# Study of flint properties for artifacts raw material sources detection in the future

PhD student, **Liga Zarina**

Prof. Dr. **Valdis Seglins**

University of Latvia, Faculty of Geography and Earth Sciences, Department of Geology

EIROPAS SOCIĀLAIS FONDS
EIROPAS SAVIENĪBA
LATVIJAS UNIVERSITĀTE ANNO 1919
IEGULDĪJUMS TAVĀ NĀKOTNĒ

## Introduction

Flint is a variety of cryptocrystalline quartz and is outspread in sedimentary rocks, forming nodules and concretionary masses that can be concentrated in distinct layers or dispersed randomly throughout the rock. From a petrological point of view, flint is categorized as a type of chert, and it often occurs just as a silicate material in carbonate rocks, where it is a replacement mineral formed in diagenesis. Flint is resistant to weathering and can be often found as pebbles or cobbles along beaches and streams. The mentioned indicates that the natural diversity of flint and chert is high and their changes in hypergenesis zone are relevant, which makes these natural silicates problematic in modern scientific studies.

At the same time flint is one of the natural raw materials, what people have used for making tools through thousands of years (Cunliffe 2001), and the conclusions regarding ancient human lifestyle in the Stone Age mainly are based on studies of flint tools. Despite the many advances in ancient material culture studies, the raw material of flint tools can be localised sufficiently accurate only in some cases, because flint is difficult datable material (e.g., Gurova 2011; Högberg et. al. 2012) and its natural diversity even in limited area is wide (Högberg, Olausson 2007).

## Materials and methods

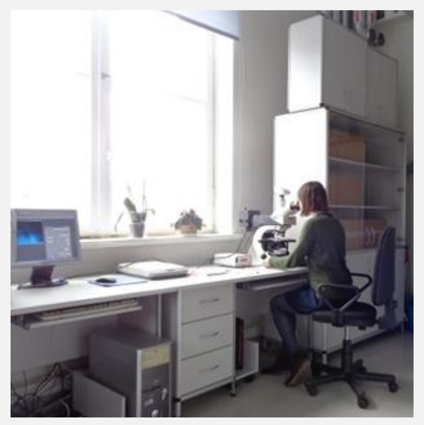
Sampling locations.

Detailed analysis of flint samples collected in Møn Island (Denmark) and Beachy Head (United Kingdom) were carried out. For comparison also samples from Latvia that cover chert and chalcedony saturated dolomite, as well flint pebbles from the Baltic Sea coast were studied.

Photodocumented flint samples UK 2, DK 3 and LV 1.

Samples and 0.5-2 mm thick flakes split from them were photodocumented by camera Sony Cyber-shot DSC-H90. Further the study was expanded from assessments in visible light to the observations in ultraviolet (UV) light range. The chosen method allows to investigate sample as a whole or any part of it in constant non-destructive conditions.

Part of the research was made using research equipment ***BioSpectrum AC Imaging System***. The study parameters were set using software *Vision Works S*, by which also was managed monochrome photodocumentation of the investigated samples. The lamps with calibrated wave length of 365 nm and 480 nm were used. Additionally three different wave length emission filters SYBR Green (515-570 nm), SYBR Gold (485-655 nm) and EtBr Red (570-640 nm) were used, as well wide picture-taking exposure time in range from 0.03 s to 2 min according to set research mode.

