

## Geosite Boží hora at Žulová – a classic mineral deposit

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### ABSTRACT

The town of Žulová is a historic centre of stone quarrying and processing of granite, in particular. The town is located in the north-western part of Czech Silesia, Czech Republic. Still, this area is little known due to its location near the borders. The absence of infrastructure, insufficient funds of the local municipalities and high unemployment prevent the town and its surroundings from exploiting the tourist potential in a wider scale. However, this town and its neighbouring villages certainly have a tourist potential, especially thanks to their preserved and beautiful landscape, interesting history and remoteness from big cities. In addition, in Žulová and the surrounding villages there are several localities interesting from the geological point of view. For geoscience tourism the geosites are valuable as deposits of various minerals of contact metamorphism and as deposits of silica or pegmatite veins. Furthermore, there are sites of historic or existing quarries related to stone processing or sites with remarkable geomorphology. This article describes the geological position and genesis of Boží hora geosite, along with its mineralogical and geotourist attractiveness.

**Key words:** tourism, contact metamorphism, Žulová Pluton, Žulová, Silesia

### INTRODUCTION

The town of Žulová lies 15 km to the north-west from the town of Jeseník, 56 km to the north from the town of Šumperk and about 16 km to the south-east from the Czech-Polish border crossing of Bílý Potok/Paczków. It adjoins the village of Kobylá nad Vidnavkou in the north, Vlčice and Skorošice in the west, Vápenná in the south and Černá Voda in the east. The town's acreage is 12.96 km<sup>2</sup> according to the cadastre register office data. Žulová is situated 12 km from the county town of Jeseník and 112 km from the regional city of Olomouc. The town has about 1,300 inhabitants (or 1,327 inhabitants according to the data of 2007). Žulová is a member of several regional unions. It is a member of Žulovsko Microregion which is a union of the surrounding villages created in 2003.

Since 1993, the town has been a member of the Union of Jeseníky Towns and Villages (SMOJ) that was created by municipalities of the Jeseník County. Since 1997 it has been also a member of Praděd Euroregion (see Fig. 1 – map of the region).

The name of Žulová town is related to the main line of business that dominated there from the 1850s till the end of the 20th century, i.e. granite extraction, stone-cutting industry and stone-industry. There used to be a technical stone-cutting school there too. At the times of the top industrial prosperity as many as 5,000 workers were employed in the quarries and workshops of the Silesian granite industry. The history of granite quarrying has been described in detail in the work by T. Kruťa (1973). However, the name of Žulová has been used since 1948, after World War II. It has replaced the original German name of



Fig. 1 Location of the Žulovsko Microregion. (adjusted according www.1)

Frýdberk is a result of the post-war evacuation of the majority of the German inhabitants. There were also other villages in the county, such as Písečná, Vápenná or Uhelná, that gained their names in a similar way. There are not many attractive sights in the town itself from a tourist point of view although it has a long history. Still, the exception is, for example, the Church of St. Josef with its church tower being the remainder of Frýdberk gothic castle, already mentioned as early as 1296. Apart from the cylindrical tower, there are also the remnants of the castle fortifications. The St. Mary Square in the town centre is bordered by several old craftsmen houses. Next, there is a column with a statue of St. Mary and a stone bridge, both from the 19<sup>th</sup> century. Another historical sight is the neo-gothic Church of Grieving Virgin Mary on top of Boží hora (sometimes referred to as a chapel). This church was built between 1878 and 1880 and replaced the former wooden building from 1712 to 1713 (Kuča, 2011). The geosite of Boží hora (God's Hill) lies to the west from Žulová. With its altitude of 527 m, it represents the highest

summit of the hilly country called Žulovská pahorkatina. Apart from the Church of Grieving Virgin Mary on the hill top and the Way of the Cross that leads from Žulová to the top of Boží hora, visitors are offered a beautiful view of the countryside from its top (see Fig. 2). In addition, those interested in geotourism may find at least three very interesting places where minerals may be gathered. These places differ in their origin and composition, and the fact that they have been clustered at such a relatively small area makes them unique. However, it must be pointed out that Boží hora has been a well-known site for mineralogists who have paid numerous visits to it for several decades. As a result, this has mirrored in the present state of the geosites with the occurrences of minerals. Currently, the sites with the major occurrences of the best known and most beautiful samples of the different minerals are rich in excavation pits, small waste dumps and debris after activities of people who explored for minerals and collected them. Still, samples of the characteristic minerals may be found even at such



