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FLINT AND FIRE

Krzemień i ogień

Maciej Pawlikowski

AGH University of Science and Technology, Department of Geology, Geophysics and Environmental Protection.
Cathedral of Mineralogy, Petrography and Geochemistry
al. Mickiewicza 30, 30-059 Kraków
e-mail: mpawlik@uci.agh.edu.pl

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Abstract

Various knapping techniques of flints used at Stone Age effected production of various implements but was reason of discovery of lightning striking i.e. creation of way kindle of fire. An article presents results of investigation of flints and relations: age of flints, crystallinity of flints – piezoelectricity, age of flints- piezoelectricity.

Key words: flints, knapping, piezoelectricity, fire

Introduction

Flint tools are an important indicator not only technological level of tools "manufacturers", but also provide important information about human migration and his his contacts between different groups of humans, sometimes in the very distant past (Pawlikowski 1980, 1990 a, b, 1992, 1993b, 2001, 2002, 2008, Ginter el al. 1996, Pawlikowski, Such 2006).

Flints, in most cases are products of secondary sponge silification, skeletons of which are constructed of silica (Kaczanowska el al. 1979, Pawlikowski 1980, Kozłowski, Pawlikowski 1989, Ginter et al. 1996). Depending on physico-chemical conditions following in the process of flints formation, silica can be accompanied by many minerals including opal, calcite, dolomite, siderite, and others. (Pawlikowski et al. 2013 a, b). As it is mainly opal that is the original silica forming sponge backbone, flints are evolving while ageing. This evolution is the opal recrystallization into quartz (Pawlikowski, Sęk in print). This recrystallization phenomenon means flints recrystallization increase, i.e. increase of quantity of quartz crystals in relation to the original opal, as well as increase of crystals dimensions of newly forming quartz.

The article presents the results of the surveys of flints in relations:

1. Age of flints - crystallinity
2. Cristallinity of flints - piezoelectricity
3. Age if flints - ability to kindle fire

Research material and methods

The research involves Triassic flints, Jurassic flints, Cretaceous flints and Tertiary flints. They were gathered:
Triassic flints - the area of Trias of dolomites and limestones of Chrzanów region (Krakow suburb region)
Jurassic flints – Kraków - Częstochowa Jura - Gard Tenczyński - region of Piekary (Kraków suburb area)
Cretaceous flints - chalk limestone from the region of Roman - Karlukowo (Bulgaria)
Tertiary flints - Theban Pliocene limestones (Egypt)

The research were performed with the use of polarizing microscopy (F 500 polarizing microscope of Chinese manufacture). Mineral composition was determined on Eltinor automatic counter (jumping method). Chalcedony was determined as quartz grains smaller than 10µm. The observed phenomena were documented with microphotographs.

The results of the research

Characteristics of the research of flints

Triassic flints (grey, shiny with spots) - Triassic of dolomites and limestones of Jaworzno region (Krakow suburb region, Poland).

Jurassic flints (grey, shiny, with light concentrations) - Krakow-Czestochowa Jura - Tenczyński Gard - region of Piekary (Krakow suburb region, Poland)

