Global Tectonics
G404
Lecture-1

Instructor
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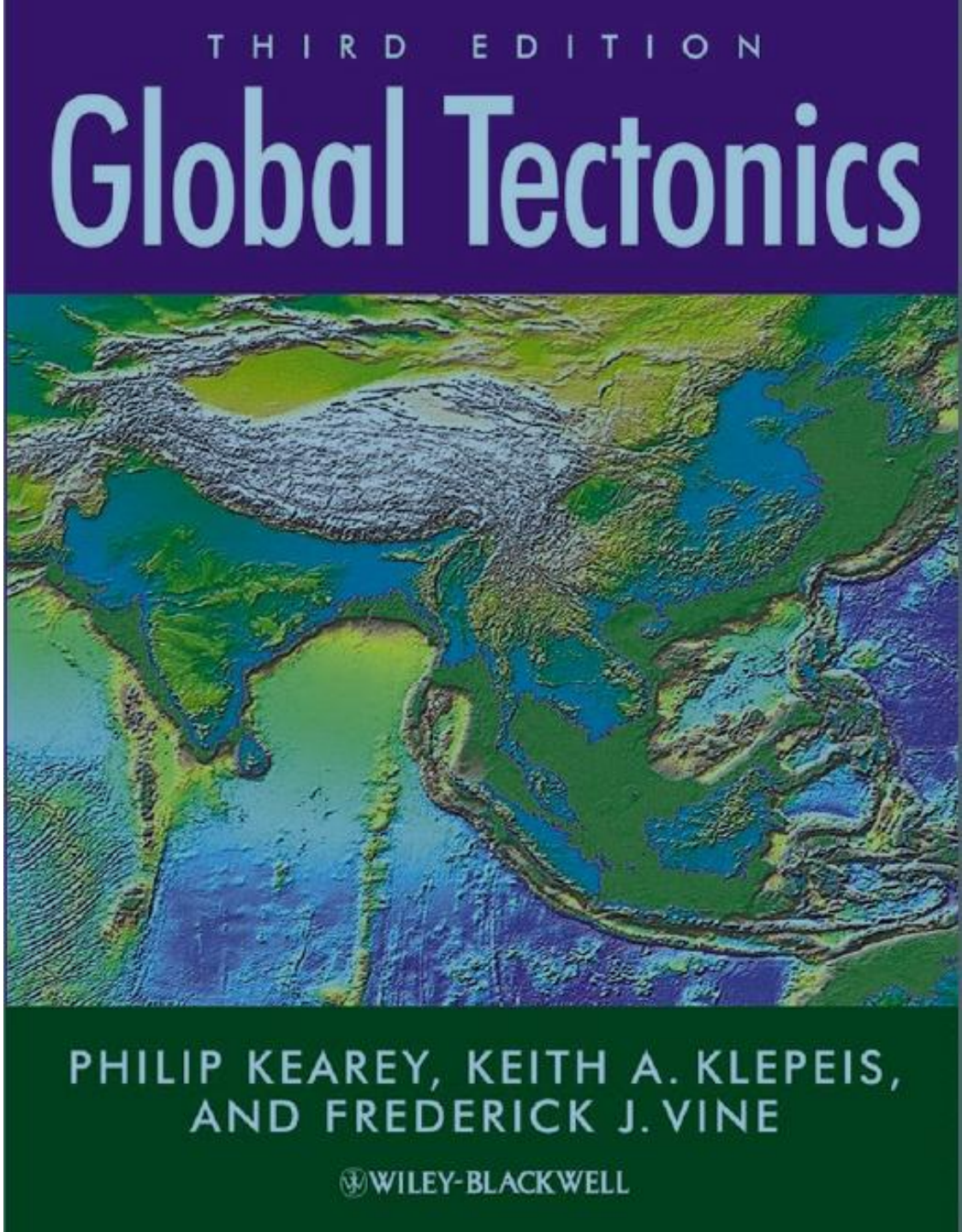
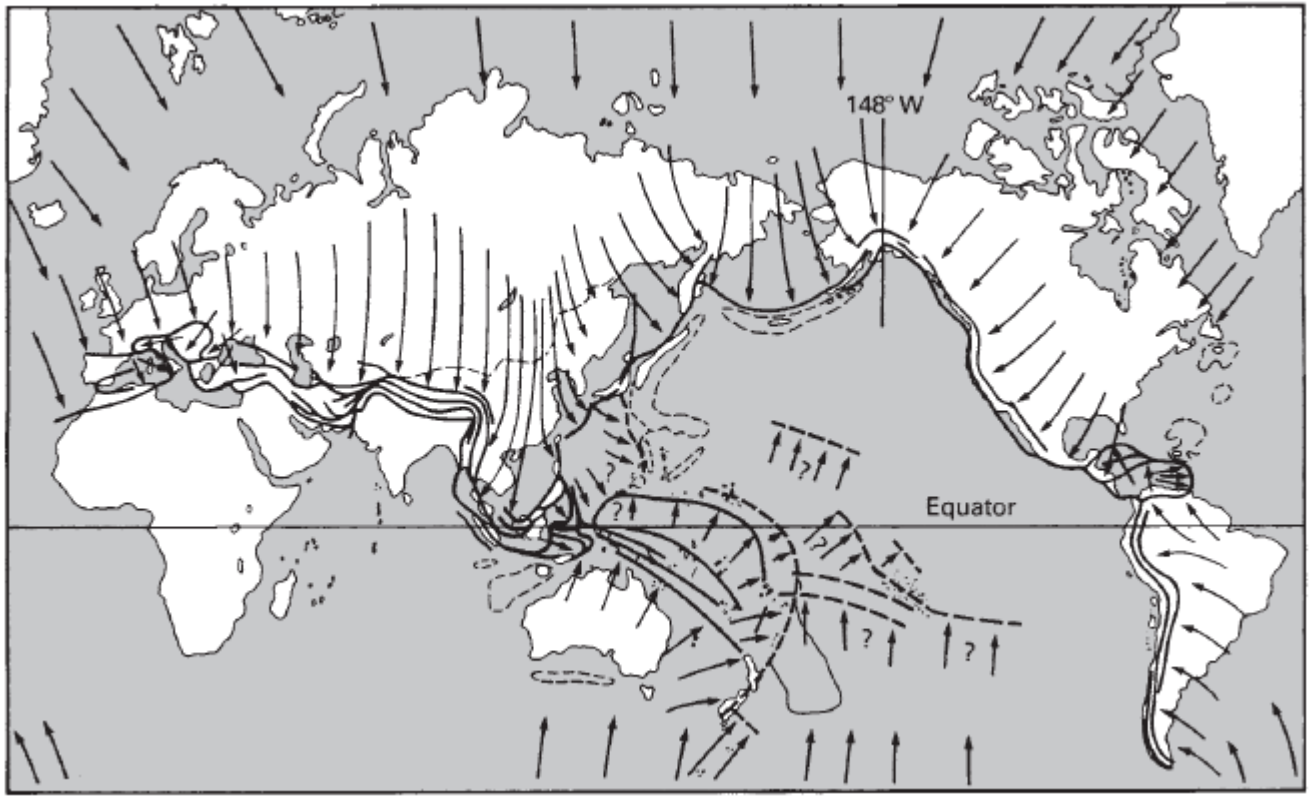


