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MINERALOGY OF THE CLAY GOUGE ON PRAGUE FAULT

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ABSTRACT
The research has dealt with mineral composition of the dislocation clays developed on the Prague fault. The Prague fault is a tectonic boundary between underlying clayey slates of Záhořany series and Skalka quartzite. The fault zone is filled with clay or sandy-silt to silty-sand matrix with scattered fragments of the surrounding rocks either slates or quartzite. Quartz, illite, kaolinite, chlorite, sporadic feldspar and gypsum were identified in powdered preparations by X-ray diffraction. The clay fraction of the taken samples is composed of illite, less kaolinite and sporadic chlorite and gypsum.

KEYWORDS: Prague fault, clay mineralogy, X-ray diffraction, clay gouge, Ordovician, quartzite, cataclasis

1. INTRODUCTION

The fault cataclastic (gouges) rocks were firstly described by Lapwort (1885). Later on many papers dealt with the theme either describing or classifying the rocks (e.g. Waters, Campbell, 1935; Hsu, 1955; Christie 1960, 1963; Reed, 1964; Spry, 1969; Higgins, 1971; Sibson, 1977). Fundamental work of Wise et al. summarizing fault rock terminology was published in 1984. Authors divided fault rocks into three basic types namely cataclasites, mylonites and metamorphic rocks. Dislocation clays together with breccia and micro-breccia belong to the cataclasites being considered as a typical product of tectonic movements occurring on dislocation planes. These clays are mostly considered as fine-grained low-temperature clays, the product of cataclase.

2. GEOLOGICAL POSITION OF THE LOCALITY

The locality with altitude 200 – 214 m above sea level is situated between Průmyslová and U Slavoje streets in Hloubětín district of Prague. It was imposed as a Natural Monument Area spreading on 0.36 ha (see Fig. 1).

The area protects a rock outcrop representing the tectonic contact between older underlying clay slates of the Záhořany rock series and younger Skalka quartzites bordering alongside of the most important fault in the Prague territory, the Prague Fault (see Figs. 2a, 2b). Skalka quartzites form massive to thick benches inset 40° towards SE. NW part of the outcrop is individualized as an anticline with limbs dipping 60 to 80° towards NW. Thickness of the benches varies. Beds superposed to quartzite are composed of dark to blackish grey clay slates as a part of Dobrotivá rock series (Ordovician) (Röhlich, 1953).

According to Vorel (1982) the fault caused vertical movement with displacement magnitude around 900 m, possibly 1000 to 1800 m in post-Ordovician period. The movement is beside other evidenced also with sporadic vertical tectonic striaes seen on the fault plane. Prague fault is considered as an important syndepositional fault active during Ordovician and Silurian periods and as a dislocation resulting from vertical movement of the sea bottom. During Silurian it served as a weak zone for ascending magmas.

Melichar and Hladil (2006) are the latest researchers dealing with the tectonic genesis of the Prague fault and its geological history. They have given several theses about the theme.

- The fault could not be active during Ordovician with regard to its position towards Ordovician sediments, where it has a character of overthrust fault.
- If the fault was active at the same structural framework as seen, a vertical movement with about 1000 m displacement magnitude would be considered alongside.
- Such movement displacement magnitude is hard to be seen within observed short fault length since its elongation into Křivoklát – Rokycany Zone has been not found.

There are not many works dealing with dislocation clay mineralogy at faults disrupting the rock series at the Prague territory. Dislocation in fills at examined locality consider variable rock types from pure clay substances to sandy-silt or silty-clay substances with fragments of either slates or quartzite. Similar fills have been found during driving of Mrázovka tunnel at faults disrupting Libeň slates where tectonic movements gave rise to substances of a clayey-silty nature containing angular slate fragments (Mašín, 2001). Similar processes have been observed at Ordovician clay slates of Záhořany series or at Skalka quartzite during building of the railway

