

MAIN DIRECTIONS OF THE FRACTURES IN THE LIMESTONE AND GRANITE QUARRIES ALONG THE SUDETIC MARGINAL FAULT NEAR VÁPENNÁ VILLAGE, NE BOHEMIAN MASSIF, CZECH REPUBLIC

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ABSTRACT

A brittle tectonic study has been carried out in the crystalline limestone and granite quarries near Vápenná village in the Rychlebské hory Mts. in the NE part of the Bohemian Massif. The quarries are situated along the Sudetic Marginal fault zone - the most important tectonic structure of the area. At the locality, the Sudetic Marginal fault separates Devonian crystalline limestones of the Branná group and Paleozoic granites of the Žulová pluton. Hundreds of measurements of joints and small-scale faults were taken in three limestone quarries on the west side of the fault. Kinematic indicators were observed as well. Equivalent measurements and observations have been performed on the fault east side in several small granite quarries. In the limestones three sets of fault have been identified (the W-E subvertical, the Sudetic NW-SE falling 45° to NE and the N-S falling 75° to W). The W-E direction of faults is the most important direction there. There are two sets of faults in the granites (the subvertical Moravo-Silesian NE-SW and the Sudetic NW-SE). The NE-SW direction is dominant. There are almost none subhorizontal faults in the studied area.

KEYWORDS: brittle tectonics, limestone, granite, quarry, fracture, Sudetic Marginal fault

1. INTRODUCTION

Vápenná village is located in the north-eastern part of the Bohemian Massif (Fig. 1). There is a lot of fault structures in this area that have been investigated by many geologists (e.g. Buday et. al., 1995; Opletal and Pecina, 2004; Skácel, 2004; Štěpančíková, 2005). Almost all faults are of variscian age, but were subsequently reactivated (Chlupáč et. al., 2002; Badura et. al., 2004). Evidence for post-Variscian movements was mainly caused by the far-field Alpine stress.

Determination of the movement sense along fault planes using kinematic indicators has been a standard procedure applied in structural studies for many years. Many fault surfaces display several lineations belonging to various movement episodes in more than one direction. In these cases, the detailed kinematic analysis should be carried out with every slickenline (Doblas, 1998).

The main goal of my work were to set up the detailed analysis of the limestones and the granites on the both sides of the Sudetic Marginal fault. I sought planes with kinematic indicators e.g. slickenlines in the limestones for determination main and less important directions of the reactivated planes.

2. GEOLOGICAL SETTING

The Javorník area is characterized by several important geological boundaries represented by faults

of the Sudetic (NW-SE) and the Moravo-Silesian (NE-SW) directions, e.g. the Sudetic Marginal fault (SMF), the Ramzová overthrust, Nýznerov fault zone (Fig 1). The mountainous area at the northeast margin of the Bohemian Massif, known as Sudety, represents the most northeasterly located exposure of the Variscan belt (Aleksandrowski et. al., 1997). They comprise the Sudetic Mountain block and the Fore-Sudetic block, separated by the Sudetic Marginal fault. All the boundaries are complex zones of ductile to brittle shearing, modified by later brittle movements (Cymerman et. al., 1997).

The Sudetic Marginal Fault follows near the northern border of the Bohemian Massif for about 250 km. It goes from Poland to Jeseník and Vrbno pod Pradědem towns and ends near Opava town on the lateral Jeseníky Marginal Fault (Buday et. al., 1995). Geological mapping (Žáček et. al., 1995) at the foothills of the Rychlebské hory Mts. - between the Bílá Voda, Javorník and Dolní Lipová towns - revealed that the Sudetic Marginal Fault could be a complex zone of NNW-SSE parallel en echelon faults 3 km in width with a complex system of internal faults (Badura et. al., 2004; Skácel, 2004). The fault system was formed during the Variscan orogeny and was reactivated during the late Oligocene. The Sudetic Marginal fault does not seem to have played any important part in the Sudetic strike-slip tectonics during the Variscan epoch (Aleksandrowski, et. al. 1997). The GPS investigations confirm the recent



Fig. 2 Calcite slickenfibres on the NW-SE fault plane, limestone quarry near Vápenná village railway station.

movements along this fault (Kontny, 2001; Schenk et al., 2002, 2003).

