

# GA02 — Physical Geography: Geomorphology & Climatology

GA02 · AFCAT General Awareness — Geography

★ Moderate-High Yield — 1-2 Questions

This chapter covers two connected topics: **Geomorphology** — the study of Earth's structure and surface features — and **Climatology** — the science of the atmosphere and weather systems. AFCAT tests the factual highlights: the layers of Earth's interior, the type of rock formed in different ways, which atmospheric layer contains what, and what causes specific wind patterns. Keep the concepts clear and the facts sharp.

➔ **AFCAT Focus:** Outer core = liquid (generates Earth's magnetic field); P-waves travel through solids AND liquids; S-waves through solids only; Marble = from Limestone (metamorphic); Richter scale = magnitude; troposphere = all weather; stratosphere = ozone layer; mesosphere = meteors burn; ionosphere = radio waves reflected; Loo = hot dry wind of North India.

## PART 1 — EARTH'S INTERIOR

### 1. Layers Inside the Earth

Scientists cannot drill below 12 km (Kola borehole, Russia). Everything we know about Earth's interior comes from studying how earthquake waves (seismic waves) change speed and direction at different depths. The interior has four distinct layers.

#### EARTH'S INTERIOR — LAYERS, DEPTH AND KEY PROPERTIES

##### Crust (0–35 km)

Thinnest layer. **Continental crust:** granite-like (Si + Al = Sial). **Oceanic crust:** basaltic (Si + Mg = Sima). Separated from mantle by **Moho discontinuity**.

**Mantle (35–2,900 km)**

Solid rock but flows slowly. **Asthenosphere** (100–200 km depth): partially molten – tectonic plates float on this. Source of volcanic magma. Separated from outer core by **Gutenberg discontinuity**.

**Outer Core (2,900–5,100 km)**

**Only LIQUID layer.** Iron and nickel (Fe–Ni). Movement of liquid iron generates **Earth's magnetic field**. S-waves cannot pass through it – this absence proved it is liquid. Separated from inner core by **Lehmann discontinuity**.

**Inner Core (5,100–6,371 km)**

**Solid iron and nickel** despite temperatures of ~5,000°C. Immense pressure keeps it solid. Hottest part of Earth. Earth's centre is here.

## PART 2 – ROCKS

# 2. The Three Types of Rocks

### ROCK TYPES – HOW THEY FORM, EXAMPLES AND AFCAT KEY FACTS

#### **IGNEOUS ROCKS (PRIMARY)**

- ▶ Form by cooling of molten magma or lava
- ▶ **Intrusive** (inside Earth, slow cooling): Granite – coarse, large crystals
- ▶ **Extrusive** (on surface, fast cooling): Basalt – fine, small crystals; Pumice
- ▶ No fossils (too hot)
- ▶ Parent rocks – all other rocks come

#### **SEDIMENTARY ROCKS (STRATIFIED)**

- ▶ Form by compaction of sediments deposited in layers
- ▶ Examples: Sandstone, Limestone, Shale, Coal, Conglomerate
- ▶ **Contain fossils** – most important for studying ancient life
- ▶ Most widespread surface rocks (~75% of Earth's surface)
- ▶ Form in water bodies – rivers,

#### **METAMORPHIC ROCKS (CHANGED)**

- ▶ Form when igneous or sedimentary rocks are changed by extreme heat and pressure
- ▶ **Limestone** → **Marble** (used in Taj Mahal)
- ▶ Shale → Slate; Sandstone → Quartzite
- ▶ Coal → Graphite → Diamond (under extreme pressure)
- ▶ No fossils (destroyed by heat)

from these

lakes, seas

and pressure)

▶ Hardest rocks

💡 AFCAT frequently asks: "Marble is a type of \_\_\_\_\_ rock."

Answer: **Metamorphic** – formed when Limestone is subjected to heat and pressure.

Also: "Which rock type contains fossils?" → **Sedimentary** (fossils are preserved as layers build up over millions of years).

## PART 3 – PLATE TECTONICS & EARTHQUAKES

### 3. Plate Tectonics – How Continents Move

Earth's crust is broken into ~15 major tectonic plates that float on the semi-molten asthenosphere and move 2–10 cm per year. Alfred Wegener proposed **Continental Drift Theory (1912)** – the idea that all continents were once joined as a supercontinent called **Pangaea**.