Fig. 2 The Church of Grieving Virgin Mary on the hill top of Boží hora. (photo by authors)

devastated sites and everybody who visits them may enjoy their great variety and appeal.

### TOURISM IN ŽULOVÁ AND ITS SURROUNDINGS

As regards the tourist industry, the town of Žulová may be considered a starting point for hiking and cycling in the surrounding countryside. The hiking and cycling trails destine for nature attractive sights with deep woods, hilly countryside and various natural formations. The town of Žulová lies at the boundary of the Žulovská pahorkatina Hills and Rychlebské Hory Mts. Considering the relief of the two mountain ridges, it appears to be an interesting and physically less demanding alternative for hiking and cycling trips when compared with the nearby Hrubý Jeseník Mountains.

Traffic accessibility of the town Žulová and its surroundings, with regard to its position at the edge of the Czech Republic,

is relatively good. A regional railway passes through Žulová (it is the railway from the spa of Lipová Lázně to the town of Javorník in Silesia). Žulová has its own railway station with a relatively high traffic. About 11 pairs of trains pass through Žulová every day.

As regards the automobile transport, the town is connected by a 1<sup>st</sup> class road, number 60, which leads through Žulová from the spa of Jeseník (the county town) and Vápenná to Uhelná and Javorník and further to the state border with Poland. From there, it continues as the road number 382 to Polish Paczków. Next, a 2<sup>nd</sup> class road number 456 starts from Žulová to Černá Voda and Stará Červená Voda towards Velké Kunětice. Near Velké Kunětice it joins the 2<sup>nd</sup> class road number 457. There are also several 3<sup>rd</sup> class roads in the area, for example the road to Nýznerov and Skorošice and a road from Skorošice through Tomíkovice towards Kobylá nad Vidnavkou with a turning to Buková.

Accessibility of this area is also ensured by bus transport. Local bus lines Jeseník -

Bílá Voda, Jeseník - Javorník , Jeseník - Vidnava and Jeseník – Žulová cross the town. The bus service to the county town of Jeseník is ensured by about 25 pairs of bus lines every day (see Fig. 1 and Fig. 3 – Map of railway network).

The social potential of tourism in Žulová has been adversely affected especially by high unemployment (up to 18 %). The majority of people are employed in industry and the building industry. Furthermore, it has an insufficient accommodation potential. As regards accommodation facilities, there are only smaller boarding houses or accommodation in private houses available in the town. The closest hotel is in the village of Černá Voda. Catering and refreshment facilities in the town are absolutely insufficient. The character of other facilities corresponds to the town size and to its financial possibilities. There are a local library, a health centre, a grocery and

several smaller shops with consumable goods available in the town.

Regarding hiking trails, red and blue tourist paths go through the town. The red path leads from Javorník to Jeseník and the blue one from Horní Lipová through Nýznerov Waterfalls to Žulová and Černá Voda.

The natural resources of Žulová surroundings are rather high. The town may be regarded as a starting point for trips to the Rychlebské hory Mountains, Nýznerov Waterfalls, to the cave 'Na Pomezí' in Lipová, to the spa of Jeseník or to Vidnava. Numerous abandoned quarries in the town surroundings may be listed among the natural objects of interest in this area. Many of the quarries have been flooded and offer swimming possibilities. Geomorphologic objects of interest include, for example, Venušiny misky (Venus Bowls) (see Fig. 4) on the top of Smolný vrch Hill. The hill is



Fig. 3 Map of railway network – blue lines. (adjusted according www.2)



**Fig. 4** Geomorphologic objects venušiny misky. (www.3, photo by Pavla Gürtlerová, 2011; photoarchive of Czech geological survey)

the so-called inselberg formed in the tropic Tertiary climate. An inselberg is a unique geomorphic formation with granite orbicular structure; many remarkable shapes developed in the rocky formations, for example, rock-basins, benches, cavities which formed by erosive activities of rain water and the orbicular structure of granite mentioned above. Also Borový vrch Hill that is 1 km to the north from Žulová has a similar character. It is also an inselberg with a rocky town on its top, which was declared a protected natural formation in 1987.