3. FIELD OBSERVATIONS

I investigated fault zone system by measuring structural elements at the outcrops on both sides of the Sudetic Marginal Fault - the most important tectonic structure of the area. These boundaries were studied in the limestone and granite quarries. At the studied locality the Sudetic Marginal fault separates Devonian crystalline limestones of the Branná group and Paleozoic granites of the Žulová granite pluton (Fig. 1).

I measured strike and dip of fracture planes, trend and plunge of lineations, fracture spacing and I recorded movement sense along fault planes using calcite steps of slickenlines. All measured data were processed by software Daisy 3_466. The division of the planes fitted standard terminology of the fractures: joints - opening mode barren fractures, faults - fractures bearing striation (reactivated).

3.1. LIMESTONE QUARRIES

The research has been carried out in three limestone quarries near Vápenná village. Measuring individual brittle tectonic elements was mainly realized in the biggest quarry near railway station. The Devonian crystalline limestones belong to the Branná group and are intensely fractured. Slickenlines on the fault planes in the limestones have clear visible sense of movements (Fig. 2).

I made also detailed investigation of the minerals, filling of the fractures and deformation of

the rocks. Faults are filled with calcite slickenfibres (Fig. 2). Joints are sometimes full of clay, soil, moss and sintr crust. I found crystals of the calcite 3 cm in size. Joints are much more occurred than faults, there were 77 % of them.

In the limestone quarries two intersecting sets of fractures with different orientation and spacing can be found (Fig. 3). The spacing of the set 1 is rather regular, quite small, and corresponds to the Moravo-Silesian (NE-SW) direction while the set 2 corresponds to the Sudetic (NW-SE) direction.

3.2. GRANITE QUARRIES

The granite tectonics is well developed in the rocks of the Žulová granite pluton where the planes have the NW-SE strike (Hrouda et al., 2001). Six small quarries were examined in the Žulová pluton near the Sudetic Marginal Fault. Granites are less jointed than the limestones and slickenlines on the fault planes are rare. There are only 12 % of faults in the granites.

4. DISCUSSION

There are two kinds of fractures in the limestones and the granites in Vápenná village vicinity - faults and joints. The faults are fractures where the movement along the plane of fracture is present. Joints or so called extended fractures on the other hand are fractures without signs of such movement. The movement along the plane of fracture is usually demonstrated by presence of some kind of the kinematic indicators – the mineral lineation.

