Chapter 2: Energy Flows and Ecosystems

Last Day…

- Most energy on Earth derives from the radiant energy of the sun
- This **radiant energy** is transformed into chemical energy and mechanical energy
- Try to understand energy in relation to transformations, how energy flows through ecosystems, and the ecosystem consequences that result

Energy

- Most of the energy available for use is called **low-quality energy**
  - diffuse, dispersed at low temperatures, difficult to gather
- The total energy of all moving atoms is referred to as **heat**, a low-quality energy
  - vs. temperature, a measure of average speed of molecules or atoms in a substance
- **High quality energy,** such as a hot fire or coal, is easy to use, but the energy disperses quickly
- Energy type should be matched to use to maximize efficiency

Energy

Laws of Thermodynamics

- The second law of thermodynamics is important
  - for organisms because they must continuously expend energy to maintain themselves; whenever they use energy, some is lost
  - because it tells us that energy cannot be recycled; it is constantly being degraded; the more we transform energy, the more is dispersed becoming less useful and lower quality
  - In geological terms we have released the energy input of millions of years in the blink of an eye (250 years)

Energy

- Some of the principal transformations that have to take place to achieve a sustainable society are
  - to view high energy consumption as undesirable
  - to reduce energy waste
  - to switch from the non-renewable sources of energy that now dominate (coal and oil particularly) to renewable sources

Abiotic and Biotic Components of Ecosystems

Ecosystem – is made of a number of abiotic and biotic components, which are connected to one another by flow of energy through them

- a collection of communities interacting with the environment
- emphasizes a systems approach
- a *Community* consists of a number of *populations* of organisms in a particular environment

Abiotic Components

- **The ecosphere**
  - Lithosphere
  - Hydrosphere (and cryosphere)
  - Atmosphere
    - Troposphere
    - Stratosphere
    - Mesosphere
    - Thermosphere

Earth's Components: Ecosphere

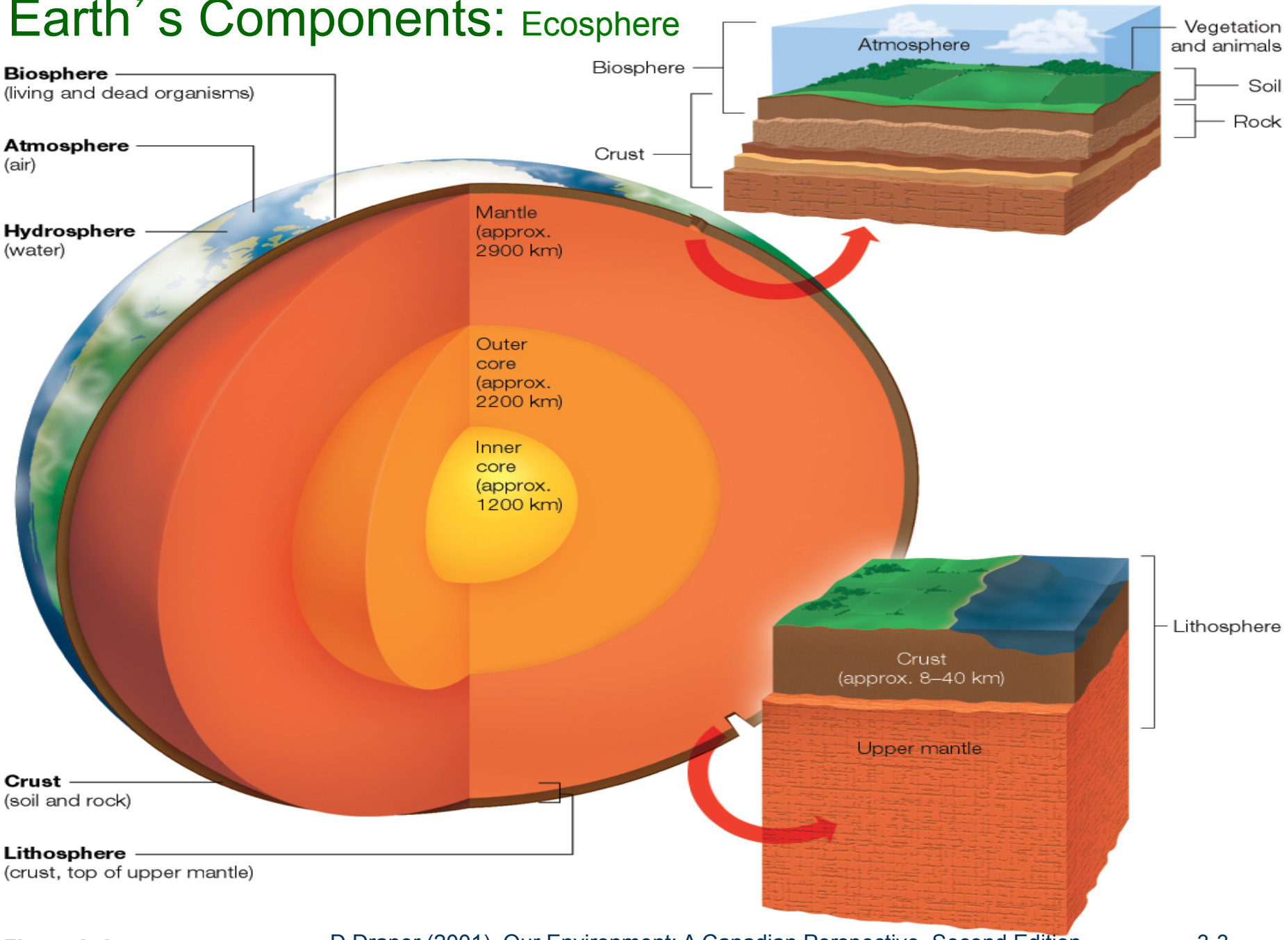
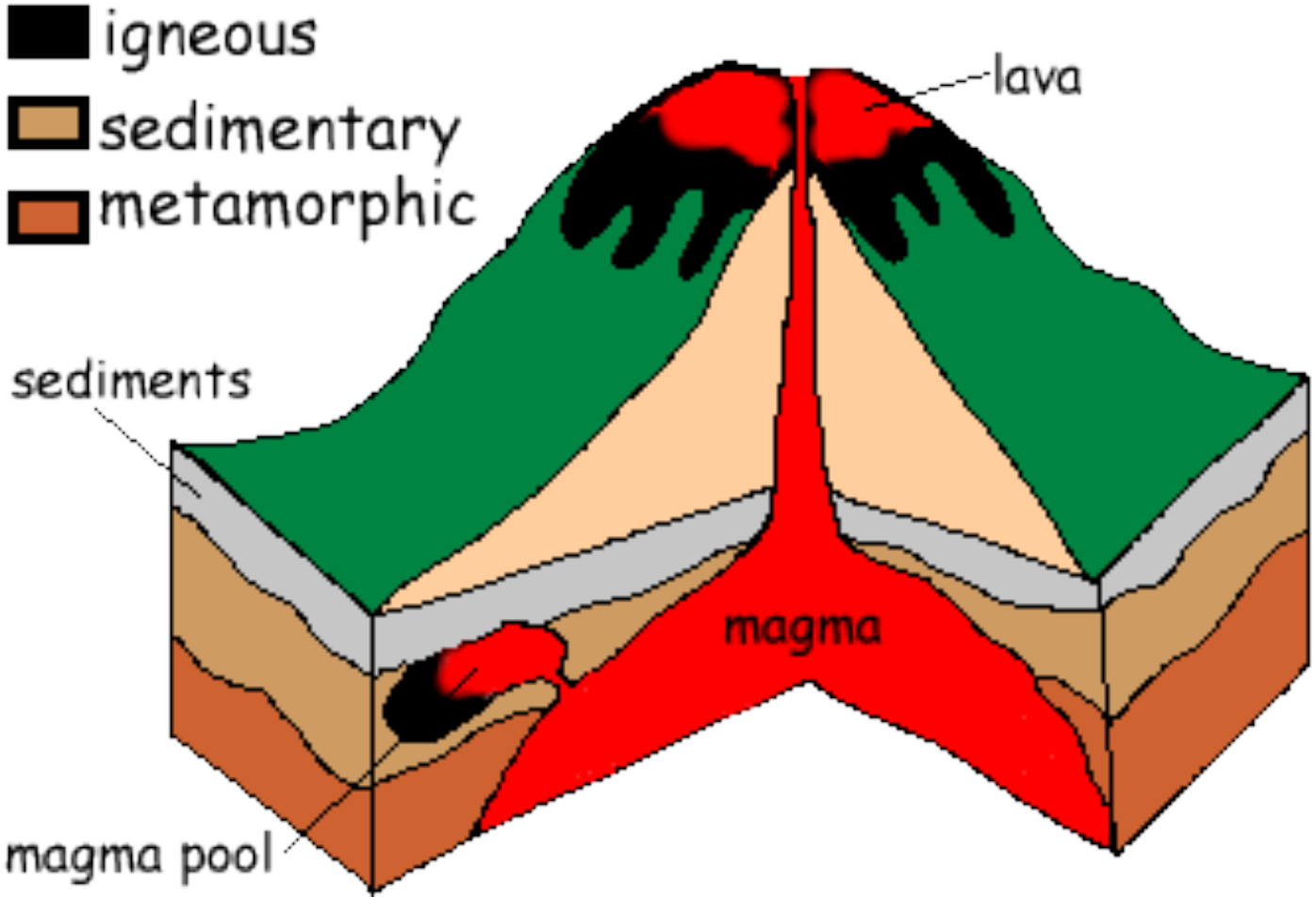


