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Review of existing systems of jaspers nomenclature and classification in Poland and worldwide

Introduction

"Jasper", from the ancient Greek "spotted stone" (Żaba 2010), is a widely used term for SiO_2-bearing rocks of sedimentary, metasomatic or metamorphic origin (Ryka and Maliszewska 1991; Kostov 2010). It is mainly built up of quartz and chalcedony, whereas Fe and Mn oxides/hydroxides, chlorite, epidote, feldspars occur as accessory phases (Żaba 2010). Jaspers show a variety of different colors patterns, and textures, which together with their technical properties render them useful for jewelry (Dietrich 2009; Kostov 2010). According to O'Donghue (2006, vide: Kostov 2010) this name refers to an "archetypal, collectable beach pebble". The various geological environments, in which jaspers may be formed in combination with their strongly diverse mineralogical composition cause them to be a polygenetic and one of the most diverse type of rocks worldwide. Hence, the problem of their nomenclature and classification has not been solved completely and seems to be an important issue that gemologists and petrologists should be aware of. The classification of jaspers is frequently based on their technical, aesthetic or economical properties (Dietrich 2009). "Dalmatian stone", also known as "Dalmatian jasper", is a good example of this. It received its name due to of its characteristic appearance resembling a Dalmatian's fur. Thus, regard-

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less of their origin (metamorphic, igneous or sedimentary), all rocks that looked like jaspers, became jaspers.

Since the term jasper is used in a broad sense and refers to different kinds of rocks, it seems to be overused by sellers, collectors, and even scientists worldwide. Hence, the name orbicular jasper refers to highly silicified rhyolite from Madagascar (Fig. 1) with characteristic, spherical zones. This unique texture observed on the rock's surface results from the devitrification of a lava flow (Polk 2012). On the other hand, "Dalmatian stone" (Fig. 2) is considered as an aplite (Bruder 2006), whereas "mokaite jasper" (Fig. 3) refers to a radiolarite (Campos-Venuti 2012).

Fig. 1. Orbicular jasper (photo by Tomasz Powolny)

Rys. 1. Jaspis orbikularny (fot. Tomasz Powolny)

Fig. 2. Pendant made of Dalmatian jasper (photo by Tomasz Powolny)

Rys. 2. Zawieszka z jaspisu dalmatyńskiego (fot. Tomasz Powolny)

Fig. 3. Bracelet made of mokaite jasper (photo by Tomasz Powolny)

Rys. 3. Bransoletka wykonana z mokaitu (fot. Tomasz Powolny)

The aim of the paper is to compare the various definitions and classifications of jaspers and a propose its nomenclature unification as well as present "spotted stones" from the economic perspective. In addition, a review of jaspers found in Poland focused on their composition or genesis and potential applications is also discussed.

1. Nomenclature and classification of jaspers

The problem of the nomenclature and classifications of jaspers and related rocks has become the subject of interest of scientists over the centuries. Kievlenko and Senkevich (1983, vide: Kostov 2010), for instance, used their petrogenesis to subdivide and group jaspers types:

- true jasper – hydrotermal-metasomatic formations and metamorphosed volcanogenic-sedimentary products that are mostly made of quartz;
- jasper-like quartzites and hornfelses that differ from true jaspers by a higher degree of recrystallization of the main mass and the presence of many impurities;
- jasperoid – postvolcanic formations of dominantly chalcedony composition;
- jasper-like effusive and intrusive rocks mainly containing feldspars and quartz (e.g. rhyolites).

Somewhat earlier, Lovering (1972) broadly discussed the meaning and application of the term jasperoid. According to him, it is a rock mostly made up of silica, formed by the epigenetic replacement (metasomatism) of primary rocks. This process usually occurs within limestones or dolomite rocks as these are relatively the least resistant to metasomatic replacement by silica. Nevertheless, jasperoids are also found in other kinds of rocks, such as shale, mudstones, extrusive igneous rocks, and metamorphic rocks, although relatively

rarely (confer Schwartz 1935). Jasperoids are abundant in many mineralized areas, in which they constitute a common product of hydrothermal alteration (Lovering 1972).