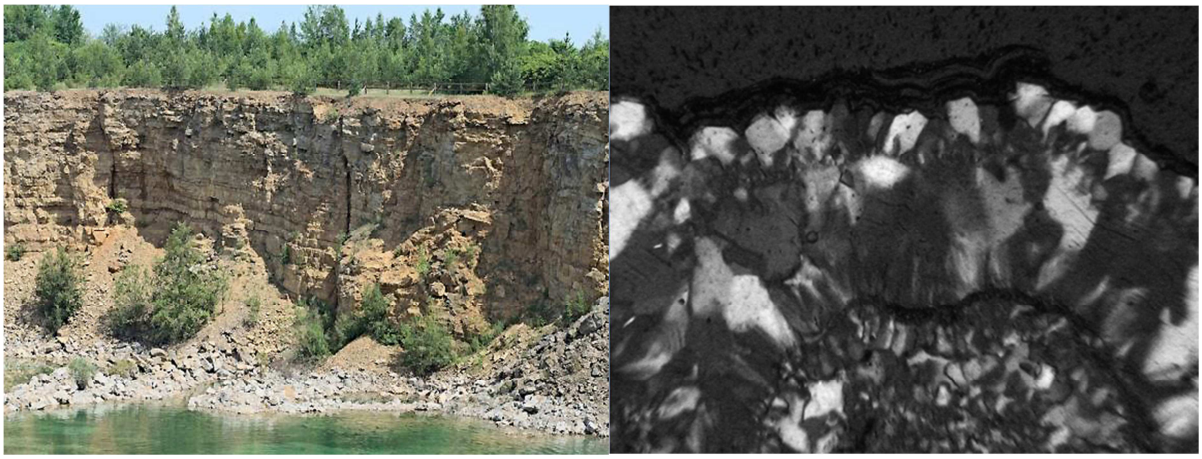
Cretaceous flints (grey, matt) - chalk limestone of region of Roman - Karlukowo (Bulgaria)

Tertiary flints - (grey, matt with spots) - Theban Pliocene limestones (Egypt)

1. **Age of flints - crystallinity**

    1. **Triassic flints**

The research concerns a number of Triassic flints have been conducted in their area of presence, i.e. in Chrzanow- Jaworzno region. Discussion was based on the research of flints from quarries located a few kilometres north from Jaworzno (Photo. 1A). Grey, shiny with spots flints are dominant here. Under microscope at some places is well crystalline quartz (Photo 1B).



A B

Photo. 1 A - quarry of limestones with flints from Jaworzno region. B - part of Triassic flint of formed of average crystalline quartz. Polarizing microscope, X polaroids, 120x magnification.

Mineral composition of Triassic flint	
Profile Jaworzno (Poland)	
Component	%
Chalcedony	80
Quartz	17
Opal	
Carbonates	1,5
Micas	
Opaque min.	0,3
Other	

Tab. 1

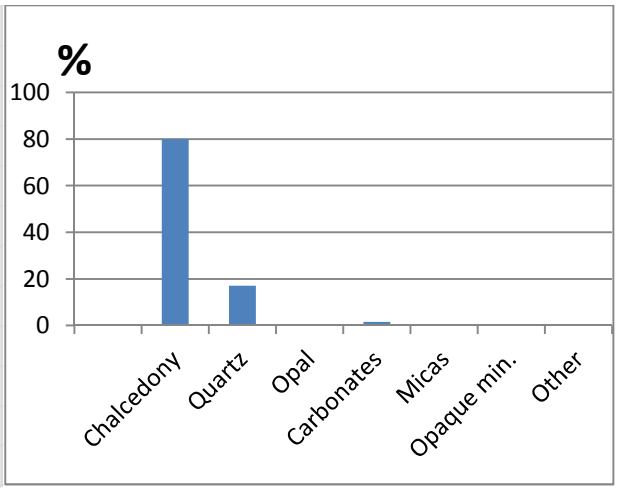


Fig. 1

Quartz and chalcedony accompanied by carbonates dominate in the flints. Opal is missing. (Tab. 1, Fig. 1).

2. Jurassic flints

The research involved flints from many Jurassic limestones occurring in Krakow-Czestochowa Jura (Kaczanowska et al 1979, Kozłowski, Pawlikowski 1989, Pawlikowski, 1980, 1989, 1990). The development summarised researches of all flints and discussed on the example of Jura limestones found in Piekary, near Krakow (Photo 2 A, B).

A B

Photo 2 A - quarry of Jurassic limestones with many silica horizons, found in Piekary, near Krakow. B - relic of structure of sponge mineralised with quartz in Jurassic flint from Piekary. Polarizing microscope, X polaroids, 80x magnification.

