Company: MAWE CK ltd. – gravelly sand mining
Address: Za Nádražím 199
381 01 Český Krumlov
The Czech Republic – European Union
Tax number: 28124359

Certificate

Specification of natural product: Moldavite

Localization:
Deposit: Chlum nad Malší (Chlum upon Malše), where the Moldavites are being obtained, is located 2 km southward from the town Ločenice, about 1 km eastward from the town Chlum upon Malše in Southern Bohemia (the Czech Republic, Middle Europe). Altitude of the deposit is approximately 540 m.

Geology:
Underlying rocks of the deposit are muscovite-biotitic granites and muscovite-biotitic paragneisses of the moldanubic crystalline complex (the biggest unit of the Bohemian massif).
Moldavites are present in the Koroseky gravelly sands (productive part of the deposit), a relic of basin sediments, which stratigraphically belongs to the era from the Upper Miocene to Pliocene. Generally, it is a gravelly sand sediment of the fluvial origin. The paleoflow, in which the Koroseky gravel sedimented in the past, was relatively broad and changed both direction and velocity frequently. In some places sediments remind deltaic sediments embedded in the limnic environment.

Occurrence of the Moldavites on the deposit follows these rules:

- Moldavite-bearing sediments occur in the form of isolated places, whose presence cannot be predicted during the mining.
- Moldavites often occur in the form of irregular ‚nests'.
- Content of Moldavites in the host rocks is highly variable.
- It has not been proved yet in any Moldavite-bearing localities that the Moldavites occur in two or more separated layers.
- Moldavites are often accompanied by the gem quality crystal quartz and smoky quartz.
- Moldavite-bearing gravelly sand layer occur from the subsurface parts of the deposits (which had been often plundered by illegal diggers) to 10.5m depth.

Contents of the Moldavites in the Moldavite-bearing horizon
In 1991 the stated content was 19.7 g/m^3, in 1999 just 12 g/m3 and in 2007 only 7.5 g/m^3. Today's content is about 3.5 g/m^3 of Moldavites in the Moldavite-bearing gravel. This decrease was caused by illegal mining done by illegal diggers in the subsurface (and richest) layers of the Chlum upon Malše deposit.

Fig. 1 A view on the quarry.

Fig. 2 Manual sorting of the Moldavite concentrate.

Tektites and Moldavites

Moldavites were first described by prof. J. Mayer in 1787 and the first discovered deposit was Týn upon Vltava (Moldauthein). First reference from Moravia (Kožichovice) came from Dr. František Dvorský from Třebíč. He wrote about Moldavites in the years 1880 and 1883. Moldavites belong to the tektite group. The name tektite comes from Greek 'tēktos' – molten – and represents the molten glassy character of the natural substances. Tektites were mentioned in specialised studies already 200 years ago when there was written that they had mysterious origin and were just called "glassy meteorites", "tears shed by the comets' and often "pieces of the Moon chipped off by a big meteorite and fallen down to the Earth".

Present knowledge of tektites is that we generally understand under which conditions they originated:

- Rock high in silica oxide and silica itself was suddenly melted in the place with low oxygen content, zero gravity and where there was high or quite high vacuum (magnitude of max. 1 mm Hg).
- In the hot liquid tektite melt the external force of the surface tension had to be overcome and cavities had to be created.
- Sometimes tektites had to pass through the gas cloud (from the blast) or through the atmosphere layer of certain density, because that is the only explanation of some flattening shapes.
- After the tektite origin, early cooling and solidification had to take place, because the tektite matrix is not homogenized enough.
- Temperature was affecting the place of origin just for a short time and is estimated to be of value at least 1400 °C.
- Forming of tektites is considered possible e.g. high above the Earth or Moon surface and is sure they fell down to Earth from the high layers of the atmosphere in different times.

