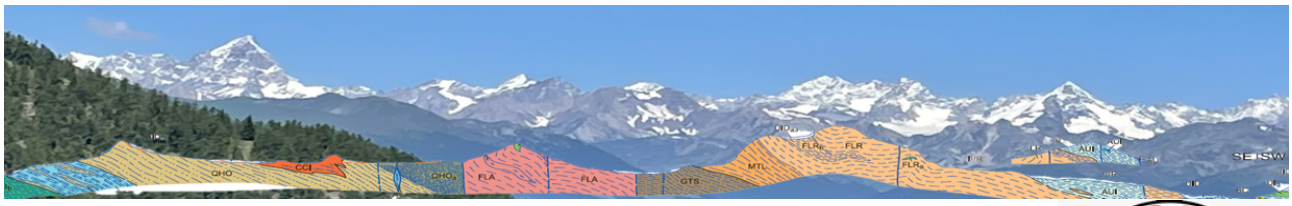

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DATA MINING TEST N.1

STUDENT CODE

THE ALPINE OROGENY: FROM ALPS TO HIMALAYA, SIMILARITIES AND DIFFERENCES

[= ALPPILAINEN OROGENIA: ALPEILTA HIMALAJALLE, SAMANKALTAISUUDET JA ERILAISUUDET]

The Alpine orogeny in the orogenic phase that in the late Mesozoic and the Cenozoic has formed the mountain ranges of the Alpine belt one of the two main mountains belts of the Earth, with western American mountains, this with an equatorial thrust. *(=Alppilainen orogenia muodosti alppilaiset vuorijonot eli Alpidit myöhäis-mesotsooisella sekä kenotsooisella maailmankaudella.)*
These mountains *(=vuoristot)* include (from west to east) the Atlas, the Rif, the Baetic Cordillera, the Cantabrian Mountains, the Pyrenees, the Alps, the Apennine Mountains, the Dinaric Als, the Albanians Alps, the Pindus, the Carpathians, the Balkanides, the Pontic Mountains, the Taurus, the Armenian Highlands, the Caucasus, the Alborz, the Zagros, the Hindu Kush, the Pamir, the Karakoram, and the Himalaya. Sometimes other names occur to describe the formation of separate mountain ranges: for example Hellenic orogeny for the Pindus, Altai orogeny for the Altai Mountains or the Himalayan orogeny for the Himalaya.

SHORT GEOLOGICAL HISTORY

The Alpine or Alpine-Himalayan orogeny is a complex of geological events (=*sarja geologisia tapahtumia*) that began in the Cretaceous (Mesozoic era - 100 m.a.) *(=hiilikaudella... 100 milj. vuotta sitten)* and ended in the Miocene (Cenozoic era - 15 m.a.) *(=mioseenikaudella... 15 milj. v. sitten)*, although some secondary processes are still in place. The Alpine orogeny is the result of a very complex geological history that began around 130 million years ago with the beginning of the Tethys closure phases, with acme beginning around 50 million years ago and is still ongoing *(=orogenian huippuvaihe oli n. 50 milj. vuotta sitten ja osa prosesseista jatkuu yhä).*

Watch at the links, which may help you to remember or to learn more about the orogeny of these two great mountainous ranges. *(=Katso videot, kopioi osoiteriville mikäli linkki ei toimi napsauttamalla)*

https://www.youtube.com/watch?v=PDrMH7RwupQ
https://www.youtube.com/watch?v=Q1VL_Agb4mM

