IESO 2026 — TURIN

WRITTEN TEST 1 — STRUCTURAL GEOLOGY, GEODYNAMICS AND EARTH SYSTEMS

Himalaya vs Apennines: two ways to build a mountain belt

Time: 100 minutes • Questions: 42 • Score: 42 points • Read all the data before answering. Only one correct answer for all questions.

Mountain belts can arise from the convergence and collision of lithospheric plates. We compare two belts representing different stages of this process: the Himalaya, the archetype of continent-continent collision, and the Northern Apennines, a collisional belt undergoing dismantling with the opening of a back-arc basin (the Tyrrhenian Sea). The deep structure of the Northern Apennines is still under study. The geodynamic interpretations adopted here reflect the currently prevailing model: a westward subduction of Adriatic lithosphere, mostly continental, beneath the Northern Apennines, whose geometry at depth is still debated. Evidence of a deep slab — seismicity and tomographic anomalies down to ~300-500 km — refers to the Southern Apennines and Calabria (Ionian slab).

SECTION A: GEOLOGICAL HISTORY AND GEODYNAMICS — Questions 1–8

Table 1: key data of the two mountain belts

HIMALAYA	NORTHERN APENNINES
• India–Eurasia collision: begins ~50-55 Ma	• European-Adria plate collision: begins ~20-27 Ma
• Current Convergence: ~4-5 cm/yr	• Current Convergence: ~1-2 cm/year
• Crustal thickness (Max Moho depth): ~70-80 km	• Crustal thickness (Max Moho depth): ~35-45 km (Marche area); ~20-25 km (Tyrrhenian Sea)
• Crustal thickening: ~2× normal (doubled)	• Crustal thickening: ~1-1.2× normal / thinned beneath Tyrrhenian
• Elevation: ~4000-5000 m	• Elevation: ~500-1500 m
• Seismicity: 0-80 km (shallow)	• Seismicity: weak and very shallow (10-20 km) in the Tyrrhenian sector, episodic and slightly deeper (15-35 km down to rare 60-70 km (or more)) in the Adriatic sector
• No active volcanism	• Tyrrhenian Arc volcanism
• Gravity anomaly: Strongly negative	• Gravity anomaly: Negative (belt) / Positive (Tyrrhenian)
• Horizontal velocity: ~40-50 mm/yr (N-NE)	• Horizontal velocity: ~2.5 mm/yr (N-NE)

