



ROSTLINNÁ VÝROBA

Referáty k X. kongresu MPS Moskva 1974

Рефераты к XX конгрессу МОР Москва 1974 г

**Papers for the Xth Congress of the I. S. S. S.
Moscow 1974**

**Referate zum X. Kongreß der I. B. G.
Moskau 1974**

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ČESKOSLOVENSKÁ AKADEMIE ZEMĚDĚLSKÝCH
ÚSTAV VĚDECKOTECHNICKÝCH INFORMACÍ

FORSCHUNGSARBEITEN AUF DEM GEBIETE DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG UND DER DARGESTELLUNG DER PEDOSPHERE IN DER ČSSR

Im allernächstem Zeitraum ist ein großer Wert zu legen auf eine einwandfreie Auswertung und Synthese der angesammelten Angaben über die Bodendecke und Bodeneigenschaften, die zu einer vollkommenen Vereinheitlichung des umfangreichen Materials über die Bodendecke der ČSSR führen würde. Man faßte bereits zusammen die gegenwärtige pedogenetischen Erkenntnisse, Ansichten auf die diagnostischen Horizonte (einschließlich ihrer Signatur) und den gegenwärtigen Stand der Klassifikations-Weltsysteme (Němeček), damit dieser Stand bei sämtlichen Regelungen respektiert werden kann. Es wurde ein System der Bodenklassen vorgeschlagen mit der Betonung, daß in diesem die Kriterien der hydrothermischen Régimes und der Merkmale, die mit diesem in Korrelation stehen, mehr ausgeprägt geltend gemacht werden.

Unumgänglich ist die numerische Bearbeitung des Analysenmaterials und seine Rückprojizierung in die Karten, mit der Vornahme von Korrekturen aufgrund der Korrelationen mit den Faktor der Bodenbildung und die Ergänzung der auf diese Weise überprüften Lücken in unserer Erkenntnis.

Man muß feststellen, daß die Ergebnisse der auf diese Weise orientierten Etappe der Pedosphäreforschung für eine längere Zeit eine wertvolle Unterlage der weiteren wissenschaftlichen Arbeiten und der praktischen Applikationen bilden werden. Sie repräsentieren jedoch die Periode der Konzentrierung der maximalen Aufmerksamkeit auf die statischen Parameter der Pedosphäre; diese muß ersetzt werden durch konkretes Studium der dynamischen Zyklen in den Böden und Modellierung ihrer Kulturumwandlung, durch konsequente Transformation gegenwärtiger Ergebnisse auf die Standortunterlagen, durch das Studium der Reaktionen und Verhalten der Standorte in der landwirtschaftlichen Produktion mit Berücksichtigung des Landschaftschutzes.

Dr. Jan Němeček, CSc.

Desátý kongres MPS v Moskvě v roce 1974 se koná u příležitosti padesátého výročí založení této společnosti. V tomto roce je tomu také 100 let od zrodu československého vědeckého výzkumu půdoznaleckého. Výsledky tohoto výzkumu ukázala 3. konference čs. půdoznalců s mezinárodní účastí v roce 1973 v Nitře. Na rozvoji MPS se podíleli čsl. půdoznalci — reprezentovaní zejména prof. Kopeckým, prof. Novákem, prof. Smolíkem a Dr. Spirhanzem — velmi aktivně, jak svědčí zvláště fakt, že k obnově mezinárodních styků po první světové válce došlo na půdoznalecké konferenci v Praze v roce 1922. Další rozvoj čsl. půdoznalství ukázaly pak dvě konference v Praze (1959 a 1965) a účast na kongresech MPS v Paříži 1956 a v Bukurešti 1964.

Referáty pro X. kongres MPS v Moskvě předkládané v tomto čísle Rostlinné výroby jsou skutečně jen skrovnou — publikačními možnostmi danou — ukázkou z bohaté činnosti čs. půdoznalců z výzkumných ústavů ČAŽ a z vysokých škol, podávané pro informaci světové veřejnosti pedologické.

Při výběru příspěvků se přihlíželo především k tématům, ohlášeným v programu X. kongresu a k jejich originálnímu, zejména experimentálnímu zpracování čsl. pedology.