THE ALPS


The Mount Blanc group

In the pre-orogenesis phase, the rocks that would build the Alpine edifice (=*vuorijono*) occupied both a sector of the southern margin (=*reuna*) of the European tectonic plate (=*tektoninen laatta*) and a sector of the northern margin of the African tectonic plate, as well as a microplate, called Adria, separated from the African plate by a western arm of the Tethys Ocean (=*Tethys-meren länsiosa*) (Ligurian-Piemontese Ocean). The convergence movements (=*lähenevä liike*) of the African plate and the Adria microplate northwards led to the progressive closure of the Ligurian-Piemontese Ocean (=*merialueen kutistuminen*), until the two continental plates collided (=*kaksi mantereista laattaa törmäsivät*). This important shortening phenomena *(=kerrostuminen päällekäin ja poimuttuminen)* led to the superposition of imposing rocky masses which shifted by up to several hundred kilometers to form imposing 'overburden strata' *(=kerrostunut kiviaines tai sedimentti)* with a general northward trend. Within them, the different layers are affected by further shortening phenomena, but maintain a certain uniformity on a regional scale (=*yhdenmukaisuus alueellisella mittakaavalla*) that allows the Alps to be subdivided into various 'paleogeographic-structural domains' *(=Alpit ovat jaettu edelleen pienempiin yksiköihin rakenteen perusteella)*. Proceeding from north to south we have: the Helvetic Domain, on which the Pennine Domain overlaps, in turn underlying the Austroalpine Domain. The first two, which make up a large part of the central-western Alpine sector, consist of rocks originally belonging to the European plate, while the Australpine Domain, which forms the backbone of the central-eastern Alps, consists entirely of 'African' rocks.

THE HIMALAYA

Annapurnas group (left) and Machhapuchchhre (right) of the main ridge of Himalayas (Great Himalaya) seen from the viewpoint near the Pokhara village

About 225 million years ago, India was a large island still situated in the Antarctic Region, and a vast ocean, the Tethys Sea, separated India from the Asian continent. When Pangaea broke apart about 200 million years ago, India began to forge northward *(=liikkui kohti pohjoista)*. In about 30 million years, the continent would have drifted further northwards by another 5,000 km, until the closing of the Tethys Ocean, which separated it from Eurasia, was complete. The oceanic lithosphere (*=mereinen kuori*) would have subducted under the active Eurasian margin, where strong compressions *(=puristus)* would have initiated the folding and uplift of the continental crust *(=mantereisen kuoren poimuttuminen ja kohoaminen)*. The collision would have started about 45 million years ago in a process that is still ongoing today. The northward movement of the Indian continental block is linked to the expansion of the present Indian Ocean.
The main collision phase with Eurasia would have occurred around 10 million years ago. The collision would have resulted in the closing of the ocean and the transformation of the sediments into a mountain range. The result was the fusion of the two continental blocks along a suture line *(=laattaraja)* that largely follows the Indus valley. The Indus suture is also marked by numerous ophiolite (*=ofioliitti*) complexes. Later, the Indian continental margin also became embedded under the Tibetan plateau, which is probably so high due to the doubling of the thickness of the continental crust.

1) Let us compare the Alps and the Himalayas, from the point of view of their formation *(=muodostuminen)* Which type of plate margin would you expect to find fold mountains such these

A. Divergent (constructive) (*=Lähentyvät*)
B. Convergent (oceanic-oceanic) (*=Erkanevat*)
C. Convergent (oceanic-continental)
D. Convergent (continental-continental)

2) the Alps and the Himalayas are then, the result

A. of the collision of two converging margins
B. of the raising of an oceanic ridge
C. of the subduction of one plate under the other
D. of the collision of two diverging margins

3) The beginning of the orogenesis

A. the two mountain chains have the same age
B. the Alps are older
C. the Himalayas are older
D. we don't have enough data

4) As typically in these tectonic areas, we can find in both mountain chains

a. earthquakes
   Y
   N

b. volcans
Y
N
c. faults and folds *(=siirroksia ja poimuja)*
Y
N

5) Which one of the following is a characteristic of this type of margin *(=reuna)*?

A. Normal faults (=normaalisiirros)
B. Transform faults (=sivuttaissiirros)
C. Reverse faults (=käänteissiirros)
D. Covering faults (=mikälie siirrostyyppi)

6) Which one of the following is not associated with this type of margin?

