| **Orientation Compass with solid fill** | **QR audio** |
| --- | --- |

Through the preceding activities, some questions arose regarding the Museum's clay lamp.

1. What was the (social) position of craftsmen in Byzantium? Can we investigate the components of the clay lamp used during the second half of the 4th century AD?

2. Have these products been exported and to where? Can we find similar products in Portugal, Cyprus or elsewhere? Can we trace their route during the Byzantine Empire?

3. Can we compare it with clay products made today? Are there commonalities/differences?

4. Can we make assumptions about the use of these clay products? What tests can we do?

*Discuss the above questions as a whole class*

**How can we answer these questions?**

**Record the results of the discussion**

| ***Students record (video or sound) the results of the discussion, concluding with the following:***  **To answer the above questions, we should:**  **● Zoom in on the object to see details**  **● Identify the ingredients from which it is made**  **● Identify ingredients from any residues inside the clay lamp**  **● Identify components that are an indication of maintenance** |
| --- |

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “1.a Problem and Solutions”* | *QR audio* |
| --- | --- |

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**How can we see item details?**

*Write down or draw* instruments or devices *we can use*

*to see details of an item*

| Devices / Instruments | Selection |
| --- | --- |
| **Magnifying glass** |  |
| **Binoculars** |  |
| **Telescope** |  |
| **Optical microscope** |  |
| **Close up view** |  |
|  |  |
|  |  |

| ***The students fill in their ideas above or design the above devices/instruments in this space.*** |
| --- |

*Discuss as a whole class about the device or the instrument that can give us the best results and choose it from the table above.*

***Through the discussion we come to the optical microscope.***

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “1.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | |

Use your mobile devices (tablets, mobiles, etc.) and scan the image below.

Watch the video and download the results provided by the device you selected for the clay lamp by pressing the "**Results**" button.

****

***Discuss with the whole class the results of this particular device***

* In the first area of interest, in the middle of the clay pot, what do you notice? What does clay look like under the Optical Microscope?





*Image 1 Image 2 Image 3*

***The discussion with the students concludes that with the Optical Microscope we can locate areas of interest, such as the area in the middle of the clay lamp (Image 1) in order to observe how the material looks magnified (Image 2). By further enlarging the sample (Image 3) we observe grains of various colors, i.e. various materials present in the clay from which the clay lamp is made.***

* In the second area of interest, inside the clay lamp, what do you notice? What does higher magnification reveal? Are there foreign substances? How would you describe them?



*Image 4 Image 5 Image 6*

***Another point of interest is the interior of the clay lamp on its rim (Image 4). Zooming in on the area of interest, inside the clay lamp (Image 5), we observe residues and take a sample to study. With higher magnification (Image 6) we observe grains of various sizes.***

| *Discuss and record what the device is doing with a short video or audio recording.*  *Why do we use it and what results does it give us?*  *Call it “1.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

* **Why do we see three different images for the same point of interest?**

**Can you sort them from smallest to largest magnification?**

*Write down your observations or draw the pictures below with arrows for the points of special interest.*

**The three images give us an increasingly larger magnification of the same point.**

**The higher the magnification, the greater the detail we can observe.**

* **What conclusions can we draw from the two different areas of interest?**

What did you notice about the morphology of the clay in the clay lamp?

Are there any foreign substance residues inside the clay lamp? What do you think might be?

(Image 5).

***Write down your observations or draw the pictures below with arrows for the points of special interest.***

**From the images we took from the Optical Microscope we observe grains of various colors and inside the clay lamp there seem to be residues of some other substance.**

**So it is interesting to get more information about these areas.**

| *Record your answers*  *in two different short videos or sound recordings.*  *Call them “1.d Conclusion A”, “1.d Conclusion B”* | *QR audio* |
| --- | --- |

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**What do we need to do to get more information**