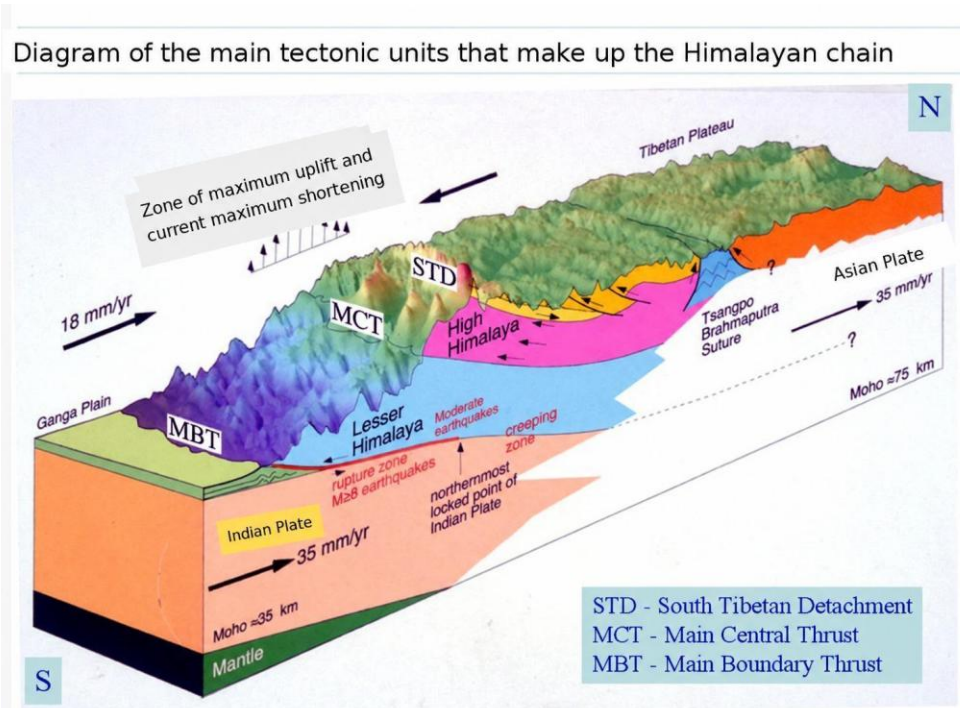

Figure 1 Himalaya tectonic diagram

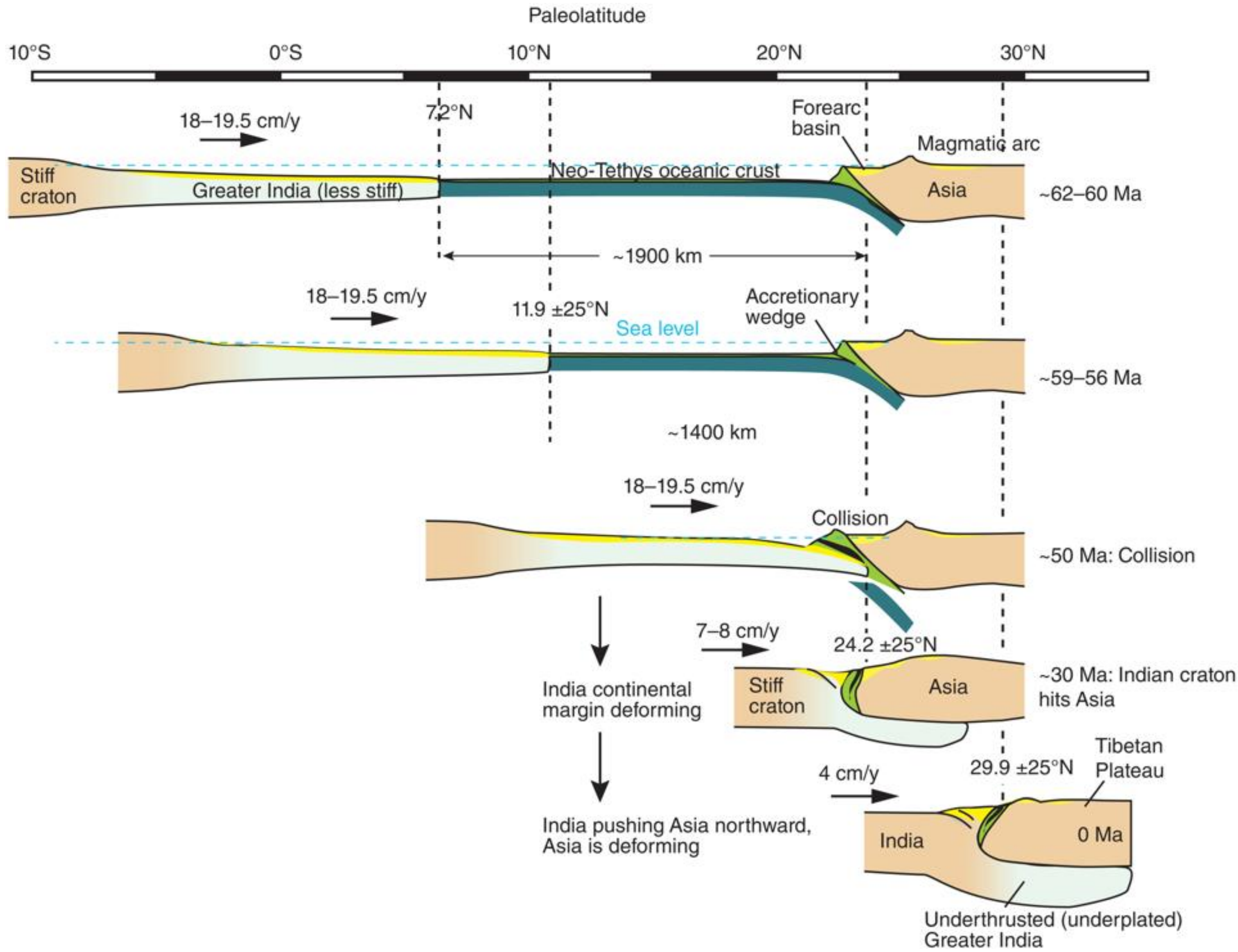

Figure 2 - Evolutionary sketch of the Himalayan belt

Question 1. The Himalayan orogeny began about 50-55 Ma ago. Observing the tectonic sketch (Figg. 1 and 2), what was the main triggering factor?

A) The melting of the mantle beneath the Tethys, which produced a volcanic arc that later collapsed to form the mountains.

B) The rifting of India from Africa which, occurring abruptly, generated a seismic wave capable of uplifting the Eurasian crust.

C) The closure of the Tethys Ocean and the resulting collision between the Indian and Eurasian plates.

D) The opening of the Atlantic Ocean, which by reorganising mantle currents pushed India northward.

Question 2. India converges toward Eurasia at ~4-5 cm/yr. Approximately how much total convergence has occurred in the last 50 million years ?

A) ~2.0 - 2.5 km

B) ~20 - 25 km

C) ~200 - 250 km

D) ~2000 - 2500 km

Question 3. The Main Central Thrust (MCT), visible in figures 1 and 2, is a major fault most active between 25 and 20 Ma. What is the correct definition?

A) A reverse fault that places high-grade metamorphic rocks (High Himalaya) over lower-grade rocks (Lesser Himalaya).

B) A normal fault formed during the gravitational collapse of the Tibetan Plateau.

C) The initial India-Eurasia collision boundary, where the ophiolites of the ancient Tethys are found.

D) The most frontal and recent thrust, today active in the Indo-Gangetic Plain.

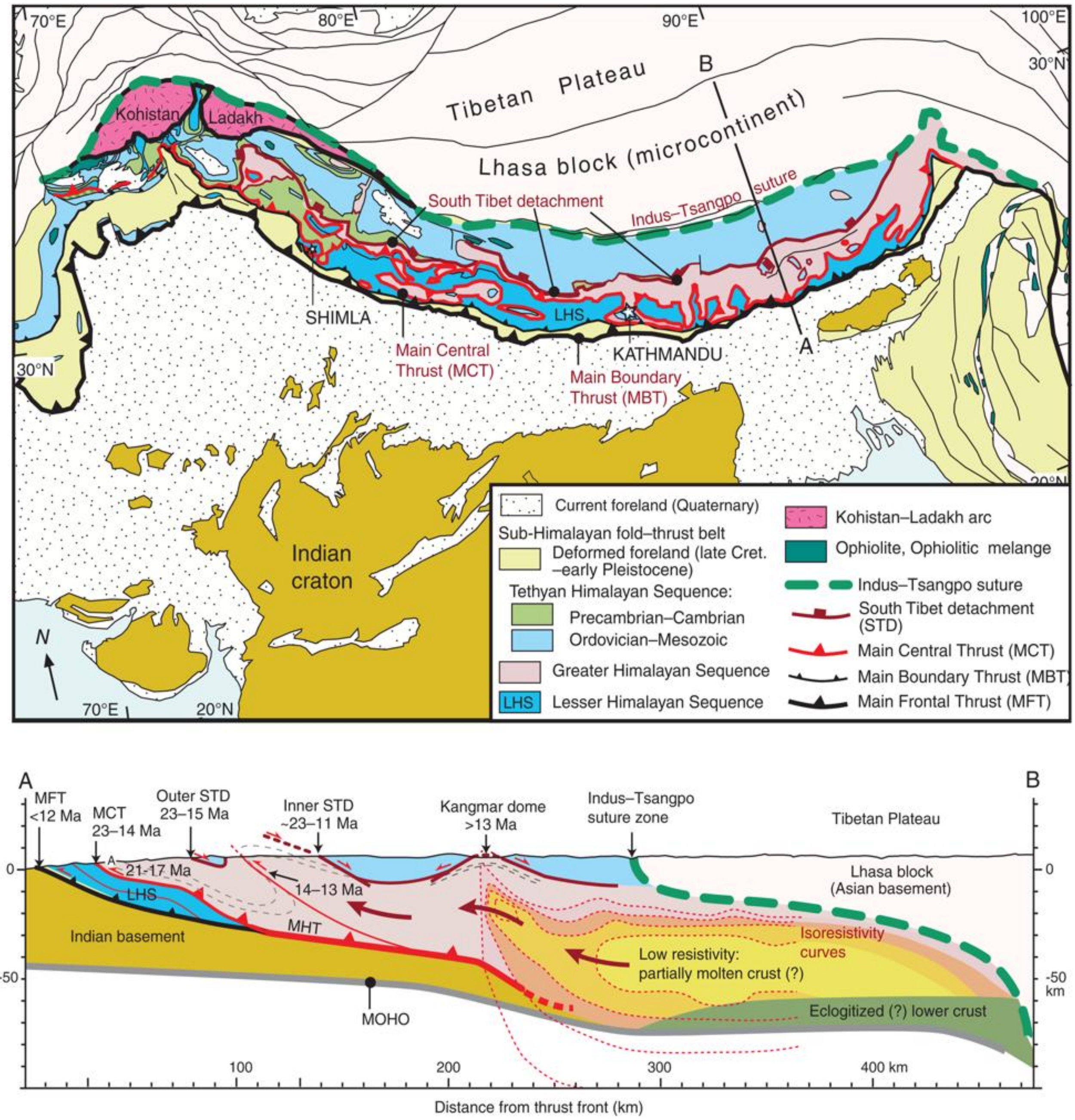

Figure 3 — Map and geological section of the Himalayan belt

Question 4. Observing figures and data provided, according to the prevailing model. Which lithospheric plate was involved in the subduction that formed the Northern Apennines?

A) The Adriatic lithosphere, subducting westward beneath the Tyrrhenian area.

B) The African plate, subducting directly northward beneath the European block.

C) The European plate, subducting southward beneath North Africa.