Similar classifications as proposed by Kievlenko and Senkevich (1983, vide: Kostov 2010) are accepted by other authors (e.g. Arinstein et al. 1986; vide: Kostov 2010). According to Arinstein et al. (1986, vide: Kostov 2010) sedimentary abiogenic and biogenic rocks consisting of SiO_2 (e.g. radiolarites) should be considered jasper-like rocks as well. On the other hand, Ryka and Maliszewska (1991) classified these kinds of rocks as jaspers.

Manutchehr-Danai (2010) defined jasper as a dense, fine crystalline, translucent to the opaque, impure variety of chalcedony or chert[1], which differs from agate in light transparency. Thus, Campos-Venuti (2012) proposed the intermediate term "jasp-agate" in case of problems with distinguishing between these two stones.

In recent years M. Campos-Venuti (2012) made an attempt to redefine the term jasper and systematize the classification of this group of rocks. He presented the variety of geological environments in which jaspers may be formed (Table 1) and divided the rocks into four basic groups: oceanic, volcanic, pseudomorphic, and chemical. Although not all the terminological problems have been solved, this book may be a valuable source of information for people who work with jaspers, such as geologists, collectors, and buyers.

Table 1. Genetic classification of jaspers after Campos-Venuti (2012)

Tabela 1. Podział jaspisów ze względu na ich genezę według Campos-Venuti (2012)

Group	Origin	Type	Environment	Precursor	Process
Oceanic jaspers	Organogenic sedimentation	Flints	Continental shelf in limestones	Organic opal	Diagenesis
		Abyssal jaspers	Abyssal plains above oceanic crust		
		BIF (Banded Iron Formation)	Early stage atmosphere		
Volcanic jaspers	Silification of volcanic rocks	Stratified jaspers	Distal volcanic tuff	Tuff	
		Massive jaspers	Proximal volcanics	Tuff/opal	Fumarolic alternation
		Rhyolitic jaspers		Lava flows	Devitrification
Jaspers on fossils	Silification of fossils	Silicified fossils	Organisms	e.g. wood, bone, etc.	Pseudo-morphosis
Chemical jaspers	Chemical precipitation	Orbed jaspers	Inside voids	–	Chemical precipitation
		Brecciated jaspers			
		Jasp-agates			

[1] Banded or nodular siliceous rocks.

Widely varying explanations of the origin and nomenclature of jaspers not only occur among researchers worldwide, but Polish petrologists also do not share a common opinion. According to Ryka and Maliszewska (1991), a jasper is an opaque to slightly translucent variety of sedimentary siliceous rock with a ribbon-like or disordered texture. It consists mostly of authigenic grains of quartz or chalcedony with admixtures of Fe oxides or hydroxides that are responsible for their red, yellow or brown colors. Sometimes it may contain remains of radiolarians, sponges or diatoms. On the other hand, Muszyński (2008) considered jasper as a variety of *rogowiec*[2]. Nevertheless, in the Polish petrological nomenclature jasper definitely belongs to the group of siliceous rocks.

Moreover, the term "porcelain jasper" was quite commonly used in gemology and petrology. It refers to "a light colored, very fine grained, completely recrystallized and pyrometamorphosed clay, marl, shale or bauxitic lithomarge" (Tomekieff 1940, vide: Grapes 2011). Niedźwiedzki (1994) noted the presence of "porcelain jasper" forming lenses within Triassic limestones at St. Anne Mountain (Upper Silesia, Poland). Callegari and Pertsev (2007) quite recently proposed the term "burned rocks" as a collective name for the following type of rocks such as: porcelanite, fused shale, porcelain jasper, etc. Combustion metamorphism was proposed as the process responsible for their origin, and they are formed during coal fires or in contact zones between some sedimentary rocks and hot melts (Ryka and Maliszewska 1991).