It is important that even the latest trends within the tourist industry and adrenaline lifestyle can be found in this area, represented by the project of mountain bike trails in Rychlebské hory Mountains. A group of enthusiastic mountain bikers and mountain bike lovers rebuilt a former unused farm-house in the village Černá Voda that became a base for mountain biking in the surrounding hills. Furthermore, a network of closed trails intended for mountain bikes exclusively was built. At present, the network is already

60 kilometres long and it consists of several trails with various levels of difficulty. It holds true for the greater part of the trails that they remarkably copy old hunting paths. That way, the trails blend with the landscape and they hardly disturb it. This project is very popular among active mountain bikers within the whole Moravian-Silesian Region and the trails have hundreds of visitors not only at weekends but also during holiday weekdays over the whole season. At the same time, this project represents an excellent model of modern tourist and leisure time activities. It was well-thought-out from the very beginning, it means from the information campaign by means of a website and social networks including shared video clips and photographs where the visitors are also asked to donate further for the centre development and building of new trails by a small voluntary donation (for potential visitors are a very good source of information about the current state trails websites <http://www.rychlebskestezky.cz/cs/>).

## GEOLOGIC DEVELOPMENT OF THE REGION

The described geosite of Boží hora is located in the so-called Žulová Pluton. It makes part of Silesicum in the Moravian-Silesian area of the Bohemian Massif. This formation was intensively deformed and regionally metamorphosed during the Variscan orogeny period. These processes resulted in melting of the lower sections of the crust and extrusion of the Variscan granitic rocks that might be as old as 340 Ma.

The Žulová Pluton extrudes in the northern part of Silesicum, and in the Czech Republic it takes up an area of about 80 km<sup>2</sup>. In the south, it is divided from the group of Branná by a peripheral Sudeten fault. Towards the north, it continues to the Polish dominion where it plunges under the Tertiary and Quaternary deposits (Chlupáč et al., 2002). The eastern edge at the contact with the Devonian system of Velké Vrbno Group is intrusive. According to Cháb and Žáček (1994), it is the top part of a huge body that continues further deep towards southeast. The main body of the Pluton is mostly created by biotite granodiorites, granites up to quartz diorites and granitoids rich in accidental xenoliths (Chlupáč et al., 2002). (See Fig. 5 – Geological map of the region)

The postorogenic origin of the massif is documented by a minimum gneissic banding, perfect cleavage of granitoids and absence of mylonitic zones (Zachovalová et al., 2002). The rocks of the Žulová Pluton mantle are markedly affected by the contact of Pluton and the surrounding basement rocks, especially large accidental xenoliths of crystalline limestones that are perceivable at many places and even in the middle of the Pluton. Characteristic Pluton mantle rocks are the following: sillimanite-biotite gneisses (migmatized in places), feldspathic quartzites, amphibolites, crystalline limestones, erlans and skarns (called tektites by some authors).

The boundary lines between the

individual types of mantle metamorphites are not sharp (Rozkošný and Souček, 1989). The rocks come from Staré Město Group, Branná Group and from core parts of Desná Dome and Keprník Dome. Various authors state the temperature and pressure of the mantle metamorphosis activated by impacts of intruding Žulová Pluton ranging from 560 °C to 800 °C and from 300 MPa to 500 MPa (Losos and Hladíková, 1988; Žáček, 2003).