D) The Tyrrhenian microplate, subducting eastward beneath the Adriatic.

Question 5. The Tyrrhenian Sea opened as a back-arc basin, with a "rollback" mechanism. How do you explain this mechanism?

A) A fixed mantle hotspot creates upwelling of hot material that uplifts and thins the crust.

B) Continental rifting entirely independent of subduction, similar to the opening of the Atlantic.

C) The African plate laterally compresses the Adriatic microplate, generating transtension.

D) The slab retreats eastward with the arc and the belt with it, opening the Tyrrhenian basin by extension.

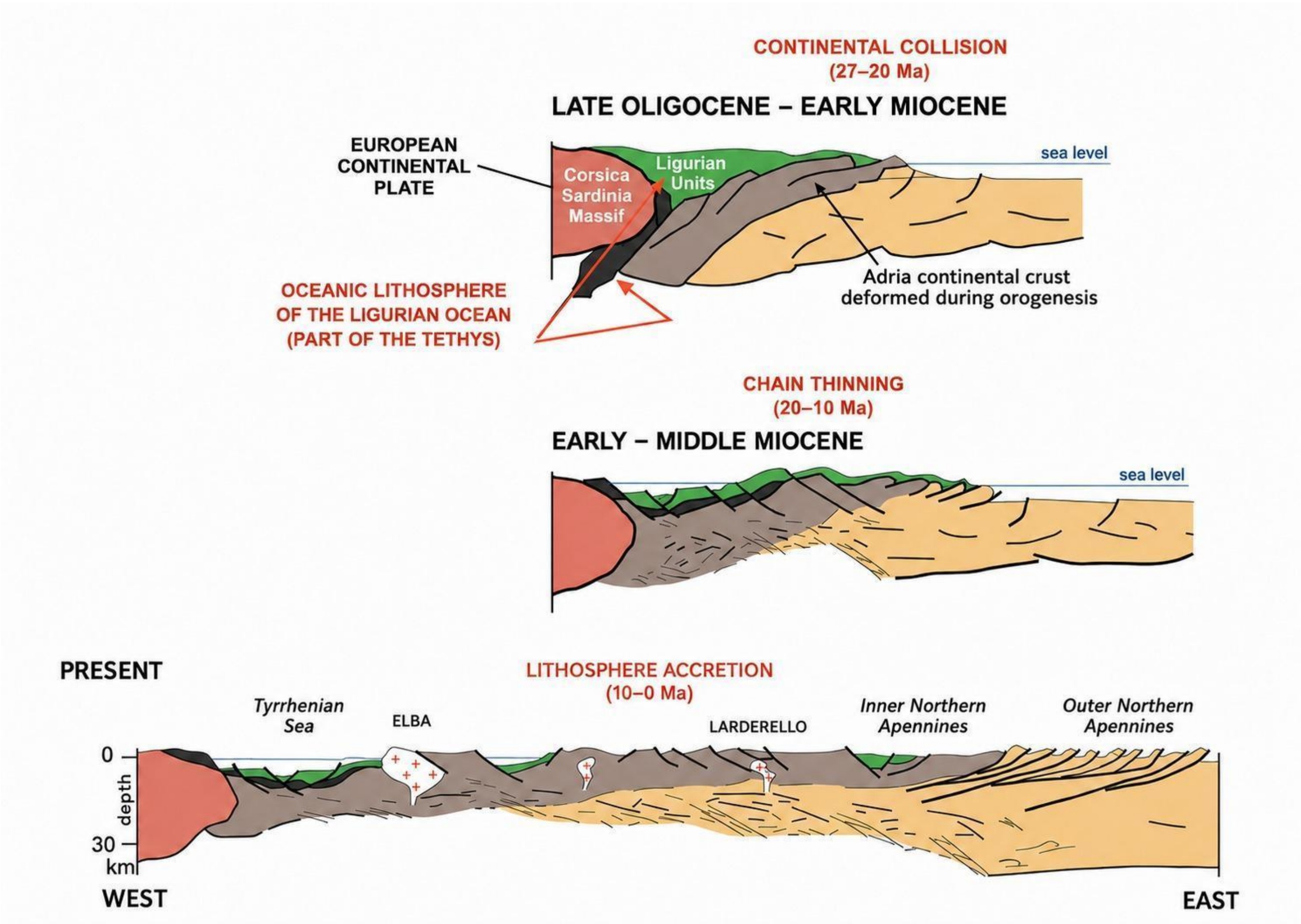

Figure 4 — section of the Northern Apennines

Question 6. Ophiolites are fragments of oceanic crust trapped in a belt after the closure of an ocean. Where are the Himalayan ophiolites found?

A) In the foredeep basin south of the belt, among the Tertiary sediments of the Indo-Gangetic Plain.

B) In the core of the highest peaks, where erosion has exposed the buried oceanic crust.

C) Along the Indus-Tsangpo Suture Zone, which marks the position of the now-closed ancient Tethys.

D) In the Lesser Himalaya, where low-grade metamorphism preserved the original ophiolites.

Question 7. Using data from Table 1, which factor explains the elevation difference?

A) The Tibetan Plateau amplifies the altimetric effect through heating of the thick crust that expands the rocks.

B) The Himalayan crustal thickness produces a greater isostatic buoyancy than the Apennines.

C) The Northern Apennines underwent a greater degree of extension after the collision.

D) The Himalaya has much lower erosion rates and preserves the accumulated relief.

Question 8. In the Southern Apennines-Calabria, hypocenters reach ~300 km depth, much deeper than Himalaya or Northern Apennines. What could be the most direct explanation?

A) The Southern Apennines are younger and seismicity is always deeper in recent systems.

B) In the Southern Apennines-Calabria there must be an oceanic slab that carries seismicity deeper.

C) Himalayan seismic stations cannot resolve deep earthquakes because of the greater thickness of the crust.

D) It depends on fault type: reverse faults give shallow earthquakes, normal faults deep ones.

SECTION B: CRUSTAL STRUCTURE AND GEOPHYSICS — Questions 9–14

Question 9. Which geophysical method is most used to determine the depth of the Moho (crust-mantle boundary) on a crustal scale?

A) Crustal seismic reflection and refraction.

B) Electrical resistivity tomography, mapping conductivity variations at depth.

C) Magnetometric surveys, measuring magnetic-field variations due to ferromagnetic minerals.

D) Surface gravity measurements, sufficient on their own to reconstruct the Moho geometry.

Question 10. The Moho reaches a much lower depth beneath the Himalaya/Tibet (see Table 1) against ~35 km of a normal crust. Which mechanism explains the thickening?

A) The heavy continental collision increased by 50% the original crust.

B) The continental collision roughly doubled the original crustal thickness.

C) The Indian crust was already ~70 km thick before the collision.

D) Intense erosion removed the upper crust, lowering the Moho.

Question 11. Gravity anomalies over the Himalaya are strongly negative (lower than expected for a mountain area). Knowing the crust (~2,700 kg/m³) is less dense than the mantle (~3,300 kg/m³), what is the cause?

A) Deep magma chambers reduce the local density of the crust.