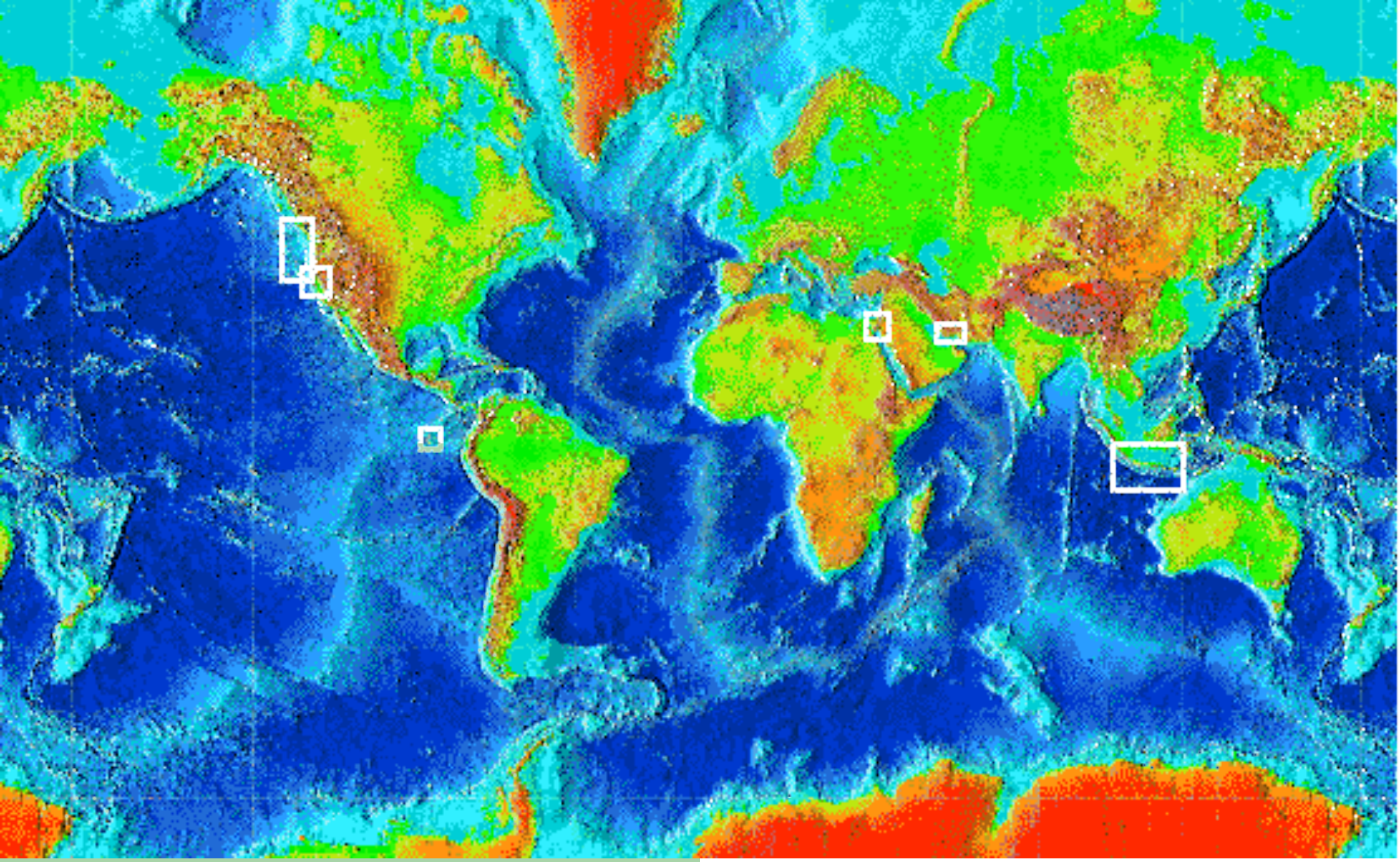
Figure 3–2
The general structure of the Earth