Names of tektites are derived from the places of their occurrence. Moldavites (in Czech vltavíny) represent one of the most famous tektite groups and were the first to be found and studied. They were named after the river Moldau (in Czech Vltava), where they were found in the middle part of the stream. Apart from southern Bohemia (areas around České Budějovice, Český Krumlov, Písek) Moldavites occur also in southwest Moravia (areas around Třebíč and Znojmo). In the world tektites can be found in Texas (Bediasites) and Georgia (Georgiaites), both in the USA, then in southeast Asia, Indonesia and Philippines (Indochinites, Javanites, Billitonites, Philippinites), in Australia (Australites) or on Ivory Coast (Ivorites).

Chemical composition of Moldavites

Tektites are basically highly siliceous glasses. High content of SiO_2, Al_2O_3 and other specific compounds is how they differ from the common artificial glass. Chemically they can resemble special artificial chemical glasses or natural obsidian. The main distinction between obsidians and tektites is the water content (up to 2 % of H_2O in obsidians versus virtually no water in tektites). Moreover, in a thin section of obsidians, features representing the first stages of crystallization can be found, which are not present within tektites.

Origin of Moldavites – theory

According to E. Preuss (1964) the Bavarian crater Ries was created after the impact of a meteorite of 500 – 1000 m diameter and 22 km/s velocity. From the crater, 50 – 100 km^3 of rock mass was ejected and relocated. Significant part of it was melted and part was vaporized under the temperature of 3000 °C and pressure of 3 – 5 GPa. The rock debris and the dust

entered the stratosphere (height about 50 km) and the Moldavite melt fell down to the surface in the form of several pseudo-consistent ‚splatters'.

Occurence of Moldavites

Moldavites occur in incoherent areas, mostly in southern Bohemia and to a lesser extent in southern Moravia (both in the Czech Republic). Several pieces was also found in Austria and in Germany (in Dresden), but these Moldavites were transported secondarily by the river.
There are slight differences between Moravian and Bohemian Moldavites. The Moravian ones are bigger in diameter and intact shapes occur more often, whereas Moldavites from Bohemia are more fragmentary or have shapes of flat drops.

Morphology of Moldavites

Morphology of Moldavites was formed secondarily after their origin and depended on the environment where the melted Moldavites fell into or on the area where the glassy rock was placed for the longest time, geologically speaking.
Morphology of Moldavites was influenced by natural acidic solutions. On the Jankov locality (southern Bohemia) Moldavites occur in compact clays with low permeability for acidic solutions that could have caused natural corrosion. On the contrary, Moldavites from the Besednice locality (also southern Bohemia) have extremely deep natural corrosion, because they are placed in highly permeable gravelly sand. It is possible that the sculptation of the Moldavites could be wiped off or destroyed completely after their forming, e.g. due to the water transport. That is the reason why Moldavites found on the fields possess just a slight sculptation. Another advantage of permeable sandy environment is the high lustre of local Moldavites, whereas those from the clays are often matt with a ‚velvet' surface.

Colour of Moldavites

Moldavites from western Moravia have mostly unattractive brown-green colour. Contrarily, Moldavites from southern Bohemia (e.g. from Chlum upon Malše) have very attractive green colour with different shades.
Colour of Moldavites is caused by the presence of octahedral Fe^{II}. Other studies indicate that besides the total iron content the colour depends to a certain extent also on its valence, and so on the bivalent and trivalent iron ratio. Research then also indicates a certain dependency on the manganese content.

Gemmological and mineralogical characteristics of Moldavites

- Chemical composition: SiO_2
- Crystal system: amorphous
- Refractive index: 1,48 – 1,51
- Birefringence: 0,000
- Hardness: 6 (Mohs)
- Density: ~2,4 $g.cm^{-3}$
- Cleavability: none
- Fracture: conchoidal, vitreous
- Fluorescence UVSW (254 nm): inert
- Fluorescence UVLW (366 nm): inert
- Phosphorescence UVSW (254 nm): inert
- Phosphorescence UVLW (366 nm): inert
- Optical characteristics: isotropic; bigger pieces, especially the whole-shaped stones, often have high inner tension, which causes anomalous anisotropic behaviour.

