Relics of laterites on the Letovice Crystalline Complex, Moravia

Relikty lateritů z letovického krystalinika (Czech summary)

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Pre-Upper-Cretaceous laterites from the Letovice Crystalline Complex (north of Brno, Moravia) were studied using phase and chemical analysis. Iron oxides were characterized also by their dissolution kinetic. Results were compared with previous works dealing with laterites in this region as well as with laterization in general. Letovice laterites are represented by both typical well preserved mixtures of kaolinite and goethite (2 localities) and recrystallized pisolitic matter composed of Al, Si and Fe oxides (1 locality).

Key words: laterite, Letovice, Moravia
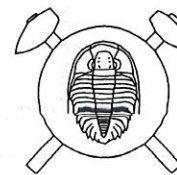
Introduction

During lateritic weathering of various parent rocks, alkali and alkaline earth metals, and silicon are quickly removed by action of water. The least mobile elements, particularly Al, Cr, Fe, and Ti remain in forms that are the most thermodynamically stable in neutral medii under oxidizing conditions as yellow, dark brown or red material called laterite. The order of various element mobilities under the conditions of lateritic weathering was summarized by Schellmann (1986). Major components of laterites are iron and aluminium hydroxides to oxides, kaolinite and quartz (Schellmann 1986, 1995). More generally speaking, the Al excess above the solubility limit of Al in Fe oxide phases is bond in a clay mineral corresponding to parent alumosilicate (see, e.g., Číčel - Novák - Horváth 1981). The fate of some other important metals depends on pH, redox conditions, and element solubilities and may yield information about the parent rock, the course of weathering, and the recrystallization of the original products. For example, Cr and Al mobilities are very similar to that of Fe. Therefore, the Cr/Fe and to a certain extent also Al/Fe ratios ought to be constants typical for a parent rock in any stage of weathering. Ni is usually depleted after destruction of intermediate silicates (Golightly 1979), the mobility of Mn depends on the form of its occurence in the parent rock and on redox conditions during the weathering (Schellmann 1986). Primary laterite may be recrystallized under climatic conditions similar to those of its formation (Zeese et al. 1994). These facts permit investigation of possible stratigraphic utilization of laterites (Köster 1955, Zeese et al. 1994) and so laterites are further studied at present.

Relics of laterite weathering crust on the territory of the Czech Republic were studied particularly in the fifties to sixties in aim to find deposits of metal ores and lately clays (Konta - Kužvart 1963, Kužvart - Konta 1968, Kudělásek - Polický - Zamarský 1972). The aim of this article is to compare the mineralogy, element composition and reactivity of laterites from Letovice, southern Moravia, with those described in literature (Schellmann 1986, 1995, Schwertmann - Fitzpatrick 1992, Schwertmann 1993), because knowledge about laterite genesis has been substantially extended since the sixties.

Geologic setting

The characteristics of the Letovice Crystalline Complex (Cadomian age) were summarized by Jelínek et al. (1984) and Mísař and Nekovařík (1986). Letovice surroundings have been described also by Tonika et al. (1987) and Mísař et al. (1992). The average chemical compositions of parent rock summarized by Jelínek et al. (1984) and Mísař and Nekovařík (1986) are used, e.g., in Table 4. Two synforms are distinguished in this region: Letovice (L-) and Roubanina (R-). Typical compositions of particularly ultramafic are different in these synforms. Letovice weathering deposits were described also by Kudělásek and Prachař (1956), Vágiová (1959), and Konta and Kužvart (1963). Laterites were described in drill holes in Křib near Kunštát-Rudka (6 km SW of Letovice) under Cenomanian sediments. High Ni content in Rudka laterite indicates its origin from ultramafic rock. In Muzlov (13 km NNW of Letovice), laterites formed on basic rocks and kaolinised Permian rocks were also referred to under Cenomanian layers (Frejková 1960). Hence, it is generally supposed that lateritization in the Letovice Crystalline Complex proceeded in the Lower Cretaceous (Kužvart - Konta 1968, Mísař - Nekovařík 1986). However, any systematic comparison of the phase and element composition of the Letovice laterites has not been done yet.