Mineral composition of Jurassic flint	
Profile Piekary	(Poland)
Component	%
Chalcedony	68
Quartz	21,3
Opal	9,9
Carbonates	0,8
Micas	
Opaque min.	0,1
Other	

Tab. 2

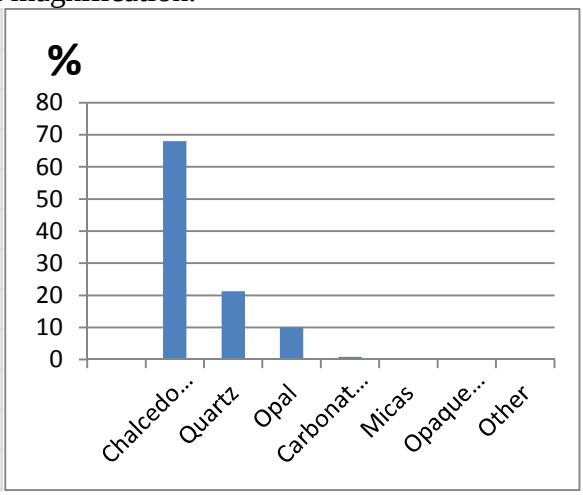


Fig. 2

The flints are formed mainly of chalcedony and quartz. Admixture opal is low, and generally does not exceed 10% (Tab. 2, Fig. 2).

Cretaceous flints

The research of Cretaceous flints Research were summarised based on years of research (Pawlikowski 1990, 1992, 1993a). It included field research conducted on a large area of the north Bulgaria in places of found Cretaceous flints (Photo 3). In addition, laboratory tests of collected flints were conducted using the most modern methods. The results of these researches will be prepared to print (Gurowa et al. - in print).

A B

Photo 3 A - nodule of black flints in limestone in area of the Temnata Cave, near Karlukowo (Bulgaria). B - microscope image of structure of grey Cretaceous flints formed from opal, microcrystalline quartz and calcite inclusions. Polarizing microscope, X polaroids, 80x magnification.

In the researched flints the main mineral components are chalcedony, quartz and opal, working together in various proportions. Chalcedony strongly dominates over quartz (Tab. 3, Fig. 3). The research revealed that many flints of this age can contain opal in quantities of even 38%. This concerns mainly grey Cretaceous flints with very good compliance to shaly

Component	%
Chalcedony	63
Quartz	24,7
Opal	10
Carbonates	0,3
Micas	
Opaque min.	0,1
Other	

Tab. 3

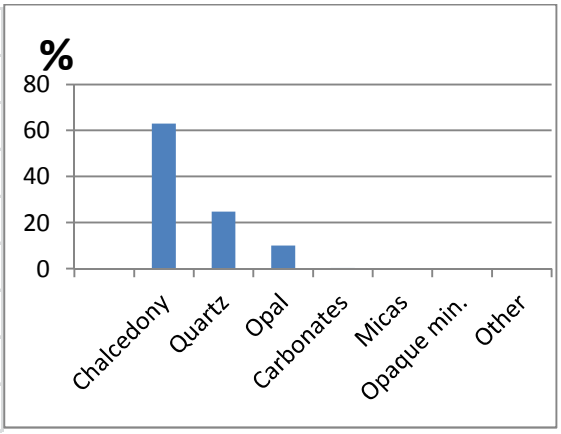


Fig. 3

technique treatment. They occur above horizon of dark flints (Fig. 3) in almost entire Bulgaria, Romania and Western Moldova.

3. Pliocene flints

These flints were subjected to researches conducted by the author (Ginter Kozłowski, Pawlikowski 1996, Pawlikowski, Wasilewski 2004, Pawlikowski, Sitarz, Sęk - in print). They form a few horizons in Neogene limestones embedded above Esna slatestones (Fig. 4).

A B

Photo 4 A - Pliocene limestone forming rock cliff on Esna slatestones. Region of Deir el Bahari (upper Egypt). B - opal- chalcedony flint structure of Thebes limestones. Visible needle if sponge mineralised with chalcedony. Polarizing microscope, X polaroids, 80x magnification.