B) The mountains are made of particularly dense rocks that attract the gravimeter.

C) The thick crust occupies the place of the denser mantle, reducing gravity.

D) Erosion removed heavy minerals from the surface, lowering the average density.

Question 12. India and Eurasia converge at ~4-5 cm/yr, but the vertical uplift of the Himalaya is only ~5-10 mm/yr. The 'missing' convergence is neither uplift nor erosion. Where does it go?

A) Much of it is absorbed by crustal thickening and by distributed deformation across the area.

B) It is entirely accommodated by subduction.

C) GPS data record only surface movement and deep convergence cannot be measured.

D) The convergence stops at the Moho: below it, the mantle flows laterally without vertical accumulation.

Question 13. The Moho is at ~20-25 km beneath the Northern Tyrrhenian, against ~35 km of normal crust. Which combination of processes explains this thinning?

A) The Tyrrhenian is a global anomaly still without a consolidated explanation.

B) Submarine erosion progressively thinned the crust over time.

C) The presence of dense volcanic rocks compressed the crust, lowering the Moho.

D) Rollback of the subducting plate and post-collisional tectonics thinned the crust.

Question 14. In the Tyrrhenian, gravity anomalies are positive, whereas over the Apennine belt they are negative. What does this contrast indicate?

A) Oceanic crust, rich in magnetic minerals, crops out in the Tyrrhenian making it denser.

B) The Apennine belt is made of rocks denser than the underlying mantle.

C) In the Tyrrhenian the instrumentation records a systematic sign error.

D) Beneath the Tyrrhenian the crust is thin and closer to the mantle, while beneath the belt the crust is thicker.

SECTION C: PETROLOGY AND METAMORPHISM — Questions 15–22

GLOSSARY.

Metamorphism: solid-state transformation due to changes in temperature (T) and/or pressure (P);
P increases by ~1 kbar every ~3 km of depth.
Index mineral: forms only in certain P-T ranges and records those conditions.
Facies: greenschist = low T and P; blueschist = low T and medium P; amphibolite = medium T and P; granulite = high T; eclogite = very high P.
P-T path: the trajectory of the rock during burial and exhumation.
Protolith: starting rock.
Migmatites: rocks derived from partial melting, forming at T > 650-700°C in the presence of water.

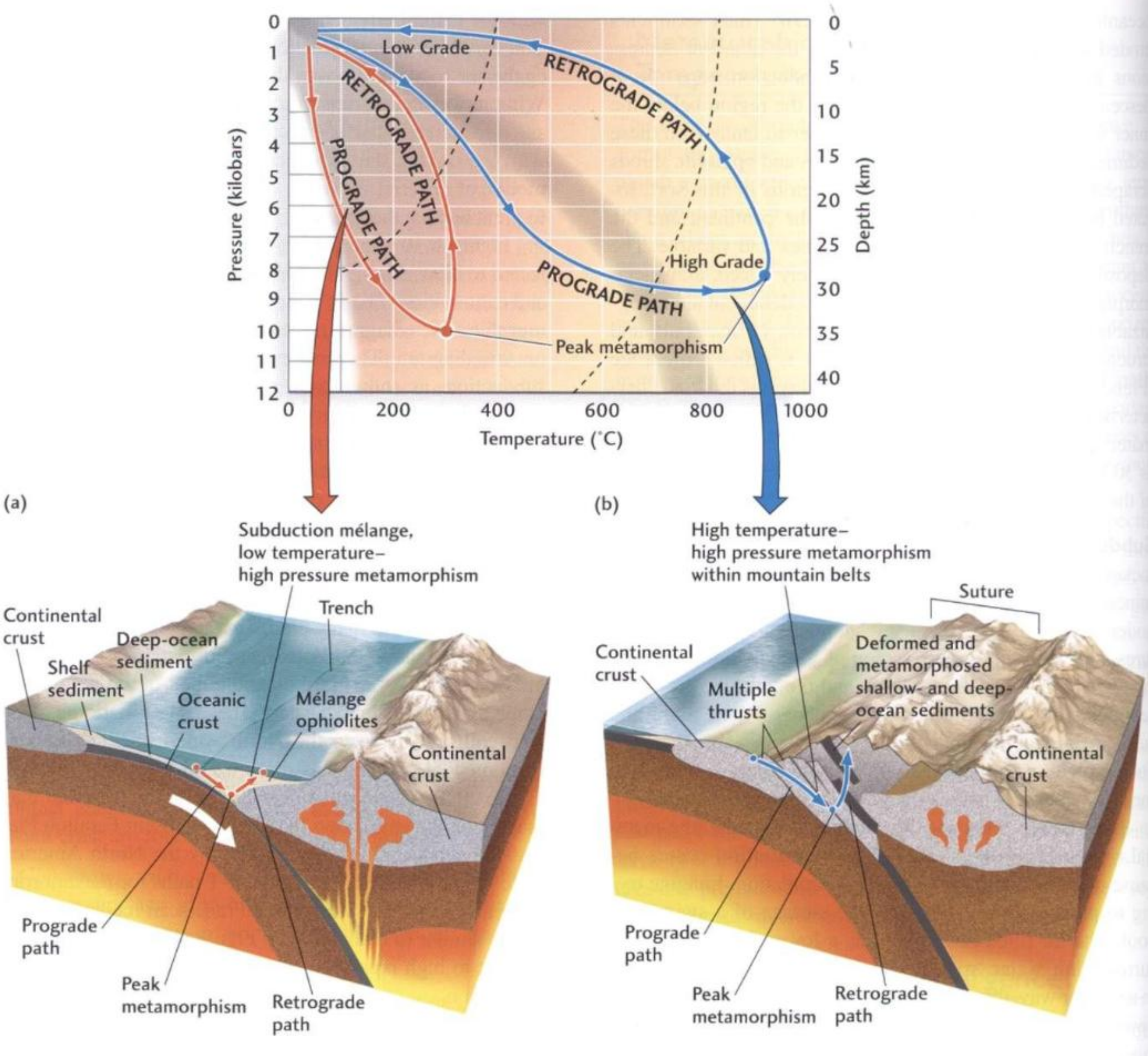

Fig. 5 — P-T diagrams of subduction and collision paths

Table 2: Index mineral with corresponding P-T conditions.

Index mineral	Stability conditions	Found in
Chlorite	Low T (<400°C), low-medium P	Both (low grade)
Biotite	Medium T (400-600°C), medium P	Himalaya, Northern Apennines
Garnet	Medium-high P (>5 kbar), medium-high T	Himalaya, Northern Apennines
Kyanite	High P (>5 kbar), medium-high T	Himalaya (High Himalaya), Northern Apennines
Sillimanite / Andalusite	Sillimanite: high T (>600°C), medium P Andalusite: high T (>600°C), low P	Himalaya, Northern Apennines
Glaucophane	High P (>8 kbar), LOW T (<450°C)	Northern Apennines
Lawsonite	Very high P (>10 kbar), low T	Northern Apennines
Omphacite	Very high P (>12 kbar), medium T	Himalaya UHP, Northern Apennines

Question 15. Kyanite, andalusite and sillimanite have the same formula (Al_2SiO_5) but different structure. In the High Himalaya (peak 8-12 kbar) which polymorph is expected?