- Melting point: 1 295 – 1 325 °C (artificial glass only 1 250 °C)
- Inclusions: Only two types of inclusions are characteristic for the Moldavites. First is lechatelierite (fig. 3), a modification of SiO_2, which occurs in the shapes of grain or is elongated into spiral hooks. Second types of inclusions are bubbles with vacuum (fig. 4). Interesting fact is that if Moldavites with big bubbles are cut and during the cutting process decrepitating occurs, this process is accompanied with a typical noise – an implosion, caused by the low pressure. In Moldavite cavities, gases such as helium, argon, neon and carbon monoxide were analysed.
- Known treatments of quality or colour: none have been published so far, in unique cases filling of the cavities by wax was found.

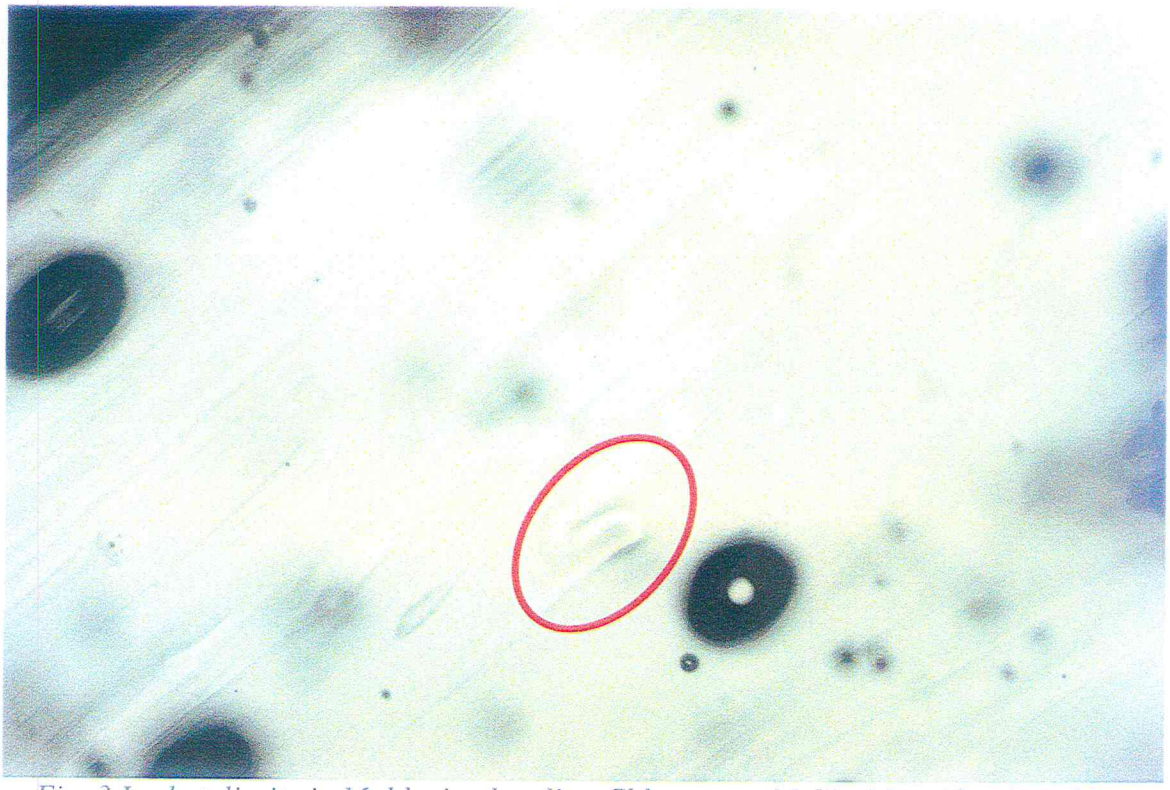

Fig. 3 Lechatelierite in Moldavite, locality: Chlum upon Malše. Magnification: 80 x.