K tématu transformace a syntézy minerálů vznikajících v půdě se vztahuje referát o tvorbě a přeměnách jílových minerálů v některých hnědých půdách ČSR. — Principům a metodám klasifikace a diagnostiky půd skupiny Cambisols je věnován referát, který vyhodnocuje výsledky výzkumu tří set profilů těchto půd v ČSR. — Absolutní a relativní stáří půd je tématem referátu, který objasňuje vznik fosilních a reliktních půd typu ferreto a jejich paleografický význam, jakož i zařazení do širšího klasifikačního systému. — Poměrně menší pozornost je v pedologickém výzkumu dosud věnována technologickým vlastnostem půdy, které podmiňují její zpracovatelnost, jejíž zlepšování představuje technický pokrok v racionálním využívání půdního fondu. Proto je cenným přínosem k tomuto tématu referát o vztazích mezi technologickými vlastnostmi půd a jejich půdotvornými substráty na základě moderních analytických metod. — K tématu o principech a metodách k řešení účinnosti melioračních opatření lze řadit referát podávající experimentální hydro-pedologickou studii o infiltraci jako dvoufázovém nemisitelném proudění v bobtnavé půdě, která poskytuje teoretické podklady pro praktické řešení otázek odvodňování půd. — Příspěvkem k tématu o geochemických cyklech určitých prvků je referát o oběhu uhlíku v ekosystému lužních lesů, jehož výzkum je součástí mezinárodního biologického programu. — Problematice půdních biontů a jejich úloze v dynamice ekosystému jsou věnovány dva referáty: Jeden o vlivu půdní vlhkosti na stupeň nitrifikace, produkci CO₂ a na rozklad celulózy. Druhý o vlivu dusíku na mineralizaci slámy v půdě. — Do rámce tématu o úloze půdy jako regulačního a regulovaného článku v biogeocénózách lze řadit referát o vztazích mezi obsahem živin v půdě a vegetaci v ekosystému částečně kultivovaných půd pod travními porosty. — Ukázkami moderní metodiky laboratorního stanovení vlastností a složení půdy jsou referáty o zjišťování chemického složení železito-

-manganových konkréci v půdních výbrusech laserovou a spektrografickou metodou a o stanovení molekulární váhy huminových kyselin v půdním humusu pomocí zjišťování jejich difuzivity v agarovém gelu.

Z velkého počtu výzkumných prací provedených půdoznalci v Československu v posledních letech byly vybrány pro tento soubor podle témat X. kongresu MPS takové, které ukazují, že současná generace půdoznalců, navazující na dobré tradice československé pedologie, rozvíjí vědu o půdě v pokrokovém duchu a snaží se o její povznesení na světovou úroveň. Úsilí o rozvoj vědecký je nerozlučně spjato se snahou, aby jeho výsledky poskytly podklady pro další rozvíjení socialistické zemědělské velkovýroby nejdokonalejším využitím půdního fondu a jeho ochranou.

Prof. ing. dr. V. Kosil, DrSc.

The tenth congress of the International Pedological Society (IPS) in Moscow in the year 1974 is being held at the occasion of the fiftieth anniversary of the foundation of this society. In this year it is also 100 years that the Czechoslovak scientific investigation of soils was established. The results obtained in this research were shown at the 3rd conference of the Czechoslovak soil scientists with international participation held in Nitra in 1973. At the development of the IPS participated also Czechoslovak soil scientists — represented particularly by prof. Kopecký, prof. Novák, prof. Smolík, and by Dr. Spirhanzl — and that very actively, as has been shown by the fact that the resumption of international contacts after World War I occurred at the Conference on Soil Science held in Prague 1922. The further development of Czechoslovak soil science was documented at two further conferences held in Prague (1959 and 1965) and by the participation at the IPS Congresses in Paris in 1956 and in Bucharest in 1964.

The papers for the Xth Congress in Moscow submitted in this issue, of „Crop Production” are only a moderate — because of the possibilities of publication — example of the wide activity of Czechoslovak soil scientists of the research institutes of the Czechoslovak Academy of Agricultural Sciences and of the agricultural colleges, submitted for the information of the pedological public of the world.

At the selection of contributions special attention was paid above all to the themes contained in the programme of the Xth Congress and to their original and especially experimental elaboration by the Czechoslovak pedologists.