**about the points of interest?**

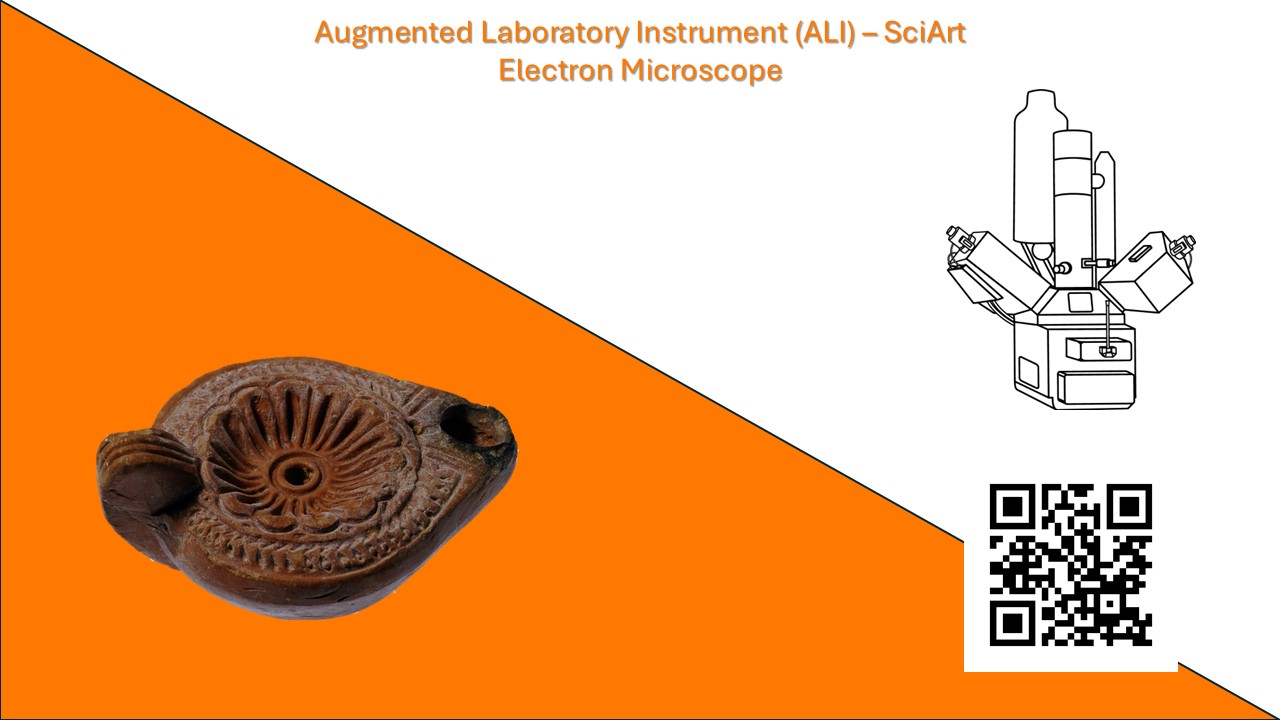
***A discussion is provoked in the whole class where students are asked to focus on the need for further magnification.***

***The teacher introduces the Electronic Microscope as a solution for extra magnification.***

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “2.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

Use your mobile devices (tablets, mobiles, etc.) and scan the image below.

Watch the video and download the results provided by the device for the clay pot by pressing the "**Results**" button.

****

***Discuss with the whole class the results of this particular device***

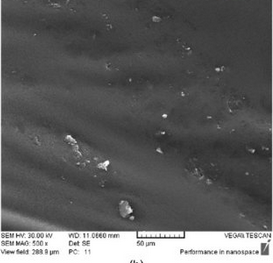
* In the first area of interest, from the sample we took from the middle of the clay lamp, what do you notice? How would you describe the clay as seen by SEM? Is it uniform or are there various formations? Are the formations the same or different in size?



***In the image 7 of the clay lamp's middle, we get from the SEM, we observe various formations in shades of gray, which means that we have different materials.***

*Image 7*

* In the second area of interest, from the sample we took from the residues inside the clay lamp, what do you notice in the SEM image? How would you describe it? SEM results detect what is the round formations you observed?