2. Review of classification of jaspers in Poland

In Poland, jaspers have been described from several regions: Świerki near Nowa Ruda (Lower Silesia), Niedźwiedzia Góra near Krakow, St. Anne Mountain (Upper Silesia) and Lanckorona (Gaweł 1953; Kamieński and Tokarski 1958; Grodzicki 1976; Heflik and Pawlikowski 1977; Niedźwiedzki 1994; Heflik and Natkaniec-Nowak 2011; respectively). In most cases, the redefinition of these rock names should be considered. Unfortunately, this is a really hard task due to the diverging terminology and non-uniform systematics of jaspers (e.g. Kievlenko and Senkevich 1983, vide: Kostov 2010; Ryka and Maliszewska 1991; Manutchehr-Danai 2010).

Jaspers found in the Permian paleobasalt mine in Świerki near Nowa Ruda mostly consist of chalcedony and subordinate amounts of opal, quartz, dolomite, calcite, hematite, goethite, and mica (Heflik and Pawlikowski 1977). Differently colored jasper types (red-brown, grey-red, green, and brown-yellow-green) form layers between shales. Their genesis is connected with low-temperature hydrothermal silification caused by fluids originating from underlying paleobasalts. To classify these rocks properly, the intensity and extent of the metasomatic alteration (silification) should be described. If this process includes at least

[2] A siliceous rock, that forms layers between other sedimentary rocks; its genesis is related to diagenetic or epigenetic processes; it is considered an equivalent of bedded chert (Muszyński 2008).

50% of the original rock mass, it may be classified as jasperoid (Lovering 1972). Otherwise, these rocks should be recognized as bedded cherts.

Light grey and black types of jaspers also occur in the porphyry and diabase mine in Niedźwiedzia Góra near Krakow. They are composed of quartz, feldspars, clay minerals, and magnetite, which gives the jasper a dark to black color. Interestingly, they contain sillimanite, which is restricted to high-temperature metamorphism. The genesis of these jaspers is connected to clay xenoliths that were taken up by lava flows and then metamorphosed during pyrogenic processes (e.g. melting), and hydrothermal, and metasomatic activity – desilification, feldspathization (Gaweł 1953). A similar origin was proposed for a porcelain jasper lens found in Triassic limestones (Fig. 4) from the St. Anne Mountain (Upper Silesia). Niedźwiedzki (1994) suggested that this rock was formed as a result of the interaction of high temperature hydrothermal fluids with carbonate rocks. Both jaspers from Niedźwiedzia Góra and St. Anne Mountain might be considered as contact metamorphic rocks and well correspond to the definition of true jasper given by Kievlenko and Senkevich (1983, vide: Kostov 2010) and Arinstein et al. (1986, vide: Kostov 2010). However, they still do not meet criteria proposed for the definition of the jasper by Ryka and Maliszewska (1991) or Muszyński (2008).

Fig. 4. Porcelain jasper from St. Anne Mountain (photo by Tomasz Powolny)

Rys. 4. Jaspis porcelanowy z Góry św. Anny (fot. Tomasz Powolny)

Green jaspers occurring in marls from Lanckorona and described in detail by Książkiewicz (1951, vide: Kamieński and Tokarski 1958) were recognized as radiolarites. They contain remains of radiolarians as well as chalcedony, hematite and clays. According to Ryka and Maliszewska (1991) they may be classified as jaspers. On the other hand, following Arinstein et al. (1986, vide: Kostov 2010), they should be defined as jasper-like rocks.

Finally, picture jaspers were recognized in Trójgarb near Wałbrzych, and which are actually rhyolites (Żaba 2010) that Skórzewski (1979) considered as an alkaline member of the late Paleozoic volcanic formation in the Wałbrzych region. These rocks mainly consist of quartz and orthoclase and according to Arinstein et al. (1986, vide: Kostov 2010) should be defined as jasper like-rocks.