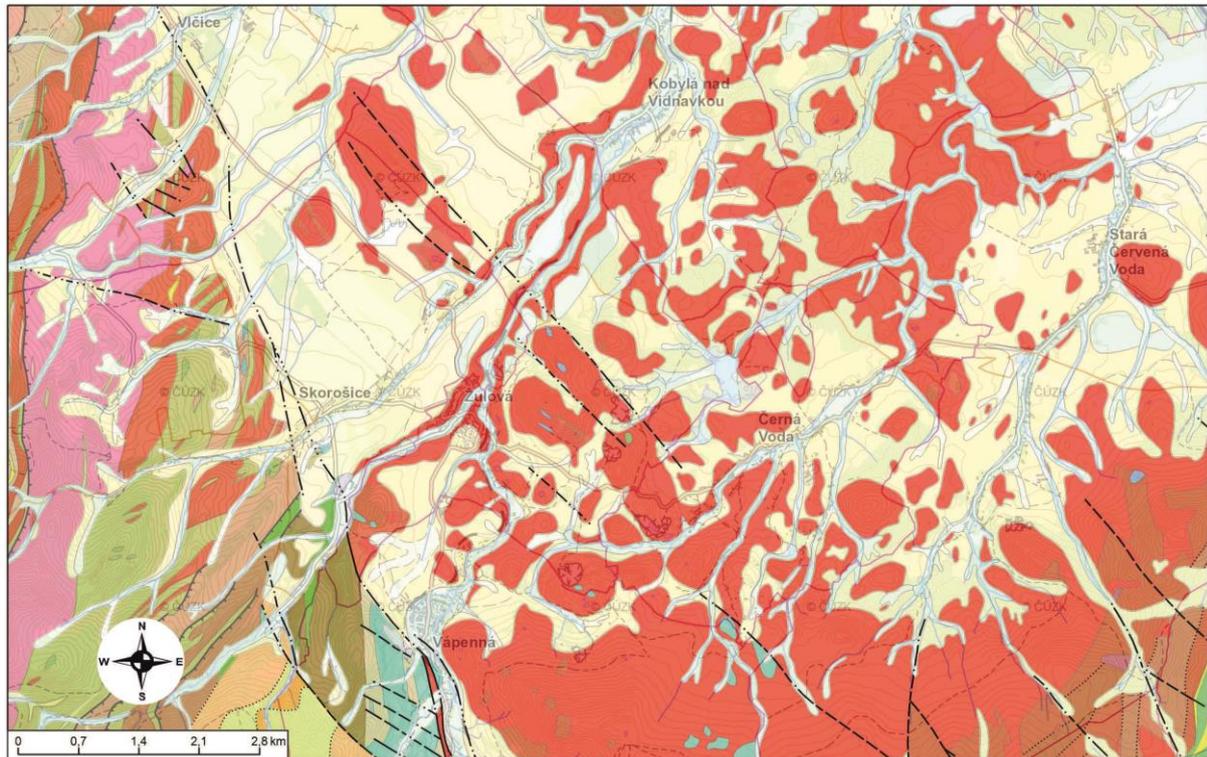
Pegmatites are rather frequent in granites and granodiorites. They most frequently appear as sheet bodies. They fill up variously oriented failure cracks in deep-seated rocks. Their thickness ranges from 4 cm to 25 cm. Pegmatites structure is simple with a narrow medium grained peripheral zone consisting of feldspars and silica with a centre of pegmatite veins filled up with coarse-grained potash feldspar and silica.

From the mineralogical point of view, the most interesting rocks of the Žulová Pluton are skarns which have been called tektites by some authors. They form in the contact zones of granitoids and the mantle rocks. These rocks have a very variable composition due to the diverse composition of xenoliths that reacted with granitoids (Mísař et al., 1983). The most typical minerals from the zones are the following: hessonite, vesuvianite, epidote, diopside, wollastonite and scheelite (see Fig. 6). The contact zones have been described in numerous geosites in Žulová and its close surroundings, for example, Vycpálek quarry, Staré Podhradí, Boží hora near Žulová, settlement near Bergov, Borový vrch Hill and Huttung quarry, Nietsche quarry, Nová Červená Voda, Stará Červená Voda, Starost quarry, Zelený vrch, Žulový vrch, etc. (Rybák, 1972).

