SCIENCE SORT
MIDDLE SCHOOL

TEKS

Sixth Grade: 6.10A, 6.10B, 6.10D

Seventh Grade: 7.8B, 7.9A

Eighth Grade: 8.8E, 8.9A, 8.9B

Vocabulary

amber, asthenosphere, body fossil, Continental Drift Theory, convergent plates, coprolite, decay, decompose, divergent plates, ecoregions, fern, fossils, lithosphere, mineralized, Pangaea, petrified wood, Ring of Fire, scavengers, sediment, sedimentary rock, trace fossil, transform plates

Pre-Show Activity

Pre-Show Lesson: Fossils and Plate Tectonics

Post this question on the board: “How do scientists find fossils if they are buried deep in the Earth?”

Materials:

Per class: plate tectonics picture (Appendix A-1), ring of fire picture (Appendix A-3)

Per group: various fossil and non-fossil pictures. Fossil pictures should include: shark’s tooth, dinosaur bone, coprolite, dinosaur footprint, amber, petrified wood, fern leaf, etc. Non-fossil pictures should include: deer bone, shark’s tooth, deer footprint, wood, leaf, etc.

Per student: student record sheets for plate tectonics model (Appendix A-2)

Procedure:

1. Give each table a collection of fossils or fossil pictures and some non-fossil pictures. Students will sort the pictures into fossils and non-fossils and be ready to explain the criteria they used to decide if the picture was a fossil.

2. Groups will share their classification and explain their reasoning.

3. Explain to students that fossils are any trace of prehistoric life. You may want to write this definition on chart paper. Explain the two types of fossils to students:

   Trace Fossils – These occur when an animal gives us proof of animal life from the past. Trace fossils include things like foot prints, burrows, and fossilized poop (coprolites). The mud or soil dries and hardens, preserving the impressions or droppings, which are later covered by more soil or sediment. Over many years, the sediment is transformed into sedimentary rock. By studying these fossils paleontologists can infer how organisms behaved, what they ate and how they interacted with one another.

   Demonstrate for students how trace fossils form by using a plastic dinosaur and soft clay in a transparent bowl. Demonstrate to student how the dinosaur steps in soft mud and leaves its footprint. Then slowly cover the clay with sand and dirt. This represents wind, water or ice eroding nearby land and depositing sediment over the footprint. It hardens and becomes sedimentary rock over millions of years.

   Review with students which of the pictures that they were given are examples of trace fossils.

   Body Fossils – When an animal or plant dies, usually the remains are eaten or decompose. Organisms with hard parts such as a mineralized shell, like a trilobite or ammonite, are much more likely to become fossilized than animals with only soft parts such as a jellyfish or worm. Body fossils of plants and animals almost always consist only of the skeleton or toughened parts because soft tissues are destroyed by decay or scavengers. On occasion, though, they get buried by mud or sediment, and, in the right conditions, they harden into fossils. The bones or original material decay, and water and minerals seep into the impression left by the original material. The water and minerals continue to dissolve the original material, replacing it, and then they harden over time.

   Model how this happens with the students by placing the plastic dinosaur into the transparent dish. Immediately bury it in sand or dirt (erosion and deposition) before it is exposed to sunlight and bacteria. The soft parts will decompose. Pour in water. Explain that the minerals in the water will stay in the bone and overtime the bone will become hardened and fossilized.

Review with students which of the pictures are body fossils.

4. *If these fossils are deeply buried in the Earth, how do we find them millions of years later?* Have students discuss this, and the questions below, in their groups.

   - What forces build up a mountain?
   - What forces can break down Earth?
   - What does erosion do to Earth's surface?
   - Are there any other forces at work on Earth's crust? (plate tectonics)

5. Explain to students the Continental Drift Theory. Scientists believe that the continents were all connected (Pangaea) when the dinosaurs first appeared on Earth and they slowly separated because of plate tectonics, which caused crustal movement. The geological forces that molded Earth millions of years ago are still working today. Show a short video on the Plate Tectonics Theory. You can find these on Teacher Tube, or the Discovery Education.