***The SEM image on the left shows the grains from the residues / debris we took from the inside of the clay lamp's rim. From their morphological characteristics, no conclusion can be drawn as to what these formations might be (if it is, for example, an foreign / unknown substance).*** 

*Image 8*

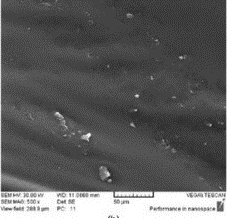
| *Describe how the device works and for what purpose we use it*  *with a short video or audio recording.*  *Call it “2.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

* **Of the two different areas of interest depicted with the SEM method, which one do you think has the highest magnification? How can we find it?**

**Image 2 has a higher magnification at 500x. We can directly read the magnification from the information given at the bottom of the image.**

***Both images are at 200x (Image 9) and 500x (Image 10) magnification. We can read the magnification from the information given at the bottom of the image.***







*Image 9 Image 10*

* **Why do we see black and white images?**

**We get black and white images because SEM does not use natural light but electrons.**

***We help the students to reach the above conclusion, also referring to the information in the video.***

* **What do we notice in the images? What might they mean for our subject?**

**Can we draw conclusions about the ingredients in the points of interest (clay and substance residues inside it)?**

**✔ No matter how large the magnification of the object is, it cannot give us clear answers about the components that make up the clay and the formations that are an indication of the existence of a foreign substance inside the clay lamp.**

**✔ So we select the points of interest identified by the SEM method to find the components that make up the clay and the foreign substance inside the glass, with a new method, the EDS.**

| *Record your answers*  *in three different short videos or sound recordings.*  *Name them "2.d Conclusion A", "2.d Conclusion B",*  *"2.d Conclusion C”* | *QR audio* |
| --- | --- |

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**What do we need to do to find the ingredients**

**of the areas of interest of the subject we are studying?**

**What should we recognize?**

***A discussion in the whole class is provoked which leads to the identification of the elements from which the materials in the areas of interest are produced (clay in the middle of the clay lamp and foreign matter inside the clay lamp).***

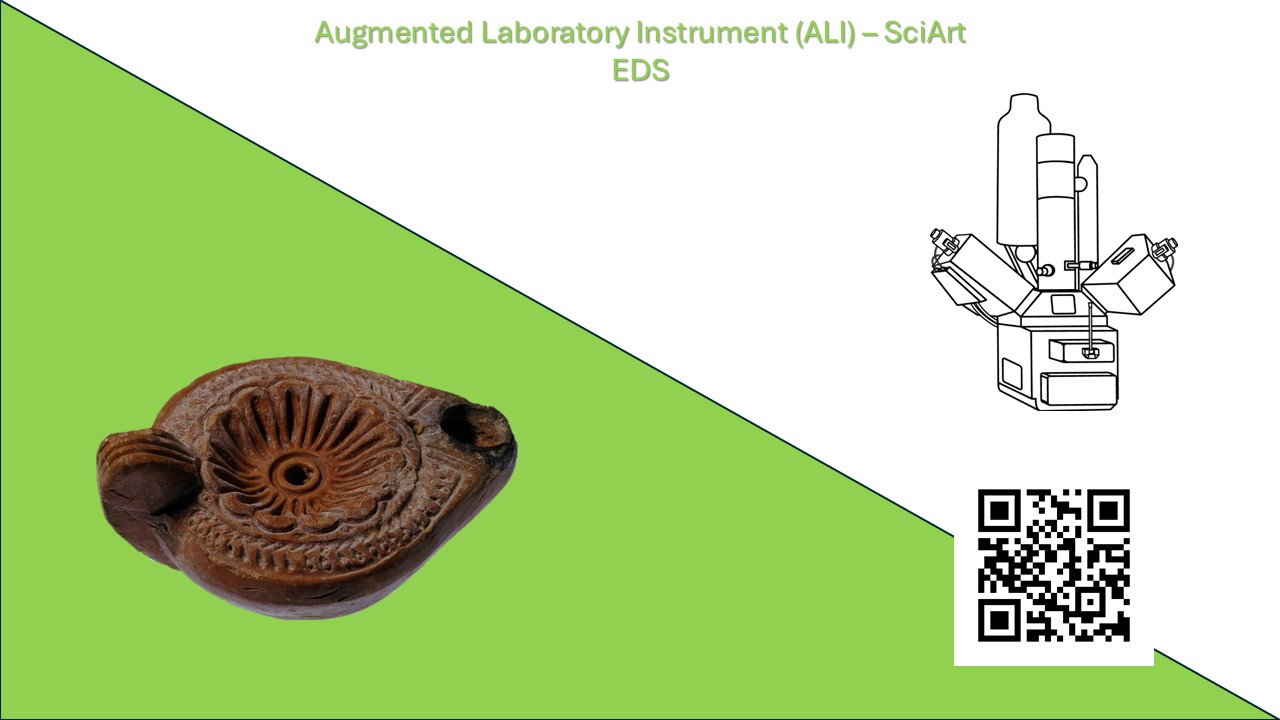
***The teacher introduces the EDS method for the elemental analysis of the selected areas. EDS is an analytical method used to identify the elements found in a sample.***

