

## PRACTICAL TEST : ROCKS AS EVIDENCE IN THE FORMATION OF THE ALPS

Subduction of the oceanic lithosphere leads to the closure of ocean basin, the approach of two continental domains and their eventual collision. Subduction and collision produce mountain chains such as the Alps. This process of convergence results in modifications due to substantial changes in pressure and temperature. **Let us study these rocks in an attempt to understand past events.**

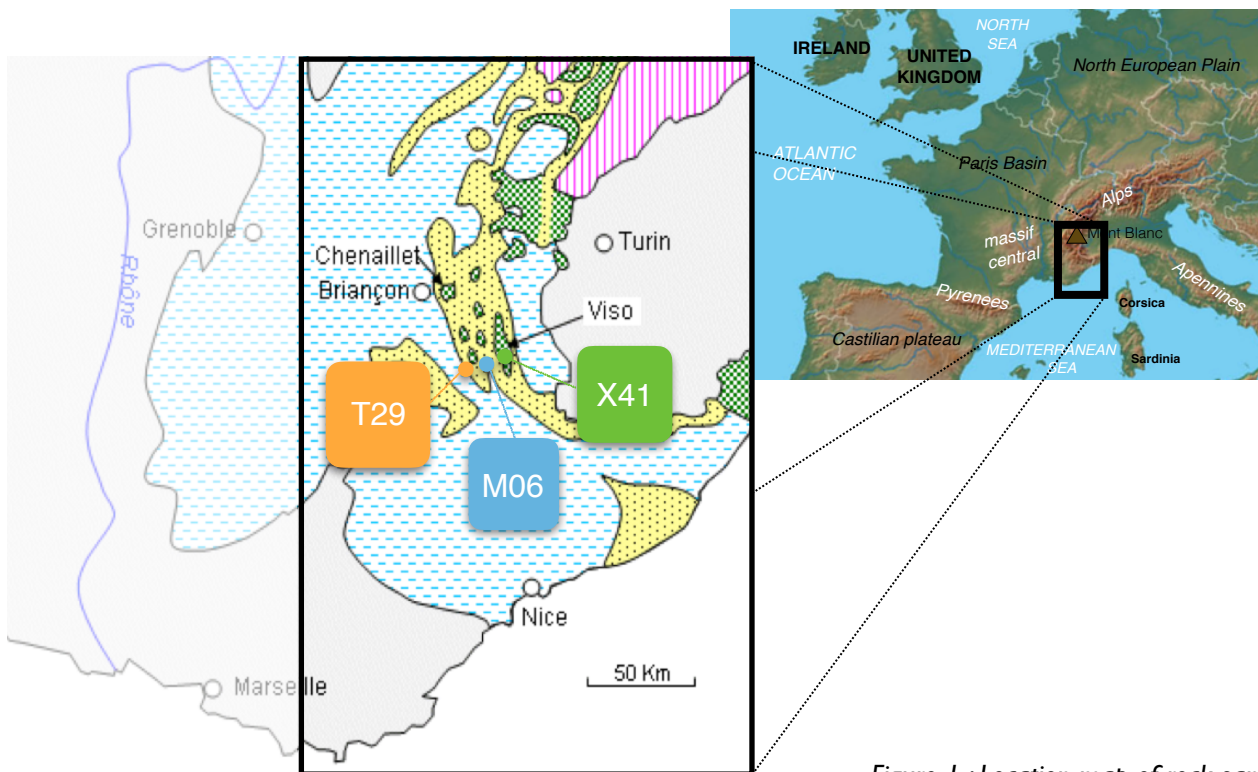


Figure 1 : Location map of rock samples

### PART I : Determining rock sample density.

#### Instructions :

- Familiarize yourself with the material provided.
- Design a method to calculate the density of rock samples.
- Calculate the densities of samples T29 and X41.
- Ask the judge for the density value of sample M06.