The places of the laterite occurence

Four groups of samples were collected in the Letovice surroundings (Fig. 1). The following localities may be distinguished:

1. *Dolní Smržov, the southern edge of the village* (samples denoted Smr+number hereafter). Amphibolite (L-synform) above the Zavadilka creek is covered by a yellow
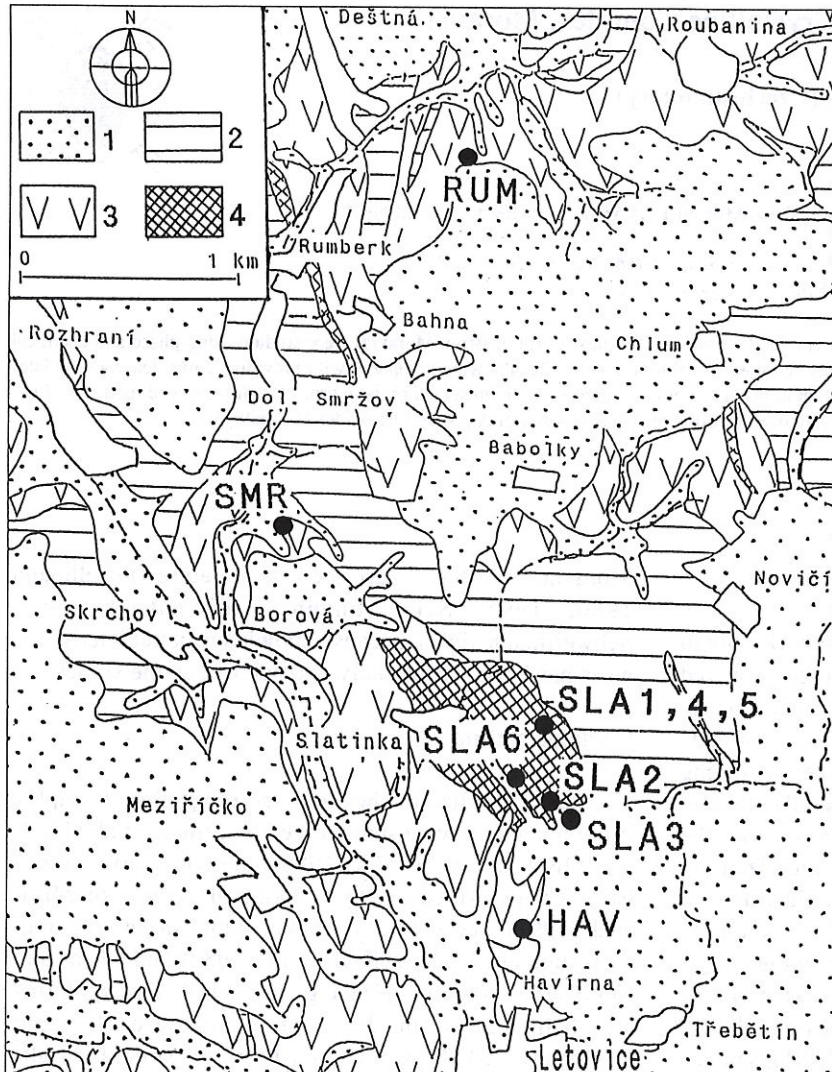
Fig. 1. Letovice surroundings with places of laterite and Slatinka red soils occurence
1 - Quaternary, Tertiary, Upper Cretaceous and Permian sediments; *2* - micaceous schists and gneisses; *3* - metagabbros and amphibolites; *4* - ultramafic rocks

clay layer and a few meters of reddish pisolitic soil. The latter was exploited as a red pigment in the middle of this century. Yellowish saprolite (totally phase-transformed parent rock with a retained notable amphibolite layer structure) occurs here (Smr12). Saprolite is a typical intermediate between parent rock and soft laterite and it occurs on the weathering surface.

2. *Panský les, east of Rumberk* (denoted Rum). Clayey or indurated, yellow to ochre laterite in a boundary between metagabbro (R-synform) and Cretaceous sediments. These deposits also were previously exploited for a pigment production.