#### PLATE BOUNDARY TYPES – MOVEMENT AND FEATURES FORMED

### ➤ DIVERGENT (CONSTRUCTIVE)

- ▶ Plates move **APART**
- ▶ New crust created from rising magma
- ▶ Forms: Mid-oceanic ridges; Rift valleys
- ▶ Example: Mid-Atlantic Ridge; East African Rift Valley

### ←CONVERGENT (DESTRUCTIVE)

- ▶ Plates move **TOWARD** each other
- ▶ One plate subducts (goes under); crust is destroyed
- ▶ Forms: Ocean trenches; Fold mountains
- ▶ Example: Himalayas (India + Eurasia collision); Mariana Trench

### ○ TRANSFORM (CONSERVATIVE)

- ▶ Plates slide **PAST** each other
- ▶ No crust created or destroyed
- ▶ Forms: Fault lines; frequent earthquakes
- ▶ Example: San Andreas Fault (California)

#### Earthquakes — Key Facts AFCAT Tests:

- **Focus (Hypocentre):** Point inside Earth where earthquake originates
- **Epicentre:** Point on surface directly above the focus — maximum damage here
- **Richter Scale:** Measures *magnitude* (total energy); logarithmic scale
- **Mercalli Scale:** Measures *intensity* (damage felt); subjective
- **P-waves:** Fastest; travel through solids AND liquids
- **S-waves:** Travel through solids ONLY — their absence in the outer core proved it is liquid

## PART 4 — THE ATMOSPHERE

### 4. Layers of the Atmosphere

The atmosphere is the thin blanket of gases protecting Earth. It is organised into distinct layers — each with different temperature behaviour and phenomena. AFCAT directly asks which layer contains what.

#### ATMOSPHERIC LAYERS — BOTTOM TO TOP WITH AFCAT KEY FACTS

**Troposphere (0–12 km)**

**All weather occurs here.** Temperature decreases with altitude (lapse rate  $\sim 6.5^{\circ}\text{C}/1000\text{ m}$ ). Contains 75% of atmosphere's mass and almost all water vapour. Aircraft fly here. Tropopause = top boundary.

**Stratosphere (12–50 km)**

**Ozone layer is here (15–35 km).** Temperature increases with altitude (ozone absorbs UV radiation). No weather; smooth flying. Jet aircraft fly here. Stratopause = top boundary.

**Mesosphere (50–85 km)**

**Meteors burn up here.** Temperature decreases again — coldest layer ( $-90^{\circ}\text{C}$ ). Mesopause = top boundary.

**Thermosphere (85–600 km)**

**Auroras (Northern/Southern Lights) occur here.** Contains the **ionosphere** — responsible for **reflecting radio waves** back to Earth, enabling long-distance radio communication. ISS orbits here. Temperature increases dramatically.

**Exosphere (600 km+)**

Merges into outer space. Very thin — individual molecules escape to space. **Satellites orbit here.** No defined boundary.

💡 **AFCAT Atmosphere Memory: T-S-M-T-E**

Troposphere → Stratosphere → Mesosphere → Thermosphere → Exosphere

Mnemonic: "*The Silly Monkey Throws Eggs*"

Temperature pattern (bottom up): **Decreases** → **Increases** → **Decreases** → **Increases**

**Ionosphere** (in Thermosphere) = radio waves reflected — a fact AFCAT specifically tests about the IAF's communication relevance!

**PART 5 — WINDS & WEATHER SYSTEMS**

## 5. Pressure Belts and Wind Systems

### GLOBAL WIND PATTERN — PRESSURE BELTS AND WIND DIRECTION

**Polar Easterlies (65°–90°)**

Cold, dry winds blowing from polar highs toward sub-polar lows; NE in NH; SE in SH

**Westerlies (35°–65°)** Blow toward poles; SW in NH; NW in SH; bring rain to western Europe; drive temperate cyclones eastward

**Horse Latitudes / Sub-tropical Highs (25°–35°)** Descending, calm, dry air → **world's major hot deserts form here** (Sahara, Thar, Arabian Desert all at ~25–30°)

**Trade Winds (5°–30°)** Blow toward equator; **NE in NH; SE in SH**; most reliable winds; drove sailing ships across oceans; responsible for tropical rainfall

**Equatorial Low – ITCZ (0°–5°)** Rising hot air; very calm (doldrums); hot and wet; no horizontal surface winds; heavy rainfall at equator

### Local Winds — AFCAT Tested

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- ▶ **Loo:** Hot, dry, dusty; blows in May–June across North India (Rajasthan, Punjab, UP, Haryana); temperatures 45–48°C; causes heat strokes
- ▶ **Chinook:** Warm, dry; descends east side of Rocky Mountains (USA/Canada); rapidly melts snow; "Snow-eater"
- ▶ **Mistral:** Cold, dry; blows from NW France down Rhône Valley to Mediterranean
- ▶ **Sirocco:** Hot, dust-laden wind from Sahara; blows into southern Europe
- ▶ **Foehn:** Warm, dry; descends Alps into northern Switzerland and Germany; similar to Chinook