6. Plate Tectonics Exploration

   Materials: Two graham cracker squares, frosting, waxed paper

   Procedure: Lead students through the following exploration:

   1. Spread some frosting over the waxed paper about 1 cm thick.

   2. Put two graham crackers very close to each other on the frosting and slowly push them apart. The graham crackers represent the Earth's crustal plates (lithosphere) and the frosting represents magma in Earth's mantle (asthenosphere).

      This represents *divergent plates*- when two plates move away from each other.

      - You've made a rift, or big crack in the ocean floor. As plates separate, magma oozes up from below and makes new ocean floor or creates underwater mountain ranges.

      - Volcanoes happen along divergent plates (Example: Ring of Fire in the Pacific Ocean - Appendix A-3)

   3. Push two crackers towards each other, making one slide underneath the other.

      This models *convergent plates*. When both colliding plates are continental plates, neither tends to sink because their densities are similar.

- Instead, continental lithosphere buckles & is uplifted.
- Fold mountain ranges are formed (Himalayas)
- Little volcanic activity occurs because rocks from the lithosphere do not sink deep into the asthenosphere. The asthenosphere is the ductile part of the earth just below the lithosphere, including the lower mantle. The asthenosphere is about 180 km thick (Source: USGS).
- Earthquakes, faulting & folding are common.

When an oceanic plate collides with a continental plate, it is pushed under because it is denser. Lithosphere materials from the oceanic crust are subducted in the trench while the continental border is fractured, folded & uplifted. Magma rises from the subduction zone through fractures. Thus, a mountain system accompanied by volcanic activity can be found on the continental edge parallel to the ocean trench, as with the Andes Mountains.

Subduction is the process of the oceanic lithosphere colliding with and descending beneath the continental lithosphere (Source: USGS).

When two oceanic plates collide, the plate’s edges are bent into a deep trench called the subduction zone. Resultant major landforms include oceanic trenches like the Marianas Trench.

4. Put two graham crackers side by side, and slide one up away from you and the other one down toward you.

These are called *transform plate boundaries*.

- When plates move past each other like this, things do not go smoothly. The plates usually get stuck on each other and then give a great lurch and move on, sending waves of vibrations through the earth’s interior.
- This causes earthquakes.

How does this related to fossils?

Millions of years after fossils are buried, the rock surrounding the skeleton rises to the Earth's surface. This happens during mountain building, earthquakes and other earth processes. The rock is worn away by wind and rain, and the fossil is now exposed, waiting to be found.

Post-Show Enrichment Activities

Activity One: Texas Ecoregions

Materials: Venn Diagram, art supplies

Procedure:

1. Assign each group (3-4 students) a different ecoregion of Texas to research. They can use the Internet for research.
2. Students will create a diagram of what this ecoregion looked like during the age of the dinosaurs and list characteristics of that time period.
3. They will also create a picture of what it looks like in the present and list characteristics of that ecoregion.
4. Students will create a Venn diagram comparing the ecoregion's features millions of years ago to its present day features.

   Possible Research Site:

   http://texastreeid.tamu.edu/content/texasEcoRegions/ (present day)

   http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_p4502_0094n.pdf (prehistoric times)

Activity Two: Model of a Fossil in Amber

Materials: small dead insect or plastic insect, bottle top, clear or light orange nail polish

Procedure:

1. Explain to students what amber is and how fossils are created in it. Explain that amber is a resin secreted by pine trees. The sap of the pine tree is very sticky and an insect that caught itself in it would get stuck. Once the insect was caught in amber it would remain there and the sap from the pine tree would continue to flow, dripping onto the insect and over time covering it up completely.
2. Create a model of a fossil in amber.
   a. Place the dead insect in the bottle cap.
   b. Take the clear nail polish and slowly drip it over insect.

c. Set the bottle cap aside to dry.

d. Repeat the process several times until the insect is completely incased like a real amber fossil.