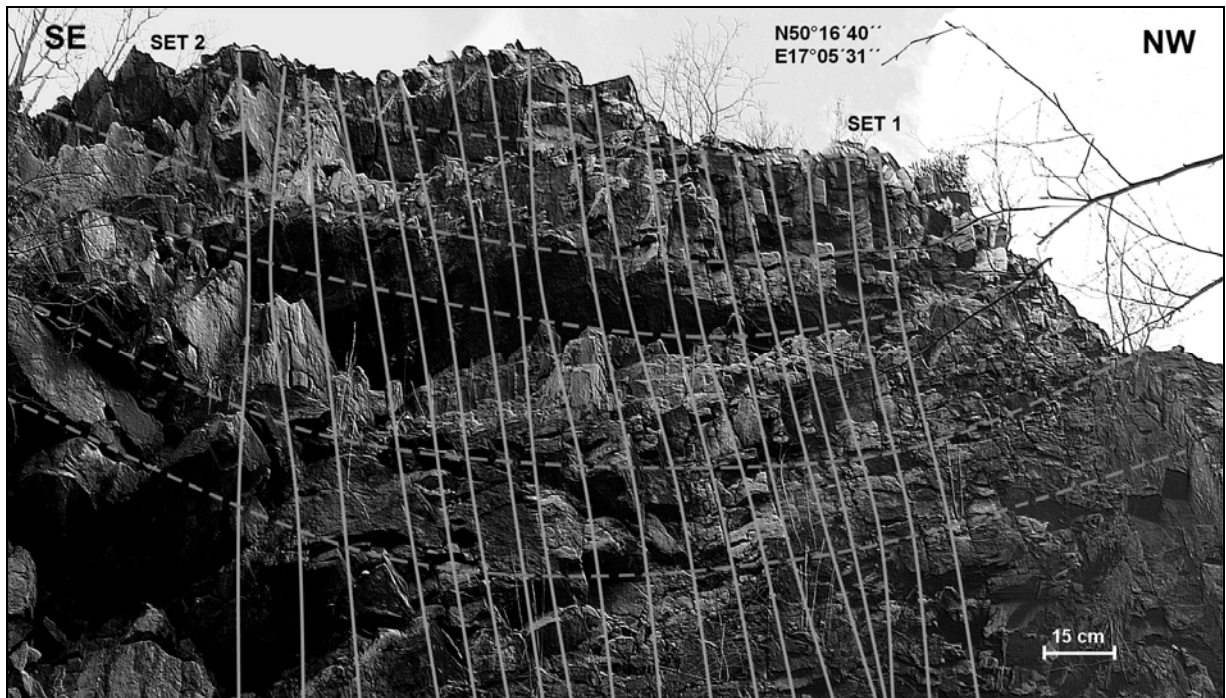


Fig. 3 Typical outcrop with two intersecting fracture sets, limestone quarry near Vápenná village railway station.

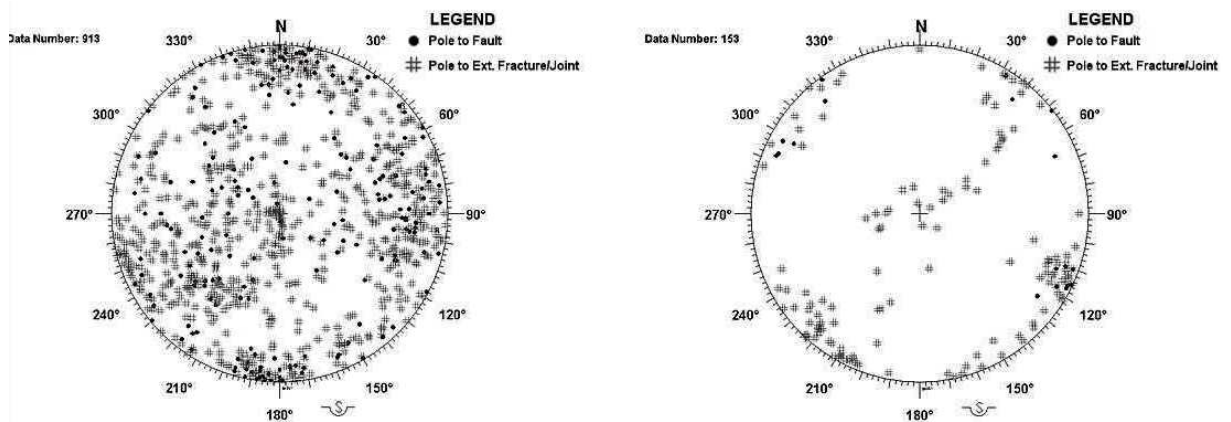


Fig. 4 Poles of all measured fracture planes, joints (double crosses) and faults (dots) in the limestone quarries (left) and the granites (right) near Vápenná village.

The contour diagrams of poles to fault and poles to joint (Fig. 5) display main directions of faults and joints and the ratio of faults and joints in the limestones (right) and the granites (left) near Vápenná village. The difference in number of measurements from the limestones and the granites has been caused by number and type of rock exposures in the limestones and the granites.

It is interesting the ratio of faults and joints in the limestones and the granites is different. When in the limestones every fourth fracture is the fault, in the granites every eighth fracture is the fault. Also the

distribution of the fractures in the granites is much more defined than in the limestones.

In the limestones (Fig. 5, right) there are faults in all directions of joints and the number of subvertical faults of W-E direction is remarkable. The contour diagram of poles to all measured fracture planes (faults and joints) in all limestone quarries (Fig. 5, left) shows four main sets of fractures in the limestones. The most frequent are there subvertical W-E fractures, NW-SE (falling under an average angle 45° to NE, the Sudetic direction), nearly vertical N-S fractures (falling under an average angle of 75° to W and subvertical) and subhorizontal fractures.