A. Granite emplacement (graniitti-intruusio)
B. Basaltic volcanism *(=basalttinen vulkanismi)*
C. Regional metamorphism *(=alueellinen metamorfoosi)*
D. Overthrust and covering layers *(=ylityöntö ja peittävät kerrokset)*

7) What happens to oceanic lithosphere as it is subducted in this type of margin?

A. The mantle wedge *(=vaipan kiila)* above the subducted oceanic lithosphere melts to form andesitic magma *(=andesiittinen magma)*
B. The subducted oceanic lithosphere increases in thickness
C. The subducted oceanic lithosphere melts to form basaltic magma
D. The subducted oceanic lithosphere disintegrates *(=tuhoutuu täydellisesti)*

8) The prevailing movement *(=vallitseva liikesuunta)* between the two plates that formed the Alps, and the Himalayas is towards

A. N
B. S
C. E
D. W

9) But it is possible to recognize some differences, in the direction of movement and in shape (write the direction using the Cardinal points *(=(pää)ilmansuuntien lyhenteet)*)

A. The main direction in Alps is
B. The main direction in Himalaya is
C. the concavity *(=koveruus)* of the chain curve of Alps is towards
D. the concavity of the chain curve of Himalaya is towards

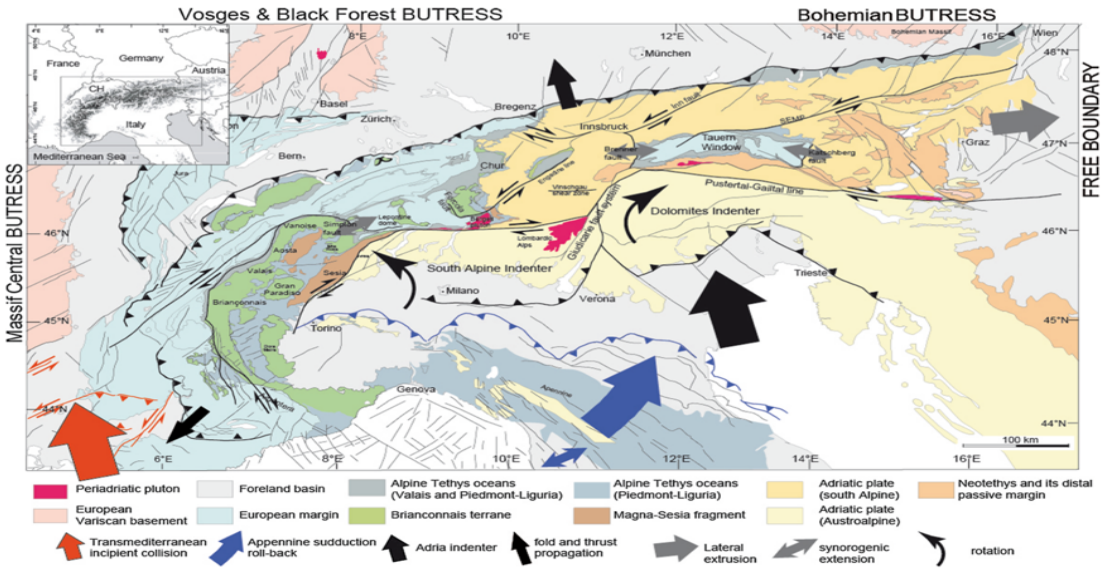
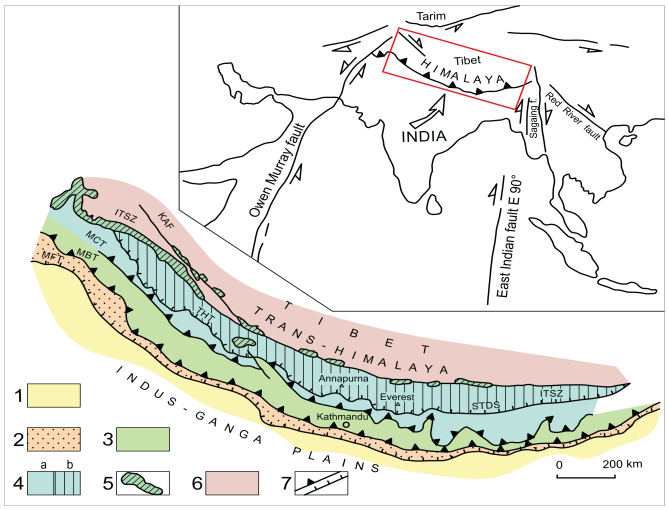