Activity Three: Amber Offers Clues to Earth's Prehistoric Atmosphere

Materials: Table (Appendix A-4), article (Appendix A-5)

Procedure:

1. Have students read the paragraph below.
2. Using the Internet or a print out, have students compare Earth's atmosphere today to what it was like during the age of the dinosaurs. If oxygen has decreased by almost 14% according to scientists, what gases do you think increased? Why?
3. After students have predicted the level of gasses in the atmosphere during the age of the dinosaurs, have them read the information below and explain if their predictions were correct. Why or why not?

Oxygen, Carbon Dioxide and the Atmosphere

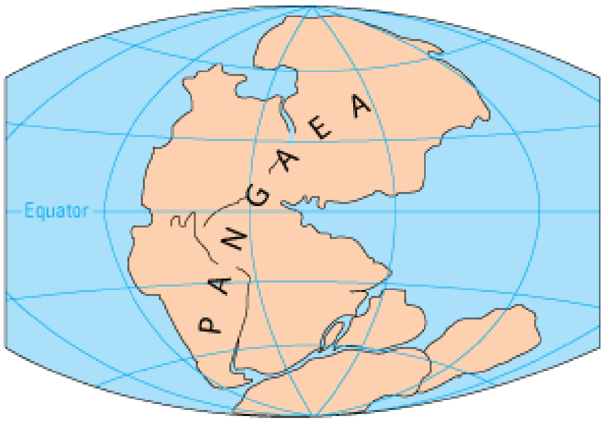
Many scientists now believe that the main causes of the Permian Extinction centered on the changing levels of carbon dioxide and oxygen, although they disagree as to the exact mechanisms that created these circumstances. In the Triassic we also see tremendous changes occurring throughout the period regarding the atmospheric content of three main gasses: oxygen, carbon dioxide and methane.

Source:

http://eonsepochsetc.com/Mesozoic/Triassic/Tri_Environment/environment.html

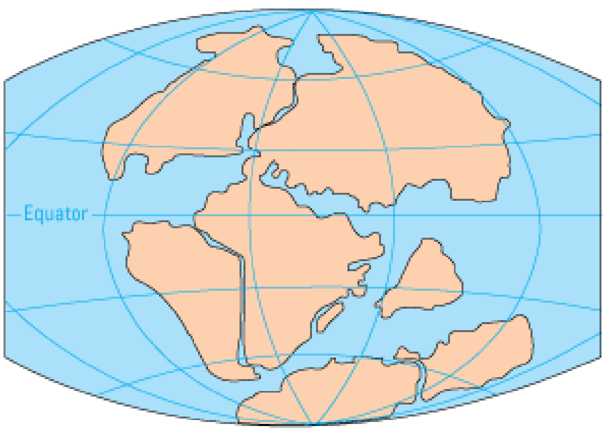
Appendix

A.

