Stop 01

IESO 2011 – Practical test Geosphere – Mineralogy

Name and surname of the Participant: ________________________________________
Nationality: ______________________________________________________________
Duration time 10 min.

Identification of mineral species
Given five different mineral samples, the candidate is requested to identify each mineral species with the aid of basic chemical/physical tests or macroscopic observations. Each mineral species holds at least one unique feature or character which discriminate it from the others (for example, it is the only one reacting with acids, it is the hardest one, it is the most symmetric one, it is the only one exhibiting metallic luster ...). The tests recommended for the identification are: (i) reactivity to hydrochloric acid attack; (ii) determination of the relative Mohs hardness; (iii) crystal habit indicative of the crystal symmetry; (iv) metallic luster.

The candidate should associate the code number (from 1 to 5) of the mineral sample to the mineral name. (2 points for each right answer)

- calcite
- quartz
- fluorite
- hematite
- sulphur
1) Connect the fossil names with the corresponding figure.

1) AMMONITE

2) BELEMNITE

3) CORAL (SCLERACTINIAN)

4) CRINOID

5) GASTROPOD

6) RUDIST

1 - __
2 - __
3 - __
4 - __
5 - __
6 - __

(0.2 pt for each right answer)
2) Inside the squares A and B there are two of the fossils illustrated above. Write the name of the fossils:

A) ________________________ (1 pt)

B) ________________________ (1 pt)

3) The geological feature labelled on the stone as C is a: (0.8 pt)

a) cross bedding  

b) flute cast  

c) ripple mark  

d) stylolite
STOP 3, 20’ Put a cross above the letter of the right column (5 pt) Name____________________
Country _____________

Which one of the stratigraphic columns does correctly illustrate the core?

A

B

C

D

Main lithology

- Soil
- Sand
- Gravel
- Sparse plants
- Animal and plant fragments
STOP 4, 20’ Name ___________________________ Country __________

Cathedral, northern side

Identify the stones in the boxed wall portion using the given samples for comparison: fill the slab contour with the appropriate color.
Roman Lapidary Museum (Lapidario Romano, Museo Civico Archeologico Etnologico) (1pt for each right answer)

Identify the stones of the following Roman monuments using the given samples for comparison: write the stone letter into the appropriate monument box.

<table>
<thead>
<tr>
<th>Stone samples</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Limestone (biocalcarenite)</td>
<td></td>
</tr>
<tr>
<td>B) Brecciated marble (“arabesque”)</td>
<td></td>
</tr>
<tr>
<td>C) Foliated marble</td>
<td></td>
</tr>
<tr>
<td>D) Limestone (biocalcarenite-biocalcirudite)</td>
<td></td>
</tr>
<tr>
<td>E) Limestone (rudist mudstone)</td>
<td></td>
</tr>
</tbody>
</table>

N. 9: Altar (ara) of Marcus Numisius Castor

N. 10 Altar (no inscription)
N. 11 Altar of Publius Clodius

N. 19 Stele of Caius Fadius Amphio

N. 29 Lion
STOP 6, 15’ Name ______________________________ Country _________________

QUESTION 1
What is the attitude (strike, dip direction, angle of dip at clockwise measurement) of the exposed surface A: (3pt)

1. 110° - 20° - 65°
2. 340° - 250° - 65°
3. 20° - 110° - 25°
4. 170° - 80° - 25°
5. 250° - 340° - 25°
6. 110° - 20° - 65°
7. 200° - 290° - 65°
8. 20° - 110° - 65°
9. 110° - 200° - 25°
10. 200° - 290° - 25°

QUESTION 2
On the surfaces (A, B, C, D) what geological features can you identify (one or more answers may be correct): (0,5 points for each right answer)

1. wave ripple marks
2. groove casts
3. flute casts
4. tectonic lineation
5. stylolites
6. fossil traces
7. tool marks
8. fossil shells
Important note:

It's possible to assume that the litological formation in the Slovenian side of the hydrographic basin of river Isonzo (called Soca in Slovenia) are the same found in the Italian side.