3. *The area east of Slatinka* was studied by Kudělásek and Prachař (1956) and Vágiová (1959) with the aim of finding new Ni deposits. Information on the minerology of weathered ultramafics was given also by Kruťa (1966). Their results are compared with ours hereafter. Two types of iron-rich materials may be found here according to the literature cited above: ore veins in serpentinite (magnetite, hematite, goethite?, ilmenite, chromite; probably the iron ore exploited in the 19th century) and a

material called laterite by Kudělásek and Prachař (1956). There are small ultramafic (L-synform) bodies in the place (see Fig. 1), each of them covered by reddish to purple-red soils mixed with fragments of parent red serpentinite. The matter is frequently washed down by meteoric water colouring surrounding ground to a striking purple shade. Samples of these topsoils were collected (further denoted Sla) and studied in this work. They are probably of the same nature as "laterite" according Kudělásek - Prachař (1956).

4. *Letovice-Havírna, the northern edge of the village.* Yellow, red or brown clayey to indurated laterites (denoted Hav) are covered by sediments at present. The laterite was tested in the 1930's for red pigment production and, lately, the shafts were filled up. Kruťa (1966) described pisolitic bauxite occuring here, composed of boehmite, hematite, gibbsite, and kaolinite. There is rare access to some of those shafts at present. The appearance of the laterite samples Hav3,5 is similar to that of Rumberk (indurated yellow to brown laterites with rare dark to black pisolites).

Technique of analyses

Samples were dried at room temperature or at 80 °C, powdered in a porcelain mortar and sieved through a 160 mesh brass sieve.

X-ray diffraction patterns (XRD) were obtained with use of Dron-2.0 with $CoK\alpha$ radiation (Soviet Union). Transmission microscopy (TEM, TESLA device with a 20 kV source, Czech Republic) was employed to search for a halloysite presence beside an excess of other clay minerals. Qualitative analysis of a magnetic phase in Havírna samples was performed with use of a vibrating magnetometer.

For chemical analyses, samples were melted with NaOH, or with $KHSO_4$ after heating with HF. Resulting solutions were analyzed by gravimetry (SiO_2), chelatometry (Al, Fe), redox titration (Mn) and by flame AAS (Cr, Mn, Ni; Zeiss 3, Germany). No analysis of the ratio Fe^{2+}/Fe^{3+} was performed as there were no evidences of the presence of Fe^{2+} in the laterites. Total Fe is hence given in the tables and figures.

Magnetic particles were separated from a sample suspenion with a hand-magnet. The resulting material was analysed by scanning electron microscopy with element analysis by EDAX based on secondary electron spectroscopy.

Abrasive stripping voltammetry was employed for the estimation of Fe oxide reactivity as was described elsewhere (Grygar 1996). A sample is mechanically deposited on a paraffin impregnated graphite working electrode and dissolved in 0.1 M perchloric acid - 0.4 M sodium perchlorate. A differential pulse mode (pulses - 50 mV after 4 s) with a scan rate 1 mV s^{-1} was utilized. Peak potentials E_P are referred to a saturated calomel electrode. The more negative the E_P obtained, the less reactive the sample is. The method yields information similar to common oxalate or dithionite-citrate-bicarbonate extracting procedures (Grygar, prepared for publication). Laterites of various origin (Trolard et al. 1995, Schellmann 1986, 1995) were used for comparison with the Letovice samples.

Results and discussion

Mineralogy of laterites

The mineralogy of weathering products obtained by XRD and TEM is summarized in Table 1. Individual iron oxide phases, clay minerals, and minor minerals are important for the evaluation of the laterite origin.

As follows from literature, a primary ferric product of lateritic weathering of ultramafic rocks containing $(Fe,Mg,Ni)SiO_3$ is Al-substituted goethite, α-FeOOH (Golightly 1979). Goethite is the most common weathering product of any iron-rich rock (Schwertmann - Fitzpatrick 1992) and hence goethite is common in Smržov clays and in all samples from Rumberk and Havírna. Although hematite, α-Fe$_2$O$_3$ is a more thermodynamically stable phase than goethite under low activity

of water and higher temperatures (Trolard - Tardy 1987), any direct topotactical dehydratation of goethite cannot proceed in nature for kinetic reasons (Schwertmann - Cornell 1991; Schwertmann - Fitzpatrick 1992). Hematite, quartz, and probably XRD amorphous aluminium oxide are major components of Smržov red soils (Table 1). Because the genetic relationship between subjacent clays and red soils is strongly supported by similar ratios of Al, Cr and Ni to Fe (see below), we may suppose that certain recrystallization of iron oxides has proceeded in Smržov laterite.