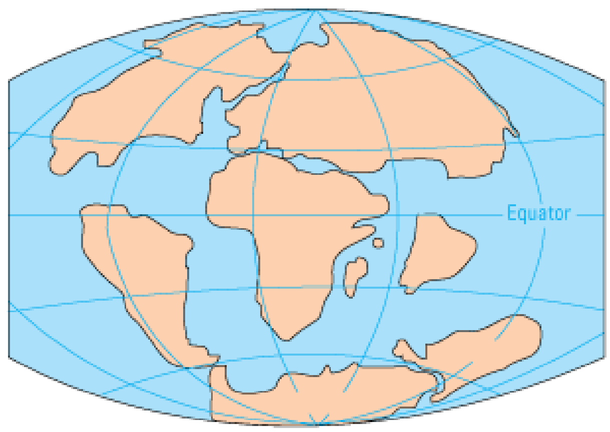


PERMIAN
225 million years ago

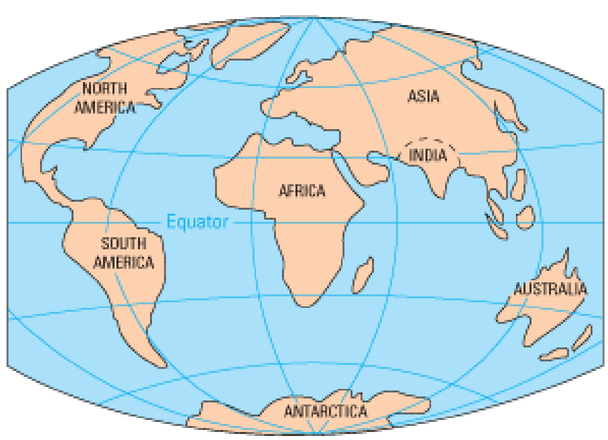
TRIASSIC
200 million years ago



JURASSIC
150 million years ago



CRETACEOUS
65 million years ago



PRESENT DAY

Source: USGS

A-2

Name ___________________________________ **Date** ___________________

Questions:

1. What do the graham crackers represent?

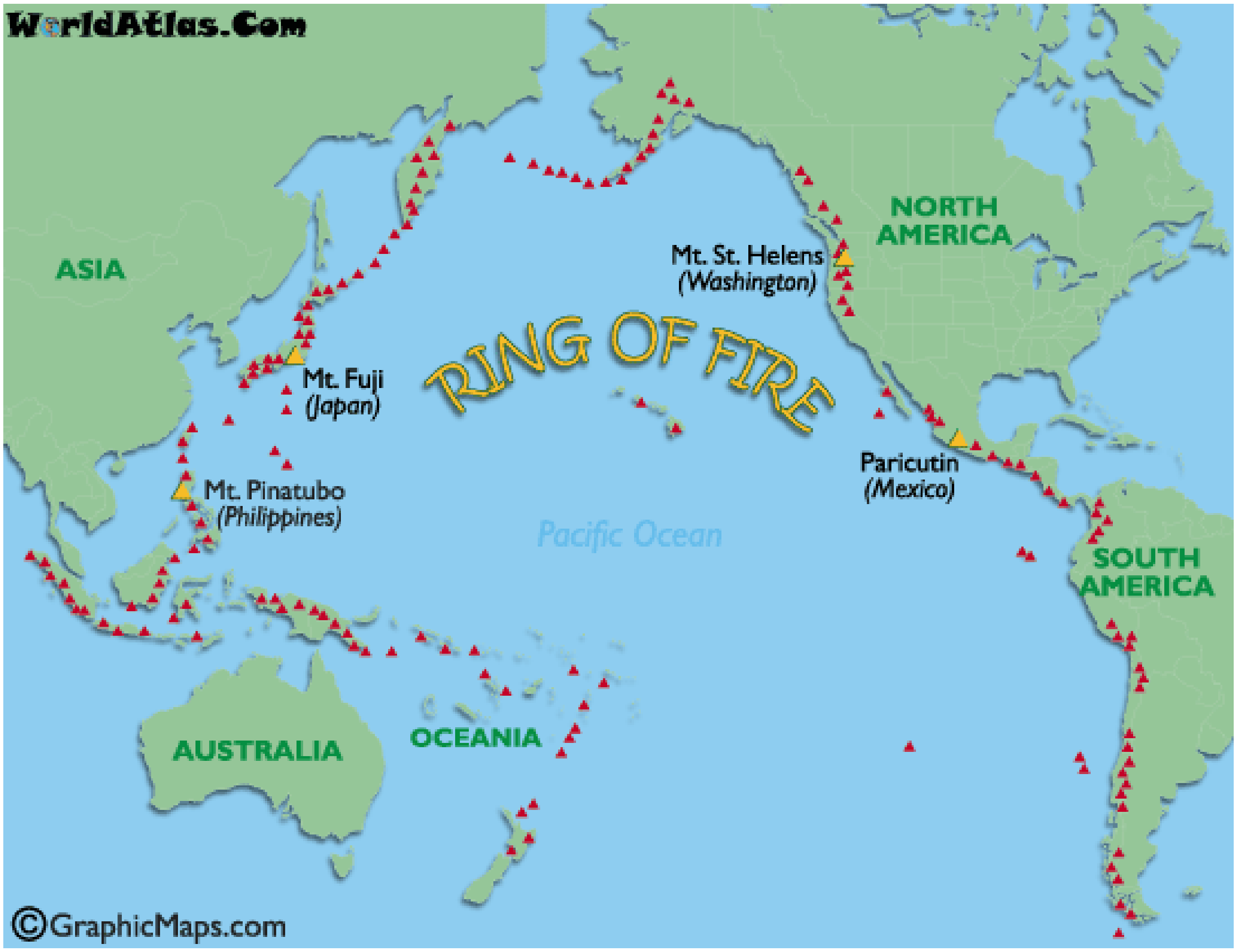
2. What did the frosting represent?