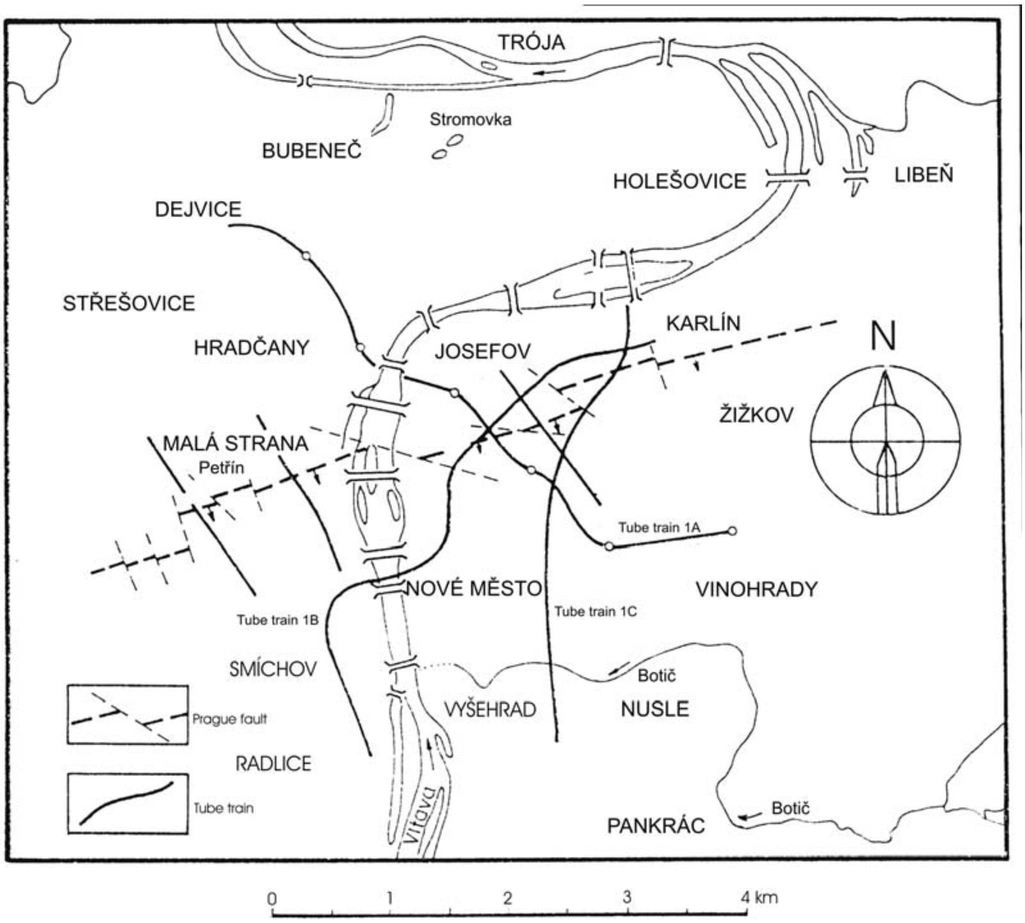

Fig. 2a Schematic map course of Prague fault (after Vorel, 1982).

corridor between Prague - Libeň and Main railway stations.

3. RESEARCH METHODOLOGY

The samples were take delivery of the fault line (see Fig. 1). In order to eliminate interference on diffractograms from non-clay minerals. The samples were prepared for separation of the clay fraction by gently crushing the samples to sand size and were wetsieve with a 63 μm mesh for random orientation of particles. Individual clay minerals were identified by X-ray diffraction analysis of the powder preparations with random orientation of particles and by the analysis of preparation with preferred orientation of particles. The particles were settled on the glass slide from the prepared water suspension. They were analyzed either in the natural forms or as samples saturated by ethylen glycol under 80 °C and samples heated at 550 °C for 1 hr. X-ray difractograph Philips PW 7310 was used on conditions of Cu K_α emission, voltage 40 kV, current 40 mA, scanning speed $1°.min^{-1}$ spreading in between 3 to 70° 2θ for random preparations and 3 to 35° 2θ for oriented preparations respectively. Obtained X-ray data were interpreted according to Micheev´s manual (1957) and Mineral Powder Diffraction File - Data Book (1980).

Kubler's index (Kubler, 1967, 1968), a value representing a width of the basal reflex of the illite at half of its height, was applied as a comparative value expressing the grade of illite crystallization. It can be expressed in millimetres or degrees 2θ. Frey (1987) applied this index to distinguish interface between diagenesis, anchimetamorphosis and epitetamorphosis. He determined the limits at 0.42 and 0.25° 2θ. Although the method is relatively inaccurate it is commonly used up to the present days.