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “3.b Conceptualization”* | *QR audio* |
| --- | --- |

| **Investigation Research with solid fill** | **QR audio** |
| --- | --- |

Use your mobile devices (tablets, mobiles, etc.) and scan the image below.

Watch the video and download the results provided by the device for the clay lamp by pressing the "Results" button.

****

***Study in your group and then discuss as a whole class***

***the results of the particular method***

***Students look at the EDS spectrum and the table of elements and identify the elements that make up the sample.***

***The teacher explains to the students that the EDS spectrum is obtained only by selecting points or regions of interest from the SEM images and asks the students to identify the elements found in the spectrum by the EDS method.***

* In the first region of interest, from the sample we took from the clay in the middle of the clay lamp, what do you notice in the EDS spectrum? What elements are detected?



***This is the spectrum we get from the EDS method for the clay. It mainly consists of carbon (10%), oxygen (30%), silicon (12%), aluminum (3%), iron (4%), calcium (1%), sodium (1%), magnesium (1%) and titanium (1%).***

*Image 11*

* In the second area of interest, from the sample we took from the residues inside the lamp, what do you observe in the EDS spectrum? What elements does the foreign substance consist of?



***This is the spectrum we get from the EDS method for the unknown substance found inside the lamp. It consists of carbon and oxygen, which is a typical feature of substances of organic origin.***

*Image 12*

| *Discuss and document how the method works*  *with a short video or audio recording.*  *What results did it give us?*  *What else did we have to do?*  *Call it “3.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

* **In the first area of interest, what conclusions do you draw about clay from the results you obtained? What elements does it consist of?**

**It mainly consists of carbon (10%), oxygen (30%), silicon (12%), aluminum (3%), iron (4%), calcium (1%), sodium (1%), magnesium (1%) and titanium (1%)**

* **In the second area of interest, inside the clay lamp, what kind of substance was found?**

**It is an organic substance since carbon and oxygen were found, which are found in organic substances.**

| *Record your answers*  *in a short video or sound recording.*  *Explain how you got there.*  *Call them "3.d Conclusion"* | *QR audio* |
| --- | --- |

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**What do we need to do to get more information about the points of interest?**