Table 1. The appearance and phase composititon of samples (phase denotation - K: kaolinite, H: halloysite, S: serpentine minerals, 15A: a clay mineral with d = 1.5 nm, Q: quartz, g: goethite, h: hematite, sp: spinel-type oxide, a: anatase, gi: gibbsite)

Slatinka: soil samples above serpentine bodies		
reddish soil	Sla1	S, Q, H?, h, g
red or reddish soils	Sla2,5,6	S, Q, h
yellowish or reddish soils	Sla3,4	S, g?, h?, Q
Havírna: clay or yellow to brown laterite in an old pit		
yellowish to brown hard laterite	Hav3, 5	g, K
grey clay	Hav4	K, g, gi
Rumberk: yellow laterite deposit		
yellow-brown soft laterite	Rum5	K, g
	Rum6	K, Q, g, H
ochre soft laterites	Rum13,14	K, g, Q, a
yellow-brown hard laterite	Rum12	K, g
	Rum15	K, g, a, gi
Smržov: layered deposit on weathered amphibolite		
yellowish clay	Smr10	K, H, Q, g
	Smr11	15A, a, g
ochre saprolite	Smr12	15A, g
red-brown soil	Smr2	15A, h, Q
red pisolitic soil	Smr3,4	h, Q

On the contrary, the presence of goethite in all Slatinka samples is much more rare, if any, and hematite is a major iron oxide here. A different, much faster pathway of weathering may promote hematite formation (Schwertmann - Fitzpatrick 1992). Schwertmann (1993) also showed that the intensive red color of soils (caused by excess of hematite over goethite) is not typical for moderate climate unless hematite is a bedrock component. In any case, red "lateritic" soils from Slatinka including also a part of the samples studied by Kudělásek and Prachař (1956) probably have not been formed by the genuine lateritic weathering. This surprising fact may be explained, for example, by the lack of suitable terraces or platforms indispensable for the weathering product accumulation and preservation. From this point of view, the situation is quite different in Křemže, South Bohemia (pre-Cretaceous weathering of serpentinized ultramafic intrusions in gabbroamphibolites, see Čech - Koutek 1947) in spite of very similar geological conditions.

It must be emphasized that the red colour of soils may be generally caused by a very small amount of hematite. Moreover, rather the hematite to goethite ratio is important for the resulting colour of soil (Schwertmann 1993). This

may be demonstrated by the example of three soil samples from Kunštát-Rudka (south west of Letovice). Their properties are summarized in Table 2. The different colours of the samples 8 and 9 are caused by a few percent of hematite in the former. Clay mineralogy of all three samples is very similar (probably derived from weathered Cretaceous sediments typical of the place), but the soil sample 7 has probably been mixed with relics of laterites (proven by well developed goethite peak on its XRD pattern) subjacent Cretaceous sediments (see Geologie setting). Surrounding soils may be coloured by hematite particles from this source because the colour strength of pedogenic (lateritic) hematite with sub-micrometer crystals is considerable. We may conclude that the red colour of soils in the region may be caused by both hematite directly from bedrock (as in Slatinka) and by smaller amounts of a hematite pigment from older weathering products. Visual purple to red colour of soils itself cannot be a proof of their lateritic origin.

Table 2. The colour and composition of soil samples from Kunštát-Rudka (7A: a 1:1 clay mineral, Mi: mica-illite, remaining phases denoted as in Table 1)

sample	colour	phase composition	Fe, %
7	red	Q, 7A, Mi, g, h	10.4
8	red	Q, 7A, Mi, h, g	4.65
9	yellowish	Q, 7A, Mi, 15A	2.95

Maghemite (γ-Fe_2O_3) is another iron oxide occuring in laterites. It is derived directly from spinel type oxides of parent rock as a relic mineral or it is formed by a specific route in soils (Schwertmann - Fitzpatrick 1992). Hav3 and Hav5 samples contain a magnetic phase. The presence of 1-2 % maghemite may be estimated from magnetic hysteresis loops. This amount is too small for XRD analysis.