As well figures expressing a distribution of individual illite polytypes can be applied to express probable grade of illite crystallization. Illite naturally occurs as a mixture of two, 1Md and $2M_1$ polytypes, the first one prevailing over second. Velde and Hower (1963) expressed ratios between both polytypes by curves using values of their diffraction intensities at 3.74 Å and 2.58 Å. They made the curves for two fractions above and below 1 μm. In case of our samples polytype $2M_1$ prevails over 1Md one in fraction above 1 μm whereas 1Md polytype dominates in fraction below 1 μm.

4. THE SAMPLES

Several research samples were taken alongside of the dislocation disrupting rocks at eastern part of

Table 1 Summary of results.

Sample No/ preparation type	quartz	kaolinite	illite	K-feldspar	gypsum	chlorite	chlorite x smectite	I-S structures
I random	x	x	x					
II random	x	x	x	x				
II oriented		x	x		x	x		
III random	x	x	x		x			x
III oriented		x	x		x			
IV random	x	x	x				x	
IV oriented	x	x	x			x		
V randomed	x	x	x					
V oriented		x	x			x		

the outcrop where all types of the fault fills representative for the whole outcrop could be found. The samples were divided into five groups (see Fig. 1):

Prague fault I – the fill. It represents a fill at highest part of the dislocation in the profile. It is composed of cataclastic angular quartzite fragments scattered in sandy-silt or clayey matrix.

Prague fault II, a bright whitish clay occurring at upper part of the outcrop profile. It represents highly kaolinized angular quartzite fragments scattered in clayey – silty matrix.

Prague fault III, mylonitized and weathered red brown material. It represents angular quartzite fragments accompanied with sporadic slate fragments, both scattered in silty – clayey matrix.

Prague fault IV, mylonitized and weathered light brown material. It represents a horizon composed of angular slate fragments with remarkable bedding scattered into a silty – clayey matrix.

Prague fault V, gray dark tectonic clay. It represents a matter composing low horizons of the profile. This horizon is of remarkably clayey nature with scattered fragments of weathered slates.

5. RESULTS

The above described samples have the following mineral composition on the basis of X-ray examination:

I – powdered preparation with random orientation of particles, composed of quartz, illite, kaolinite

II – powdered preparation with random orientation of particles, composed of quartz, illite, kaolinite, K – feldspar,

II – preparation with preferred orientation of particles, composed of illite, kaolinite, gypsum, chlorite

III – powdered preparation with random orientation of particles, composed of quartz, illite, kaolinite, gypsum, I-S structures

III – preparation with preferred orientation of particles, composed of illite, kaolinite and gypsum

IV – powdered preparation with random orientation of particles, composed of quartz, illite, kaolinite, smectite or chlorite

IV– preparation with preferred orientation of particles, composed of kaolinite, illite, chlorite and quartz

V – powdered preparation with random orientation of particles, composed of quartz, illite, kaolinite,

V – preparation with preferred orientation of particles, composed of illite, kaolinite and chlorite (see Table 1)

In detail was study illite, sample No. V. In clay gouge samples is Kubler index (KI) of illite in the range 0.7 (Δ2θ°). The illite KI with values in the range 0.55-0.75 (Δ2θ°) indicates a deep diagenesis zone and paleo-temperatures of about 130-150 °C (Merriman and Frey, 1999; Árkai et al., 2002).

On the basis of peaks area 15-35 2θ° was identified the 1Md polytype of illite. Clay gouge illite is neoformed. Powder XRD polytype analysis shows that the clay fraction contains the predominance of 1Md illite polytype over $2M_1$ illite polytype. This subscribes to the examination of Ylagan et al. (2002) and Solum et al. (2005).