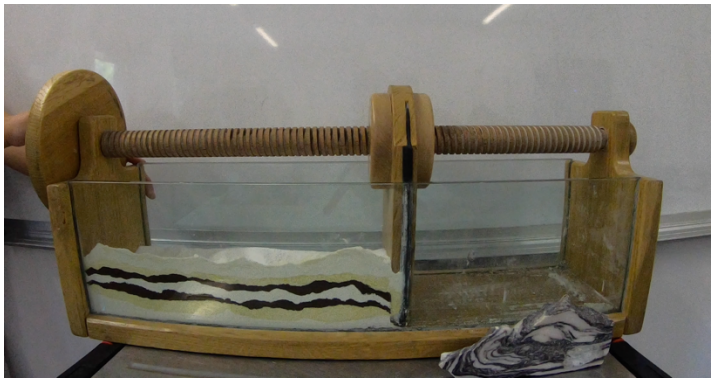
Fig. 1 Tectonic sketch map of the Alps within their geodynamic context (modified after Sue 1998; De Graciansky et al. 2011)



INDIAN PLATE: 1 – Indian plains of Quaternary alluvial deposits covering ancient not mobilized craton; 2–5 – Part of craton mobilized in orogenic accretionary prism: 2 Sub-Himalaya – Miocene-Pleistocene molasse sediments of Siwalik Group; 3 – Lesser Himalaya; 4 – a) Higher Himalaya, b) Tibetan Tethys Z one; 5 – Ophiolites; ASIAN PLATE: 6 – Trans-Himalaya (Tibetan Himalaya); 7 – Prominent thrust boundaries, detachments.

THE VERGENCE

The vergence in an orogenesis is the direction of tectonic movement that a given geological structure (fold, thrust, etc.) generated mainly by a thrust tends to present; vergence is therefore the direction along which anticlinal folds tend to lie and then overturn.