3. Economic significance of jaspers, jasperoids, and jasper-like rocks

The application of jaspers and related rocks has been related mainly to jewelry. The majority of these "spotted stones" belong to a group of decorative gemstones. They are sold as elements of bracelets, pendants or raw stones for gems collection. Generally, the occurrences of jaspers are not treated as typical mineral deposits. However, their rarity together with a relatively low market value result in these rocks being be considered as accompanying material in many mining areas worldwide. The resources of the Polish "spotted stones" from the diabase mine in Niedźwiedzia Góra and the paleobasalts mine in Świerki near Nowa Ruda tend to decrease due to the fact that they are popular among collectors and geologists.

On the other hand, jasperoids may be treated as a guide to some ore deposits (Lovering 1972). Not only is the precise study of these rocks valuable for mineralogy and petrology, but also it seems to be economically reasonable. Lovering (1972) divided jasperoids into 2 groups: favorable (related to ore) and unfavorable (not associated with ore). The main differences between these types are based on: megascopic characteristics, major and minor distribution of elements as well as textural characteristics. The favorable jasperoids are often genetically related to silver, gold, lead, zinc, etc. deposits (Lovering 1972). Moreover, some types of them may be treated as gemstones.

Some jasper outcrops may also be significant for geotourism development in particular areas. The porcelain jasper lens occurring in Lover Silesia has recently become one of the geological points worth seeing in the St. Anne Mountain landscape park. The outcrop of this rock is unique in Poland and should still remain under special protection.

Finally, some jaspers and related rocks (especially of igneous origin, e.g. rhyolites) may be applied both in jewelry and industry. Porphyry from Trójgarb may be considered as a gemstone – a variety of, the so called, picture jasper. On the other hand, this rock represents feldspar raw material, because it contains a significant amount of K-feldspar. Skórzewski (1979) noted, that porphyry from Trójgarb with high alkalinity modulus i.e. 25 and low Fe_2O_3 content at 0.4% has a potentially economic significance and could be used to make faience, sanitary products or semi-vitreous porcelain. "Metamorphic jaspers" (jaspilite) are important iron deposits for the metallurgical industry (e.g. jaspilite from Krivoy Rog in Ukraine, vide Baranov et al. 2009), whereas radiolarites may be used as refractory materials.

4. Concluding remarks

To conclude, the terminology and classification of jaspers should undoubtedly be unified worldwide in order to avoid misinformation for potential buyers and collectors of the "spotted stones". In some cases, the petrological and gemological study of individual jasper types is necessary since macroscopic identification of the stone has become a difficult task. The problems mentioned in this paper arise from the fact that originally the term "jasper" was used mostly in jewelry, not petrology. These historical and cultural conditions may be responsible for the fact that this term is still used for all "spotted stones", regardless of their genesis and mineralogical composition. Thus, a proper definition of jasper could be twofold:

1. The term "jasper" could be applied as a marketplace name for rocks of various genesis and mineralogical composition, with technical, aesthetic, textural properties (e.g. hardness, color, ability for polish) that make them valuable for jewelry. In this context jasper is just a decorative gemstone, the "beach pebble".
2. On the other hand, the term "true jasper" couldbe introduced to petrology in order to better distinguish what is jasper, and what is not. The definition of this rock has already beenproposed, for instance, by Kievlenko and Senkevich (1983, vide: Kostov 2010). "True jasper" defined in this way (vide chapter 1) may simultaneously meet the requirements of other rocks of quartz composition and hydrothermal-metasomatic or metamorphic origin. Secondary quartzite, for instance, is a rock type that forms due to the hydrothermal-metasomatic replacement of predominantly felsic and intermediate volcanic rocks – subordinately also sedimentary or intrusive rocks (Heflik 1993). On the other hand, the term jaspilite also seems to meet the requirements of "true jaspers". Ryka and Maliszewska (1991) considered jaspilite as a thinly-banded metamorphic rock, similar to banded jasper, that consists of quartz, magnetite, and hematite. Finally, jasperoids or burned rocks, described above, also appear to have a lot in common with "true jasper". Thus, the definition of "true jasper" proposed by, for instance, Kievlenko and Sankevich (1983, vide Kostov 2010) may be confusing in some cases. Eventually, additional criteria, such as type and amount of admixtures, quartz-chalcedony ratio, and geotectonic environment should be introduced.