The theme of the transformation and synthesis of minerals arising in the soil is the subject of the paper on the forming and transformations of clay minerals in some of the brown forest soils of the Czech Socialist Republic. With the principles and methods of the classification and diagnosis of soils of the Cambisol group deals the paper evaluating the results obtained in an investigation of three hundred profiles of these soils in the Czech Socialist Republic. The absolute and relative age of soils is the subject of a paper illuminating the origin of fossil and relict soils of the ferreto type and their paleographic significance, as well as their ranking in the wider classification system. In the pedological research comparatively less attention has been paid hitherto to the technological properties of soils affecting their workability, and the improvement of which constitutes a technical progress in the rational utilization of the soil fund. Therefore, a valuable contribution to this theme is a paper on the relations between the technological properties of soils and their soil forming substrates on the basis of modern analytical

methods. With the theme on the principles and methods applied for the investigation of the effectiveness of amelioration measures may be ranked the paper submitting an experimental hydropedological study of infiltration as a two-stage immiscible flow in swelling soil, which provides theoretical bases for a practical solving of problems of soil drainage. A contribution towards the theme of geochemical cycles of certain elements is the paper on the circulation of carbon in the ecosystem of low lying river forests, the investigation of which is a component of the international biological program. The problems of soil bions and their task in the dynamics of the ecosystem are the subjects of two papers: One of these deals with the effect of soil moisture on the degree of nitrification, on the production of CO₂, and on the decomposition of cellulose. The second deals with the effect of nitrogen on the mineralization of straw in the soil. Within the scope of the theme of the part played by the soil as regulatory and regulated link in biogeocoenoses may be ranked the paper on the relations between the nutrient content in the soil and the vegetation in the ecosystem of partially cultivated soils under grass stands. Examples of the up-to-date methods of laboratory determination of the properties and of the composition of soil are the papers on the determination of the chemical composition of ferric-manganese concretions in thin soil sections by means of the laser and spectrographic methods, and on the determination of the molecular weight of humic acids in the soil humus by means of the determination of their diffusivity in agar gel.

Of the large number of research works carried out by soil scientists in Czechoslovakia in recent years such papers have been selected for this collection according to the themes of the Xth Congress of the IPS that show that the present generation of soil scientists, continuing the excellent tradition of the Czechoslovak pedology, are developing soil science in a progressive spirit and are endeavouring to raise it up to the world standard. The attempt at a scientific development is inseparably linked with the endeavour that its results should provide bases for a further development of socialist agricultural mass production by means of a most perfect utilization of the soil fund and its protection.

V. Kosil

Десятый конгресс МПС в Москве в 1974 году состоится по случаю 50-ой годовщины со дня основания этого сообщества. В этом же году также будет 100 лет от основания чехословацкого научного почвоведческого исследования. Результаты этого исследования были продемонстрированы на 3 конференции чехословацких почвоведов с международным участием в Нитре в 1973 году. В развитии МПС весьма активно приняли участие чехословацкие почвоведы, а именно, проф. Кепецкий, проф. Новак, проф. Смолик и д-р Шпирганзл, о чем свидетельствует в особенности факт, что к возобновлению международных связей после первой мировой войны дошло на почвоведческой конференции в Праге в 1922 году. Дальнейшее развитие чехословацкого почвоведения подтвердили две конференции в Праге (1959 и 1965) и участие в конгрессах МПС в Париже (1956) и в Бухаресте (1964).

Доклады для 10 конгресса МПС в Москве, представленные в данном номере «Растениеводство», являются действительно лишь скромным — вызванные возможностями публикации — образцом богатой деятельности чехословацких почвоведов научно-исследовательских институтов Чешской сельскохозяйственной академии и высших учебных заведений, поданной для информации мировой общественности почвоведов.

При выборе статей прежде всего принимались, во внимание темы, соответствующие программе X конгресса, и их оригинальная, в частности экспериментальная разработка чехословацкими почвоведом.

К теме трансформация и синтеза минералов, образующихся в почве, относятся доклады о образовании и преобразовании илестых минералов в некоторых бурых почвах ЧСР. — Принципам и методам классификации и диагностики почвы группы *Cambisols* посвящен доклад, который оценивает результаты исследования 300 профилей этих почв в ЧСР. — Абсолютный и относительный возраст почв является темой доклада, в котором содержится объяснение образования фосильных и реликтных почв типа феррето и их палеографическое значение, а также включение в более широкую классификационную систему. — Сравнительно мало внимания в почвоведческом исследовании до сих пор уделяется технологическим свойствам почвы, обуславливающим ее обрабатываемость, улучшение которой представляет технический прогресс в рациональном использовании земельного фонда. Поэтому весьма ценен по этой теме доклад о связях между технологическими свойствами почв и их почвообразующими субстратами на основе современных аналитических методов. — К теме о принципах и методах решения эффективности мелиоративных мероприятий можно отнести доклад, излагающий об экспериментальном гидропочвоведческом изучении инфильтрации, как о двухфазном несмешивающимся течении в набухшей почве, которая дает теоретические данные для практического решения вопросов осушения почв. — По теме о геохимических циклах определенных элементов является доклад о круговороте углерода в экосистеме пойменных лесов, значение которого является составной частью международной биологической программы. — Проблематике почвенных бионтов и их значению в динамике экосистемы посвящены два доклада: 1) о влиянии почвенной влажности на степень нитрификации, продукции CO₂ и на разложение целлюлозы; 2) о влиянии азота на минерализацию соломы в почве. — К теме о роли почвы в качестве регулируемого и регулирующего звена в биогеоценозах можно отнести доклад о связях между содержанием питательных веществ в почве и вегетацией в экосистеме частично культивируемых почв под травостоями. — Образцами современной методики лабораторного определения свойства и состава почвы являются доклады об определении химического состава железисто-марганцевой конкреции в почвенных шлифах лазерным и спектрографическим методом и об определении молекулярного веса гуминовых кислот в почвенном гумусе при помощи установления их диффузивности в агаровом геле.