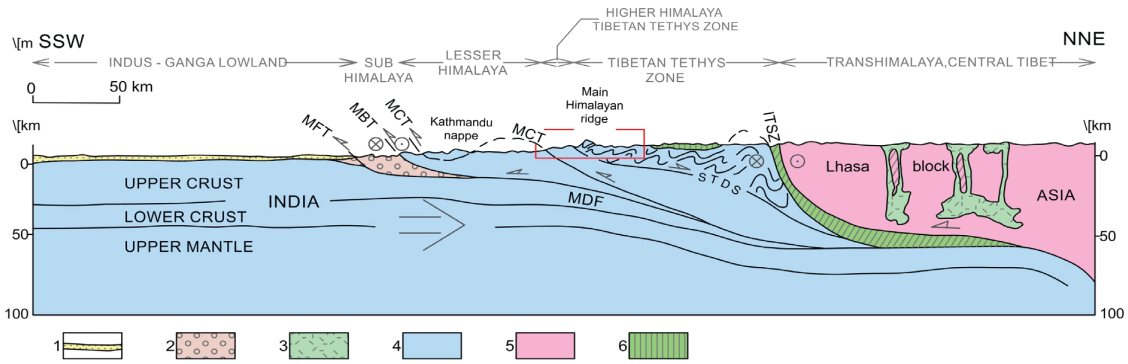


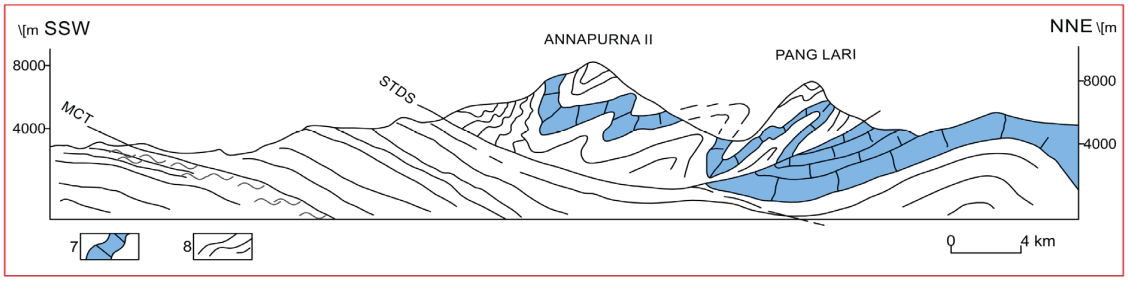
10) Then in this case the vergence is towards

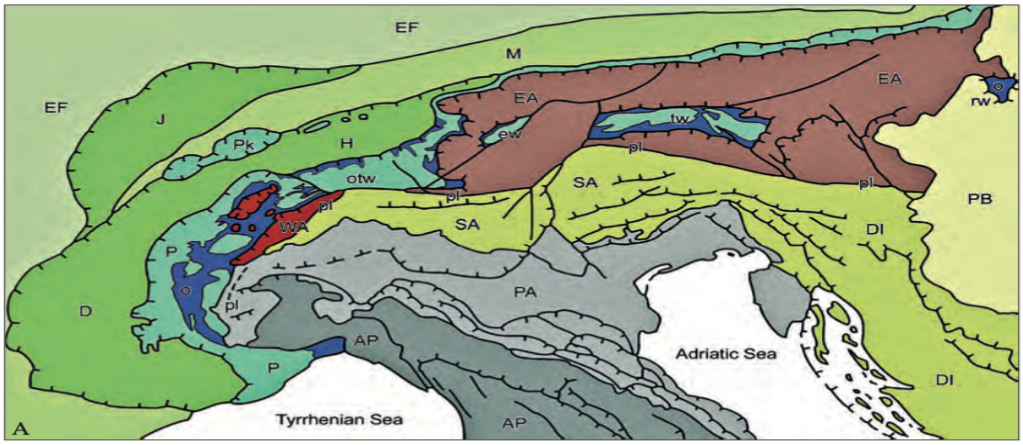
a. Left
b. Right

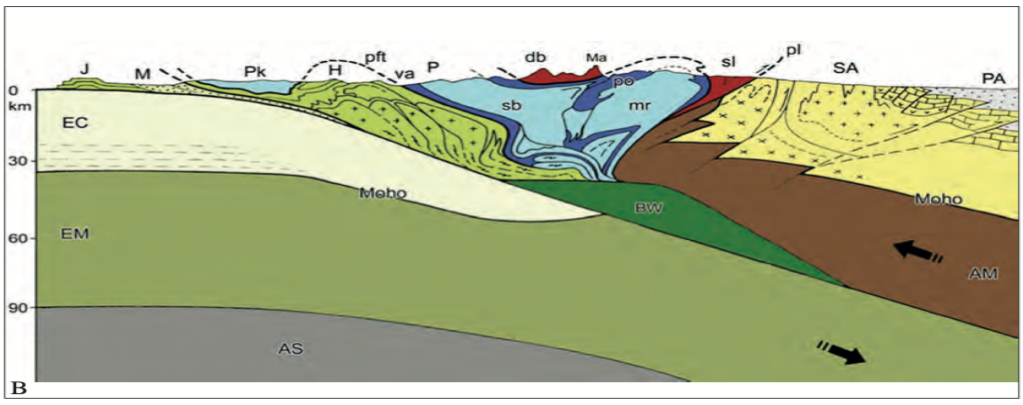
c. While in Himalaya is towards (Write the direction using the cardinal points)

d. And in the Alps is towards (Write the direction using the cardinal points)