**Can we use the FTIR method to see what additional information it can give us?**

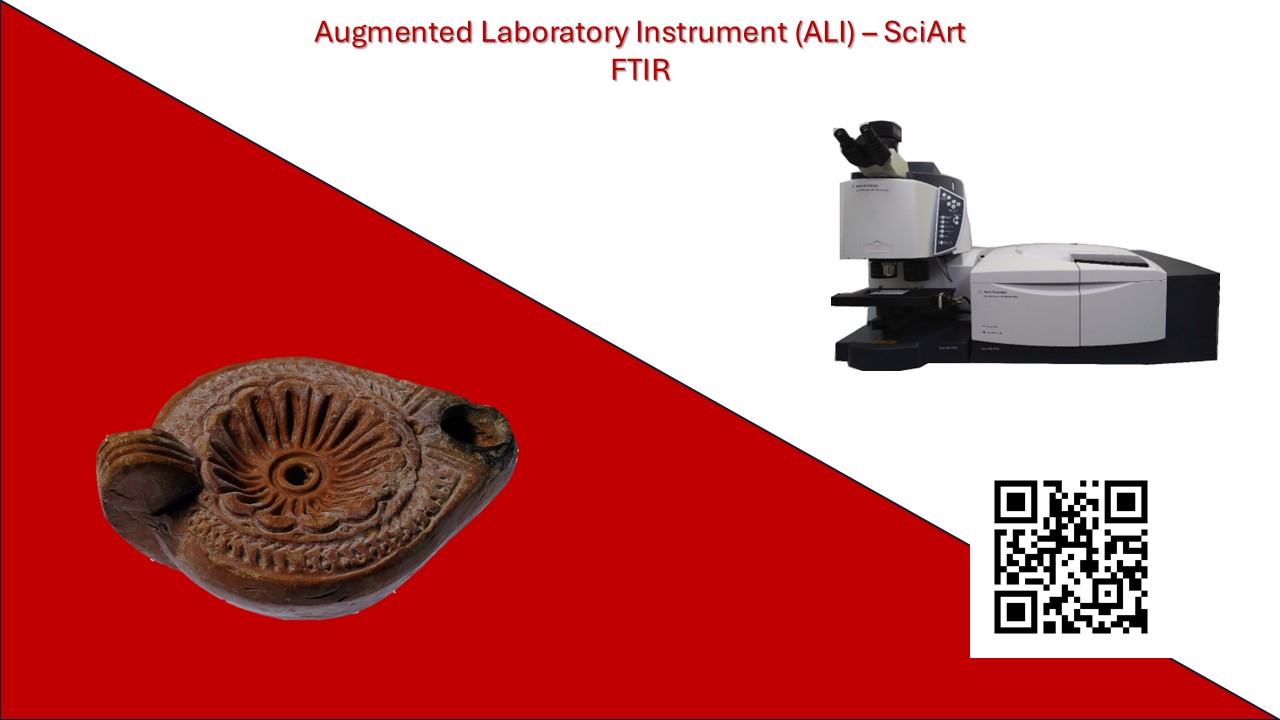
***A discussion is provoked in the whole class where we direct the students to focus on the need for further investigation with the FTIR method.***

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “4.b Conceptualization”* | *QR audio* |
| --- | --- |

| **Investigation Research with solid fill** | **QR audio** |
| --- | --- |

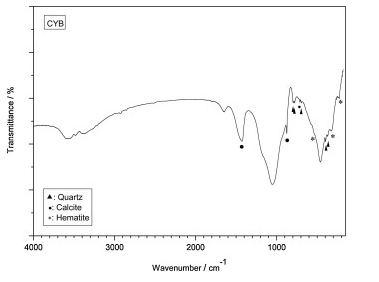
Use your mobile devices (tablets, mobiles, etc.) and scan the image below.

Watch the video and download the results provided by the device for the clay lamp by pressing the "Results" button.

****

***Discuss in the whole class the results of this particular method***

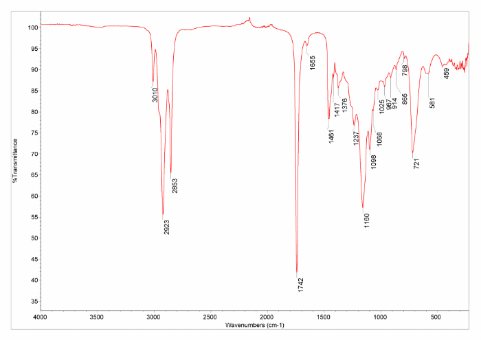
* In the first area of interest, what information do we get from the FTIR spectrum about the material of the clay lamp?



***The FTIR method gives us the information that it is ceramic.***

*Image 13*

* In the second area of interest, what is the foreign substance detected by the FTIR method inside the clay lamp?