3. In the first model that you made, what kind of plate boundary was demonstrated? What land feature did it form? How would this geological movement affect fossils buried in the Earth's Crust?

4. In the second model that you have made, what kind of plate boundary was demonstrated? What land feature did it form? What other effects did this geological movement have on Earth? How could this affect fossils buried in the Earth's Crust?

5. In the third model, what kind of plate boundary was demonstrated? What land feature did it form? What other effects did this geological movement have on Earth? How could this affect fossils buried in the Earth's Crust?

A-3


WorldAtlas.Com
ASIA
NORTH AMERICA
Mt. St. Helens
(Washington)
RING OF FIRE
Mt. Fuji
(Japan)
Paricutin
(Mexico)
Mt. Pinatubo
(Philippines)
Pacific Ocean
SOUTH AMERICA
AUSTRALIA
OCEANIA
©GraphicMaps.com

A-4

Table 7a-1: Average composition of the atmosphere up to an altitude of 25 km.

Gas Name	Chemical Formula	Percent Volume
Nitrogen	N_2	78.08%
Oxygen	O_2	20.95%
*Water	H_2O	0 to 4%
Argon	Ar	0.93%
*Carbon Dioxide	CO_2	0.0360%
Neon	Ne	0.0018%
Helium	He	0.0005%
*Methane	CH_4	0.00017%
Hydrogen	H_2	0.00005%
*Nitrous Oxide	N_2O	0.00003%
*Ozone	O_3	0.000004%

* **variable gases**

Graphic Source: University of British Columbia

A-5

Amber Yields Clues to the History of Oxygen in Earth's Atmosphere

Gas bubbles trapped in amber show an oxygen-rich Cretaceous atmosphere

Republished from a information release posted by USGS in June, 2009.

Compositional History of Earth's Atmosphere

Ages of ice samples found on the Earth cover a span approaching 200,000 years. Gas bubbles trapped in that ice can be used to learn about the composition of Earth's atmosphere at the time they were trapped in the ice. But how can we tell what the Earth's atmosphere was like before that?

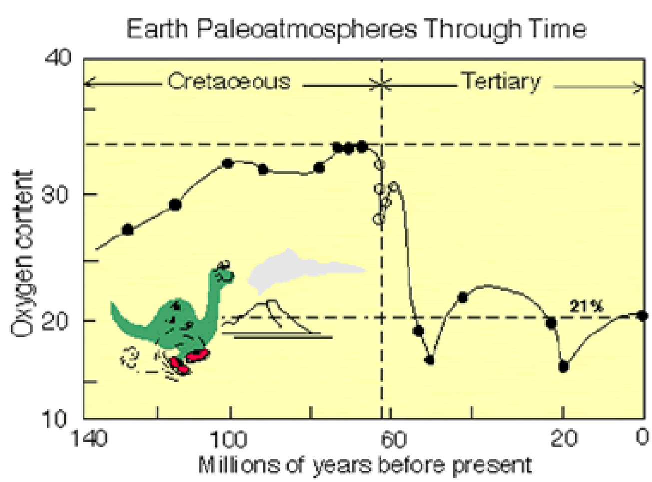
Recently, USGS scientists have used a gas QMS to determine the oxygen level of ancient samples of Earth's atmosphere from a most unlikely place - amber. The fossilized resin of conifer trees, amber is interesting to scientists as a medium that traps insects, small animals, and plants, preserving them through geologic time for future study.

