Wednesday, November 10, 2010

Chapter 9
• Disturbance and Succession (p 185-186)
• Biodiversity over time (Figure 13-3, but from another source)
• Ecotones (p 183)

Chapter 11
• Oxygen, ozone, and life (p 210-212, p 214, p 217, p 222)

A brief timeline for earth’s atmospheric composition
Estimates of the present global macroscopic species diversity vary from 2 million to 100 million species, with a best estimate of somewhere near 10 million.
Figure 9-3

ECOTONE

Deciduous forest species

Grassland species

Deciduous forest ecosystem

Grassland–forest ecotone (boundary)

Grassland ecosystem

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Figure 9-3

ECOTONE

Increased diversity
Figure 9-4
Chapter 11 – Effect of Life on the Atmosphere: The Rise of Oxygen and Ozone

Key Questions

• How did early forms of life on earth affect atmospheric composition?

• When did oxygen become more abundant?

• When did the ozone layer form and how did it affect life on earth?

• How much has atmospheric oxygen changed over the past 540 million years?

• What determines the abundance of atmospheric oxygen today?
Why Is Ozone Essential for Life on Earth?
Absorption of DNA-Damaging UV radiation!
A ‘time line’ for Earth’s Atmospheric Composition

4.5 bya (educated guess)
- No free O$_2$ (would have reacted with hydrogen to form water and also with rocks)
- Probably lots of N$_2$ and H$_2$O from early bombardment period
- CO$_2$ from outgassing (e.g., volcanoes), but not well understood at this point
- CH$_4$ would be oxidized by oxygen in rocks and water to form CO$_2$
- Lots of ultraviolet light hitting Earth due to lack of a oxygen or ozone shield

3.5 bya (from stromatolites)
- photosynthetic methanogenic bacteria likely first appeared, but in an atmosphere with H$_2$O vapor and CO$_2$, the most likely product of this early photosynthesis was CH$_4$ via the reaction
$\text{CO}_2 + 4 \text{H}_2 \rightarrow \text{CH}_4 + 2 \text{H}_2\text{O}$
~ 2.7 bya – cyanobacteria (blue green algae)

\[ \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{CH}_2\text{O} + \text{O}_2 \]

Evidence – fossils and banded-iron formations (most of which formed 1.9 bya)

~2.3 bya – \( \text{O}_2 \) begins to rise in the atmosphere
Where the early oxygen went is still a mystery, but likely into rocks (forming the banded iron) or it reacted with reduced compounds coming out of rocks (volcanoes).

~1.9 bya – enough ozone (\( \text{O}_3 \)) was produced by \( \text{O}_2 \) to absorb UV light – \( \text{O}_2 \) was probably about 1-15% of the present-day value of 20% of the atmosphere

560 mya – multicellular organisms appear in the fossil record
Banded Iron Formations (sedimentary…appearing 3.7 billion years ago, and lasting and 570 million years ago)
The buildup of O$_2$ had consequences – the sun was dimmer back then, and the greenhouse effect was even more important. Extra oxygen in the atmosphere resulted in loss of CH$_4$, a greenhouse gas that is 20 times more potent than CO$_2$ - ICE AGES!