The Lithosphere

1. Tectonic Processes
2. Geomorphological Processes
3. Environmental issues in Lithosphere

1. Tectonic Processes in the Lithosphere

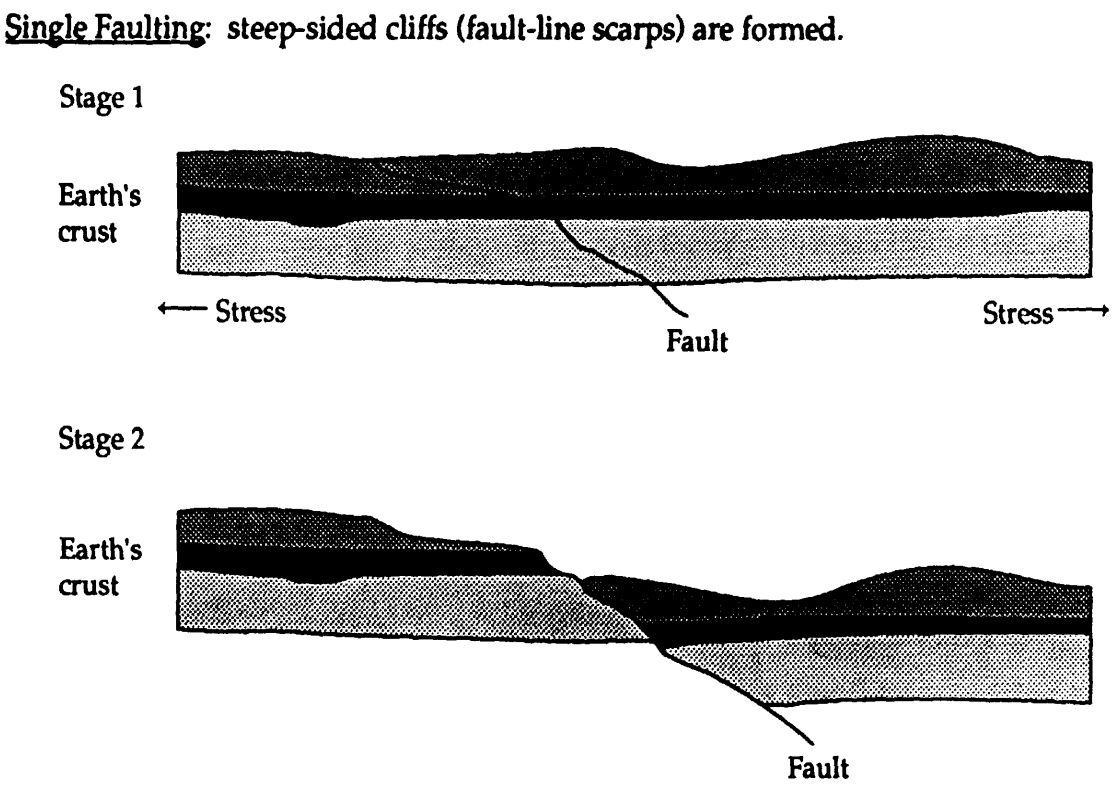




Continental Drift – earth is broken into huge slabs or plates, each moving in response to the currents of molten material below the earth's crust