Chapter 1 – Historical Perspective on Global Tectonics

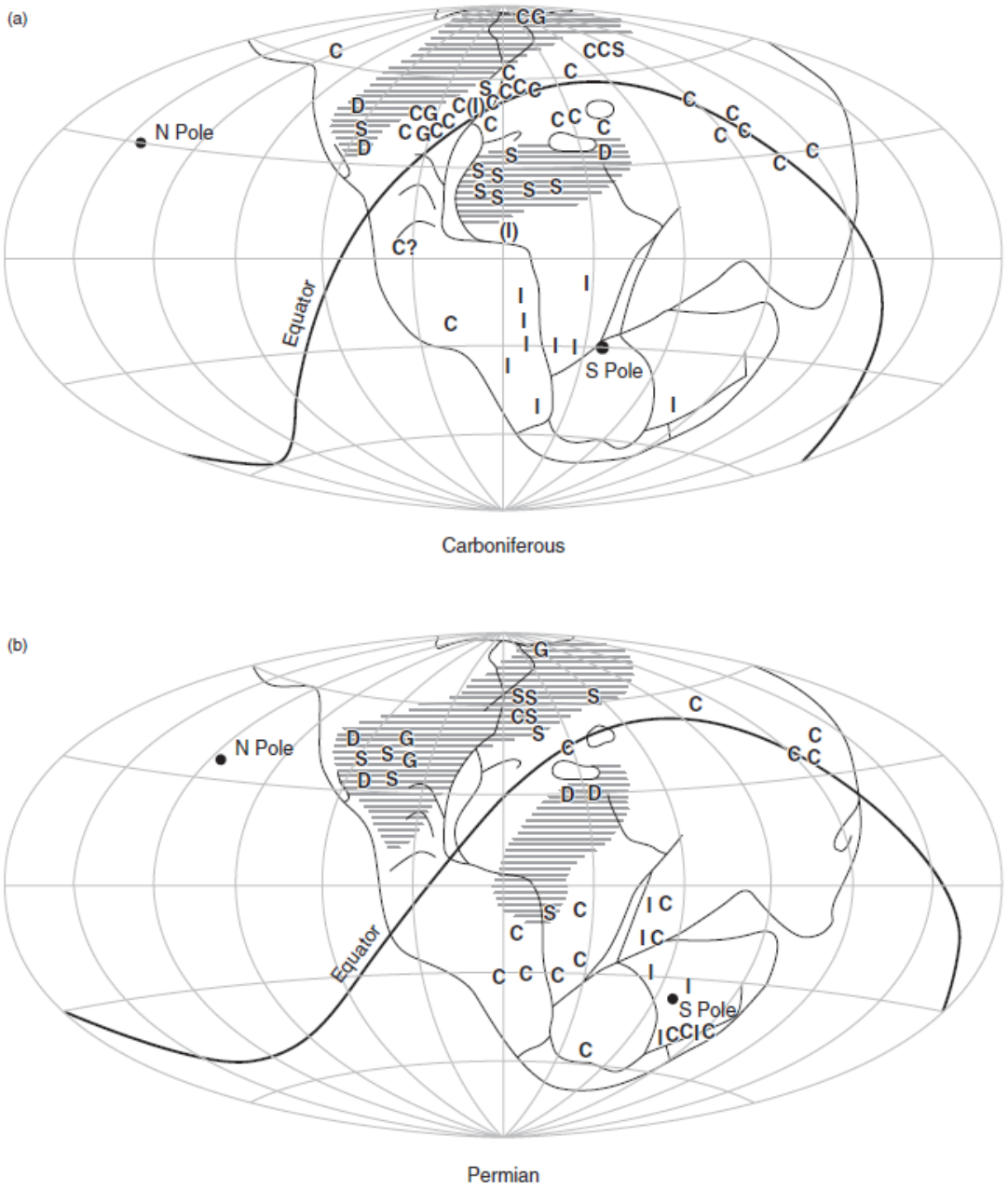
1.1 Continental Drift

- **Early Observations**:
  - The similarity between the coastlines of South America and Africa was noted as early as 1596 (Ortellius) and later by Francis Bacon (1620).
  - Early explanations were tied to biblical catastrophism (e.g., Noah’s Flood, Atlantis).
  - Antonio Snider (1858) proposed continental drift sensu stricto and created a pre-drift reconstruction.
- **Shift to Uniformitarianism**:
  - James Hutton and Charles Lyell advocated for gradual geologic processes over catastrophism.
  - Despite this, early drift theories (e.g., George Darwin, 1879) still invoked catastrophic events like lunar ejection from the Pacific.