***The FTIR method gives a spectrum with inverted peaks for the foreign substance inside the lamp indicating that the foreign substance is oil.***

*Image 14*

| *Discuss and record how the FTIR method works*  *with a short video or sound recording.*  *What results did it give us?*  *Call it “4.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion** **Thought outline** | **QR audio** |
| --- | --- |

* **Can you summarize the results of the FTIR method in the table below for the two points of interest?**

| **Points of interest** | **Material – Substance** |
| --- | --- |
| Oil clay lamp | **Ceramic** |
| Foreign substance residue inside the clay lamp | **Oil** |

| *Record your answers*  *in a short video or sound recording.*  *Explain how you got there.*  *Name them “4.d Conclusion”* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | | |

*Discuss as a whole class.*

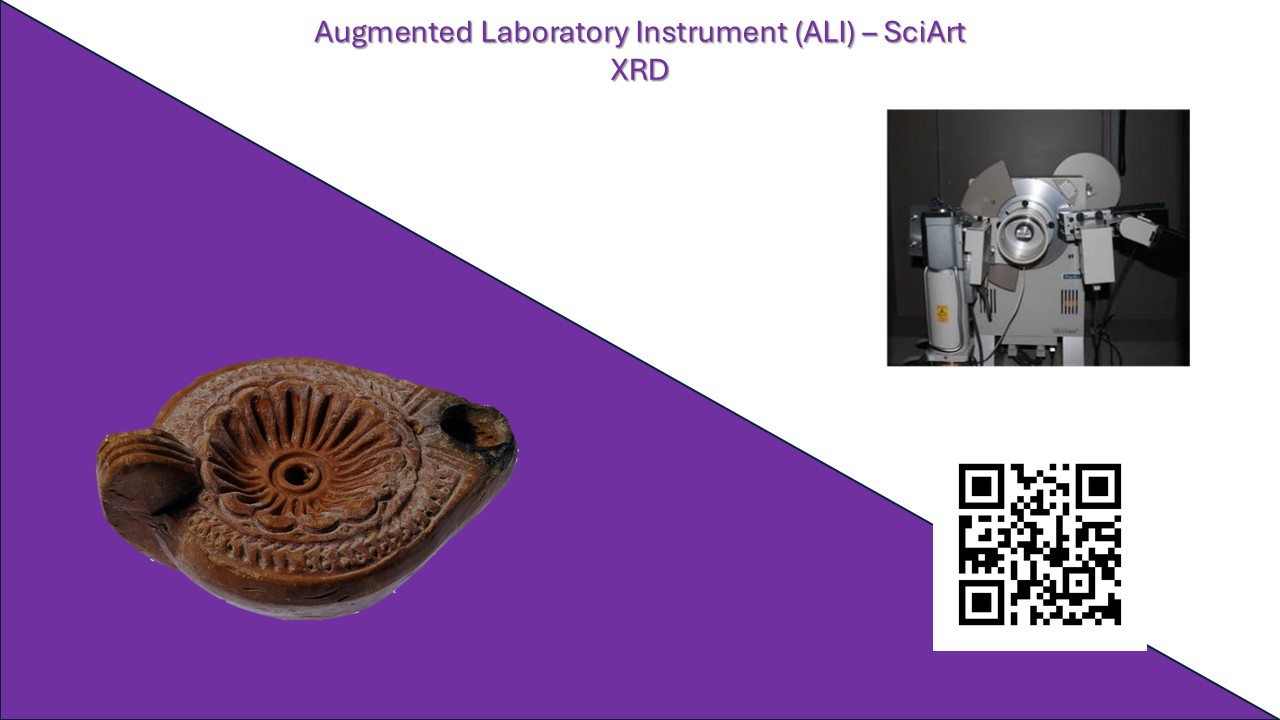
**What would the XRD method show differently for the two points of interest?**

***The teacher introduces the need to apply another method to accurately identify the composition of materials, the XRD method.***

| *Record the opinions discussed*  *with a short video or sound recording.*  *Call it “5.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Investigation Research with solid fill** | **QR audio** | | |

Use your mobile devices (tablets, mobiles, etc.) and scan the image below.

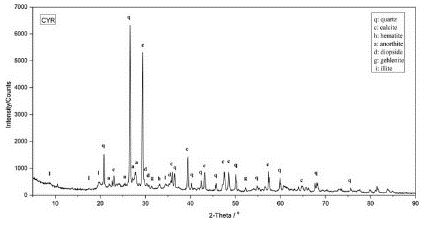
Watch the video and download the results provided by the device for the clay lamp by pressing the "Results" button.