A) Andalusite: it is the most common polymorph in continental rocks.

B) Kyanite: the Himalayan conditions of 8-12 kbar fall within its stability field.

C) Both in equilibrium: at 8-12 kbar they coexist.

D) Neither: at high P only sillimanite forms.

Question 16. The migmatites of the High Himalaya contain light leucosomes (granitic composition). Migmatites require T > 650-700°C in the presence of water; the Himalayan peak is 650-750°C. What conclusion follows?

A) The migmatites indicate granulite facies from previous events (>900°C).

B) The migmatites formed by contact metamorphism near a local intrusion.

C) The peak conditions (650-750°C) exceed the threshold: migmatite formation is consistent with the data.

D) The peak conditions are too cold: the migmatites cannot have formed in place.

Question 17. Glaucophane is a blue sodic amphibole, stable at high P (>8 kbar) and low T (<450°C). Rocks with glaucophane have been found in some Apennine units. Which conclusion is correct?

A) Glaucophane forms by hydrothermal alteration on the ocean floor near ridges.

B) Glaucophane indicates contact metamorphism near a granitic intrusion at high T.

C) The units underwent very high-T metamorphism (>800°C), typical of granulite facies.

D) The units reached high P (>8 kbar) while keeping low T (<450°C) consistent with rapidly subducted lithosphere.

Question 18. In a Himalayan gneiss, garnet crystals (medium-high P and T) contain inclusions of chlorite and biotite (low grade). Knowing that low-grade minerals form first and are later engulfed by high-grade ones, what do the inclusions indicate?

A) The garnet grew during prograde metamorphism, engulfing the pre-existing low-grade minerals.

B) The garnet formed first, at low grade; chlorite and biotite grew later in microfractures.

C) Garnet and inclusions are in equilibrium: formed simultaneously at the same grade.

D) The inclusions formed in fractures of the garnet during a retrograde metamorphism process.

Question 19. Some Tuscan units show low pressures (~1.4-3 kbar, i.e. ~6-10 km depth) but high temperatures (500-600°C); the Tyrrhenian heat flow today is high (>100 mW/m², against ~60 mW/m² on the average continental crust). Which process explains low P and high T?

A) Extensional tectonics associated with magmatism raised the geothermal gradient.

B) Deep burial in a cold subduction zone, with a low thermal gradient.

C) Rapid erosion removed great thicknesses, reducing P without changing T.

D) A meteorite impact produced local heat and decompressed the crust.

Question 20. Using the index-mineral table, which sequence represents increasing metamorphic grade (increasing temperature) in pelitic rocks?

A) Sillimanite → Garnet → Biotite → Chlorite.

B) Garnet → Chlorite → Sillimanite → Biotite.

C) Chlorite → Biotite → Garnet → Sillimanite.

D) Biotite → Chlorite → Garnet → Sillimanite.

Question 21. Figure 5 describes two P-T paths: "**High T - High P**" as in the thicker Himalayas (conditions: 650-750°C at 8-12 kbar) and **"Low T - High P**" as in some oceanic lithosphere Ligurian units (conditions: 300-450°C at 10-15 kbar). Which explanation is most consistent?

A) The different erosion rates of the two structures control the decompression rate, and therefore global pressure.

B) The different compositions of the starting rocks between the continental Himalaya and the oceanic Ligurian units react differently to temperature and depth.

C) The different age: P-T paths evolve systematically with geological time.

D) Thicker crust retains heat, while colder oceanic lithosphere subducts rapidly without heating.

Question 22. Along the Himalayan MCT you can observe sillimanite gneiss (high grade) above the plane; chlorite phyllites (low grade) below the plane. How is this bottom-top grade sequence defined?

A) Normal gradient: grade increases downward, as expected from geothermics.

B) Inverted gradient: grade is higher above and lower below the contact, as in a reverse fault.

C) Contact gradient: younger rocks are always on top, regardless of grade.

D) Not interpretable without knowing the age of the rocks.

SECTION D: MAGMATISM AND GEOCHEMISTRY — Questions 23–28

GLOSSARY.

Peraluminous: magma with Al_2O_3 in excess of Na_2O+K_2O+CaO; forms by melting of clay-rich sedimentary rocks (pelites).

Subduction signature (LILE/HFSE): fluids released by the slab carry LILE (K, Rb, Ba, Sr — water-soluble) but not HFSE (Nb, Ta, Ti — immobile): result LILE high + HFSE low.

MORB: mid-ocean-ridge basalt, 'normal' composition, neither LILE-enriched nor HFSE-depleted.

Question 23. Why is there currently no significant volcanism along the Himalayan collision zone, unlike the Tyrrhenian arc?

A) The collision is too old for volcanism to be still active.

B) The Himalayan crust is too thick to allow magma to rise.

C) Erosion removed all volcanic products, but magmatism continues at depth.

D) There is no subducting oceanic slab under the Himalaya.

Question 24. Himalayan leucogranites have Al_2O_3 ~15% and are peraluminous (Al_2O_3 > Na_2O+K_2O+CaO). Which source produces a peraluminous magma?

A) Partial melting of former mudstones, rich in Al_2O_3.

B) Melting of the lithospheric mantle, poor in Al relative to the crust.

C) Melting of oceanic crust subducted to great depth.

D) Assimilation of carbonate sediments during magma ascent.

Question 25. The volcanic products of the Southern Tyrrhenian have K_2O ~4% and a LILE↑/HFSE↓ signature. Vesuvius and Campi Flegrei belong to the Tyrrhenian arc. What type of magma is expected?

A) Primitive basalts with MORB composition (low K_2O, no subduction signature).

B) Only rhyolites from melting of the Campanian continental crust.

C) Potassic and ultrapotassic magmas (high K_2O, LILE↑).

D) Carbonatites with abundant calcium and low silica.

Question 26. Slab fluids carry LILE (soluble) but not HFSE (immobile) into the overlying mantle, lowering its melting point. Which statement correctly describes the result?

A) Crustal contamination adds LILE during magma ascent.

B) Fractional crystallisation of Ti oxides removes the HFSE during ascent.

C) The mantle is intrinsically poor in HFSE from melting events prior to subduction.

D) The enriched mantle produces magmas with high LILE and low HFSE.

Question 27. Tyrrhenian arc basalts show LILE↑ and HFSE↓; those of the Southern Tyrrhenian, formed by asthenospheric decompression without a slab-fluid contribution, tend to resemble MORB. Which difference distinguishes them?

A) Back-arc basalts have little fluid contribution.

B) Back-arc basalts have higher K_2O due to a more enriched source.

C) Arc basalts have systematically higher SiO_2: this is the main discriminating criterion.

D) The two types are geochemically identical: only the geographic label changes.

SECTION E: STRUCTURAL GEOLOGY AND MAPPING — Questions 28–34

SYMBOLS.