## MINERAL PROSPECT OF BOŽÍ HORA – GEOSITE DESCRIPTION

### Andělské domky

The first described geosite lies at the



**Fig. 5** Geological map of the region. The main part of the map (red colours) represent granitoid rocks of Žulová pluton. From neighboring units (the left side of the map) are separated by faults NNW-SSE direction. (www.4)

south-eastern foothill of Boží hora in a small forest about 150 m to the left from the road that leads from Žulová to Černá voda (see Fig. 7). Literature refers to it as *Andělské domky* (Angel Houses) or 'Coral Holes' (Pauliš, 2001). This geosite consists of holes and small piles of material. They were created during exploration and digging of primary quartz dikes. Rock crystals from the veins were processed as decorative objects and souvenirs already in the 18<sup>th</sup> century (Pauliš, 2001). The local digging did not have an industrial character or was not intense. It had a form of primitive digging of colourless crystals

in shallow pits from the surface. An exploratory examination of the geosite found two silica veins 0.5-metre thick under a layer of waste pile in 1996. The veins occasionally contained cavities filled up with fragments of quartz aggregates and colourless crystals 6-7 cm in length, exceptionally as long as 10 cm. The veins may represent a core of pegmatite body. Despite the fact that only small crystals and fragments of quartz crystals and rock crystals may be found at the geosite at present, it still belongs among the most frequently visited geosites. (See Fig. 8 Quartz crystal and Present state).



**Fig. 6** Typical mineral specimens from contact zones – wollastonite, hessonite, epidote. (photo by authors)

### Abandoned shelf quarry at south-eastern slope of Boží hora

Another geosite is an abandoned quarry situated about 300 m to the south-east from the top of Boží hora. The easiest access to this geosite is by means of a forest path that turns to the left from the road leading from Žulová to Černá Voda. The forest path leads up directly to the quarry (it passes the geosite of Angel Houses) (see Fig. 7).

The single-bench shelf quarry with the face length of about 30 m and height of about 15 m was built in the granodiorites of Žulová Pluton. Quarrying was terminated in the 1970's. The mined biotite granodiorites have a light grey colour. The rock is characterized by regular separation, which means that it is an excellent material for stonework. In practice, it was given a trade name of 'Silesian Granite'.

Biotite granites of Žulová Pluton used to be quarried there, in places with veins of

aprites and pegmatites. A bimetasomatic zone between the primary limestone and paragneiss in adjacent proximity of the granitoid intrusion can be found at the entrance to the quarry. The maximum thickness of the bimetasomatic zone is 20 cm. (see Fig. 9)

In the centre of the quarry face visitors may observe a pegmatite vein from 0.5 m to 1 m thick and 4 m long. The vein has a light colour. The pegmatite blocks originating in this vein can be found on the quarry bottom too.

### Contact mineral occurrences on the south-eastern slope of Boží hora

There are remnants of excavation pits related to garnet digging in the full-grown beech forest on the top of Boží hora. They lie about 100 m to the south-east below the Church of Grieving Virgin Mary (see Fig. 7). Searching for garnets at this place