Several clay minerals have been found in the Letovice laterites. Kaolinite is the most common one because feldspars have been present in basic rocks. Kaolinite is the major constituent of Rumberk and Havírna goethitic laterites. For example, the sample Hav4 contains well crystalline kaolinite with a Hinckley index close to 1. Well developed structure indicates, that kaolinite has not been recrystallized and it was formed in the early stages of weathering (Köster 1955). Minor halloysite accompanies kaolinite in a few samples (Table 1) according to the most intensive XRD peak (diffracting parameter *d* close to 1 nm) and a characteristic shape of crystals on TEM micrographs (Číčel - Novák - Horváth 1981). The clay mineral of the soft laterites from Smržov probably belongs to the smectite group. These minerals are less stable than kaolinite, which enabled the continuing desilification mentioned below.

On the contrary, any reflections of clay minerals have not been observed in the region d = 0.7-1.6 nm in Slatinka samples but those of serpentine, although 2:1 phyllosilicates are common products of serpentinite laterization (Golightly 1979, Číčel - Novák - Horváth 1981). For example, significant occurence of nontronite in weathered ultramafics (Bojanovice, North Moravia) was reported by Kudělásek - Polický - Zamarský (1972). The absence of those silicates supports our hypothesis about a different formation pathway of Slatinka red soils, as not only desilification, but also removal of Mg is in a very early stage.

Minor phases (quartz or gibbsite) are formed whenever a considerable excess of Si or Al, respectively, is present in parent rocks and resulting laterites (Schellmann 1986). In line with this rule, quartz occurs in Rum13, whereas Rum15 and Hav4 contain gibbsite admixtures. Quartz may arise under specific conditions of weathering due dry periods. However, a mechanical admixture of quartz from overlying sandstones cannot be excluded particularly in Rumberk (Rum13) without further microscopic study of quartz grain morphology.

Anatase is present in Rumberk and Smržov samples due to high titanium content in basic parent rocks (see also Schellmann 1986) and low Ti mobility. Anatase is quite common in weathering products unless ilmenite was present in parent rock (Zeese et al. 1994).

A complete sequence of well preserved laterite deposits includes also so-called *ferricrete, Fe crust* or *cuirasse de fer*, a hard cover of the deposit containing mainly secondary kaolinite and hematite, pisolites of Fe and higher Mn oxides, free Al oxides, and only rarely traces of relic minerals. The recrystallization process is enhanced by continuing weathering accompanied by action of soil solutions with dissolved organic substances and by altering levels of ground water (Köster 1955). Therefore, originally porous microcrystalline primary laterite transforms to a characteristic indurated and/or pisolitic material of bright red colour (Golightly 1979, Zeese et al. 1994). Pisolites, prevailing hematite, and XRD amorphous free Al oxides are present only in Smržov red soils. Hard laterites from Rumberk (see Table 1) do not contain a significant amount of hematite and only the sample Rum15 contains gibbsite. Hence, only Smržov soils and Rum15 may be suspected to be further recrystallized.

Element composition of laterites

Changes of the ratios of the three major elements, Al, Si, and Fe, during chemical weathering of rocks may be easily demonstrated by triangular diagrams (Figs. 2-4) as was proposed by Schellmann. During the weathering, parent rock (in zone I in Fig. 2) is quickly depleted in Si while a mixture of Al-substituted iron oxides and kaolinite is formed (zone II in Fig. 2). When excess Al oxide is present, also free Al oxides arise (so called bauxitic laterite, zone III). Because the Al/Fe ratio is preserved in this desilification step, a corresponding position of the matter in the trigonal diagram moves along the line arising from the Si vertex (see dotted lines in Figs. 3 and 4). Products of serpentine weathering from the north-east of Letovice (Sla1-6 and the samples described by Kudělásek - Prachař, 1956) represent an initial stage of the process. The points corresponding to the samples occur close to a theoretical curve of the desilification of serpentine (see Fig. 4).

However, a small extent of desilification of the Slatinka topsoils and their abundant occurence in thin layers intimate different conditions of their formation in comparison with real laterization. All stages of the desilification of basic rocks may be demonstrated by represenative laterites from Smržov, Rumberk, and Havírna (Figs. 3 and 4).