Attitude (strike/dip): the long line = strike; the short tick = dip direction; the number = dip angle in degrees.
Thrust (reverse fault): line with filled triangles on the upper block.
Normal fault: line with ticks on the downthrown side.
Décollement: dashed line, detachment plane on weak levels (clays, evaporites).

Question 28. Along the Himalayan MCT, you can observe mylonites, tectonic breccias and sliding streaks; above the plane high-grade gneiss, below the plane low-grade phyllites, with the upper block moving southward. Which interpretation is correct?

A) The younger rocks are found north of the fault.

B) The thrust dips northward and the upper block was thrust southward.

C) The thrust is inactive and the arrow only indicates the direction of the ancient Tethys.

D) It is a normal fault that downthrows the northern block.

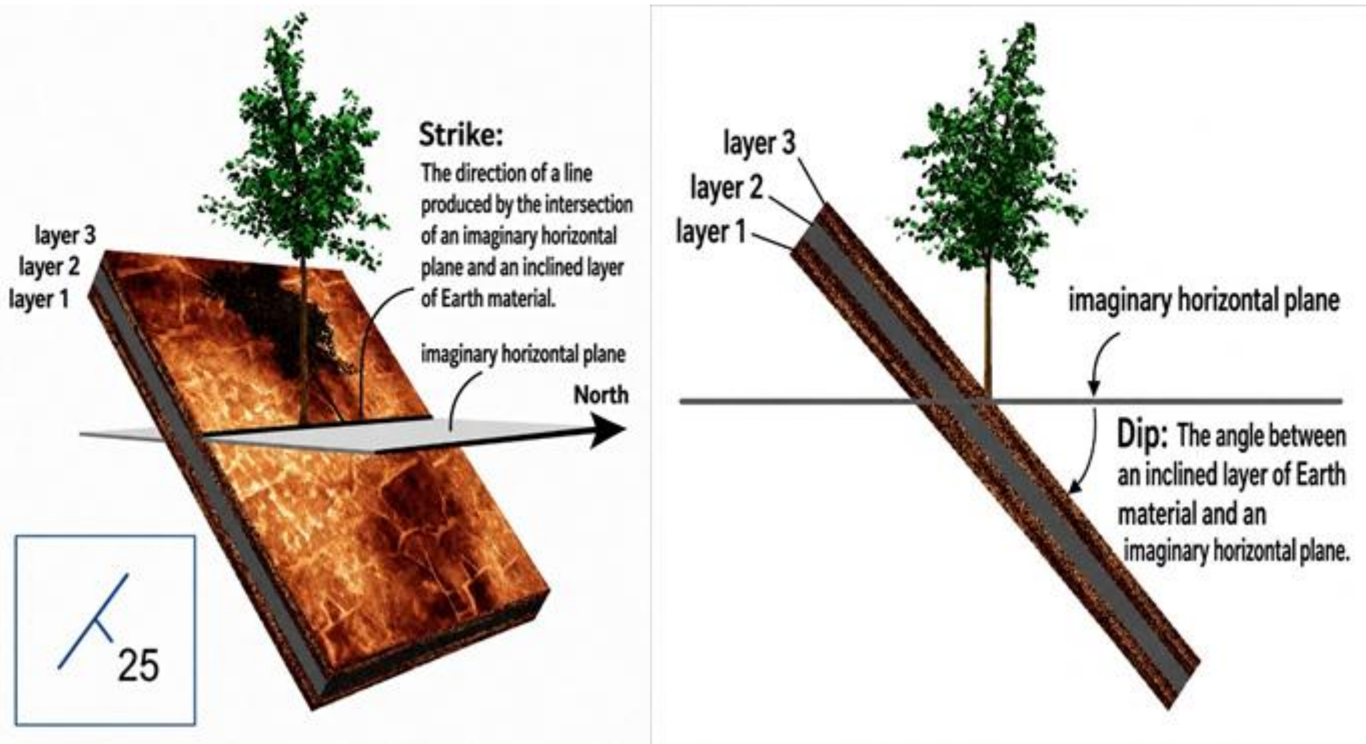

Fig. 6 — Attitude symbols

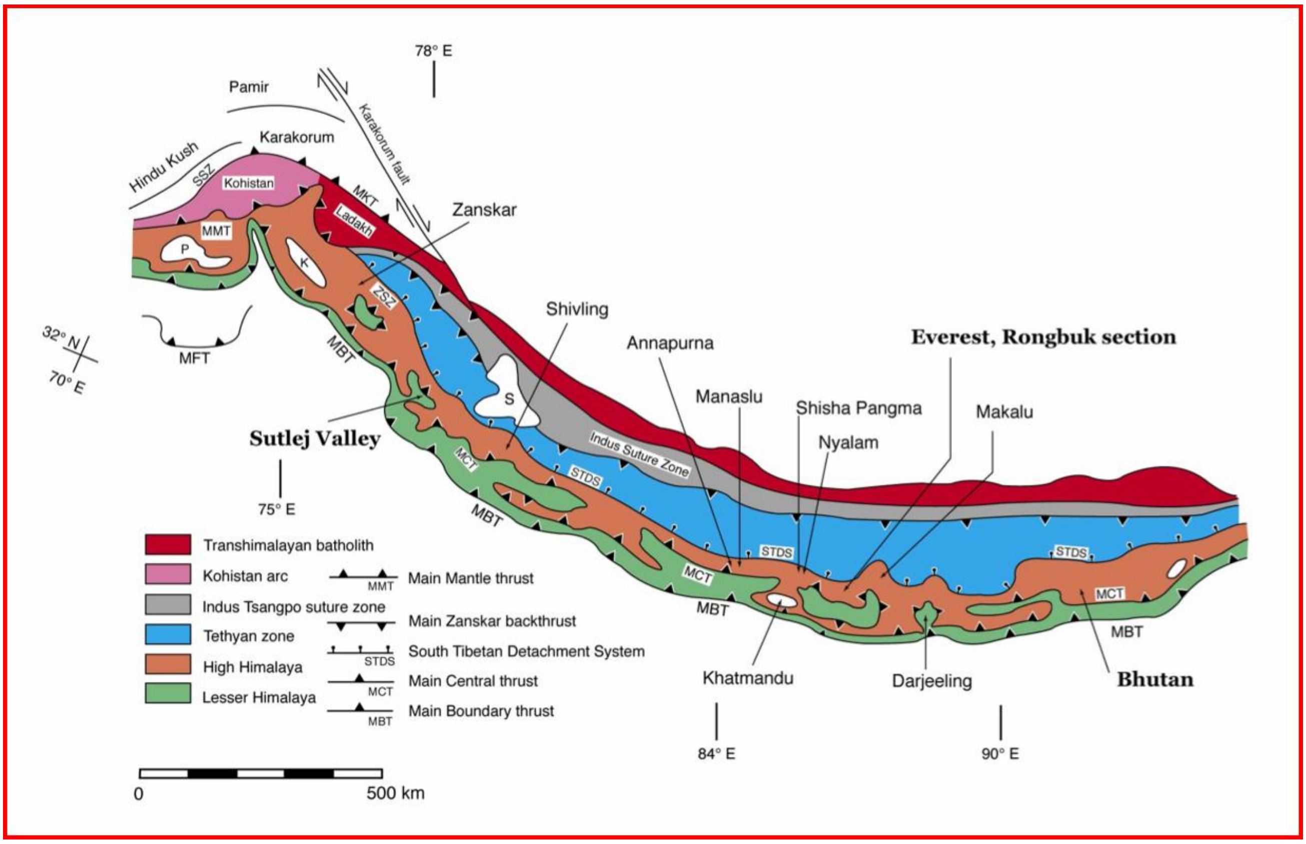

Fig. 7 — Himalayan geological map (MCT top-to-S, STD top-to-N);