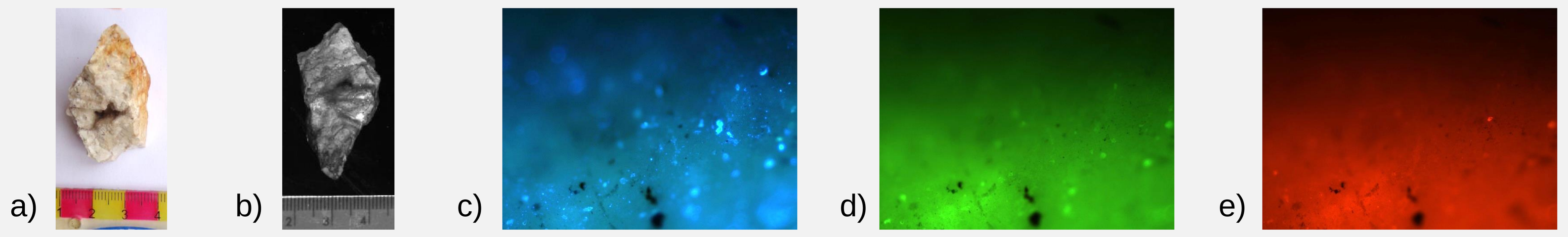


Additional data with microscope ***Leica DM 2000*** were obtained. Flakes of the samples were investigated in magnification of 50 times. The fluorescence studies were carried out under ultraviolet light in three different modes which accordingly were formed using filters with ultraviolet excitation zone 340-380 nm (emission zone from 425 nm, blue), blue excitation zone 450-490 nm (emission zone from 525 nm, green) and green excitation zone 525-560 nm (emission zone from 590 nm, red). The exposure time of camera *Leica DFC 420*, which is connected with the microscope, was set using software *Image Pro Express* accordingly to the research mode.

Further a comparative analysis of the acquired images was carried out. The possible interpretations regarding characteristics of flint structure were evaluated, which further could be useful for flint raw material difference assessment and facilitation of subsequent analysis, such as sample selection for chemical analysis and later interpretation of obtained results.

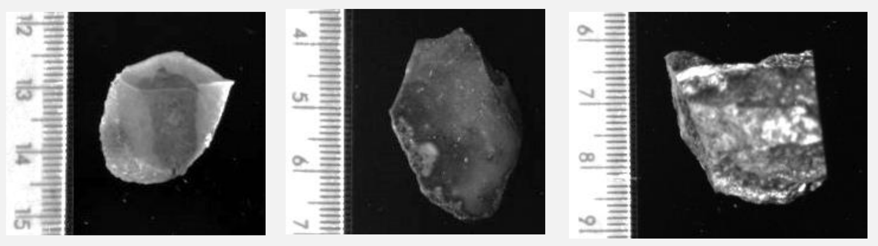
## Results

Comparison of the images obtained in different ultraviolet lighting modes gives more complete information for characterization of flint structure and helps to evaluate heterogeneity of impurity locations, which can be indicative feature about flint formation conditions. By changing ultraviolet lighting modes it was possible in certain modes distinguish different features for sample's characterization.




**Flint sample LV 1 photodocumented in different lighting modes.**
a) visible light, b) 480 nm wavelength emitting lamp, for the reflected light used filter EtBr Red (570-640 nm), c) ultraviolet excitation zone 340-380 nm (emission zone from 425 nm, blue), d) blue excitation zone 450-490 nm (emission zone from 525 nm, green), e) green excitation zone 525-560 nm (emission zone from 590 nm, red).