****

*Discuss in the whole class the results of this particular method*

***Students observe the graph extracted from the XRD (diffractogram) and the table of chemical compounds identified.***

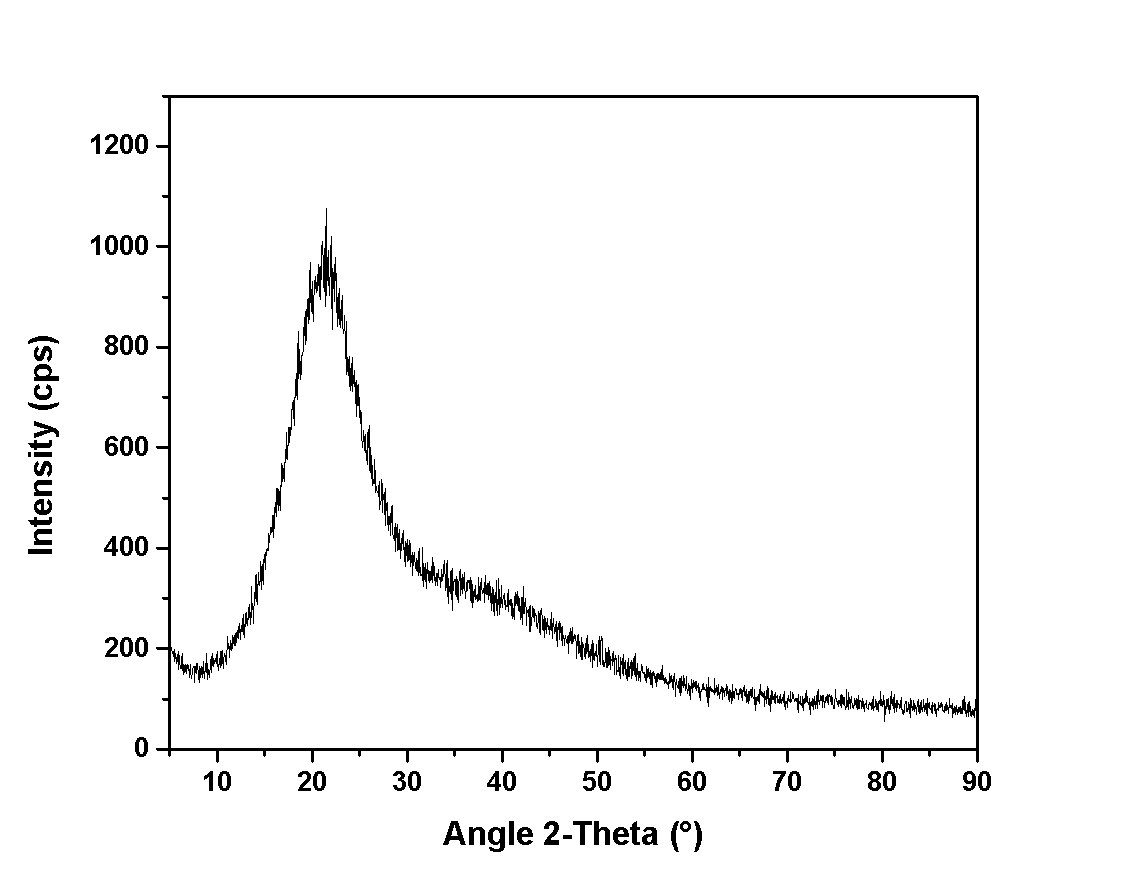
* In the first area of interest, from the clay lamp sample, based on the XRD pattern, which material is confirmed?



***The crystalline phases identified are typical of ceramic. The clay lamp is confirmed to be ceramic.***

*Image 15*

* In the second region of interest, from the residues inside the clay lamp, based on the XRD pattern, which substance is confirmed?