Further desilification of laterite (a shift from the zone II to the zone III) may proceed in various ways. Köster (1955) and Schellmann (1995) mentioned the possibility of coagulation and taking away of kaolinite by water flows. The divergence of kaolinitic samples from Havírna (Hav4 on the one and Hav3 and Hav5 on the other hand) may be the result of such a phase separation. This type of desilifi-

Fig. 4. Composition of red soils from Slatinka (plus), samples described from the place by Kudělásek - Prachař (1956) (triangle), and Havírna laterites (box). Dotted line: theoretical desilification of ultramafic, L-synform

cation ought to lead to a characteristic shift of position in the triangular diagram: a more kaolinite rich fraction directly from the Fe vertex close to zone II (see Hav4), the Fe enriched fraction in the opposite direction (Hav3, Ha5). On the other hand, a decomposition of alumosilicates by a continuing intensive laterization process may lead even to the loss of Si with respect of Al (bauxitization). The bauxitized sample shifts in the trigonal diagram then further along the line arising from the Si vertex from zone II to zone III. Less stable alumosilicates must enhance the process. This is probably the case of Smržov red soils (see above).

The ratio of Al, Cr, Mn, and Ni to Fe of the parent rock is preserved in the laterites from Smržov and Rumberk (see Tables 3 and 4). The Mn to Fe ratio is more dispersed in Rumberk and Smržov laterites, probably because Mn mobility depends on the particular circumstances at any point of laterite profile (Schellmann 1995). This dispersity is probably enhanced by recrystallization of the original laterite of Smržov proven by its phase composition. However, the Al to Fe ratio may be undoubtedly used as an indicator of the laterite source: the difference between basic rocks (amphibolite and metagabbro of both R- and L-synform are very similar from this point of view) and ultramafic is statistically significant and the same is valid for the corresponding laterites (Smržov, Rumberk) and serpentine weathering products from Slatinka. The ratio of Ni and Cr to Fe is at least an order of magnitude bigger in serpentine than in basic rocks, but there is a possibility of nickel loss in the later stages of weathering similarly as in upper layers of nickeliferrous laterites (Golightly 1979). With respect to the Al/Fe ratio, samples Hav3 and Hav5 are probably products of basic rock weathering despite a relatively high Cr content (Table 4). Cr/Fe ratios up to 0.13 were found by the EDAX analysis of magnetic particles of Hav3 (see Technique of analysis), indicating a presence of Cr-rich magnetic spinel as a relic mineral.
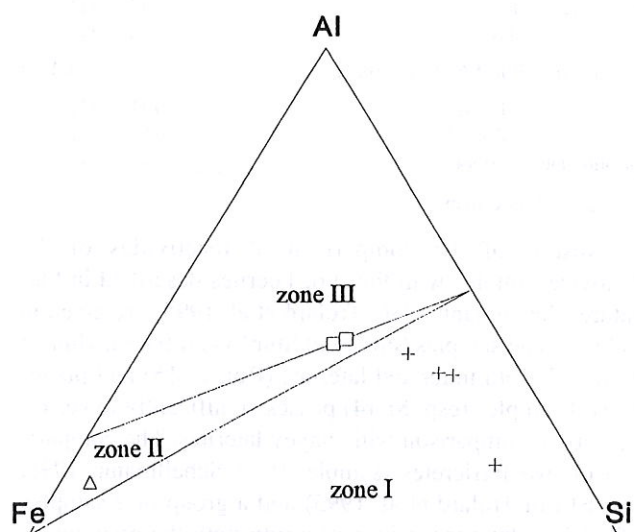