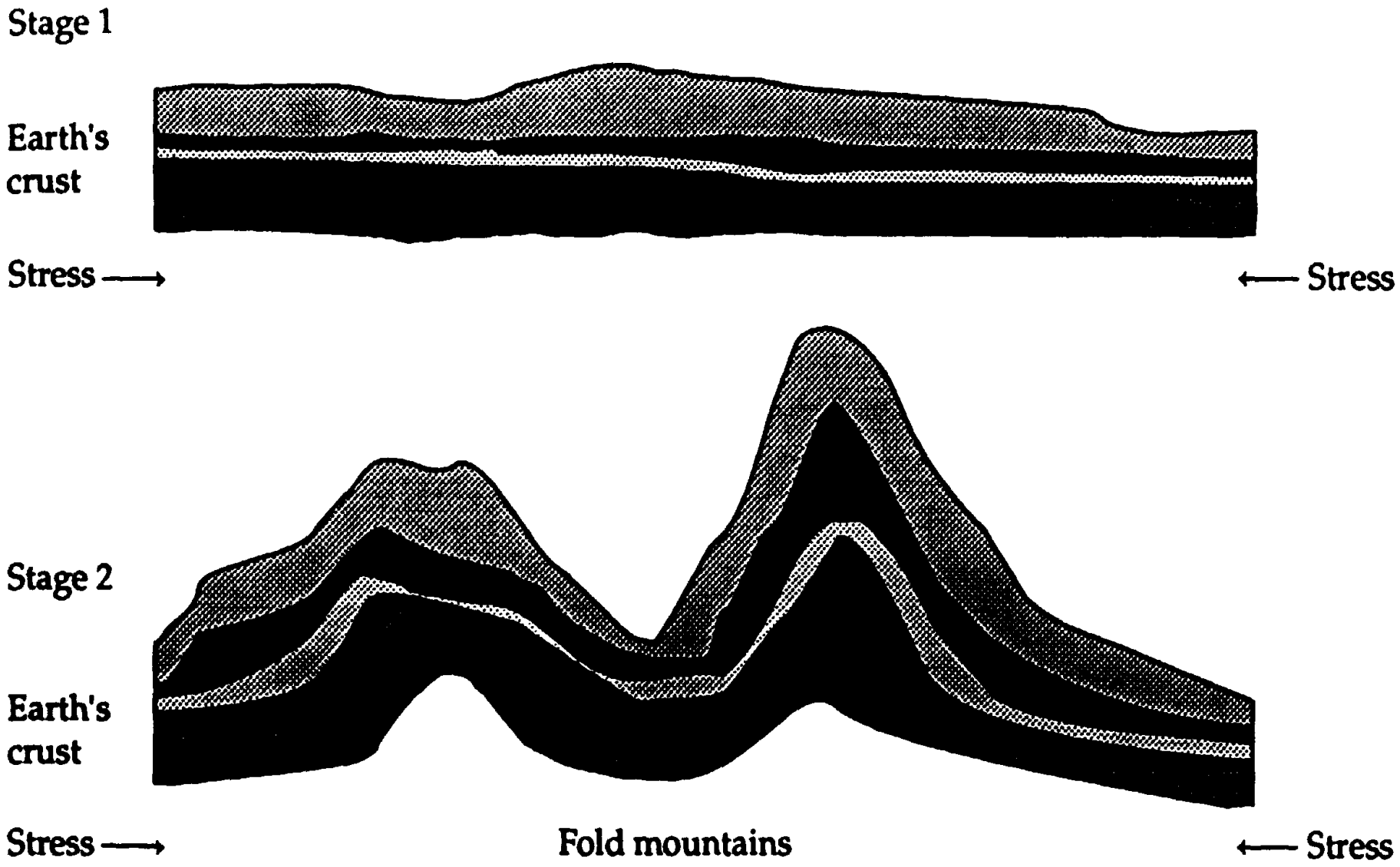
Pangea

Faulting: process that fractures the earth's crust



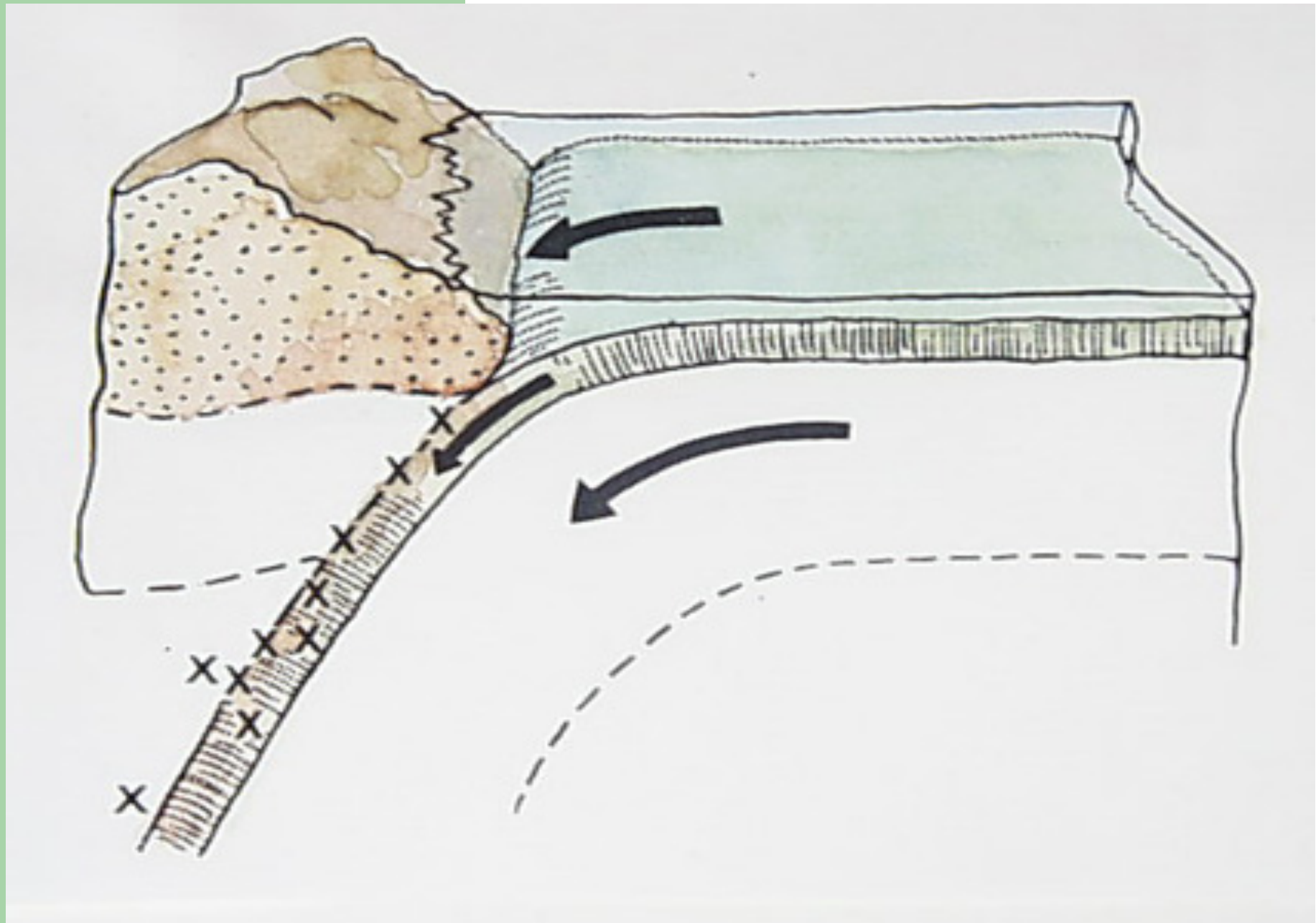
The formation of a fault-line scarp as a result of single faulting