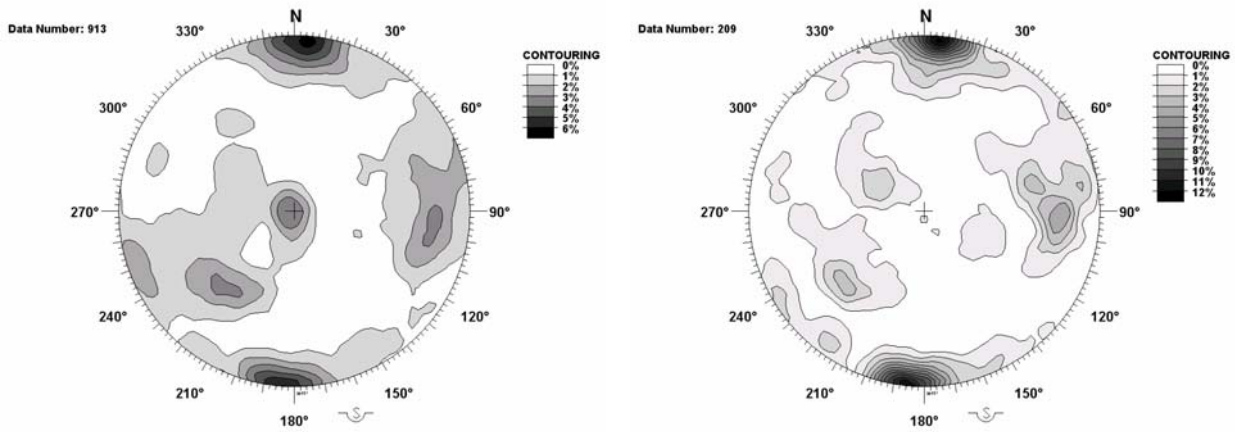


Fig. 5 Contour diagrams of poles to planes of all fractures (left diagram) and the faults (right diagram) in the limestone quarries near Vápenná village.

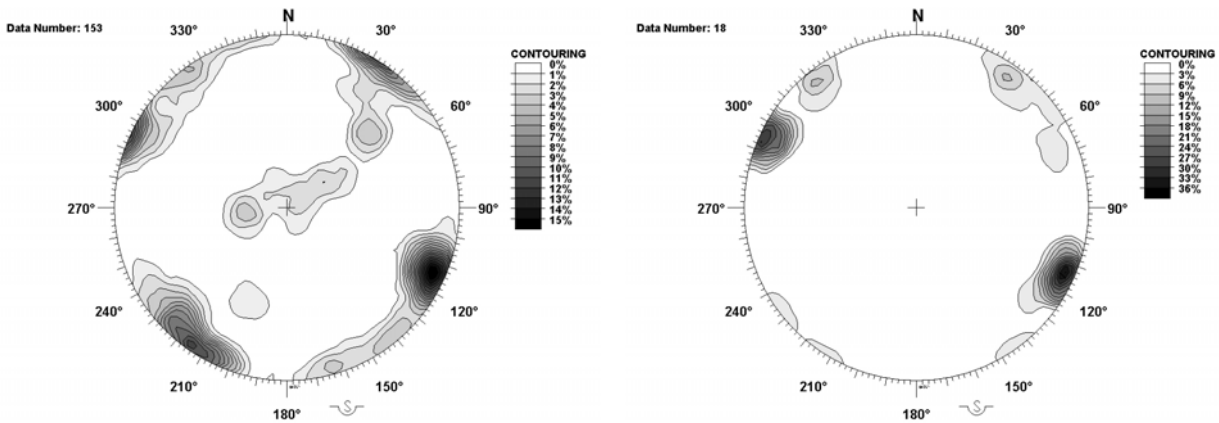


Fig. 6 Contour diagrams of poles to planes of all fractures (left diagram) and faults (right diagram) in the granites near Vápenná village.

The contour diagram of poles to fault (Fig. 5, right) identifies the reactivated Variscan fracture planes in the limestones. Both contour diagrams correlate very well. There are many reactivated planes between all sets of fractures except subhorizontal one. It seems clear enough the subhorizontal fractures were not reactivated at all. On the other hand the W-E directions of faults seem to be very important in the limestones.

In the granites there are three well defined orthogonal sets of the fractures (Fig. 6, right, Fig. 6, left). These are subvertical NW-SE fractures (so called the Sudetic direction), subvertical NE-SW fractures (so called the Moravo-Silesian direction) and subhorizontal fractures.