Из большого числа исследовательских работ, проведенных почвоведом в Чехословакии за последние годы, были выбраны по теме конгресса МПС такие, которые свидетельствуют о том, что современная генерация почвоведов, которая продолжает хорошую традицию чехословацкого почвоведения, развивает науку о почве в прогрессивном духе и стремится ее поднять на мировой уровень. Стремление о развитии на научной основе нераздельно связано с целью, чтобы его результаты предоставили материалы для дальнейшего расцвета социалистического сельскохозяйственного крупного производства путем наиболее рационального использования земельного фонда и его охраны.

V. Kosil

Der Zehnte Kongreß der Internationalen Gesellschaft für Bodenkunde in Moskau im Jahre 1974 wird gelegentlich des fünfzigsten Jahrestages der Gründung dieser Gesellschaft veranstaltet. In diesem Jahre sind auch 100 Jahre seit dem Entstehen der tschechoslowakischen bodenkundlichen Forschung verflossen. Die Ergebnisse dieser Forschung zeigte die 3. Konferenz tschechoslowakischer Bodenfor-

scher bei internationaler Teilnahme im Jahre 1973 in Nitra. An der Entfaltung der Internationalen Gesellschaft für Bodenkunde beteiligten sich die tschechoslowakischen Bodenforscher, repräsentiert vor allem durch Prof. Kopecký, Prof. Novák, Prof. Smolík und Dr. Spirhanzl, u. zw. sehr aktiv; darüber zeugt besonders die Tatsache, daß es zur Erneuerung der internationalen Fühlungsnahme nach dem ersten Weltkrieg gelegentlich der Konferenz für Bodenkunde in Prag im Jahre 1922 kam. Die weitere Entwicklung der tschechoslowakischen Bodenkunde zeigten sodann zwei Konferenzen in Prag (1959 und 1965) sowie die Anteilnahme an den Kongressen der Internationalen Gesellschaft für Bodenkunde in Paris 1956 und in Bukarest 1964.

Die Referate für den X. Kongreß der IGB in Moskau, die in dieser Nummer der Zeitschrift „Rostlinná výroba“ vorgelegt werden, bringen ein nur bescheidenes — durch Publikationsmöglichkeiten gegebenes — Beispiel der reichen Tätigkeit tschechoslowakischer Bodenforscher von den Forschungsinstituten der Tschechoslowakischen landwirtschaftlichen Akademie und von den Hochschulen, dargeboten zwecks Information der bodenkundlichen Weltöffentlichkeit.

Bei der Auswahl der Beiträge wurden vor allem Themen, die im Programm des X. Kongresses angekündigt worden waren und ihre Original-, vor allem jedoch Experimentalbearbeitungen von den tschechoslowakischen Bodenforschern ins Auge gefaßt.