The recent extraction by scientists, of ancient DNA from organisms entombed in amber much like in the science-fiction novel and movie, Jurassic Park is an example of why scientists are intensely interested in amber. Minute bubbles of ancient air trapped by successive flows of tree resin during the life of the tree are preserved in the amber.

Amber - the fossilized resin of conifer trees - provides a unique means of protecting intricate samples of the past. This mosquito, lying trapped for 45 million years in a piece of amber, is almost perfectly preserved. USGS image.

The Oxygen-Rich Cretaceous Atmosphere

Analyses of the gases in these bubbles show that the Earth's atmosphere, 67 million years ago, contained nearly 35 percent oxygen compared to present levels of 21 percent. Results are based upon more than 300 analyses by USGS scientists of Cretaceous, Tertiary, and recent-age amber from 16 world sites.* The oldest amber in this study is about 130 million years old.



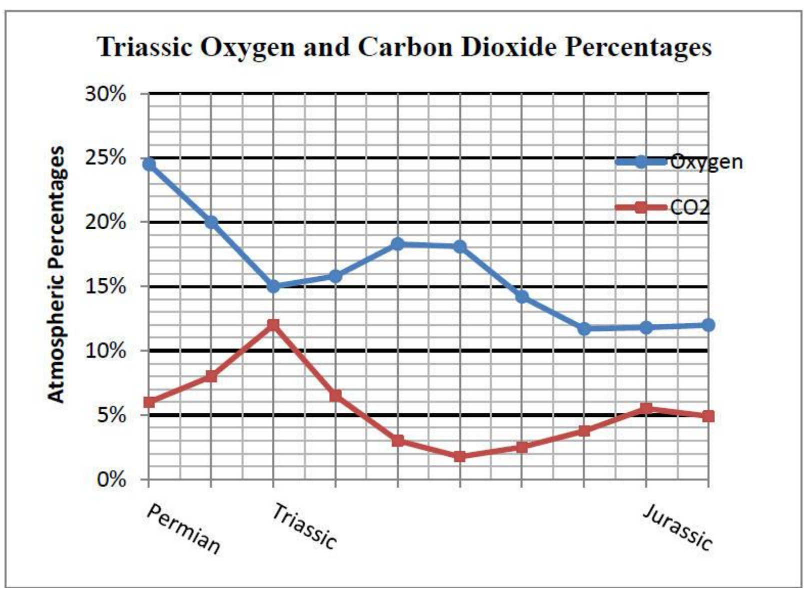
This chart shows a major decrease in oxygen content in the atmosphere from 35 percent to the present day level of 21 percent. This decrease occured about the same time that the dinosaurs disappeared - 65 million years ago. USGS image.

Significance of Cretaceous Oxygen Levels?

The consequences of an elevated oxygen level during Cretaceous time are speculative. Did the higher oxygen support the now extinct dinosaurs? Their demise was gradual in the transition from late Cretaceous to early Tertiary times, as was the decrease in oxygen content of the atmosphere.