Jaspers are definitely an interesting and valuable group of rocks. Each specimen is unique. "Spotted stones" are predominantly important as decorative gemstones. As for now, the way of solving nomenclature problems – mentioned and discussed in the article – is the matter for petrology and gemology. The introduction of the term "true jasper" could give some "spotted stones" a more "elitist" and "exclusive" character. Moreover, a relatively rare occurrences of some types of jaspers together with their specific properties may result in the significance of some rocks increasing in the nearest future. The popularity of particular gemstones, such as striped flint varies with time and seems to be an important factor for economic significance of decorative gemstones.

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PRZEGLĄD ISTNIEJĄCYCH SYSTEMÓW NOMENKLATURY I KLASYFIKACJI JASPISÓW W POLSCE I NA ŚWIECIE

Słowa kluczowe

jaspis, jasperoid, skały jaspisopodobne, jaspilit, jaspis porcelanowy, radiolaryt

Streszczenie

Tematem artykułu jest problematyka nazewnictwa i klasyfikacji jaspisów oraz skał im pokrewnych w Polsce i na świecie. Termin jaspis jest obecnie różnie definiowany przez badaczy zajmujących sie gemmologią i petrologią. Zróżnicowanie aktualnych poglądów dotyczących wspomnianych typów skał niesie ze sobą poważne konsekwencje. Termin jaspis cechuje się stosunkowo dużą popularnością wśród osób zajmujących się dystrybucją i sprzedażą kamieni ozdobnych. Jego stosowanie często okazuje się mylące dla potencjalnych nabywców „cętkowanych kamieni". Z tego względu istotne wydaje się wprowadzenie do nomenklatury gemmologicznej i petrologicznej terminu jaspis prawdziwy (ang. *true jasper*). W artykule przedstawiono przegląd jaspisów występujących w Polsce oraz ich klasyfikację w świetle definicji podawanych przez różnych autorów. Uwzględniono w nim także ekonomiczne aspekty wykorzystania różnych rodzajów jaspisów. Większość tego typu skał ma zastosowanie w jubilerstwie, kamieniarstwie i produkcji drobnej galanterii kamiennej. Podobne do jaspisów pod względem mineralogicznym skały o charakterze jasperoidów mogą z kolei stanowić cenny wskaźnik przy poszukiwaniu złóż epitermalnych metali, takich jak np. złoto.

REVIEW OF EXISTING SYSTEMS OF JASPERS NOMENCLATURE AND CLASSIFICATION IN POLAND AND WORLDWIDE

Keywords

jasper, jasperoid, jasper-like rocks, jaspilite, porcelain jasper, radiolarite

Abstract

Nowadays, the term "jasper" is variably defined in petrology and gemology. The unification of the nomenclature and the classification of jaspers seems to be an essential challenge for petrologists worldwide. This misnomer is very commonly used among sellers or collectors of various gemstones. Therefore, a huge diversity in the mineralogical composition, geological settings and genesis of particular "spotted stones" is reported. In this paper the term "jasper" is proposed for all "spotted stones" which have technical properties that make them useful for jewelry and in the production of small stone accessories. Nevertheless, the introduction and approval of the term "true jasper" for rocks of hydrothermal-metasomatic origin and metamorphosed volcanogenic-sedimentary products to petrologic nomenclature is recommended. Different types of jaspers and related rocks have various economic significance. Jaspers or jasper-like rocks are decorative gemstones applied in jewelry, whereas others may be used as refractory materials or feldspar raw materials. In contrast, the petrographic research of jasperoids is useful during prospecting new ore deposits.