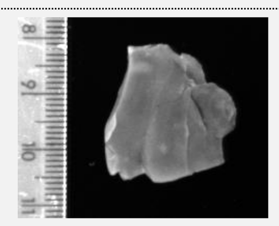
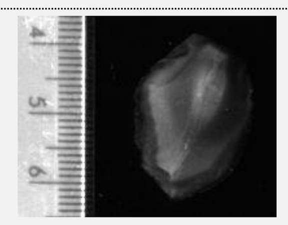
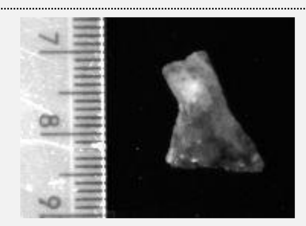
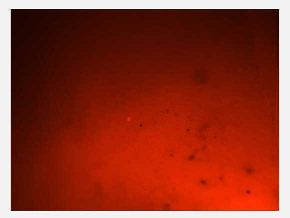
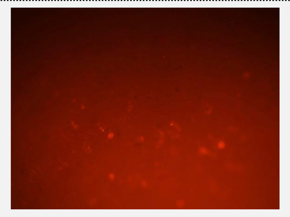
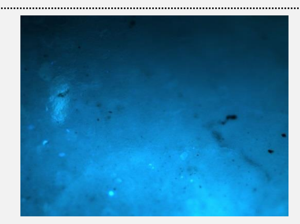
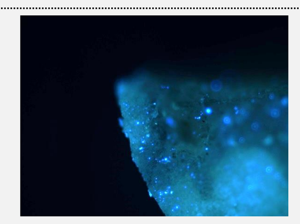
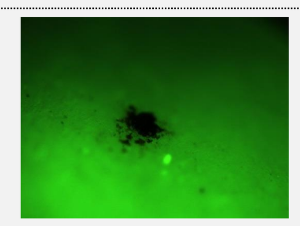
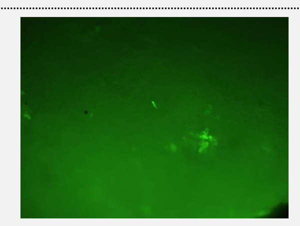
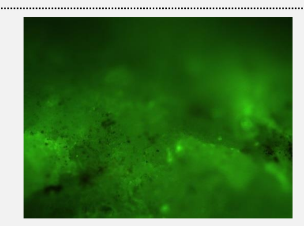
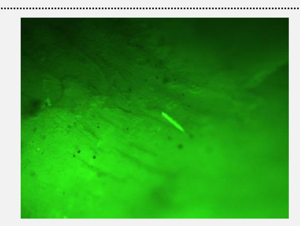
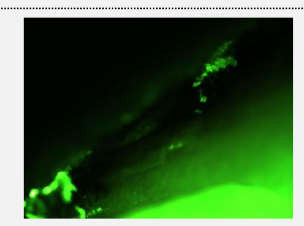
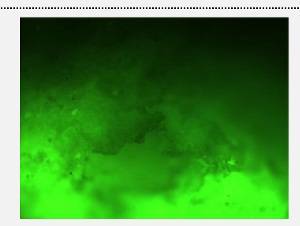
In the study with BioSpectrum AC Imaging System none of the samples showed pronounced fluorescent effects. However a heterogeneous structure, cracks, as well as different layers of material and graininess were detectable. The best results so far are obtained with 365 nm wavelength emitting lamp, for the reflected light using filter SYBR Gold (485-655 nm), the exposure time of 5 s to 20 s and with 480 nm wavelength emitting lamp, for the reflected light using filter EtBr Red (570-640 nm), the exposure time of 0.03 s to 0.1 s.



**Flint samples DK 2, UK 1 and LV 4.
365 nm wavelength emitting lamp, filter SYBR Gold (485-655 nm).**

In the study the heterogeneity regarding to inclusions, grain size, amount of fluorescent impurities, features of fracture etc. was evaluated. For further studies this would help to build sets of features which would allow to distinguish flint according different place of origin.
Our study indicated that such identifiable features as rock color, caverns, graininess, structure, layers, cracks, fluorescent inclusions and inclusions of organic matter can be determined.

**Heterogeneity features in samples DK 1, UK 2 and LV 3 detected in different research modes.**

| Feature<br>Research mode | Sample DK 1, Møn Island, Denmark | Sample UK 3, Beachy Head, United Kingdom | Sample LV 1, Vidaga, Latvia |
|---|---|---|---|
| **Rock color, caverns**<br>Visible light |  |  |  |
| **Structure, layers**<br>365 nm, filter SYBR Gold (485-655 nm) |  |  |  |
| **Graininess**<br>Green excitation zone 525-560 nm (emission zone from 590 nm, red) |  |  |  |
| **Fluorescent inclusions**<br>Ultraviolet excitation zone 340-380 nm (emission zone from 425 nm, blue) |  |  |  |
| **Inclusions of organic matter**<br>Blue excitation zone 450-490 nm (emission zone from 525 nm, green) |  |  |  |
| **Cracks**<br>Blue excitation zone 450-490 nm (emission zone from 525 nm, green) |  |  |  |

