor spreading, the effect of **more rock in the oceans** causes the oceans to **flood** over and onto the continents, creating large **inland shallow seas**. During the mid-Cretaceous (110-85 million years ago), global sea level was over **200 m (660 ft) higher** than it is today!



(Fig. #17.22)

- ♦ **2 Sea Level Changes:** if all the glacial ice (mostly on Antarctica and Greenland) were to melt, global sea level would **rise about 70 m (230 ft)**. At the peak of the last ***Ice Age*** 20,000 years ago, sea levels **dropped about 140 m (460 ft)**. That gives a total swing of **210 m (690 ft)**! The sea level changes due to glaciation operate independently of seafloor spreading. They can **cancel each other out** or cause **great rises and falls** that put **major stresses** on life.



♦ **3 Numbers and Sizes of Continents:** a large, **combined landmass** will have a **lesser** number of species than several, smaller, **isolated landmasses**, due to **competition** for the shared food supply and living space. When Pangaea broke up, there was an increase of shorelines, a reduction of harsh continental interiors, and made other habitat changes which **species either coped or went extinct**.

♦ **4 Continental Position and Glaciation:** the shifting of continents plays a role in the **climatic conditions** on Earth. When large landmasses move closer to the **North and/or South poles**, enough snow can be caught and accumulated into massive **ice sheets** that can bury entire continents and plunge the Earth **into an Ice Age**.

♦♦ **5 Volcanic Causes:** **flood basalts** have caused immense amounts of **basaltic lava** to flow over large areas in a relatively short geologic time span. **Flood basalts** on the ocean floor create large **oceanic plateaus** (e.g., *Ontong Java*) that can cause sea level to **rise** up to **10 m (33 ft)**!

♦ **6 Changes in Atmospheric and Oceanic Composition:** flood basalts release **massive volumes of gases**. On continents, they may be **greenhouse gases**. In sub-sea eruptions, the oceans absorb and dilute some of the gases, leading to changes in ocean water **acidity and oxygen** concentrations. Resulting **large** temperature increases cause extreme stress on some species.

♦ **7 Climate Change Causes:** the following sequence of events could occur: (1) concentrated volcanism emits tremendous **volumes of gases**; (2) the **composition** of the atmosphere and

oceans changes; (3) the altered atmosphere and oceans changes the **heat balance** of Earth via the **greenhouse effect**; and, (4) the **global climate** undergoes significant changes.

- The climatic history of Earth shows drastic changes from very cold (***Ice Ages***) to very warm (***Torrid Ages***).

♦ **8 Ocean Composition Causes:** if the buffering systems of the oceans is overwhelmed, the resultant changes in ocean composition can be lethal some species.

- During Earth's **warmest** episodes, the polar waters were too **warm to sink**. The **decay of organic matter** on the ocean bottoms robbed bottom waters of **oxygen**, making it **anoxic**, and bottom-dwelling species were pushed into extinction.
- **Salinity** changes can also be lethal to some species. In times of glacial retreat, the flow of cold, fresh meltwater **lowered** salinity. When the Mediterranean Sea was formed, **evaporation increased the salinity** to crises levels for most species there.

♦ **9 Extraterrestrial Causes:** an **asteroid or comet impact** is likely to cause wildfires, acid rain, tsunamis, and a huge dust cloud that blocks sunlight and creates weeks of months of **dark "winter."** When the dust settles, a **greenhouse rise** in temperature follows. This could lead to **mass extinction**.

♦♦ **10 Biologic Causes:** some species **go extinct every day** due to low population size (**"gambler's ruin"**), reduced geographic area (a **smaller** area correlates to **fewer** species), competition, and **predation** (just driving down the numbers can allow **"gambler's ruin"** to finish the job) including epidemic disease.

♦♦ **Multiple Causes of Mass Extinctions:** any **one** of the factors above can cause enough local stress to drive one or more species into extinction, but to **end the existence of numerous species around the world** requires **two or more causes** described above to **either occur simultaneously or be closely spaced in time on a global scale.** (Fig. #17.17)

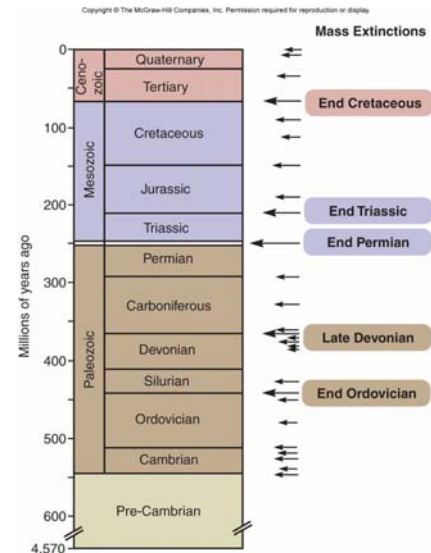
♦♦ **Mass Extinctions: the “Big Five:”**

► **(1) End Ordovician:** the 3rd largest of the five in two bursts of extinction 1 million years apart, occurring about **443 million** years ago. It was the 2nd biggest extinction of **marine life**, as all known life at that time was confined to the **seas and oceans.**

- **Cause:** appears to have been due to **continental drift** of significant landmasses to the **south polar** region, causing a global **temperature drop, glaciation, and consequent lowering of sea level (i.e., Ice Age)**, which destroyed species’ habitats around the continental shelves.

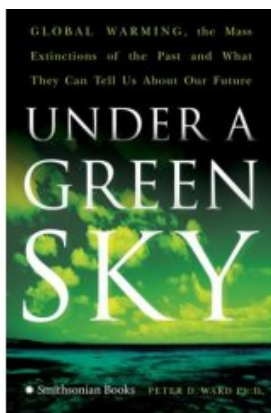
► **(2) Late Devonian:** occurred about **364 million** years ago, when the continents were just beginning to move together to form **Pangaea** and there were plants, insects and amphibians on land, and fish in the seas, along with huge reefs. This extinction seems to have affected **only marine life (50% extinction).**

- **Cause:** appears to have been due to sea level change, ocean **anoxia**, possibly triggered by global **cooling** and/or oceanic volcanism. The **“greening” (tall trees, plants)** of the continents may have led to reduced **CO₂, algal blooms and anoxia.**



►♦ (3) **End Permian**: occurred about **253 million** years ago, over about 1 million years. The seas had been full of animals that lacked mobility and on land, there were amphibians as big as pigs and mammal-like reptiles larger than sheep. It became **Earth's most severe mass extinction**: **~95% of all marine species and 70% of all terrestrial species became extinct!** It is also the only known mass extinction of **insects**.

- **Cause**: appears to be from a **combination of events** operating on **different time scales**: (1) the continents had been pushed together to form **Pangaea**, which closed off most of the equatorial sea, very little tropical shorelines and creating a harsh, arid, desert interior; (2) **seafloor spreading slowed** its pace, creating a larger ocean basin and resulting **fall** in sea level; (3) the **“Siberian Traps Flood Basalt”** that erupted for about 1 million years (mantle plume or very large asteroid impact?), sending huge amounts of **CO₂** into the atmosphere, and melting the **permafrost**, which released tremendous amounts of **methane** into the atmosphere, all leading to intense **global warming and acid rain**. A warming ocean allowed for massive methane gas hydrate release; and, (4) **O₂** levels plunged and a possible vast release of **H₂S** from the warmer, **anoxic** oceans poisoned life on both land and sea. **Greenhouse extinction!**



Peter D. Ward, *“Under a Green Sky: Global Warming, the Mass Extinctions of the Past, and What They Can Tell Us About Our Future,”* HarperCollins, (2007).

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