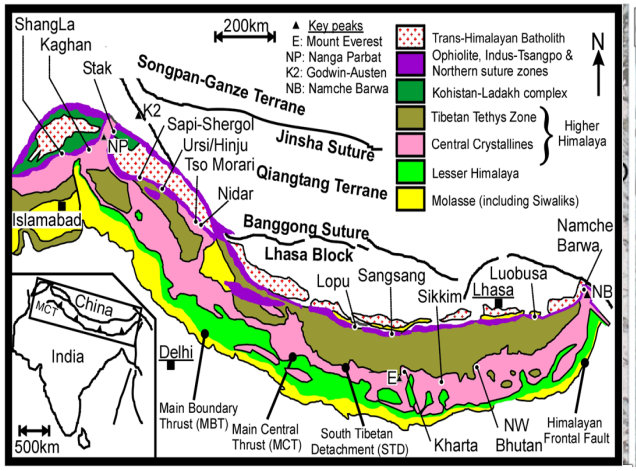


GEOLOGY and PETROGRAPHY

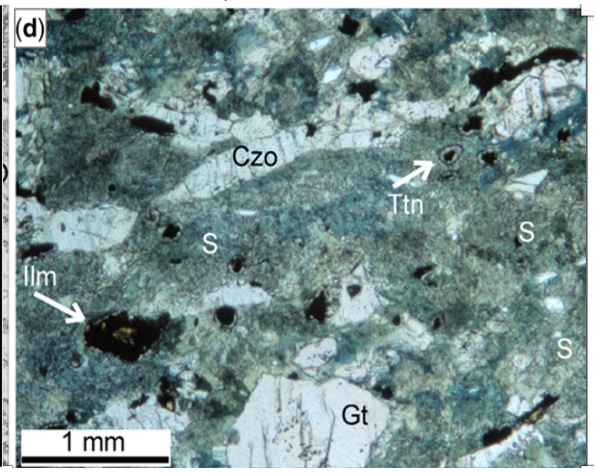
In the **Himalayan orogenesis** the Eurasian plate was partly crumpled up above the Indian plate but due to low density the continental plate could not be subducted, and this caused the continental crust to thicken due to folding and faulting by compressional forces pushing up the Himalaya and the Tibetan Plateau. The thickness of the earth's crust on the border between the Himalayas and Tibet reaches 70 km, or about 30 km more than the adjacent territories *(=viereisillä alueilla)*. The Himalayas as a distinct mountain range is much simpler being the result of giant long lasting continual collision not interrupted by the relaxation extensional periods. The thickening of the continental crust marked the end of volcanic activity in the region as any magma moving upwards would solidify before it could reach the surface.

https://www.youtube.com/watch?v=8dxotQINycE

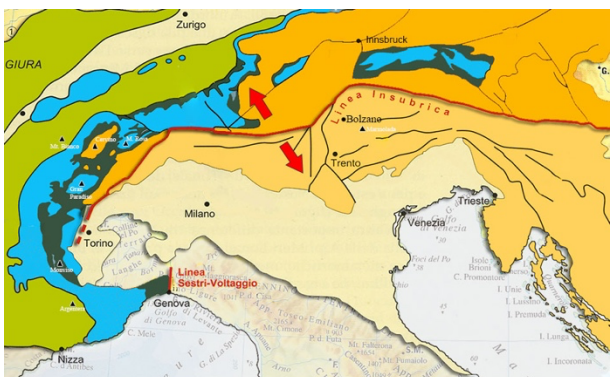
In the **Alpine orogenesis** African lands occupied the highest elevations of this building while the European plate wedged itself under the African one. Between the two continents the oceanic depth, returned to the surface completely transformed by the high pressures and temperatures to which they had been subjected. The frequency and magnitude of earthquakes *(=maanjäristysten yleisyys ja voimakkuus)* in the Alps and the Himalayas depend on the collision rate of the tectonic plates *(=riippuu laattojen törmäysnopeudesta)*. This is because the faster they collide, the cooler the temperatures and the larger the areas that generate earthquakes. This increases the relative number of large earthquakes because the plate collisions in the Alps are more ductile than those in the Himalayas, reducing the hazard of earthquakes