## Discussion

The internal structure of the research material is recognizable, furthermore various inclusions, squares and diffuse, cracks and other disparities, which often cover most of the research objects, are evident. This explains why so far determined flint properties are so very different and enables to mark the specific locations for the further composition research. At the same time, in particular in comparative regional studies, it is often assumed that certain investigated flint sample is homogeneous and typical and in such sample detected physical properties and chemical composition can be used in a broader context (e.g., Baltrūnas et al. 2006, Högberg et al. 2012). However, it should be noted that the flint is a heterogeneous material, and it is generally characteristic to many sedimentary rocks and is their important distinguishing feature.

The study results indicate that the flint sample assessments in ultraviolet light provides valuable information and it is comparable to the data that can be obtained by traditional petrographic microscopic methods. However, these methods are destructive and can not be applied to research of archaeological materials. Although it is not always easy to determine the optimal technical parameters for the studies in ultraviolet light (wavelength, applied light filters, etc.), the method allows to obtain high-quality additional data on the investigational flint objects.

The importance of possibility to perform detailed photodocumentation and accordingly the observations of various optical parameters that can be registered in the database should be noted. This allows subsequent image analysis, for example, using red-green-blue (RGB) color model for comparisons, the corresponding data can be processed with mathematical methods.

## Conclusions

Our study confirms the validity of certain procedure and research sequence - from initial macroscopic evaluation, testing in ultraviolet light, detailed studies of the selected areas to samples selections for further non-destructive chemical analysis and subsequent results interpretations.

The research results are promising, but they should be studied additionally in many aspects, including the diversifying and increasing the sample collection so they could be more widely used, especially in archaeological material detailed studies. The major applies to the procedure before flint tools chemical and physical tests. They should be pre-analyzed in ultraviolet light, where the homogeneity of flint material can be determined, and the obtained data further should be assessed in the light of this aspect.

The images obtained in ultraviolet light can be relatively safe interpreted. The differences and similarities of the research material can be compared and, thus, it is possible distinguish new additional features for flint artifacts raw material source localization.

Such simplistic assessment of features can not be considered as the final result, although, obtained results so far allow to develop a further detailed methodology. In future this procedure will likely improve, but at present the results are important for localization studies of flint tools raw material sources.

## Acknowledgements

This work has been supported by the European Social Fund within the project «Support for Doctoral Studies at University of Latvia - 2» and by the National Research Program NatRes project Mineral resources.

Thanks for collegues from Faculty of Biology of University of Latvia, especially to prof. I.Muiznieks, as well to asoc.prof. G.Stinkulis and PhD student D.Pipira from Faculty of Geography and Earth Sciences of University of Latvia for support in research process.

## References

Baltrūnas, V., Karmaza, B., Kulbickas, T., Ostrauskas, T. 2006. Siliceous rocks as a raw material of prehistoric artefacts in Lithuania. Geologija 56. Vilnius, pp.13-26.

Cunlife B. 2001. The Oxford illustrated history of Prehistoric Europe. Oxford University Press, 532 p.

Gurova, M. 2011. Prehistoric flint assemblages from Bulgaria: a raw material perspective. Magyar Nemzeti Múzeum Budapest, pp. 96-115.

Högberg, A., Olausson, D. 2007. Scandinavian Flint – an Archaeological Perspective. Aarhus University Press, 158 p.

Högberg, A., Olausson, D., Hughes, R. 2012. Many Different Types of Scandinavian Flint – Visual Classification and Energy Dispersive X-ray Fluorescence. Fornvännen 107. Stockholm, pp. 225-240.

PhD student, **Liga Zarina**, liga.zarina@lu.lv
Prof. Dr. **Valdis Seglins**, valdis.seglins@lu.lv
University of Latvia, Faculty of Geography and Earth Sciences, Department of Geology,
Alberta street 10, Riga, Latvia, LV-1010