Quaternary covers

26
25
24
23

Cenozoic sequence
19 b: sandstone and shale

19 a: sandstone, breccias and shale

18: limestone

_Mesozoic sequence_

17 c: limestone

16 c: limestone

16 b: limestone

15 a: limestone
14: limestone

13 c: dolomite rock

13 a: dolomite rock

12 c: dolomite rock and limestone

9: dolomite rock and limestone
Stop 8, 15’
Name_________________ Country____________

In this test you are expected to recognize the minerals of the rock, estimate their abundance and classify the rock based on the Streikseisen diagram.
Fill all tables and Streikseisen plot. Report the name of the rock.

Characters of the rock forming minerals (not all are present in the rock):

**Plagioclase:** White milky appearance, anhedral to subhedral (elongate prismatic habit), sometimes twinning and cleavage detectable.

**Quartz:** Colourless to greyish, is the most transparent, often anhedral interstitial, conchoidal fractures, no cleavage.

**Biotite:** Black-dark brown, vitreous lustre, thin cleavage system, hexagonal euhedral sections are in general subequant..

**Pyroxene:** Black, prismatic elongated, cleavage parallel to the elongation.

**Olivine:** Green, dark green, prismatic subequant, no cleavage.

**Oxides:** Equant, fine grained, black metallic lustre.

**Tourmaline:** Strongly elongated to acicular habit, light brown to greenish.

**K-Feldspar:** Orange to reddish, forms large crystals, anhedral to subhedral, sometimes twinning and cleavage detectable.

In the following table select the minerals you recognize on the selected areas of the pillar, then indicate the amount of each phase. Minerals not recognized must be indicated as 0%. To evaluate the amount of each mineral phase use the reference grids in the next page. Note that indicating the amount of minor phases as <10% means total is not expected to be 100%.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>&lt;10%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourmaline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-Feldspar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In order to define the rock you must recalculate the relative amount of Q, A and P

<table>
<thead>
<tr>
<th></th>
<th>Estimated value</th>
<th>Recalc to 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q (Quartz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (K-feldspar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P (Plagioclase)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum Q+A+P</td>
<td></td>
<td>Sum =100</td>
</tr>
</tbody>
</table>

Reference grids
Plot in Q-A-P by colouring the composition; 
You can use the triangular plot aside to help in finding the correct position

The observed rock is: ________________________________

Score:
Plot in the right field: 4 points
Plot in the fields adjacent to the correct one: 1 points
STOP 9, 20’ Records from the past
- Instruction sheet -

Background information
To help to make climate forecasts for the future, it is useful to study past climate. The field of science which aims to gain better insight into past climate on Earth and the mechanisms that are causing climate change is called palaeoclimatology.

The floors of oceans and lakes are covered with various layers of mud-like sediments, which contain fossils. One type of fossil from lake or ocean sediments that is often used by palaeoclimatologists is diatoms. Each kind of diatom has a different shape of its skeleton. This difference is used to identify the various fossil types of diatom.

In addition to this, every species grows optimally under a certain temperature called the optimal temperature (To), so the presence of a certain species can provide some clues about the climate at the time when the individuals were still alive.

Scientists can determine the temperature at the time of formation, which is called the balanced average temperature (Tm), by applying the following formula:

\[
T_m = \frac{\sum (n_j \times T_{j,0})}{\sum n_j}
\]

where:
- \(T_m\) is the balanced average temperature (°C)
- \(n_j\) is the number of diatoms of a specific type
- \(T_{j,0}\) is the optimal temperature of the specific type of diatom (°C)

Aim
Reconstructing a climate history by analyzing the types of diatoms from a sediment core.

Materials
10 Petri dishes that correspond to sediment samples from different parts of a sediment core. The depth and age are indicated on each Petri dish. (BP years = years Before Present)

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Age (BP years)</th>
<th>Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>3000</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>4000</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>5000</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>6000</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>7000</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>8000</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>9000</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>10000</td>
<td>50</td>
</tr>
</tbody>
</table>

Each Petri dish contains 12 pink, green, yellow and purple beads. Each color represents a specific type of diatom that survives best in certain temperatures (= optimal temperature, To).