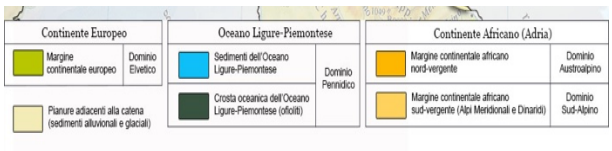


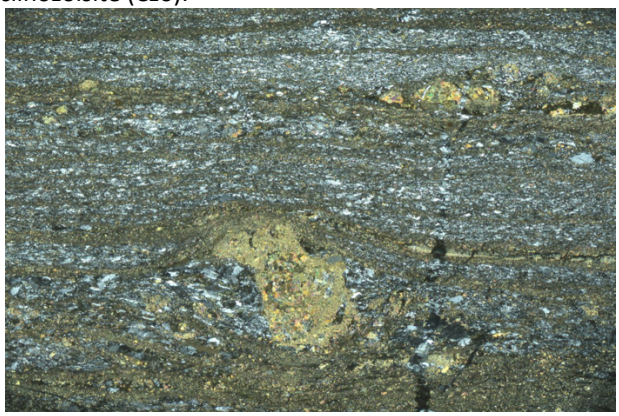
Simplified geology of the Himalaya showing the main subdivisions, and boundaries, that apart from the intrusive granites, are all tectonic



eclogite showing complete replacement of omphacite by diopside, plagioclase and amphibole (S), titanite (Ttn), and ilmenite (Ilm) replacing rutile. Large grains are clinozoisite (Czo).







blue schist, metamorphic rock containing glaucophane, a blue amphibole, formed when the original rocks basalt or peridotite is subjected to large differential stresses, while maintaining a relatively low temperature.

11) Then, Himalaya is characterized by: mark the right answers, more answers are possible)

a. the greater height of the mountains.
b. a more complex structure
c. the presence of a E-W huge fault which may have influenced the morphology and the presence of valleys or the course of rivers.
d. the presence of ophiolites.
e. deep roots reaching the upper mantle
f. the presence of rocks of the highest metamorphic grade due to a higher pressure in the collision.
g. the presence of rocks of a minor metamorphic degree, with well-preserved sedimentary structures and fossils
h. the presence of high pressure and low temperature minerals.
i. the widespread presence of granite magmatic bodies due to higher temperatures reached during orogenesis.
j. strata that in their displacement have also affected the discontinuity of Moho

12) While, Alps are characterized by: (mark the right answers, more answers are possible

a. the greater height of the mountains.
b. a more complex structure
c. the presence of a E-W huge fault which may have influenced the morphology and the presence of valleys or the course of rivers.
d. the presence of ophiolites.
e. deep roots reaching the upper mantle
f. the presence of rocks of the highest metamorphic grade due to a higher pressure in the collision.
g. the presence of rocks of a minor metamorphic degree, with well-preserved sedimentary structures and fossils
h. the presence of high pressure and low temperature minerals.
i. the widespread presence of granite magmatic bodies due to higher temperatures reached during orogenesis.
j. strata that in their displacement have also affected the discontinuity of Moho

This test was carried out with the scientific support and some materials provided by the Himalayan Geological Society, which we thank for the help.