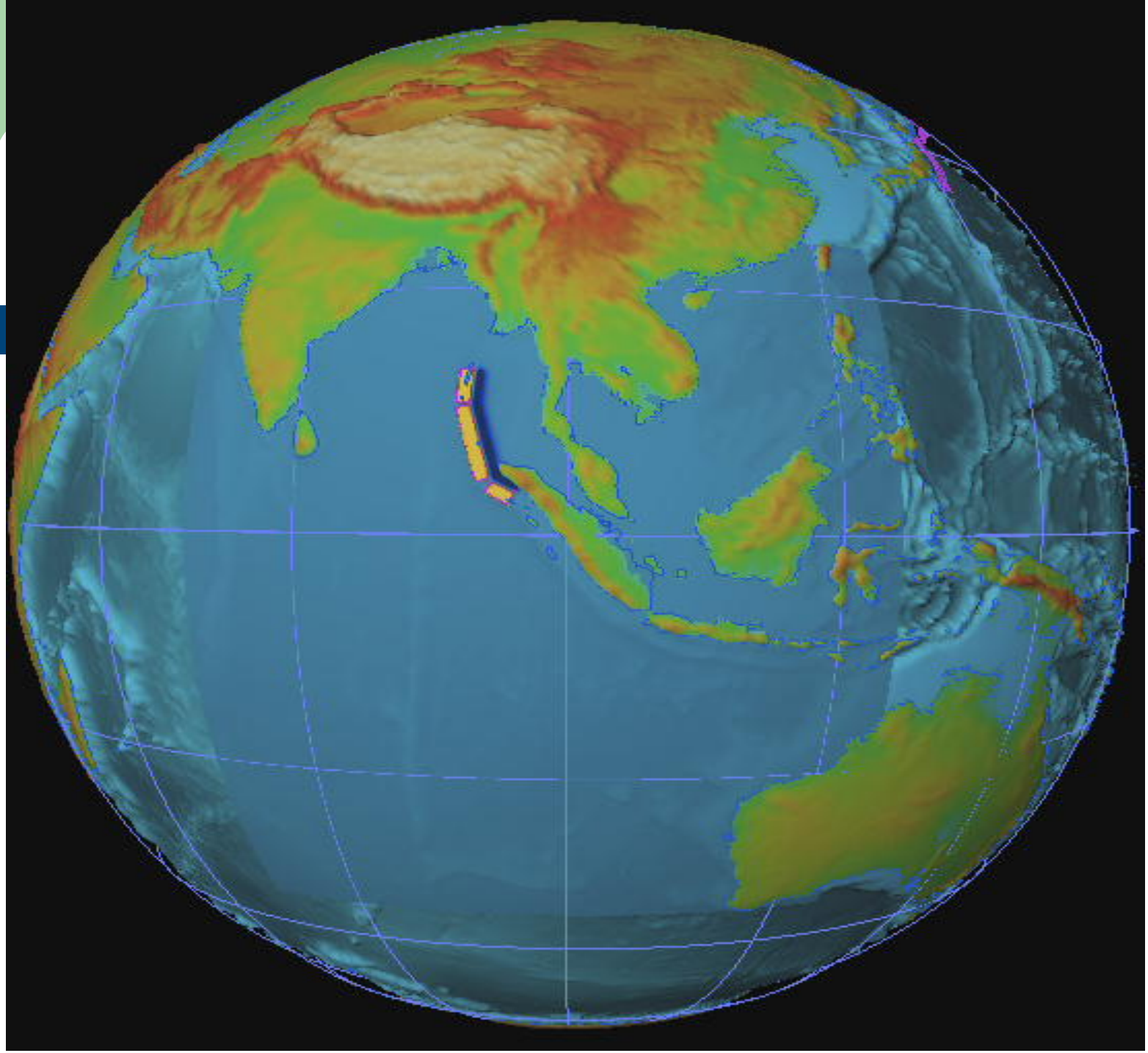
Folding – bends and deforms the earth's crust