6. PARENT MATERIAL AND CLAY GOUGE

The composition of the fault filling is determined by a character of mother- as well as surrounding rocks. There are several tectonic deformations or mylonitized zones in the Prague territory. The zones are mostly developed in Ordovician slates (Kovanda, 2001). These rocks are folded i.e. they have remarkable plastic deformations. Mylonitized clayey zones indicate a local exceeding of plasticity limits conducing to development of a brittle tectonics as seen at the studied outcrop. As seen, both the dark underlying clayey Ordovician slates of Záhořany series and the light Skalka quartzite influenced mineral compositions of the taken samples. The mylonitization of the rocks at Prague fault zone indicates former tectonic movements (Kříž, 1999). According to Šindelář et al. (2006) the cracks in the studied rocks are often filled with secondary minerals such as limonite and gypsum. This was confirmed on the basis of two taken samples (II, III). The dislocation fill with prevailing clayey matrix is equal to clay slate as a mother rock whilst sandy fills with low clay content equal to the Skalka quartzite. Similar phenomenon was described during realization of the railway building project in the territory between Praha – Libeň station, Praha – Masaryk's station and Praha – Main station.

7. CONCLUSION

The clay gouge have a polymineral composition, that contain quartz, illite, kaolinite, and small amount chlorite, smectite, mixed layer illite-smectite and gypsum. Illite was in detail study. Illite contain the predominance of 1Md illite polytype and Kubler index is 0.7 ($\Delta 2\theta°$).

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Fig. 1 Prague fault (Hloubětín) with marked places where the samples were taken (Photo M. Šťastný, 2007).

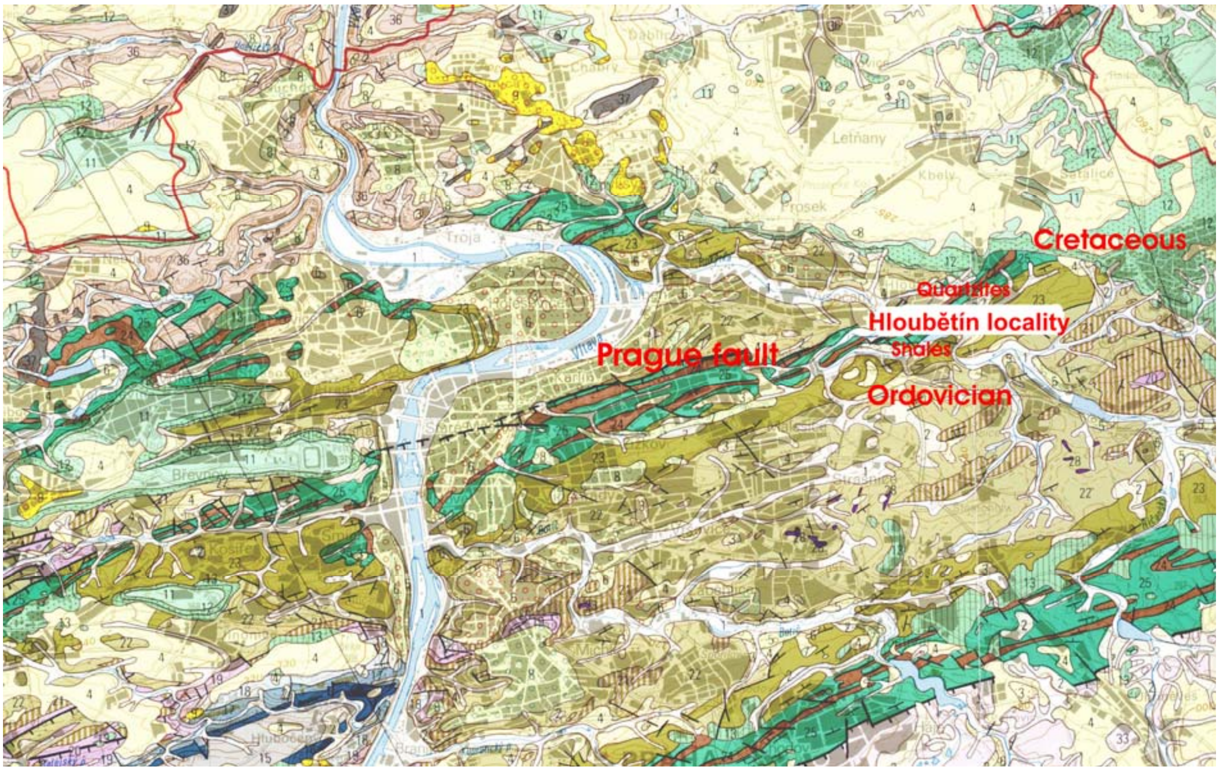

Fig. 2b Geological map of the vicinage of Prague fault (after Kovanda, 1995).