<table>
<thead>
<tr>
<th>Type of diatom</th>
<th>To (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pink</td>
<td>20</td>
</tr>
<tr>
<td>yellow</td>
<td>15</td>
</tr>
<tr>
<td>green</td>
<td>10</td>
</tr>
<tr>
<td>purple</td>
<td>5</td>
</tr>
</tbody>
</table>

Procedure
1. Color the attached diagram (on the worksheet) according to the diatom composition found in each Petri dish. Count the amount of beads of each color found in each Petri dish and color the circles accordingly. From the bottom (horizontal axis) to the top of each column of circles, color first the pink ones, then the yellow ones, the green ones, and the purple ones.
2. Draw a line above the top set of pink dots; this will give you a line with the age on the X-axis and the number of diatoms per type on the Y-axis.
3. Calculate the balanced average temperature (Tm) for depths at 1000 years BP, 4000 years BP and 7000 years BP. Fill the “Table of the Tm values” and answer the question according to the instructions provided.

This activity has been adapted for IESO2011 from the original version titled “Experiment from the Past” published by International Polar Foundation http://www.educapoles.org/
Records from the past (2,4pt)

− Worksheet, Diagram −

<table>
<thead>
<tr>
<th>Age (years BP)</th>
<th>( n_{pink} \times T_{0, pink} )</th>
<th>( n_{yellow} \times T_{0, yellow} )</th>
<th>( n_{green} \times T_{0, green} )</th>
<th>( n_{purple} \times T_{0, purple} )</th>
<th>( n_{total} )</th>
<th>( T_m (°C) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
T_m = \frac{(n_{s1} \times T_{a,s1}) + (n_{s2} \times T_{a,s2}) + (n_{s3} \times T_{a,s3}) + (n_{s4} \times T_{a,s4})}{n_{s1} + n_{s2} + n_{s3} + n_{s4}}
\]

\( T_m \) = balanced average temperature (°C)

\( Sn \) = type of diatom

\( T_{a, Sn} \) = optimal temperature of the type of diatom (°C)

\( n_{Sn} \) = amount of diatoms of a certain type

This activity has been adapted for IESO2011 from the original version titled “Experiment from the Past” published by International Polar Foundation [http://www.educapoles.org/](http://www.educapoles.org/)
### Analysis of the results

**Question 1 (0.6pt)**  
Put the 3 time periods listed in the table above in the following ordinated list from the coldest (1) to the warmest (3)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (coldest)</td>
<td>=</td>
<td>time period___________ Age (years BP)</td>
</tr>
<tr>
<td>2</td>
<td>=</td>
<td>time period___________ Age (years BP)</td>
</tr>
<tr>
<td>3 (warmest)</td>
<td>=</td>
<td>time period___________ Age (years BP)</td>
</tr>
</tbody>
</table>

**Question 2 (1.5pt)**  
The curves for the two warm periods show exactly the same maximum in terms of number of “pink diatoms” while the balanced average temperature (Tm) for these periods differ, how can you explain that? (mark one correct answer)

- a) The most recent warm period has more “purple diatoms”
- b) The Tm takes into account the relative composition of diatoms present in each sample
- c) The Tm takes into account the age of each samples
- d) The optimal temperature of the “pink diatoms” changes according to the ages

This activity has been adapted for IESO2011 from the original version titled “Experiment from the Past” published by International Polar Foundation [http://www.educapoles.org/](http://www.educapoles.org/)
STOP 10 15’
Practical activity - Remote Sensing
Processing and analysis of digital satellite imagery

Instructions

- Download the data (Landsat satellite imagery of Venice)
- Generate computerised colour images in
  o True colour
  o False colour
- Answer the questions

1) Data Download

Download all files from http://download.terra.unimore.it/ieso/ and save them on the Desktop (double clicking on every file)