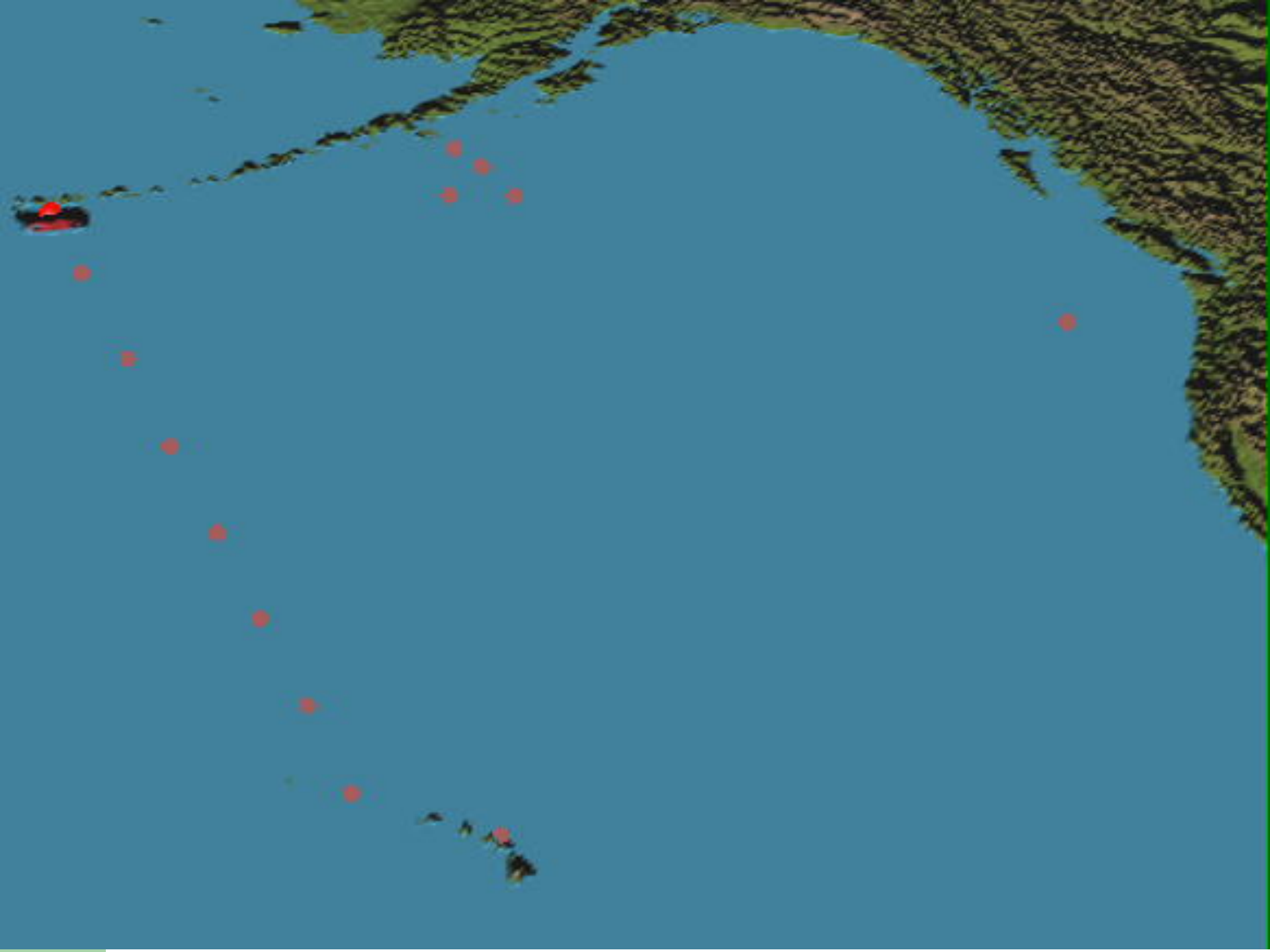


How fold mountains are formed

Subduction: dense plate pushed under lighter one





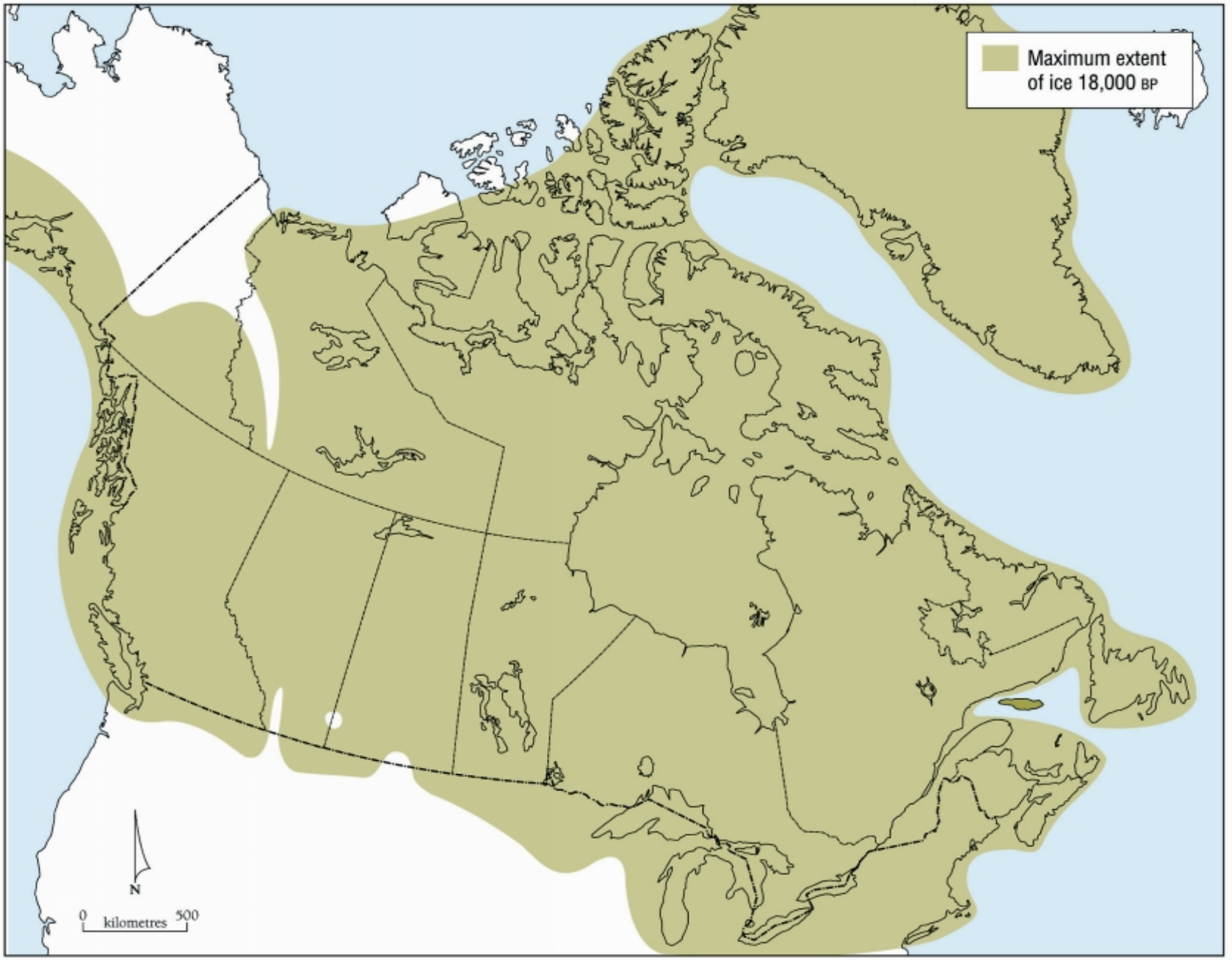


2. Geomorphological Processes in the Lithosphere

Weathering: a complex compound is reduced to its simpler component parts, transported via physical processes, or biodegraded over time