### Cyclones — Tropical vs Temperate

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- ▶ **Tropical Cyclone:** Warm ocean (>26°C); intense & destructive; has calm "eye" at centre; anticlockwise in NH; clockwise in SH (Coriolis)
- ▶ **Names:** Hurricane (Atlantic), Typhoon (Pacific), Cyclone (Indian Ocean)
- ▶ **Temperate Cyclone:** Along polar front; west to east movement; no eye; brings prolonged rain/snow to mid-latitudes
- ▶ Anticyclone = high pressure = outward flowing winds (opposite of cyclone)



**Q1. The ionosphere is responsible for:** AFCAT PYQ

- (a) Weather formation    (b) Protecting Earth from UV radiation  
(c) Reflecting radio waves back to Earth    (d) Burning up meteors

✓ Answer: (c) Reflecting radio waves

The **ionosphere** (part of the Thermosphere, 80–600 km altitude) contains electrically charged particles (ions) that **reflect radio waves** back to Earth's surface. This is what makes long-distance AM radio communication possible — signals bounce off the ionosphere and travel far beyond line-of-sight. This fact is especially relevant for AFCAT as the IAF relies on radio communication. The stratosphere contains ozone (UV protection); mesosphere burns meteors; troposphere has weather.

**Q2. Which seismic wave can travel through both solid and liquid material?**

AFCAT PYQ

- (a) S-waves only    (b) L-waves only    (c) P-waves only    (d) Both P and S waves

✓ Answer: (c) P-waves only

**P-waves (Primary/Compressional waves)** travel through solids, liquids, and gases — the only seismic waves that pass through all states of matter. **S-waves** travel through solids only. When an earthquake occurs, S-waves disappear on the opposite side of Earth (the "shadow zone") because they cannot pass through the liquid outer core. This absence proved the outer core is liquid — a key scientific discovery made entirely through seismic wave analysis.

**Q3. Marble is an example of which type of rock?** AFCAT PYQ

- (a) Igneous    (b) Sedimentary    (c) Metamorphic    (d) Volcanic

✓ Answer: (c) Metamorphic

**Marble** is a metamorphic rock formed when **limestone** is subjected to heat and pressure underground. The calcite crystals in limestone recrystallise into larger grains giving marble its characteristic sheen and texture. Marble was used to build the Taj Mahal. Key metamorphic rock pairs: Limestone → Marble; Shale → Slate; Sandstone → Quartzite; Coal → Graphite → Diamond. This rock-type question appears almost every year in AFCAT.

**Q4. 'Loo' is a local wind associated with:** AFCAT PYQ

- (a) Cold, moist conditions in the Himalayas

(b) Hot, dry conditions in North Indian plains during summer

(c) Cool sea breeze along the western coast (d) Coastal winds in Tamil Nadu

✓ Answer: (b) Hot, dry conditions in North Indian plains

**Loo** is a hot, dry, dusty wind that blows during May–June from the west and northwest across the North Indian plains (Rajasthan, Haryana, Punjab, UP). Temperatures can reach 45–48°C, causing severe heat strokes and fatalities. It blows strongly in the afternoon, usually subsiding by sunset. This is India's most famous local wind and a direct AFCAT factual question.

## Quick Memory Chart — GA02

### Earth's Interior

- ♦ Crust → Mantle → Outer Core (liquid) → Inner Core (solid)
- ♦ Moho: crust–mantle boundary
- ♦ Gutenberg: mantle–outer core boundary
- ♦ Outer core (liquid iron): generates **magnetic field**
- ♦ P–waves: solid + liquid; S–waves: solid only

### Atmosphere

- ♦ Troposphere: **weather**; temp decreases ↑
- ♦ Stratosphere: **ozone layer**; temp increases ↑
- ♦ Mesosphere: **meteors burn**; coldest layer
- ♦ Thermosphere: **ionosphere** (radio waves); auroras
- ♦ Exosphere: satellites; merges with space

### Rocks & Winds

- ♦ Igneous: cooling magma (Granite, Basalt)
- ♦ Sedimentary: layers + fossils (Limestone, Coal)
- ♦ Metamorphic: heat + pressure (Marble←Limestone)
- ♦ Horse latitudes (25–35°): **deserts form here**
- ♦ Loo: hot dry wind; North India; May–June

**Connecting forward:** Chapter GA03 covers Oceanography — how ocean currents shape the climate of coastal regions. Then GA04 brings everything together with Indian Geography, where you'll see how the Himalayas, Indian Ocean currents, and monsoon winds interact to create India's unique climate and landscape.



**Mock Tests**



**Subject Quiz**



**Telegram**

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