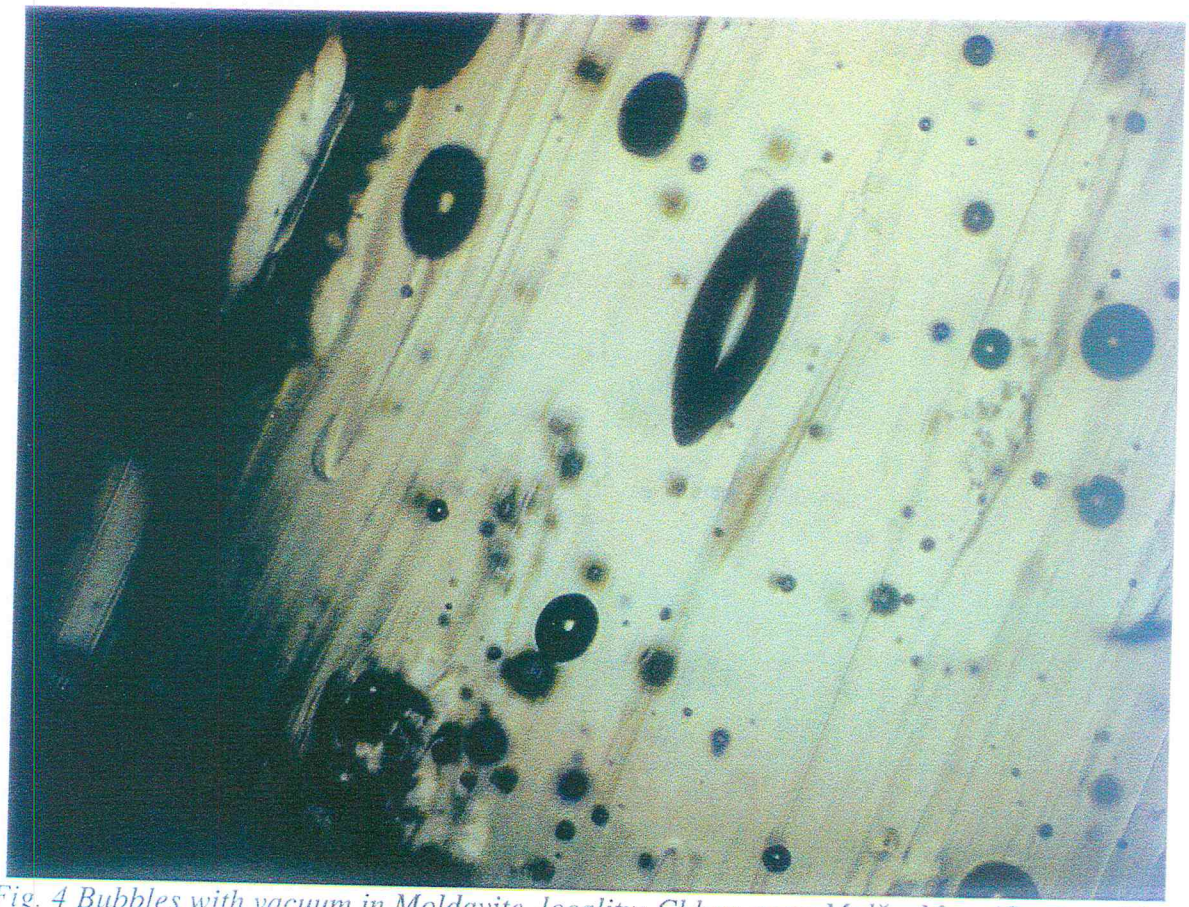

Fig. 4 Bubbles with vacuum in Moldavite, locality: Chlum upon Malše. Magnification: 80 x.

Imitations: In China imitation of Moldavites made of glass with a similar sculpture started to be manufactured around the year 2002. Distinction is possible e.g. via the inclusions: lechatelierite or bubbles with vacuum, which are typical for Moldavites.

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Written by: RNDr. Radek Hanus, Ph.D.
Autorized expert in precious metals and gemstones with a specialization on the evaluation of authenticity
Technically qualified person in the field ‚geochemistry and Earth structure research'