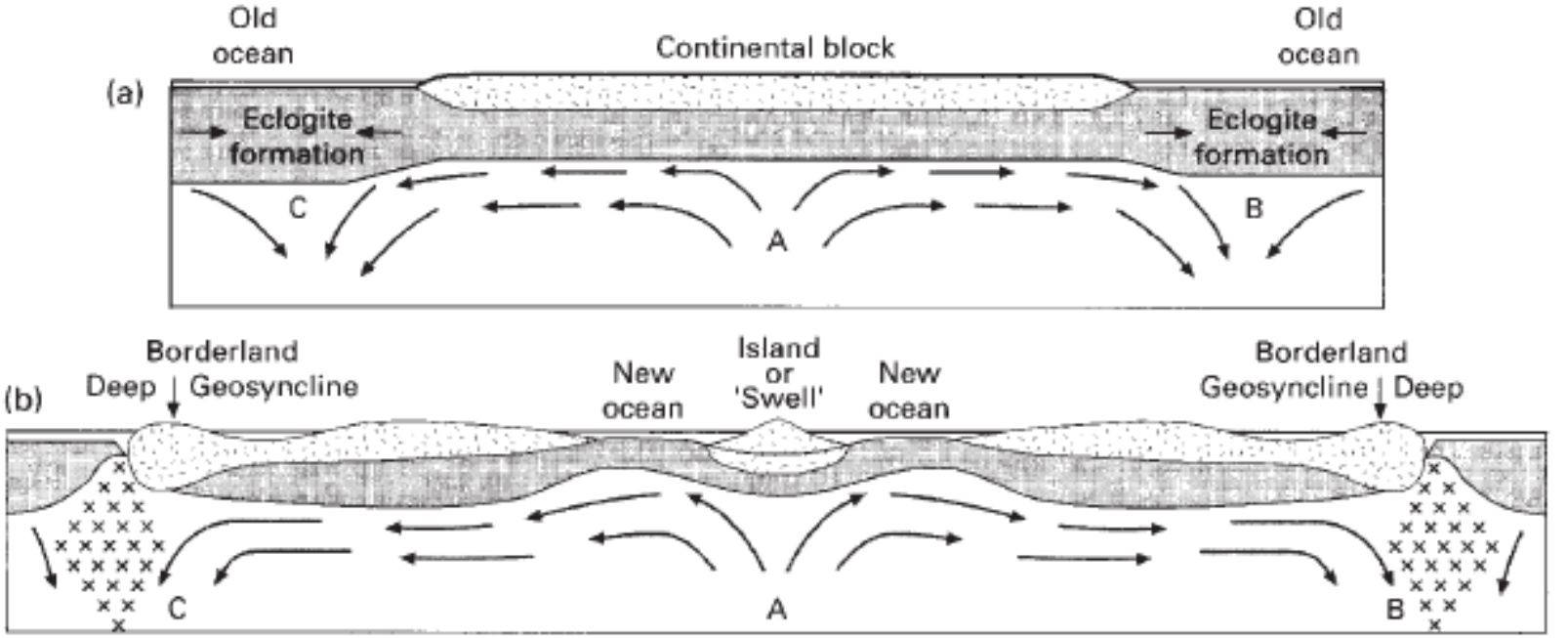


Taylor's mechanism for the formation of Cenozoic mountain belts by continental drift (after Taylor, 1910).