Fig. 2. Mean composition of world laterites according to parent rock composition. Plus: acid rocks, clay shale, sandstone; box: basic rocks; triangle: ultramafic. Zone I: parent rocks, early stages of desilification (lateritic soils) or laterites with an excess of non-reactive SiO₂; zone II: mixtures of aluminuous iron oxides and 1:1 clay minerals (laterites); zone III: laterites with free aluminium oxides, bauxitic laterites, bauxites
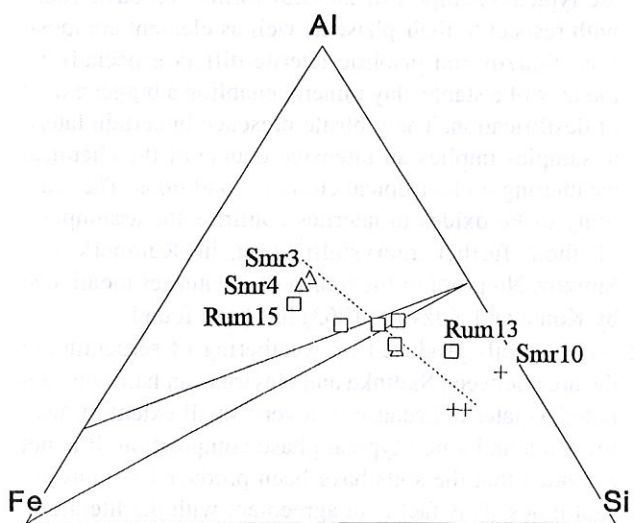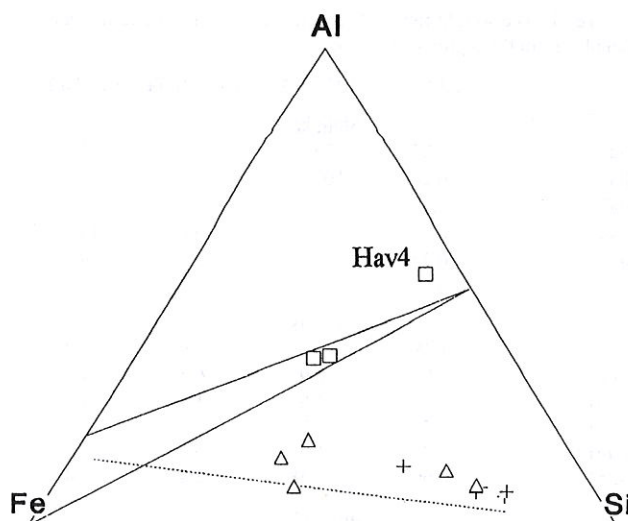

Fig. 3. Composition of laterites from Smržov (plus: clays, triangle: red soils) and Rumberk (box). Dotted line: theoretical desilification of amphibolite, R-synform (parent rock composition according Jelínek et al. 1984 and Mísař - Nekovařík 1986)

Table 3. The weight ratios of Al, Cr, Mn and Ni to Fe in the lateritic samples from the region of Letovice

	Al/Fe	10^3*Cr/Fe	10^3*Mn/Fe	10^3*Ni/Fe
Slatinka				
Sla1	0.21	55	8.6	11
Sla2	0.20	100	36	33
Sla3	0.21	21	8.6	17
Sla4	0.17	15	5.0	14
Sla5	0.24	23	13	9.0
Sla6	0.23	23	10	9.3
Rumberk				
Rum5	1.28	3.3	4.0	2.3
Rum6	0.95	2.9	6.5	1.8
Rum12	0.76	1.8	1.5	1.6
Rum13	1.7	2.7	16	1.7
Rum14	1.0	1.5	20	0.84
Rum15	0.69	0.78	2.4	0.43
Smržov				
Smr2	0.91	3.1	7.8	1.3
Smr3	0.94	3.1	11.3	0.7
Smr4	0.84	2.6	8.6	1.2
Smr10	3.8	4.0	4.2	4.4
Smr11	0.71	1.1	7.8	1.1
Smr12	0.80	2.7	23	1.9
Havírna				
Hav3	0.51	24	3.8	2.2
Hav4	4.2			
Hav5	0.56	41	3.5	2.8

Table 4. The comparison of Al, Cr, Mn and Ni to Fe weight ratios in parent rocks (Mísař - Nekovařík 1986), laterites from Letovice studied and listed in literature. Outliers and samples with a non-typical phase composition (Smr10) have been excluded in the case of samples described in this work

	Al/Fe	10^3*Cr/Fe	10^3*Mn/Fe	10^3*Ni/Fe
ultramafic L-rock[1]	0.09(0.06)	17(10)	8(6)	11(1)
Sla1-6	0.21(0.02)	27(16)	9(3)	12(3)
Ref.[2]	0.10(0.04)			5.5(2.3)
Ref.[3]	0.21			
typical laterite				
on ultramafic[4]	0.06	55	18	24
amphibolite R-rock[1]	0.9(0.2)	2.8(1.7)	8.5(3.9)	1.0(0.7)
Rum5,6,12-15	1.1(0.4)	2.2(1.0)	8.4(7.7)	1.4(0.7)
amphibolite L	1.0(0.3)	2.1(0.8)	8.4(5.4)	0.8(0.5)
Smr2-4,11,12	0.84(0.09)	2.5(0.8)	7.3(1.4)	1.2(0.4)
Hav3,5	0.53	33	3.7	2.5
typical laterite				
on basalt[4]	0.66	1.7	5.9	0.8