Density T29 =	
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Density X41 =	
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Density M06 =	
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**Question 1: The density of sample T29 is... (only one possible answer)**

- 1-  $1.9 \text{ g x cm}^{-3}$       5-  $2.4 \text{ g x cm}^{-3}$   
 2-  $3.9 \text{ g x cm}^{-3}$       6-  $78.4 \text{ g x cm}^{-3}$   
 3-  $15.7 \text{ g x cm}^{-3}$       7-  $5.7 \text{ g x cm}^{-3}$   
 4-  $3.0 \text{ g x cm}^{-3}$       8-  $0.8 \text{ g x cm}^{-3}$

**Question 2: The density of sample X41 is... (only one possible response)**

- 1-  $3.8 \text{ g x cm}^{-3}$       5-  $2.0 \times 10^{-3} \text{ g x cm}^{-3}$   
 2-  $124.7 \text{ g x cm}^{-3}$       6-  $7.4 \text{ g x cm}^{-3}$   
 3-  $3.3 \text{ g x cm}^{-3}$       7-  $9.7 \text{ g x cm}^{-3}$   
 4-  $0.6 \text{ g x cm}^{-3}$       8-  $2.8 \text{ g x cm}^{-3}$

**Question 3 : In general, when a magmatic rock has a density that is higher than another (one answer possible)**

- 1- it is composed of more silicates.  
 2- it has undergone a higher degree of diagenesis.  
 3- it contains a greater proportion of ferromagnesian minerals.  
 4- it has a higher proportion of water.  
 5- it is older.

**PART II : Determining rock water content****Instructions :**

- Familiarize yourself with the material provided (annotated photos, graph paper).
- Complete the table below to determine the percentage of water in the samples.
- Ask the judge for the water content value of sample M06.

Mineral	Group	M <sub>molar</sub> of the mineral g/mol	M <sub>water</sub> contained in one mole of mineral (g)	T29			X41		
				% Observed mineral	% water in the mineral	% in the rock	% Observed mineral	% water in the mineral	% in the rock
Actinolite	Amphibole	488	18						
Augite	Pyroxene	281.7	0						
Chlorite	Mica	559	72						
Glaucophane	Amphibole	796	18						
Grossularite	Garnet	502.5	0						
Hornblende	Amphibole	572	18						
Jadeite	Pyroxene	140.5	0						
Phengite	Mica	472	36						
Plagioclase	Feldspar	341	0						

**Total percentage of water in the samples**

2 of 4

T29

X41

M06

**Question 4 : The water content of sample T29 is approximately :**

- |          |          |
|----------|----------|
| 1- 1.6%  | 5- 56.9% |
| 2- 4.8%  | 6- 3.7%  |
| 3- 32.0% | 7- 2.8 % |
| 4- 0%    | 8- 0.6 % |

**Question 5 : The water content of sample X41 is approximately :**

- |          |          |
|----------|----------|
| 1- 0%    | 5- 6.7%  |
| 2- 4.7%  | 6- 48.9% |
| 3- 7.5%  | 7- 1.6%  |
| 4- 44.0% | 8- 0.9%  |

**Question 6 : If we assume T29 became X41. The differences in the water content of the rocks are explained by... (one answer possible)**

- 1- longer exposure to meteoric water.
- 2- an increase in pressure and a decrease in temperature.
- 3- an increase in temperature and a decrease in pressure.
- 4- an increase in pressure and temperature.
- 5- a decrease in pressure and temperature.
- 6- longer contact with microorganisms that have used the water in rocks.

**Question 7 : Based on your knowledge and the results of your calculations, sample X41 corresponds to... (only one answer possible)**

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| 1- a blueschist facies metagabbro. | 5- an eclogite facies metagabbro. |
| 2- a basalt.                       | 6- a peridotite.                  |
| 3- a blueschist facies granite.    | 7- a diorite.                     |
| 4- an andesite.                    | 8- a blueschist facies limestone. |

**Question 8 : Based on your knowledge and the results of your calculations, sample M06 corresponds to... (only one answer possible)**

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| 1- a blueschist facies metagabbro. | 5- an eclogite facies metagabbro. |
| 2- a basalt.                       | 6- a peridotite.                  |
| 3- a blueschist facies granite.    | 7- a diorite.                     |
| 4- an andesite.                    | 8- a blueschist facies limestone. |