Oxygen

The low oxygen levels during the Permian Extinction dropped even further during the Early Triassic, leveling off at a little below 15%. (Modern percentages are at 21%). It stayed near this level for almost 5 million years, from 245 to 240 millions of years ago.[1] Early Triassic rocks found in Antarctica bear this out for they contain a rare, green mineral called ***Berthierine*** which cannot form when oxygen levels are high. Finding Berthierine in Early Triassic strata confirms the presence of low oxygen levels continuing well into the Triassic Period.[2]



Eventually the oxygen percentages began to slowly climb, reaching 18% in the Middle Triassic, possibly due to the increasing number of plants pumping oxygen into the atmosphere as a byproduct of photosynthesis. But soon afterwards, these levels plummeted, and by the end of the period oxygen fell below even the lowest levels of the Permian.[3] In fact, the oxygen levels of the late Triassic were at their lowest point in over 500 million years, since life has existed on Earth. This resulted in another mass extinction, where more *species* were lost than during any other extinction.

Carbon Dioxide

The CO2 levels at the beginning of the period were the highest in over 350 million years, indicating a hot climate worldwide. But these levels would drop off precipitously by the middle of the period, nearing modern-day levels and cooling the climate. The dropping CO2 levels would also result in cooler ocean temperatures enabling the marine creatures to slowly regain a foothold in once-deserted regions.

Methane

Methane can dramatically impact temperatures and speed up the greenhouse effect in the earth's atmosphere even more so than CO2; indeed, some estimate it to be as much as 20 times more influential than carbon dioxide. If methane did indeed play a significant role in the Permian extinction as many scientists believe it to have done, these levels would have remained high as well, taking time to dissipate and be reabsorbed by the surrounding environment.[4]

The changing amounts of these gases in the atmosphere have profound effects both on the environment as well as the flora and fauna struggling to live and successfully reproduce in that environment. As with the Permian, much of the Early Triassic fauna would have been restricted to sea level communities where oxygen would have been more available than at higher altitudes. At the end of the Permian Period, the available oxygen at sea level would have been equivalent to living at 15,000 feet today,[5] higher than most of the mountains in the continental United States. And since the oxygen levels in the Triassic fell even lower, the available habitats were even more dramatically reduced.

Heat and Metabolism

Along with low oxygen, high CO2 and methane was the oppressive heat which made matters even more difficult for all forms of Life. Higher heat requires a higher metabolism in order to cool the body, otherwise temperatures within the body would reach lethal levels. But raising the metabolic rate of any organism requires more oxygen – and oxygen was in short supply. If Life was to survive in such an environment, it had to innovate. This innovation resulted in two significant life forms: mammals and dinosaurs. These two amazing groups will successfully adapt strategies to combat their harsh environment and survive the extinction events at the end of the Triassic Period.

Climate

The excessive levels of carbon dioxide and methane ensured that the temperatures remained high for many millions of years during the Triassic. The trend since the Early Permian was one of increasing aridity when it is estimated that 40% of the land was arid or semiarid. By the Early Triassic, it is estimated that as much as 80% of the land was arid or semiarid.[6] The enduring heat, the position of the continents affecting ocean currents which brought rain and more moderate temperatures, and the deformation caused by rising mountains were all factors contributing to this increased aridity spreading across Pangea, especially in the interior of North and South America. Yet it is in such desolate places that the early beginnings of the dinosaur lineage, the Archosaurs, can be found.

This is not to say that the world was one big desert. Areas of a semi-arid character are not deserts of rolling sand dunes, but they simply experience less than normal rainfall (anywhere from 10 to 20 inches) and are usually covered in low shrubs and grasses. Furthermore, because the warm temperatures were global, the climate at the poles was mild and glaciers nonexistent. There were also coastland and riparian areas where temperatures were moderate with generous rainfall. Because the climate differed significantly throughout Pangea, there were notable regional variations in both plants and animals, the main differences occurring between the southern continent of Gondwana and the northern continent of Laurasia.

Gradually the climate moderated in some regions and it is apparent that there were strong seasonal fluctuations in these areas, possibly resulting in significant monsoonal seasons. Coastal regions, slowly being inundated by the shallow seas due to continental subsidence, were becoming more humid and moderate than the arid interiors. The general trend during the Triassic was a slow move away from the intense heat and a significant reduction of desert expanses.

Source: http://eonsepochsetc.com/Mesozoic/Triassic/Tri_Environment/environment.html