They are formed by chalcedony and opal underlying together in various proportions; in many samples opal content can reach even 50% (Tab. 4, Fig. 4). In addition, there are flints, in which opal strongly dominates over chalcedony. It was verified that these flints are practically not suitable for knapping sparks.

Component	%
Chalcedony	47
Quartz	
Opal	50,2
Carbonates	2,4
Micas	
Opaqye min.	0,1
Other	

Tab. 4

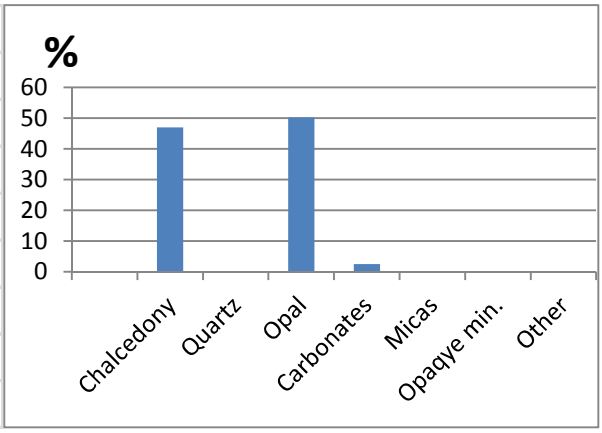


Fig. 4

2. Cristallinity of flints - piezoelectricity

Quartz (Photo. 5) is one of the main components of flints and one of few minerals with strong piezoelectric. This feature lies in the fact that under the influence of pressure quarts on the ends of crystal generates potential differences, i.e. electric current. Voltage between terminals of quartz plate can reach tens of thousands of volts. These different voltages cause spark knapping, i.e. mini electrical discharge. Vice versa - quartz subjected to variable tensions vibrates at specific intervals.

In quartz crystals there are certain directions in which these properties are exceptionally strong (Fig. 5 A). This is connected with structure of mineral, and causes that rising voltage and at the same time electrical discharges (sparks) are very strong during striking in these directions (Fig. 5B).

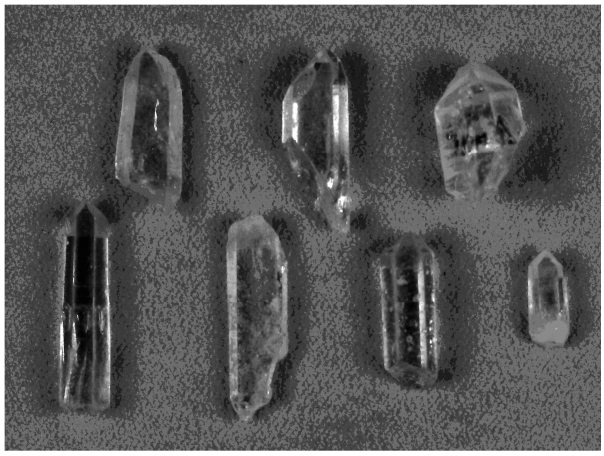
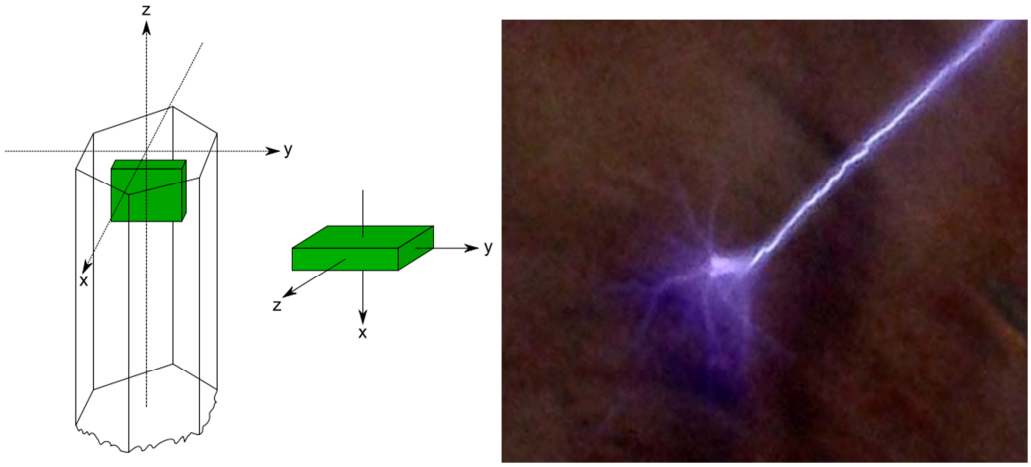