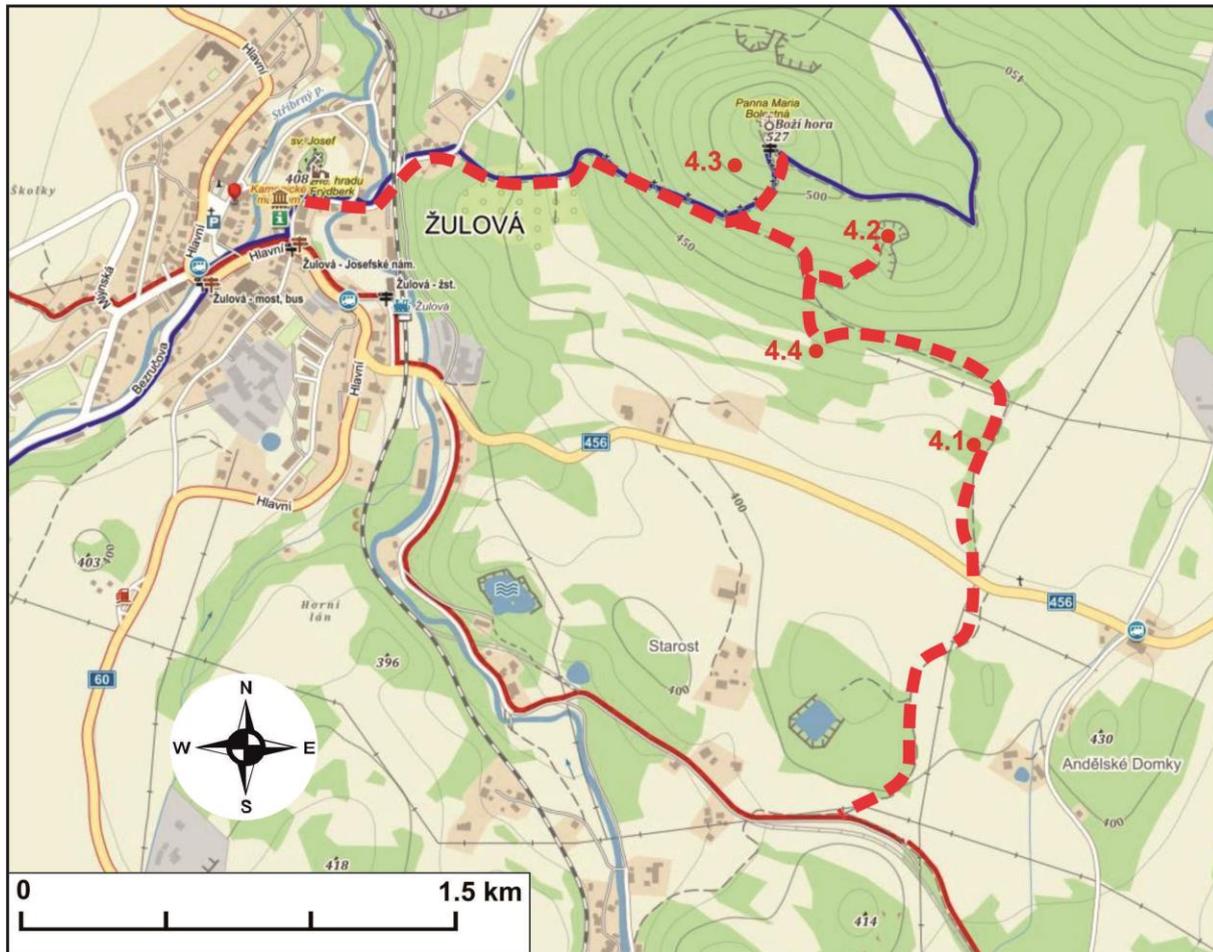


Fig. 7 The map of Boží hora showing the localities and proposal turistic trail (red dotted line).



Fig. 8 The quartz crystal founded in locality Andělské domky and present state of this place. (photo by authors)



Fig. 9 A contact zone between limestone and paragneiss on abandoned shelf quarry. (photo by authors)

started in the 19<sup>th</sup> century when they were used for production of souvenirs. The garnets come from tektites and their composition corresponds to hessonite. They occur in the form of separate crystals up to the size of 5 cm ingrown in quartz, or coarse-grained crystalline aggregates in tektite. Apart from the garnets, the excavation pits and debris also contain crystals and aggregates of dark green epidote with characteristic grooves in the crystalline surfaces and brown crystals of vesuvianite that are often ingrown in hessonite. Although this geosite is topped

with debris material at the present, you may still find nice specimens of minerals of the contact metamorphic zone. (see Fig. 10)

