6. Mesozoic mass extinctions

a. end-Triassic (pp. 408-409, 411)

i. ~20% of animal families gone

ii. Cause (?): impact in eastern Canada

iii. Cause (?): warming event from volcanic CO_2 gas (Pangaea breakup flood basalt volcanism)

iv. Adaptive radiation in dinosaurs after

b. Cretaceous-Tertiary boundary (= K-T bdy.) (pp. 437-443)

i. Most famous extinction, but not the biggest

ii. Terrestrial victims - dinosaurs, pterosaurs

iii. Marine victims (lots of things)

iv. Cause - intensely debated

a) Lots of hypotheses

i) Angiosperm alkaloid poisoning

ii) Mammals eating dinosaur eggs

iii) Increased tectonic activity & climate change

iv) Racial/taxonomic senility (heteromorph ammonites)

v) Supernova

b) <u>One theory</u> - impact theory (asteroid) (chondrite)
i) Alvarez & K-T boundary in Italy

ii) Extraterrestrial objects are Ir-rich

iii) <u>Proposal</u>: a 10 kilometer-sized object hit Earth & caused climate change & extinction

iv) Other evidence
a) Ir-rich clay at K-T boundary is global

b) <u>Shocked</u> quartz grains at K-T

c) <u>Stishovite</u> at K-T

d) Melted rock droplets at K-T

e) <u>Microdiamonds</u> (billions of them) at K-T

f) <u>Extraterrestrial amino acids</u> above & below K-T boundary

g) <u>Soot</u> at K-T

h) Carbonate-rich K-T sections have calcite dissolved away below the boundary

i) Fern spike just after K-T
(below, ferns are 20% of the spores & pollen microfossils)
(above, ferns are 100% of the spore microfossils)

v) Impact site - where is it?
a) Long <u>unknown</u> (big problem!)

b) Found by NASA (Ames Base) in early 1990s

vi) <u>New</u> evidence in & near Chicxulub
a) Chicxulub is 180 km in size (largest impact in last 1 billion years)

b) Mega-tsunami deposits at K-T in the Gulf of Mexico area (80 meter thick boulder bed/conglomerate in places, with 1 kilometer(?)-sized clasts) (>300 feet tall wave)

c) Meters' worth of ground motion, even 1000s of km away (ocean shelf slumping)

d) Chicxulub dates exactly to K-T (= 65 Ma) (<u>despite</u> claims that it predates K-T by ~300,000 years)

e) <u>Largest</u> melted rock droplets are nearby

f) Iridium is <u>in</u> Chicxulub impact breccia & melt rocks

g) Chicxulub Crater is asymmetrical (= low-angle impact, estimated at ~30°, from the southeast)

vii) Impact consequences that may have caused extinctions?

a) Darkness

b) Cold (Africa projected to be 30° cooler)

c) Acid rain & acidified upper ocean

d) Wildfires

e) Torrential rainstorm (hypercane)

i) Impact superheated the atmosphere

ii) Impact evaporated ~1 cm of ocean

iii) Atmosphere got water-supersaturated

f) All of these cause food web to collapse (& creatures died)

g) Detritus-based food chains ~unaffected; freshwater swimmers & terrestrial diggers & omnivorous organisms were more likely to survive (extinction was selective, <u>not</u> random)

viii) K-T extinction in Northern Hemisphere <u>versus</u> Southern Hemisphere

a) Land plant extinction is best known from North America

b) Only 4 pollen species go extinct in Antarctica

c) South American plants recovered quickly after K-T (<u>Ex</u>: at 64 Ma), unlike North American plants

d) After K-T, fossil insect diversity is reduced in North America; <u>not so</u> in Europe

e) Coccolithophorid extinction

i) ~65% of species go extinct in the Southern Hemisphere

ii) >90% of species go extinct in the Northern Hemisphere

f) Conclusion

c) Alternative hypotheses

i) <u>Gradual</u> extinction near K-T bdy?

a) Several sections show gradual decline in dinosaur fossils & gradual increase in mammal diversity

b) This is an illusion formed by secondary deposition in channel deposits (get K fossils mixed with Tertiary fossils)

c) Sections without secondary deposition of fossils show a rapid, sudden change at K-T

d) Gradual extinction hypothesis is wrong

ii) Lots of volcanism & climate change
a) Mantle rocks are relatively iridium-rich

b) Deccan Traps (India) (not Ir-enriched!)

iii) Multiple impacts
a) Kara Impact - 70 Ma
b) Chicxulub Impact - 65 Ma
c) Boltysh Impact - 65 Ma
d) Shiva Impact - 65 Ma

e) K-T sections in India have three iridium spikes

f) A giant wave hit eastern Africa at 65 Ma