Erosion: The wearing away of land or soil by the action of wind, water, or ice

Transportation and Deposition: the natural processes of moving and laying down a deposit of something (wind, water, waves, ice)



Maximum extent of ice, 18,000 **BP**

Great Lakes: 13,000 Years Ago

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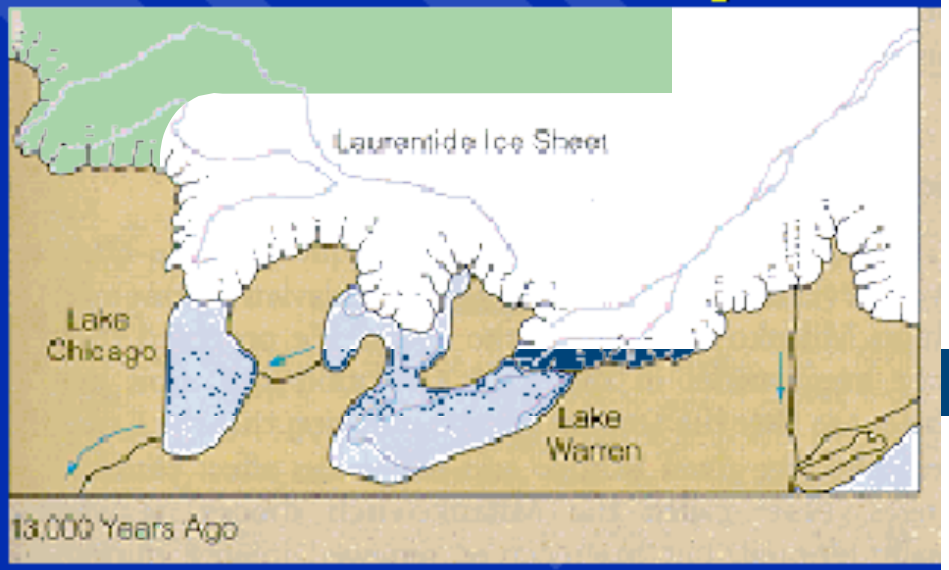

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Great Lakes: 11,500 Years Ago

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Great Lakes: 9500 Years Ago

20

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Great Lakes: 6000 Years Ago

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Energy Diffusion

TECTONIC PROCESSES

Slow but steady

Crustal movement
- folding
- faulting
- subduction

Rapid / Instantaneous

Earthquakes

Volcanic Activity

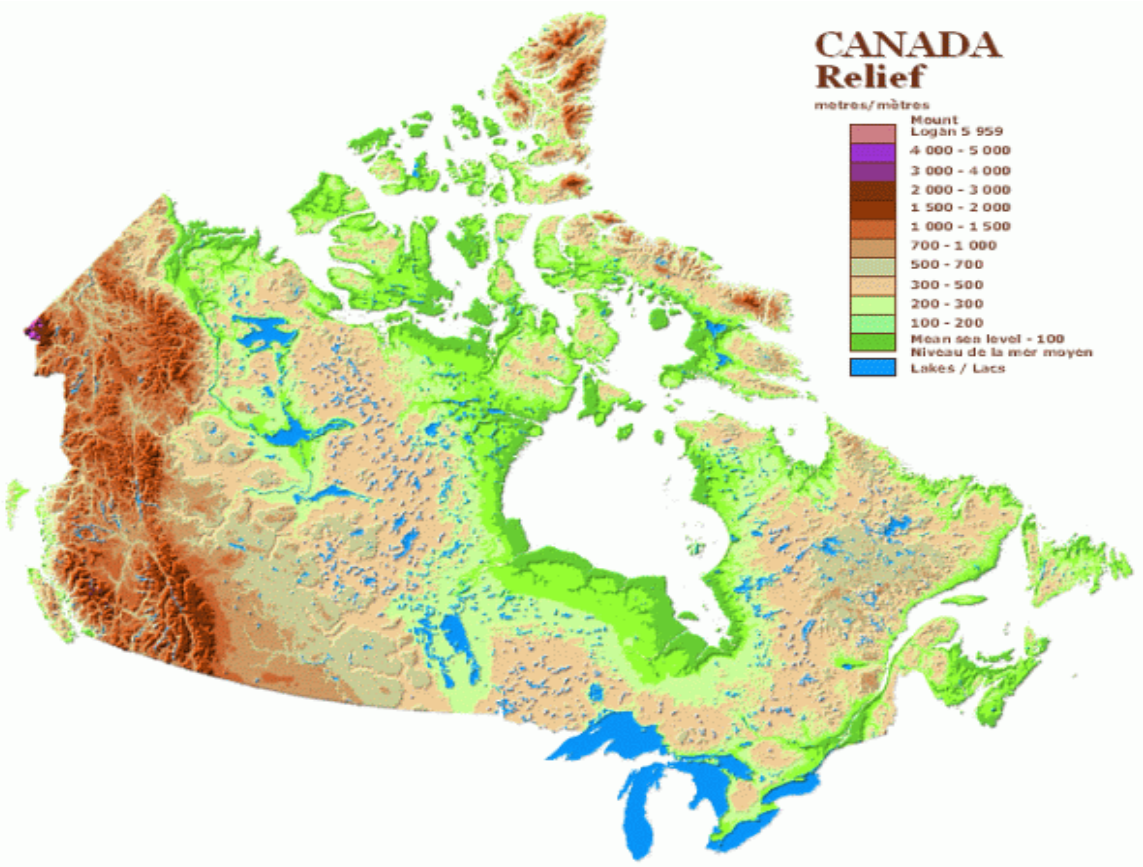
GEOMORPHOLOGICAL PROCESSES

Weathering → Erosion → Transportation → Deposition

- Physical
- Chemical

mass movement - slopes
wind - dryland environments
water - rivers
waves - coastal areas
ice - high latitudes / high altitudes