Photo 5 - examples of large and very pure quartz crystals with good piezoelectric properties (mountain crystal - Jegłowa).



A B

Fig. 5 A - planes of cut quartz crystal to obtain plates of the best piezoelectric properties (by http://pl.wikipedia.org/wiki /Piezoelektryki#Kwarc._ CE.B1), B - single spark obtained from piezoelectric quartz. 20x magnification.

3. Age of flints - ability to kindle fire

Formation of flints in limestones is related with recrystallization of opal into chalcedony, i.e. small-crystal quartz (Hasse R. 1989, Pawlikowski, Sek, in print). The recrystallization phenomenon generates microcrystals of quartz in opal mass. The researches shows that quartz crystallization is conducted in favoured directions, mainly related to diagenetic pressure of rocks laying, and is in line with direction of elongation of flint nodules (Fröhlich 2006). In this direction in the context of quartz crystals arrangement in flint, piezoelectric properties are the most favourable. This causes that sparks can be knapped the easiest and the most effectively in direction of elongation of flints concretions. Therefore, sparks knapping in this direction can easily kindle fire.

The research of flints of formations of different ages indicate that in general recrystallization of opal into quartz is associated with age of flint. Older flints are mainly chalcedony-silica. The youngest are opal-chalcedony or chalcedony-opal. The general volatility of mineral composition of age-related involves a number of additional factors leading to significant variation of mineral composition, even within a single age of flint.

However, taking into account all these factors, it can be concluded that young flints (mainly opal) are not suitable for knapping sparks, or only low number of flints are suitable.

Older flints, mainly chalcedony or chalcedony-quartz are great for knapping sparks. Therefore, in order to kindle fire older flints should be used. We can only assume that the man of Stone Age recognised flints suitable and not suitable to kindle fire. This hypothesis can be confirmed by further research.

Conclusions

1. The research has shown general relationship between the age of flint and crystallinity. The researched flints older, Triassic and Jurassic contain more amount of quartz (chalcedony) than opal. The tertiary age contain the largest amount of opal and the lowest amount of quartz. Crystallinity of flints does not have significant influence on their susceptibility to shaly technique treatment. On the basis of conducted experiments, it can be seen that the technique if better to treat flints with larger amount of opal, and is slightly worse for flints with large amount of quartz.
2. However, older flints are more suitable to knap sparks than younger flints. This is associated with flints with increasing with age recrystallization of opal into quartz.
3. There is a relationship between the directional orientation of quartz crystals in flint, and piezoelectric effect, i.e. susceptibility to knapping sparks. In only one direction after impact with other flint, sparks are knapped better than in other directions.
4. Knapping sparks, and thus kindling fire is the result of piezoelectric quartz properties in flints. Due to impact, on quartz crystals potential difference is formed, which is disclosed in the form of sparks on impacted surface of flint. The voltage of electric current can reach thousands of volts.
5. Shaly treatment technique can cause sparks, and was without any doubts discovery method of kindling fire in prehistory.
6. On the nearest to us blue bodies, i.e. the Moon, Mars, and Venus there are no quartz and flints. Therefore fire kindling there is impossible.

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