Zu dem Thema der Transformation und Synthese von den im Boden entstehenden Mineralien bezieht sich das Referat über die Bildung und Veränderungen von Tonmineralen in einigen braunen Böden der ČSR. — Den Prinzipien und Methoden der Klassifikation und Diagnostik der Böden der Gruppe Cambisols ist das Referat, das die Forschungsergebnisse von drei Hundert Profilen dieser Böden in der ČSR auswertet, gewidmet. — Das absolute und relative Bodenalter ist ein Thema des Referates, das das Entstehen der fossilen und relikten Böden des Types Ferreto und ihre paläographische Bedeutung sowie Einreihung in ein breiteres Klassifikationssystem klarlegt. — Eine verhältnismäßig geringere Aufmerksamkeit wird bisher in der bodenkundlichen Forschung den technologischen Bodeneigenschaften, die ihre Bearbeitungsfähigkeit bedingen, gewidmet; die Verbesserung dieser Eigenschaft bedeutet einen technischen Fortschritt bei der rationellen Ausnutzung des Bodenfundes. Aus diesem Grunde bildet einen wertvollen Beitrag zu diesem Thema das Referat über die Beziehungen zwischen den technologischen Bodeneigenschaften und den bodenbildenden Substraten aufgrund der modernen analytischen Methoden. — Zum Thema über Prinzipien und Methoden der Lösung der Wirksamkeit von Meliorationsmaßnahmen kann das Referat angeschlossen werden, das eine experimentelle hydropedologische Studie über die Infiltration als einer unmischbaren Zweiphasenströmung im Schwellboden betrifft und theoretische Unterlagen für eine praktische Lösung der Bodenentwässerungsfragen bietet. — Ein Beitrag zum Thema über geochemische Zyklen bestimmter Elemente ist das Referat über den Kohlenstoffkreislauf im Ökosystem der Auenwälder, dessen Forschung einen Bestandteil des internationalen biologischen Programmes bildet. — Zwei Referate sind der Problematik der Bodenbionten und ihrer Aufgabe in der Dynamik des Ökosystems gewidmet, u. zw. eines dem Einfluß der Bodenfeuchtigkeit auf den Nitrifikationsgrad, die CO₂-Produktion und auf die Zellulosezerersetzung; das zweite behandelt den Einfluß des Stickstoffes auf die Mineralisierung von Stroh im Boden. — In den Rahmen des Themas über die Aufgabe des Bodens als eines Regelungs- und geregelten Gliedes in den Biozönosen kann das Referat über die Beziehungen zwischen dem Nährstoffgehalt im Boden und der Vegetation im Ökosystem teilweise kultivierter Böden unter den Grasbeständen eingereiht

werden. — Als Beispiele der modernen Methodik der labormäßigen Bestimmung der Bodeneigenschaften und -zusammensetzung dienen Referate über die Bestimmung der chemischen Zusammensetzung von Eisen-Mangan-Konkretionen in den Bodenschliffen mittels der Laser- und spektrographischen Methode und über die Bestimmung des Molekulargewichtes der Huminsäuren im Bodenhumus durch die Ermittlung ihrer Diffusivität im Agargel.

Aus einer großen Anzahl der von den Bodenforschern in der Tschechoslowakei vorgenommenen Forschungsarbeiten wurden für diese Gesamtheit laut den Themen des X. Kongresses der Internationalen Gesellschaft für Bodenkunde solche ausgewählt, die es aufzeigen, daß die gegenwärtige Generation der Bodenforscher — in Anknüpfung an gute Traditionen der tschechoslowakischen Bodenkunde — die Wissenschaft über den Boden in fortschrittlichem Geiste entfaltet und bemüht ist, diese auf das Weltniveau zu heben. Die Bestrebung um wissenschaftliche Entwicklung ist untrennbar mit dem Willen verbunden, daß die Ergebnisse Unterlagen für eine weitere Entfaltung der sozialistischen landwirtschaftlichen Großproduktion durch die vollkommenste Ausnutzung des Bodenfondes und dessen Schutzes bieten.

V. Kosil

CLAY MINERAL FORMATION AND ALTERATION IN SOME BROWN FOREST SOILS

V. SIROVÝ

SIROVÝ V. (Institute of Soil Science, Praha - Ruzyně). *Clay Mineral Formation and Alteration in Some Brown Forest Soils*. Rostlinná výroba (Praha) 20 (5): 451-459, 1974.

Conclusions concerning the formation and alteration of clay minerals in dependence on the parent rock and the reaction of the medium are derived from the comparison of the mineralogical composition of the clay fraction and its changes in the profile of brown forest soil on gabbrodiorite and in the profile of acid brown soil on granite. The development of montmorillonite from the products of primary mineral weathering is a characteristic process of the clay mineral formation in the profile of soil on gabbrodiorite during weathering. Micaceous minerals, mixed-layer minerals and kaolinite occur at the same time. The formation of micas and 10 + 18 Å interstratifications, accompanied by the partial chloritization of the new-produced minerals, becomes prevalent with advancing weathering. In acid brown soil on granite, the initial stage of weathering is characterized, in the clay fraction, only by a light transformation of mica into vermiculite and the mica-vermiculite interstratifications, vermiculite is only slightly chloritized. The content of micas decreases and the proportion of chloritized vermiculite increases in the direction to soil surface, with advancing weathering. The maximum degree of chloritization is obtained in the metamorphic horizon where, at the same time, the content of the mica — chloritized vermiculite interstratifications also reaches the highest level. Together with the upper part of the C-horizon, the B-horizon contains also the greatest amount of kaolinite. The increased content of kaolinite may be due to the soil forming processes responsible for the accumulation of aluminium in these horizons. Apparently, the dechloritization effect of a high content of organic substances plays some role in the humus horizon.