2) Open the satellite imagery

a) Start the LEOWorks3.0 programme (clicking on the Windows Start button)

b) Open the following files and press OK on the Image Preview window (cf. Fig.1):

- Venice_Band_1.tif (channel 1, blue)
- Venice_Band_2.tif (channel 2, green)
- Venice_Band_3.tif (channel 3, red)
- Venice_Band_4.tif (channel 4, near infrared NIR)
- Venice_Band_5.tif (channel 5, short wavelength infrared SWIR)
- Venice_Band_7.tif (channel 7, short wavelength infrared SWIR)

3) True-colour combination of spectral bands: generate a real colour image

- In the Menu bar click on: Image -> Combine from... -> [Red Green Blue], a new window called Combine RGB appears (cf. Fig.2)

- On the three input windows select the bands:
  a) for red (Select Red Band) select Venice_Band_3.
  b) for green (Select Green Band) select Venice_Band_2
  c) for blue (Select Blue Band) select Venice_Band_1.
• Clicking **OK** the combined true-colour image appears.
  Keep it open in order to compare it with the next results.

4) **False-colour combination: generate an infrared false colour image**

• Repeat the steps of point 3) choosing now the following association of spectral bands (cf. Fig.3):
  a) for red select *Venice_Band_4*,
  b) for green select *Venice_Band_3*
  c) for blue select *Venice_Band_2*.

• Clicking on **OK** you obtain now an infrared false colour image of Venice.
  Keep it open in order to compare it with the next results.

5) **Try another combination: generate a different false colour image using other spectral bands (754)**

• Repeat the steps of point 3) choosing now this association of spectral bands (cf. Fig.4):
  a) for red select *Venice_Band_7*,
  b) for green select *Venice_Band_5*
  c) for blue select *Venice_Band_4*.

• Clicking on **OK** you obtain now a different false colour image of Venice.

You have now created three different combined images of the same subject. Observe and compare them in order to answer the following questions.
Questions
Only one answer per question is correct, mark the right one. Every right answer corresponds to 0.35 points. 15’

The LANDSAT system constitutes the longest continuous record of the Earth surface

1) The Landsat satellite is  
   a) polar  
   b) geostationary

2) Landsat is used  
   a) for weather applications  
   b) land use  
   c) to constantly monitor a localised region on the Earth surface  
   d) none of them

The geometrical resolution of an image is the size of the pixels in meters.

3) Given that the Landsat images cover an area of 20 km × 20 km and that there are 500×500 pixels in the image, which is its resolution?  
   a) 20  
   b) 40  
   c) 400  
   d) no answer is correct

In this practical activity you used different spectral bands, every single image reflects a part of the electromagnetic spectrum

4) Which of the following bands are outside the visible spectrum?  
   a) red  
   b) red and NIR  
   c) near and middle infrared  
   d) green and blue

The combined images are, respectively, true- and false-colour combinations of the three visible channels red, green, blue, or further spectral channels of a Landsat scene.

5) False-colour images are used to  
   a) increase the interpretability of satellite images  
   b) provide visually impaired people a mean for detecting the same features in land use

Comparing the combined images obtained from steps 3), 4), 5) in the Instruction sheet:

6) The colours of the different features of the soil depend on the bands selected for the combination, because every object has its own radiation characteristics  
   a) true;  
   b) false

7) Which channel is best suited to give information regarding vegetation?  
   a) green  
   b) infrared  
   c) red  
   d) none of them

8) The infrared range is very useful for interpreting the Earth’s surface because  
   a) it consists of reflected and emitted energy  
   b) it gives information about the vitality/health status of the vegetation  
   c) none of them  
   d) both of them

Referring to the image obtained combining the spectral bands 7, 5, 4:

9) For which application is this combination useful?  
   a) to detect coast lines and shores that are well defined due to this combination  
   b) to find textural and moisture characteristics of soils  
   c) both of them  
   d) none of them

10) In combined image 754, vegetation appears to be  
   a) red
b) green
c) blue