- **Alfred Wegener’s Contribution (1912)**:
  - Proposed **Pangea**, a supercontinent that later split into **Laurasia** (northern continents) and **Gondwana** (southern continents).
  - Evidence included:
    - Matching geologic structures and fossils across continents.
    - Permo-Carboniferous glaciation patterns (southern continents near the pole, northern continents near the equator).
  - Criticisms: Lack of a plausible mechanism; Wegener’s proposed rotational forces were too weak.
- **Arthur Holmes’ Mechanism (1928)**:
  - Suggested **mantle convection currents** driven by radioactive decay as the driver of continental motion.

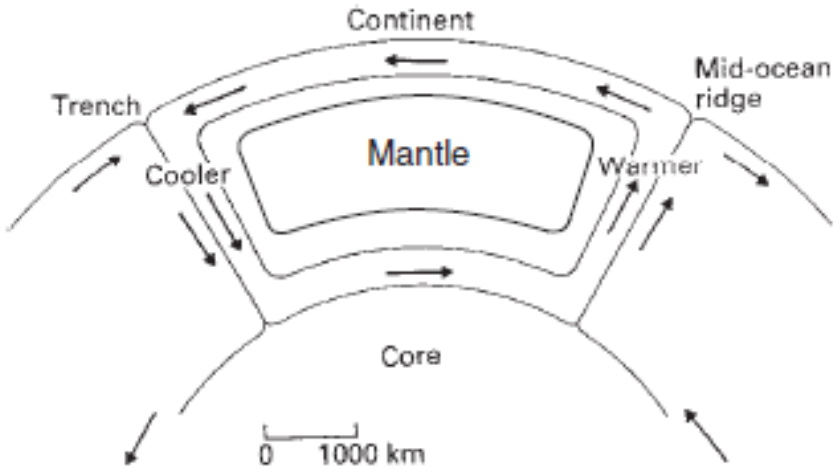


Wegener's reconstruction of the continents (Pangea), with paleoclimatic indicators, and paleopoles and equator for (a) Carboniferous and (b) Permian time. I, ice; C, coal; S, salt; G, gypsum; D, desert sandstone; hatched areas, arid zones (modifi ed from Wegener, 1929, reproduced from Hallam, 1973a, p. 19, by permission of Oxford University Press).


(a)
Old ocean
Continental block
Old ocean
Eclogite formation
Eclogite formation
C
A
B
(b)
Borderland Deep
Geosyncline
New ocean
Island or 'Swell'
New ocean
Borderland Geosyncline
Deep
C
A
B

Sea Floor Spreading and Plate Tectonics

- **Post-WWII Discoveries**:
  - Oceanic crust was found to be young (<200 Ma), thin (7 km), and chemically distinct from continental crust.
  - **Hess (1960) and Dietz (1961)**: Proposed **sea floor spreading**—new crust forms at mid-ocean ridges and is recycled at trenches.
- **Key Confirmations**:
  - **Vine-Matthews Hypothesis (1963)**: Magnetic striping on the sea floor recorded Earth's magnetic field reversals, proving sea floor spreading.
  - **Transform Faults (J. Tuzo Wilson, 1965)**: Explained connections between tectonic features.
  - **Plate Tectonics Theory (1967–68)**: Earth's lithosphere is divided into rigid plates moving over the asthenosphere.



The concept of sea floor spreading (after Hess, 1962).

Geosynclinal Theory (Pre-Plate Tectonics)

- **Static Earth Model**:
  - Geosynclines were thought to be fixed, subsiding sediment basins that later folded into mountain ranges.
  - Failed to explain tectonic origins; replaced by plate tectonics, which linked geosynclines to **rifted** (passive) and **active** (subduction-related) margins.

1.4 Impact of Plate Tectonics

- **Unifying Theory**:
  - Explains mountain formation, volcanic/earthquake distribution, fossil/rock correlations, and climate changes.
  - Connects geologic processes to atmospheric/oceanic circulation (e.g., sea level changes, glaciation patterns).
- **Ongoing Questions**:
  - Mechanisms of plate motion remain debated.
  - Applicability to ancient geologic records and continental interiors is still explored.