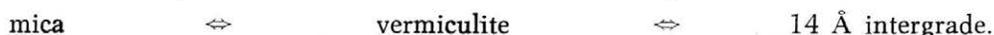
brown forest soils; clay minerals; montmorillonite; vermiculite; micas; interstratification; chloritization; weathering

Brown forest soils are a very good object for the study of the formation and alteration of clay minerals in soils. The reason is that they develop under different site conditions and on various parent rocks. This makes it possible to study what factors influence the composition of the soil clay fraction and to determine the degree of their effect.

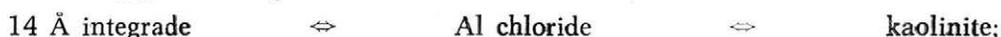
It can be assumed that in soils on sedimentary rocks the clay minerals which are already contained in these rocks play the most important role in the composition of the soil clay fraction. On the other hand, in soils on metamorphic, and particularly igneous, rocks clay minerals are formed as products of the weathering of the primary minerals. This weathering (hence also creation) becomes an integral part of the soil-forming process.

The origin of clay minerals is treated in detail by Keller (1964) who draws attention to the effect of the reaction of the medium and the presence of various ions in the solution; this, in turn, depends on the mineralogical composition of the substratum, on the climate, relief and related hydrothermic con-

ditions. It follows from this that brown forest soils are the soil types where various clay minerals are encountered. In view of the highly dynamic character of soil conditions, there frequently occur mixed-layer minerals, or intermediate types of clay minerals. These minerals are mentioned already by Rich and Obenshain (1955); like Klages and White (1957), they designated them as intergradient chlorite-vermiculite. Dixon and Jackson (1962), and Jackson (1963) describe intergradient montmorillonite-vermiculite-chlorite. Jackson (1964) explains the origin of these intergrades on the basis of hydroxy-aluminium ions fixation in the interlayer space of minerals occurring as a result of mica weathering (montmorillonite, vermiculite) in which it partially produces an interlayer hydroxide sheet. Jackson considers this process as a characteristic function of chemical weathering in soils. The 18 Å intergrades appear mainly in alkaline soils in which montmorillonite is more stable. In acid soils, the 14 Å intergrades occur as a result of the following reaction:



With further accumulation of aluminium as interlayers in 2:1 minerals, weathering proceeds by the reactions:



this means that the occurrence of kaolinite in acid soils may be due also to pedogenesis, and that kaolinite is not only of inherited origin. This view is corroborated also by Wilson (1973). As he believes, this complete degradation of trioctahedral minerals takes place mainly in the B-horizon and in the upper part of the C-horizon; the vermiculitization of mica, together with aluminium interlayering take place in the A-horizons. At the same time, Wilson arrives at the conclusion that these effects are most marked in well-drained soils of low pH (< 5). On the other hand, Brown and Newman (1973) assert the possibility of the occurrence of montmorillonite with interlayer aluminium in soils with neutral reaction.

It is the purpose of the trials described in this paper to find, using two selected brown forest soil profiles, to what extent the processes of the formation and alteration of clay minerals are influenced by the parent material and, possibly, by other factors and conditions of the soil-forming process.

MATERIAL AND METHODS

The following two profiles were chosen from a large set of brown forest soils (more than 50 profiles) for the purposes of this study, with respect to the parent rock and other conditions of the soil-forming process.

1. Brown forest soil on gabbrodiorite (site Luhy, district Příbram), altitude 332 m above sea level, average annual precipitation 550–600 mm.

2. Acid brown forest soil on granite (site Čistá, district Sokolov), altitude 783 m above sea level, average annual precipitation 800 mm.

The basic characteristics of these two profiles are presented in Table I.

Besides these two profiles, a sample of the clay fraction from the metamorphic horizon of an acid brown soil on gneiss (Vranov, district Sokolov), was used to complete some conclusions. The characteristics of this fraction can be considered as approximately the same as the characteristics of the mentioned acid brown soil on granite.