The contour diagram of poles to fault (Fig. 6, right) illustrates the dominance of reactivated fractures in the NE-SW Moravio-silesian direction. There are some faults in the Sudetic direction (NW-

SE) as well and almost none subhorizontal faults like in the limestones.

5. SUMMARY AND CONCLUSIONS

Four sets of joints have been found in the limestones on the west side of the Sudetic Marginal fault and three sets of joints in the granites on the east side of this fault. There are faults in all directions of joints except subhorizontals (Fig. 6). In the limestones three sets of fault has been identified (the W-E subvertical, the Sudetic NW-SE falling 45° to NE and the N-S falling 75° to W). The W-E direction of faults is the most important direction there.

There are two sets of faults in the granites (the subvertical Moravo-Silesian NE-SW and the Sudetic NW-SE). The NE-SW direction is dominant. There are almost none subhorizontal faults in the studied area (Fig. 7).

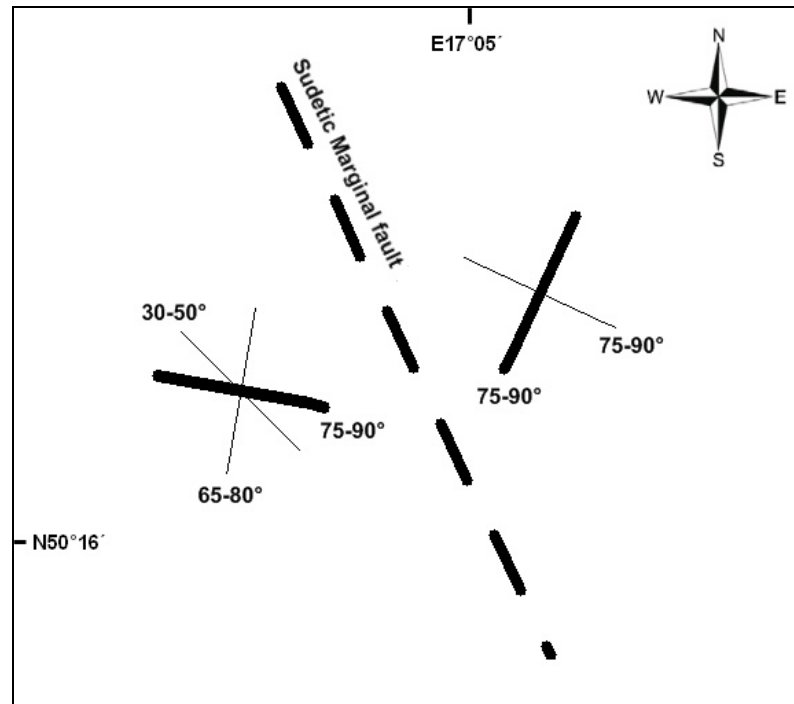


Fig. 7 Schematic draft of the Sudetic Marginal fault in Vápenná village vicinity. The strikes (lines) and the dips (numbers) of the faults (the reactivated fractures) on the both sides of this fault, left - the limestones, right - the granites.

Map (Fig. 8) summarises all brittle fractures measured in the area under study. Rose diagrams show orientation of joints and faults in several parts of the limestone quarry and in two other small limestone quarries (left) and six granite quarries (right). There are all main and less important directions that were discussed.

The sense and direction of kinematic indicators were not discussed in this article. Detail processing of the observed indicators will point to direction and sense of movements along reactivated Variscan fractures in the area.

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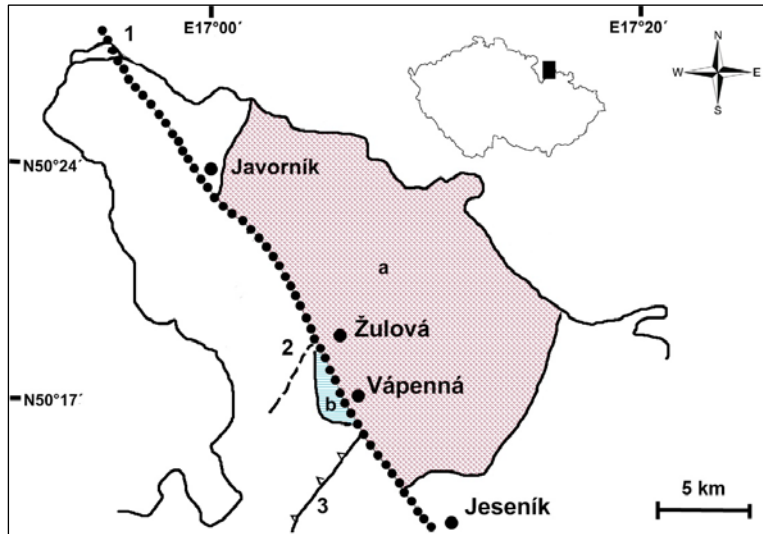