3. Environmental issues in the Lithosphere



Shield Environments

- Oldest geologically (3-4 BY)
- Exposed areas of ancient, stable continental rocks or cratons
- Buried in places by younger sediments

Environmental Issues in the Shield

- High mineral potential from heat and pressure (metamorphosis)
- Obtaining minerals leads to:
  - Landscape / hydrological changes
  - Extraction and disposal as waste
  - Release of acid gases from smelting
  - Deforestation faster that regeneration
  - Habitat Loss
  - Not densely populated

Fold Mountain Environments

- Active mobile belts that develop along margins of some continental cratonic blocks
- Deposited sediments (shield erosion) are crumpled through folding (Orogenesis)
- Volcanic material injected into cracks
- Youngest rock (approx. 600 MYA - 100 MYA)

Environmental Issues in Fold Mountain Environments

- Naturally restricted until technology and rapid population growth increased:
  - Mining, forestry and Hydro
  - Tourism and recreation values
  - Slope destabilization, pollution, waste
  - Turbidity and silt in streams
  - Soil erosion, flash flooding

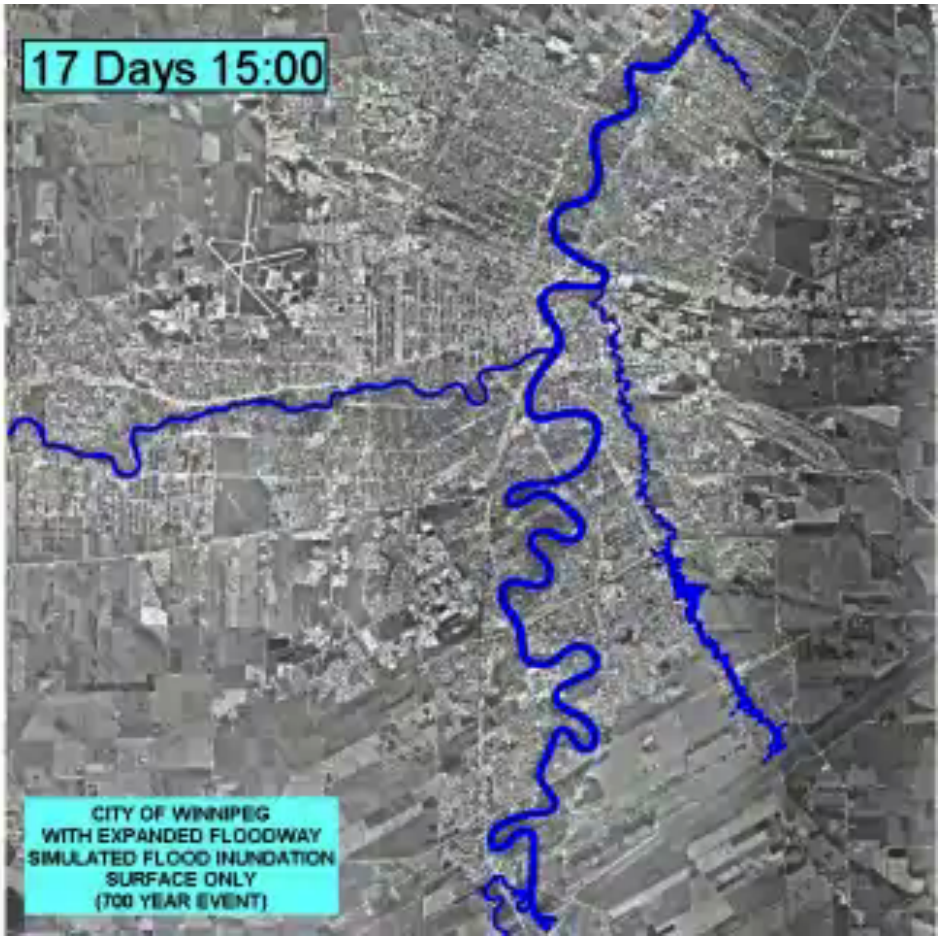
Plain Environments

- Sediments eroded from shield and mountains and deposited in major sedimentary basins (Great Plains 100-250MYA)
- Consolidate into shale or sandstone
- Formed from the skeletons and shells of organisms, and chemical processes that created carbon compounds
- Recent deposits of unconsolidated fluvial, lacustrine and glacial deposits
- Also formed in continental shelves

Environmental Issues in Plain Environments

- Agricultural revolution to domesticate plants and animals
- Aquatic environment altered by irrigation and deterioration of soils
- Flooding / drought / diversions
- Nutrient loading affects Water quality
- Building materials, fossil fuel


17 Days 15:00
CITY OF WINNIPEG
WITH EXISTING FLOODWAY
SIMULATED FLOOD INUNDATION
SURFACE AND BASEMENT
(700 YEAR EVENT)


17 Days 15:00
CITY OF WINNIPEG
WITH EXPANDED FLOODWAY
SIMULATED FLOOD INUNDATION
SURFACE ONLY
(700 YEAR EVENT)

Conclusions

- We have technological solutions, land-use planning and mitigation techniques to address many localized environmental issues (First Wave Issues)

- How do modern environmental risks (Natural Disasters?) challenge our traditional approach to environmental issues in the second wave of the movement?