The clay fraction (particles less than 0,001 mm) was separated from soil by repeated decantation without any chemical pretreatment. Soil was dispersed only mechanically, by trituration in paste form. Although all the clay fraction was

Depth cm	Horizon	Clay < 0.001 mm %	Carbon %	pH/H ₂ O	pH/KCl	C. E. C.	Base saturation %
Brown forest soil on gabbrodiorite							
0—23	Ap	10.2	1.03	5.5	5.1	14.9	63
23—42	Bv	8.7	0.73	5.9	5.2	13.5	65
42—67	BC	12.6	0.65	6.5	5.5	16.5	78
67—95	IIBC	13.8	0.29	6.8	5.8	14.3	84
95—110	IIC	9.7	0.11	6.9	5.7	22.2	90
Acid brown forest soil on granite							
0—20	Ap	7.0	3.07	4.5	4.3	23.9	13
20—44	Bv	7.6	0.87	5.1	4.3	11.5	12
44—75	BC	6.3	0.47	5.3	4.5	8.2	15
75—100	C	1.4	0.41	5.5	4.6	5.9	18
100—120	C	1.7	0.25	5.7	4.6	4.1	25

not separated excellently in this way, the possibility of influencing some minerals by chemical preparation was avoided. The influence of various chemical pre-treatments on the soil clay fraction properties was demonstrated by a number of authors (Beutelspacher, Fiedler 1963, Harward et al. 1962, Perez-Rodriguez, Wilson 1969), and by the own experiments of the present author (Sirovy 1967). Oriented clay specimens saturated with Mg, Mg + glycerol, K were used for X-ray diffraction analysis. The K-saturated specimens were X-rayed also after heating to 300 and 500 °C. Besides this, the clay samples from the Vranov profile were also extracted with hot 0,5 NaOH according to Hashimoto and Jackson (1960). Electron microscopy was employed in order to reveal the changes in clay morphology in the profile.

RESULTS

The X-ray diffractograms of the clay fractions from the brown forest soil profile on gabbrodiorite are presented in Fig. 1. Reflections in the range of 12 and 14 Å occur in the part of the profile over the parent material, besides the reflections of kaolinite (7,12 Å) and mica (10,02 Å) the intensity of which shows no large changes within the whole profile. The intensity of the former reflections, particularly 14 Å, decreases with the depth of the profile, and their contraction increases after K-saturation. Contraction stops at values about 12 Å after heating to 300 and 500 °C; this, together with the 4,75 Å reflection in the uppermost parts of the profile, testifies to the presence of chloritized layers in the clay mineral structure. After glycerol solvation, intensive 14,21 Å peaks occur; this demonstrates that swelling 18 Å layers are also present in the clay fraction. The increasing content of interstratified minerals in the direction to soil surface can be observed also from the course of X-ray diffractograms within 7—10 Å. In the surface horizon, the 7,12 Å peak is broadened towards the 8,17 Å reflection (stable after K-saturation and after heating to 300 °C) which

apparently belongs to an interstratification of a higher order. The intensity of this reflection decreases with depth, and the 7,12 Å peak is more sharp at the same time.