### **PART III : Reconstructing a partial geological history of the Alps.**

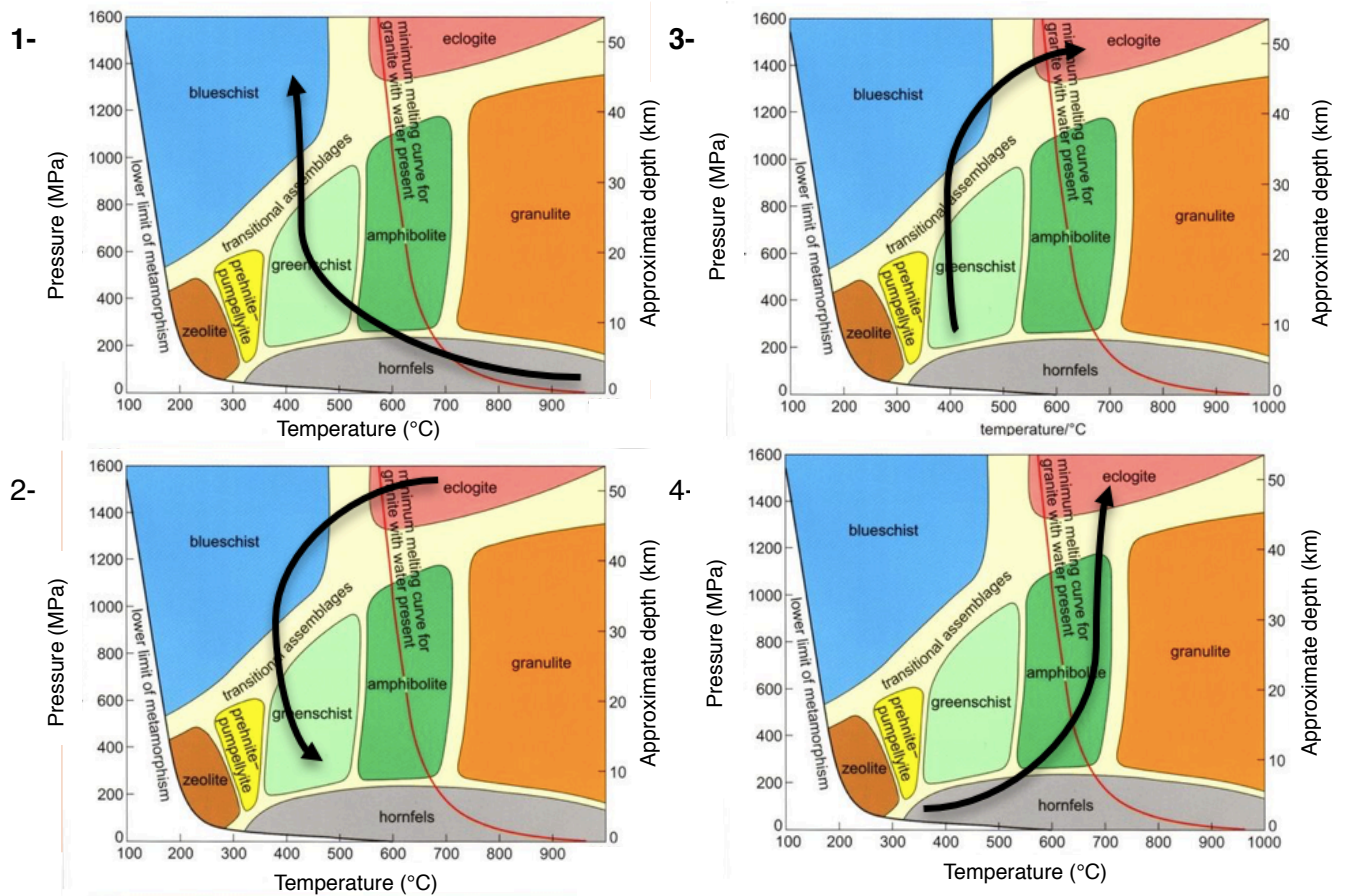
The three rocks T29, M06, and X41 are connected in the same geodynamic context: the subduction of the Alpine Ocean (the Tethys). During this process, these three rocks have undergone transformations leading to changes in their density and their water content.

**Question 9 : The physical and mineralogical transformations observed in the three samples may be referred to as : (only one answer)**

- |                                |                |
|--------------------------------|----------------|
| 1- Crustal anatexis.           | 5- Diagenesis. |
| 2- Fractional crystallisation. | 6- Magmatism.  |
| 3- Metamorphism.               | 7- Tectonism.  |
| 4- Volcanism.                  |                |



**Question 10 : Four possible routes of rock development are given below. Which one best corresponds to your calculations and conclusions ?**



**Question 11 : Considering the figures below, which of the following figure best illustrate ?**