#### **Abandoned marble quarry on the southern slope of Boží hora**

A small pit quarry lies on the southern foothill of Boží hora, below the forest path leading to the shelf quarry described above. The pit quarry, founded in marbles of Žulová Pluton mantle, has been abandoned and overgrown by vegetation (see Fig. 7). Its approximate dimensions are 40 x 20 m. Apart from crystalline limestone also veins

of pyroxenite pegmatite extrude. These veins extrude in lenticular bodies of medium grained crystalline limestone from which they are incised. They are predominantly represented by white plagioclase with marked insets of clinopyroxene (diopside – Fe diopside) that are several centimetres long and by small crystals of titanite. However, in the past crystals of titanite found there were up to 2 cm big. The titanite is of a light brown colour and its crystals form characteristic rectangular 'envelopes'.

### PROPOSAL OF A GEOTOURIST NATURE TRAIL

This chapter proposes a nature trail to experience Boží hora geosites, which starts from and returns to the centre of Žulová. The Church of St. Josef in Žulová has been chosen as the starting point. Visitors may explore the remnants of the Frýdberk Castle fortifications and its cylindrical tower at the very beginning of the tour. A blue tourist

path leads from St. Josef Church to the top of Boží hora. The path follows the pilgrimage stops along the Way of the Cross up to the Church of Grieving Virgin Mary on the top. On this route there is also the geosite with occurrences of contact minerals on the south-eastern slope of Boží hora (see Fig. 7). From there, the proposed trail continues up to the Church of Grieving Virgin Mary as mentioned above. There are beautiful views of the Žulovská pahorkatina Hills and Rychlebské hory Mountains' panoramas from the top. Further on, the blue tourist path continues from the Church of Grieving Virgin Mary along the old forest path that follows a contour line. Next, the nature trail leaves the blue tourist path and continues along the forest path to the south-east towards the abandoned shelf quarry. There is another stop at the second geosite where visitors may observe a contact zone between limestone marble and paragneiss at the quarry entrance. The Žulová Pluton rocks that extrude in the form of granodiorite with pegmatite vein are visible on the face in the quarry centre.



**Fig. 10** A typical material that can be found in contact zones – hessonite. (photo by authors)

The nature trail continues along the forest path for about 300 m. On the right, below the forest path, there is another mineralogical stop, the abandoned marble pit quarry. Small crystals of titanite may be found in pegmatite veins material lying on the quarry bottom. The last mineralogical stop of this nature trail is at Andělské domky (Angel Houses or Coral Holes) geosite that lies in a small forest to which the mentioned forest path leads. Quartz crystals and fragments of rock crystals may be found there. From there on, the nature trail returns to Žulová. Firstly, it is advisable to cross the road leading from Žulová to Černá voda and continue along the field path, which connects to the red tourist path after 800 m. This tourist path passes flooded quarries and leads back to the square in Žulová. The proposed nature trail is about 4.5 km long and, with the exception of the uphill gradient towards the top of Boží hora, it is a physically undemanding trip.

## CONCLUSION

The article aims to inform readers about a very geotourist attractive region of Žulová and its surroundings. Analogously to works by Štrba and Kurtová (2013), Teplická et al. (2011), Velázquez et al. (2013), a geotourist nature trail was proposed herein. The example of Boží hora shows that several diverse geological phenomena may be found at a very small area. The nature trail recommended here is just one from several possible routes visitors to Žulová and its surrounding may take and experience. This nature trail offers visitors traces of former human activities that markedly have formed this area in the past centuries and evidence of geological activities that had shaped this landscape much earlier. The tourist potential of Žulová and of its surrounding has not been fully utilised, which is attributed to the economic possibilities of the town and of the whole region. This is also affected by the proximity of the Hrubý

Jeseník Mountains that attract a huge part of tourists and also by the region's position at the edge of the Czech Republic, in former Sudetenland. However, in spite of this 'handicap', viable tourist projects found their place there. The example of Rychleby Trails project shows that also an area on the edge of tourism industry interest, which lacks necessary infrastructure, may attract prospective visitors and upraise tourism with improvements to local economy. Better knowledge of the geological attractiveness of the described locality may positively contribute to this situation.

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