[1] Jelínek et al. (1984), Mísař - Nekovařík (1986)

[2] Kudělásek - Prachař (1956)

[3] V. Rosický, according to Kudělásek - Prachař (1956)

[4] Schellmann (1986)

Reactivity of iron oxides

With respect to dissolution kinetic, certain differences among Fe oxides may be distinguished. Highly crystalline phases, goethite and hematite, have very similar properties, and the rate of their dissolution is directly proportional to a specific surface area (Grygar 1996). The reactivity decreases significantly with Al for Fe substitution (Trolard at al. 1995). Primary goethite and hematite have similar specific surface areas of a few tens m^2g^{-1} and similar Al con-

tents. Hence, their reactivities are similar and they may be completely extracted from the mixture under similar conditions. On the contrary, recrystallization leads to generally less reactive ferricretes (Trolard et al. 1995, Zeese et al. 1994). Abrasive stripping voltammetry may be used as a simple way to estimate the iron oxide reactivity (Grygar 1996). This approach is based on the comparison of studied samples with those of known origin.

Table 5. Peak potentials E_P of lateritic Fe oxides. If E_P is a mean value of a homogeneous group of samples, corresponding standard deviations (s.d.) and number of samples (n) are given

laterite	E_P, V	s.d. (n)
primary laterites (on ultramafic to acid parent rocks)	-0.04	0.01 (9)
ferricrete on ultramafic	-0.16	(1)
claystone	-0.08	(1)
clay laterites Rum5,6,14, Smr10, Hav3,5	-0.02	0.02 (6)
hard laterites Rum12	-0.11	(1)
Rum15	-0.075	(1)
pisolitic laterite Smr4	-0.15*	(1)

* a very flat maximum

Results of the comparison of reactivities of the Letovice samples with those of laterites described in literature (Schellmann 1986, Trolard et al. 1995) are given in Table 5. The samples Smr2 and Smr3 yield flat maxima at < -0.1 V. Both indurated laterites (Rum12,15) and pisolitic soil samples (esp. Smr4) posses significantly lower reactivity in comparison with clayey laterites. The comparison of two ferricretes (sample #1 of Schellmann, 1995, and F15 of Trolard et al. 1995) and a group of 9 samples of primary laterites is in conformity with the assumption of decrease of Fe oxide reactivity due to recrystallization.

Conclusion

1. Yellow to brown laterites from Havírna and Rumberk are typical examples of laterites formed on basic rocks with respect to their phase as well as element composition. Smržov red pisolitic laterite differs especially by the lack of a stable clay mineral enabling a bigger extent of desilification. The gibbsite presence in certain laterite samples implies an intensive course of the chemical weathering under tropical climatic conditions. The reactivity of Fe oxides in laterites confirms the assumption of their further recrystallization in Rumberk and Smržov. No proof of the transport of laterites mentioned by Konta and Kužvart (1963) has been found.

2. Red topsoils produced by weathering of serpentine in the area between Slatinka and Havírna can hardly be denoted as laterite because of a very small extent of desilification and a non-typical phase composition. It is not excluded that the soils have been produced in more recent times. This fact is in agreement with the literature: neither Kudělásek and Prachař (1956) nor Vágiová (1959) described a typical laterite comparable to that of Rumberk or Smržov. We may conclude that any real laterite on Letovice ultramafic has not been found yet.

3. Element and phase composition of laterites as well as their Fe oxide reactivities may be used for the study of laterite origin and further recrystallization. Therefore, our aim is to continue the study of other Bohemian and Moravian laterite relics.

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Relikty lateritů z letovického krystalinika

Předsvrchnokřídové laterity z letovického krystalinika na Moravě s. od Brna byly studovány pomocí fázové i chemické analýzy. Oxidy železité byly charakterizovány rovněž kinetikou jejich rozpouštění. Výsledky byly srovnány s předchozími pracemi zejména Kuděláska a Prachaře (1956) a Konty a Kužvarta (1963) a rovněž s literaturou o lateritizaci obecně. Letovické laterity jsou zastoupeny dobře zachovanými směsmi kaolinitu a goethitu (2 lokality) a rekrystalovanou směsí oxidů Fe, Al a Si (1 lokalita). Autoři by rádi pokračovali ve srovnávání dalších českých lateritů s cílem přispět k poznání předkřídového zvětrávání na našem území.