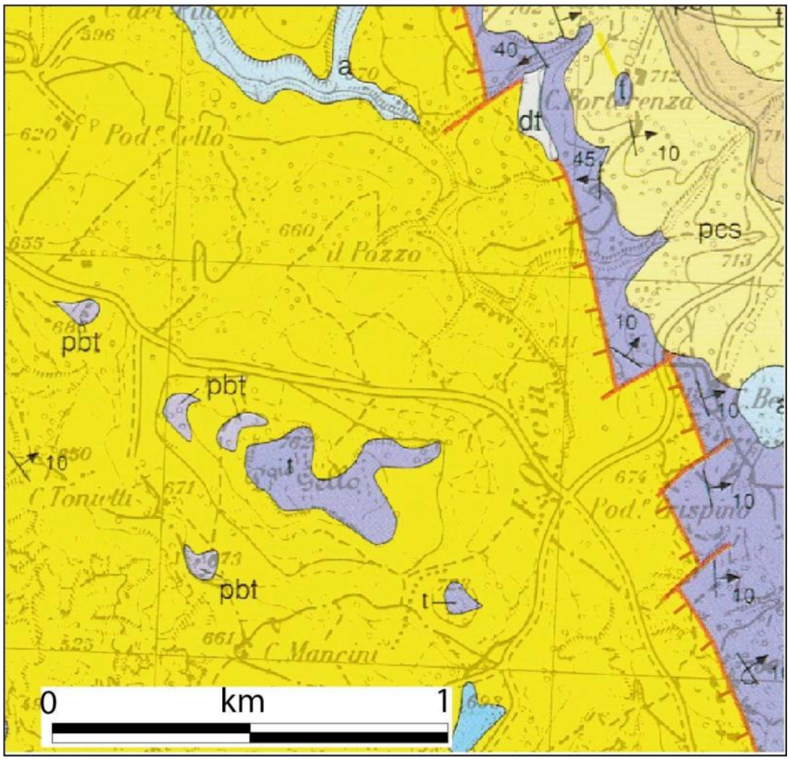

Fig. 8 — map of an Apennine area

Question 29. In the Himalayan map the STD has top-to-N movement (normal fault) and the MCT top-to-S (thrust): they bound the High Himalaya above and below respectively. Which kinematic pair is correct?

A) MCT top-to-S and STD top-to-N: opposite senses coexisting at different crustal levels.

B) Both top-to-S: they are coeval and kinematically parallel.

C) Both top-to-N: the MCT was reactivated with opposite kinematics.

D) Both contacts have strike-slip kinematics parallel to the belt.

Question 30. In a map of the Northern Apennines, a normal fault has ticks on the western side (ticks = downthrown side). What does it indicate?

A) The western block rose: it is the footwall of the fault.

B) The western block was downthrown, coherent with the westward opening of the Tyrrhenian.

C) The fault is a masked thrust: Apennine symbology is inverted relative to the standard.

D) The fault is inactive: Apennine normal faults stopped in the Pleistocene.

Question 31. Two attitude measurements 200 m apart have the same strike but opposite dips: site A dipping 45° to the East, site B 40° to the West; the beds dip away from each other. Which structure lies between A and B?

A) The fault is a masked thrust: Apennine symbology is inverted relative to the standard.

B) Reverse fault: the change in dip indicates a tectonic contact.

C) Antiform: the beds dip away from the centre.

D) Synform: the beds dip toward each other.

Question 32. The décollement is a basal plane along which the entire belt 'slides' over the basement. In which rocks does a décollement form most easily, and why?

A) Limestones and quartzites: rigid and competent, they resist deformation and form sharp surfaces.

B) Basement granites: the smoothed surfaces act as natural slip planes.

C) Shales, evaporites (salt, gypsum) and overpressured clays which are weaker and ductile.

D) Volcanic rocks: high porosity reduces cohesion and favours sliding.

Question 33. Anticline and syncline are adjacent folds. On a map, how are they distinguished by the age of the strata cropping out in the core?

A) The anticline has the youngest strata in the core; the syncline the oldest.

B) Both have the oldest strata in the core: they are distinguished only by dip.

C) The age of the strata does not allow them to be distinguished without subsurface data.

D) The anticline has the oldest strata in the core; the syncline the youngest.

SECTION F: COMPARATIVE SYNTHESIS — Question 34

Within the Wilson Cycle, the Himalaya and the Apennines represent successive stages. The Northern Apennines developed, in their final phases, high-temperature metamorphic conditions typical of crustally thinning sectors; the Himalaya is still under construction, without magmatism or thinning. The Southern Apennines and the Tyrrhenian represent the interaction of subduction and extension on the upper plate, linked to rollback.

Question 34. A geologist studies two samples. Sample 1: gneiss with garnet + kyanite + biotite, chlorite inclusions in the garnet, High T-High P path. Sample 2: blueschist with glaucophane + lawsonite, P >10 kbar, T ~350°C, Low T-High P path. Which association is correct?

A) Both Himalayan: the glaucophane of Sample 2 can also form at low P in the presence of sodium.

B) Sample 1: Apennine cold subduction (Low T-High P) — Sample 2: Himalayan collision (High T-High P).

C) Sample 1: Himalayan collision (High T-High P) — Sample 2: Apennine cold subduction (Low T-High P, Ligurian units).

D) Sample 1: Tyrrhenian back-arc basin (Low P-High T) — Sample 2: High Himalaya UltraHigh P with coesite.

SECTION G: INTERACTIONS AMONG EARTH SYSTEMS — Questions 35-42

Scientists compared sediment export from river basins in the Himalaya and the Northern Apennines. The observations are summarized in Table 3.

Table 3. Selected environmental and geological characteristics of river basins in the Himalaya and the Northern Apennines

Observation	Himalaya	Northern Apennines
Mean mountain elevation	4,500 m	1,100 m
Mean annual precipitation	1,850 mm	1,750 mm
Mean basin slope	32°	18°
Mean river discharge	690 m³/s	240 m³/s
Suspended sediment concentration	1,180 mg/L	320 mg/L
Dissolved calcium	68 mg/L	41 mg/L
Dissolved silica	23 mg/L	11 mg/L
Vegetation cover	Moderate	Dense
Glacier coverage	Extensive	Very limited
Mean uplift rate (GPS)	6 mm/yr	1 mm/yr

Question 35. Based on Table 3, which interpretation best explains the greater sediment export from the Himalayan basins?

A) Similar rainfall, combined with gentler slopes, lower discharge, slower uplift, and denser vegetation.