Fig. 1 Vápenná village localization (a – Žulová granite pluton, b - Limestones of the Branná group, 1 – Sudetic Marginal fault, 2 - Nýznerov fault zone, 3 – Ramzová overthrust).

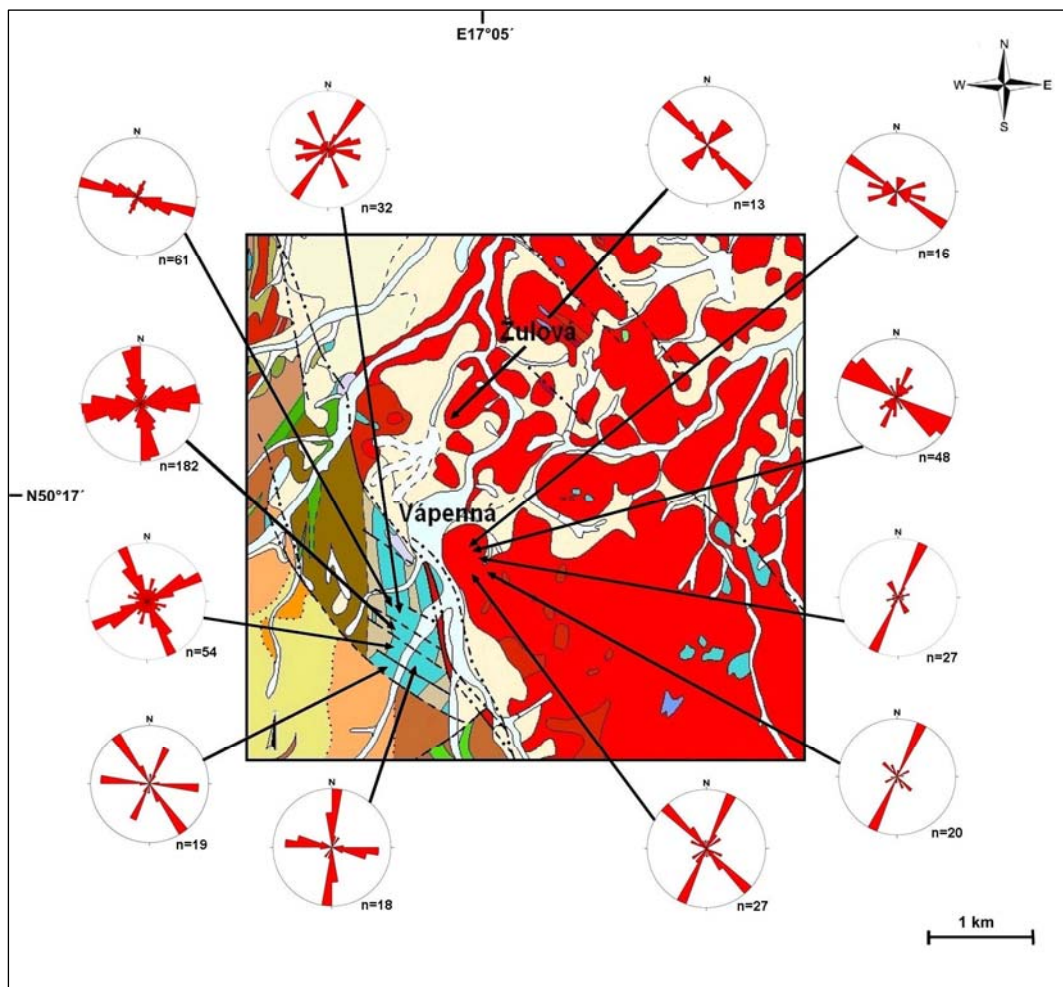


Fig. 8 Rose diagrams of all brittle fractures in the studied area.