***The XRD pattern (diffractogram) of the substance inside the clay lamp confirms that we have an organic substance.***

*Image 16*

| *Discuss and record how the method works*  *with a short video or sound recording.*  *What results did it give us?*  *Call it “5.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

* **Record the material/chemical compound you identified using the XRD method.**

| **Points of Interest** | **Material - substance** |
| --- | --- |
| Oil clay lamp | **Ceramic as confirmed by FTIR** |
| Foreign substance residues inside the clay lamp | **Organic substance therefore oil as confirmed by FTIR** |

| *Record your answers*  *in a short video or sound recording.*  *Explain how you got there.*  *Name them “5.d Conclusion”* | *QR audio* |
| --- | --- |

**Back to the original questions……**

1. What was the (social) position of craftsmen in Byzantium? Can we investigate the components of the clay lamp used during the second half of the 4th century AD?

2. Have these products been exported and to where? Can we find similar products in Portugal, Cyprus or elsewhere? Can we trace their route during the Byzantine Empire?

3. Can we compare it with clay products made today? Are there commonalities/differences?

4. Can we make assumptions about the use of these clay products? What tests can we do?

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**How can we use the conclusions we have drawn from archaeometric methods to answer the original questions?**

*Write questions you can ask an AI machine,*

*so with the answers it will give you and the results you already have*

*to answer the initial questions*

| ***The teacher moderates a discussion in the whole class in order to formulate the questions that the students need to answer the above questions. Such questions may be:***   * **What objects are made of clay?** * **Since when is clay used in pottery?**   ***The questions in ChatGPT must be in English because it does not give correct answers in Greek.*** |
| --- |

| *List the questions you will ask in ChatGPT*  *with a short video or sound recording.*  *Call it “6.b Conceptualization”* | *QR audio* |
| --- | --- |
| **Investigation Research with solid fill** | **QR audio** |

Use ChatGPT to collect information about the above questions. Record the information you need to answer the questions.

| **Question** | **Key Points in ChatGpt’s Answer** |
| --- | --- |
| What is made of clay? | **Clay is used in a wide range of applications and industries due to its ability to mold and harden when exposed to high temperatures. Some of the main uses of clay are pottery and brick making** |
| Since when is clay used in pottery? | **Clay has been used in pottery since ancient times, with some of the earliest known pottery dating back to the Neolithic period, around 10,000 BC. Since this time, man has used clay to create various ceramic objects for use in everyday life, as well as for decorative and ceremonial purposes.** |
|  |  |
|  |  |
|  |  |

*Discuss the answers as a whole class*

*to the specific questions you asked in ChatGPT.*

| *Note the main points of the answers for each question.*  *Did it help you find the answer? How;*  *Call it “6.c Investigation”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

*Record the answers to the initial inquiry questions.*

| **1. What was the (social) position of craftsmen in Byzantium? Can we investigate the components of the clay lamp used during the second half of the 4th century AD?** |
| --- |
| ***ceramic*** |
| **2. Have these products been exported and to where? Can we find similar products in Portugal, Cyprus or elsewhere? Can we trace their route during the Byzantine Empire?** |
| ***………………………………..*** |
| **3. Can we compare it with clay products made today? Are there commonalities/differences?** |
| **Clay is a type of earthy material that consists mostly of water vapor and tiny grains that come from the weathering of rocks. Clay also contains other materials besides aluminum, including:**  **1. Sand: Sand adds texture and stability to clay and can improve its properties for making ceramics**  **2. Clay: Clay may also contain aluminum, but in smaller amounts than the dominant aluminum used in pottery**  **3. Mud: In some cases, mud can be added to the clay to give it extra moisture and flexibility**  **These materials are combined and shaped by the addition of water to create a uniform, molded clay that can be used for ceramic creations and other constructions** |
| **4. Can we make assumptions about the use of these clay products? What tests can we do?** |
| ***With the archaeometric methods applied to the clay lamp, traces of oil were found ……………………………..*** |

|  | *QR audio* |
| --- | --- |

**Create a video of your answer to each question**

**in the form of an interview.**

**One or the other of you will ask the question**

**and one or the other will answer!!!**

*Name the videos "Final Answer 1", "Final Answer 2", etc.*