B) Similar rainfall, combined with steeper slopes, higher discharge, faster uplift, and less vegetation.

C) Higher rainfall alone, independent of differences in relief, discharge, uplift, and vegetation.

D) Denser vegetation alone, independent of differences in relief, discharge, uplift, and rainfall.

During one hydrological year, extreme rainfall events were recorded in specific sites of both mountain belts. Remote sensing and field observations are summarized in Table 4.

Table 4. Conditions during storms in the two mountain belts

Observation	Himalaya	Northern Apennines
Rainfall during storm	240 mm	230 mm
Landslides mapped	118	21
Sediment delivered to rivers	High	Moderate
Population density on steep slopes	High	Moderate

Question 36. Based on Tables 3 and 4, which interpretation best explains the larger number of landslides and greater sediment delivery in the Himalaya?

A) Atmospheric processes, because rainfall was a relevant difference between the regions.
B) Geological processes, because slope controls landslides.
C) Hydrological processes, because river transport determines slope failure.
D) Interactions among rainfall, steep relief, runoff, sediment transport, and human exposure.

Question 37. Scientists collected river-water and sediment samples from one Himalayan basin and one Northern Apennine basin during the same season. Based on Table 3, which hypothesis is most strongly supported by the combined chemical and sedimentary evidence?

A) Higher rainfall decreased both mineral dissolution and suspended sediment transport.
B) Steep relief enhanced mechanical weathering and river transport.
C) Lower vegetation cover exposed more bedrock and reduced erosion of calcium and silica.
D) Faster river flow and vegetation cover increased mineral dissolution.

Question 38. Two regional authorities are evaluating mountain-highway routes on the mountain belts. Based on tabled data, which engineering assessment is most strongly supported?

A) More extensive stabilization is required along the Himalayan route because of harsher conditions.
B) More extensive stabilization is required in the Northern Apennines because uplift is slower.
C) Less extensive stabilization is required in the Himalaya because of moderate vegetation.
D) Similar stabilization measures are appropriate because the two belts are comparable.

Two mountain regions in the Himalaya supply freshwater to nearby communities. Their hydrological characteristics are summarized in Table 5.

Table 5. Water-resource characteristics of the two sites in the Himalayas

Observation	Region 1	Region 2
Mean annual river discharge	High	Moderate
Seasonal variation in river flow	Low	High
Glacier coverage	Extensive	Very limited
Population density	High	Moderate

Question 39. Based on Table 5, which region currently has the more reliable year-round water supply?

A) Region 1, because glacier storage moderates seasonal variation in river flow.
B) Region 2, because fewer people depend on river water.
C) Both regions, because their annual precipitation totals are similar.
D) Neither region, because seasonal variations do not indicate water availability.

Scientists monitored a Himalayan river basin for 20 years. The observations are summarized in Table 6.

Table 6. Changes in tectonic, climatic, hydrological, and sedimentary indicators over 20 years

Observation	1st year	20th Year
Mean annual uplift (GPS)	5.8 mm/yr	6.1 mm/yr
Mean annual precipitation	1,820 mm	1,845 mm
Extreme rainfall events (>100 mm/day)	3 events	9 events
Mean river discharge	610 m^3/s	640 m^3/s
Suspended sediment concentration	910 mg/L	1,280 mg/L
Vegetation cover	No significant change	

Question 40. Based on Table 6, which phenomenon had the highest percentage increase in the overall period?

A) Extreme rainfall events.

B) Mean annual precipitation.

C) Suspended sediment concentration.

D) Mean river discharge.

Representative geophysical observations from the Himalaya and Northern Apennines are summarized in Table 7.

Table 7. Elevation, crustal thickness, and gravity anomalies in the Himalaya and Northern Apennines

Observation	Himalaya	Northern Apennines
Mean elevation	4,500 m	1,200 m
Average crustal thickness	72 km	38 km
Gravity anomaly	Strongly negative	Slightly positive

Question 41. Which option would require further evidence beyond the observations in Table 7?

A) The effective difference in height of the Himalaya

B) The effective depth of the Moho in the two regions.

C) The effective amount of the gravity anomaly in the two regions.

D) The statement that gravity is stronger in the Northern Apennines than in the Himalaya.

Scientists from two teams A and B compared uplift rate, annual precipitation, sediment flux, and representative landscapes from two sites in the Himalaya and Northern Apennines. Quantitative evidence is presented in Fig.s 9-11, landscapes of the sites are shown in Fig.s 12-13.

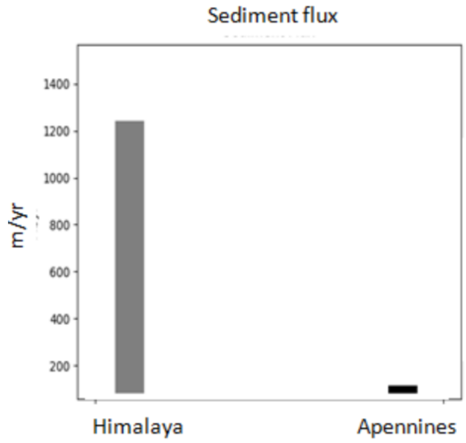

Figure 9. Mean sediment flux in the considered sites

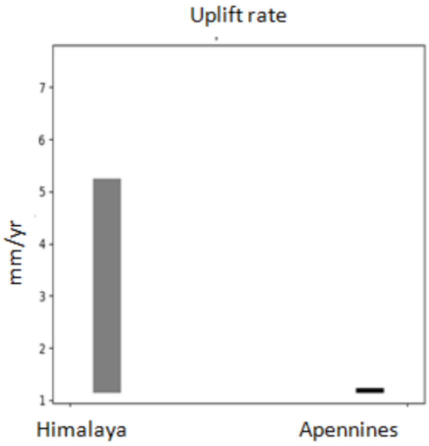

Figure 10. Mean uplift rate in the considered sites

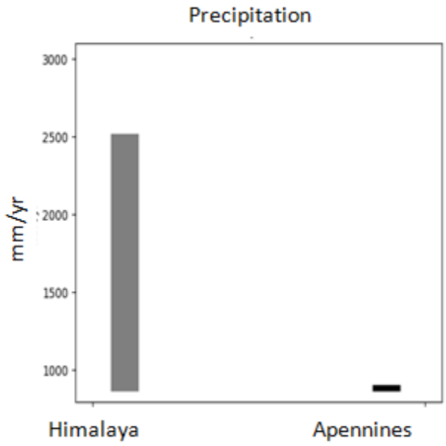

Figure 11. Mean annual precipitation in the considered sites

Figure 12. Representative Himalayan landscape

Figure 13. Representative Northern Apennine landscape

Question 42. Team A interprets the greater Himalayan sediment flux as primarily climate controlled. Team B interprets it as primarily tectonically controlled. Based on figures, which evaluation is best supported?

A) Team A is supported because the evidence is more consistent with uplift differences.

B) Team A is supported because the evidence is more consistent with precipitation differences.

C) Team B is supported because the landscape photographs show differences in steepness of slopes.

D) Neither Team A nor Team B is fully supported by the available evidence.