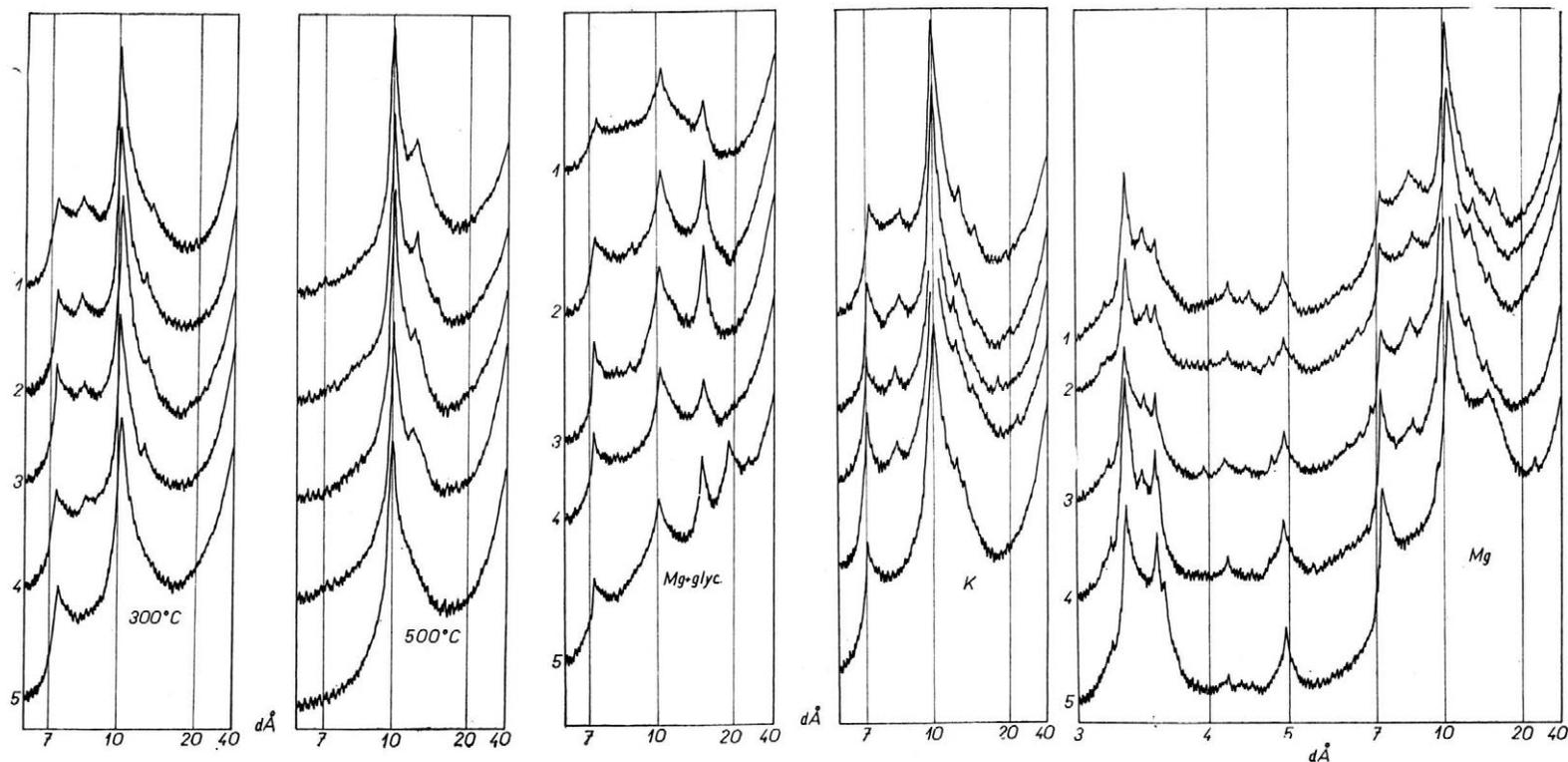
The clay fraction from the depth 95–110 cm, showing much simpler X-ray diffractograms, considerably differs from the clay fraction in the upper part of the profile. There is an intensive reflection at 14 Å and the reflections 14,21 and 18,5 Å after glycerol solvation. K-saturation results in a high contraction (there remain only poor peaks at 12,3 and 11,7 Å); after heating to 300 °C the contraction is complete (10,02 Å). Hence the minerals present, with the exception of kaolinite and mica, can be referred to as montmorillonite and vermiculite (reflections 14,2 and 3,60 Å). In view of the form of the transition between the 10 and 14 Å reflections, and to the shift of the reflection up to 18,5 Å after glycerol solvation, even the interstratifications 10 + 18 Å cannot be excluded.

A somewhat different picture is provided by X-ray patterns from acid brown soil on granite, as shown in Fig. 2. The kaolinite reflection reaches the maximum relative intensity in the metamorphic horizon; on the other hand, the mica reflection shows an apparent increase in the desintegrated parent rock and reaches the maximum intensity in the last sample where it becomes particularly sharp. This is connected also with the differences in the morphology of the clay fraction, as indicated in Fig. 3. In addition, clear reflections in the 12, 14 Å, or even 24 Å range were observed. Due to the fact that they mostly show no apparent changes after glycerol solvation and after K-saturation, and that the contraction after heating to 300 °C is not complete, they can be denoted as reflections of chloritized vermiculite and mica-vermiculite interstratifications. It can be stated, in view of the changes in the intensities of reflections within the profile, that chloritization reaches the highest level in the metamorphic horizon and gradually decreases with depth; the content of vermiculite as such increases in the last sample. The greatest quantity of interstratified minerals is also observed in the metamorphic horizon. The increase of the content of feldspars in the clay fraction in the last sample also deserves mentioning (peak at 3,17 Å).

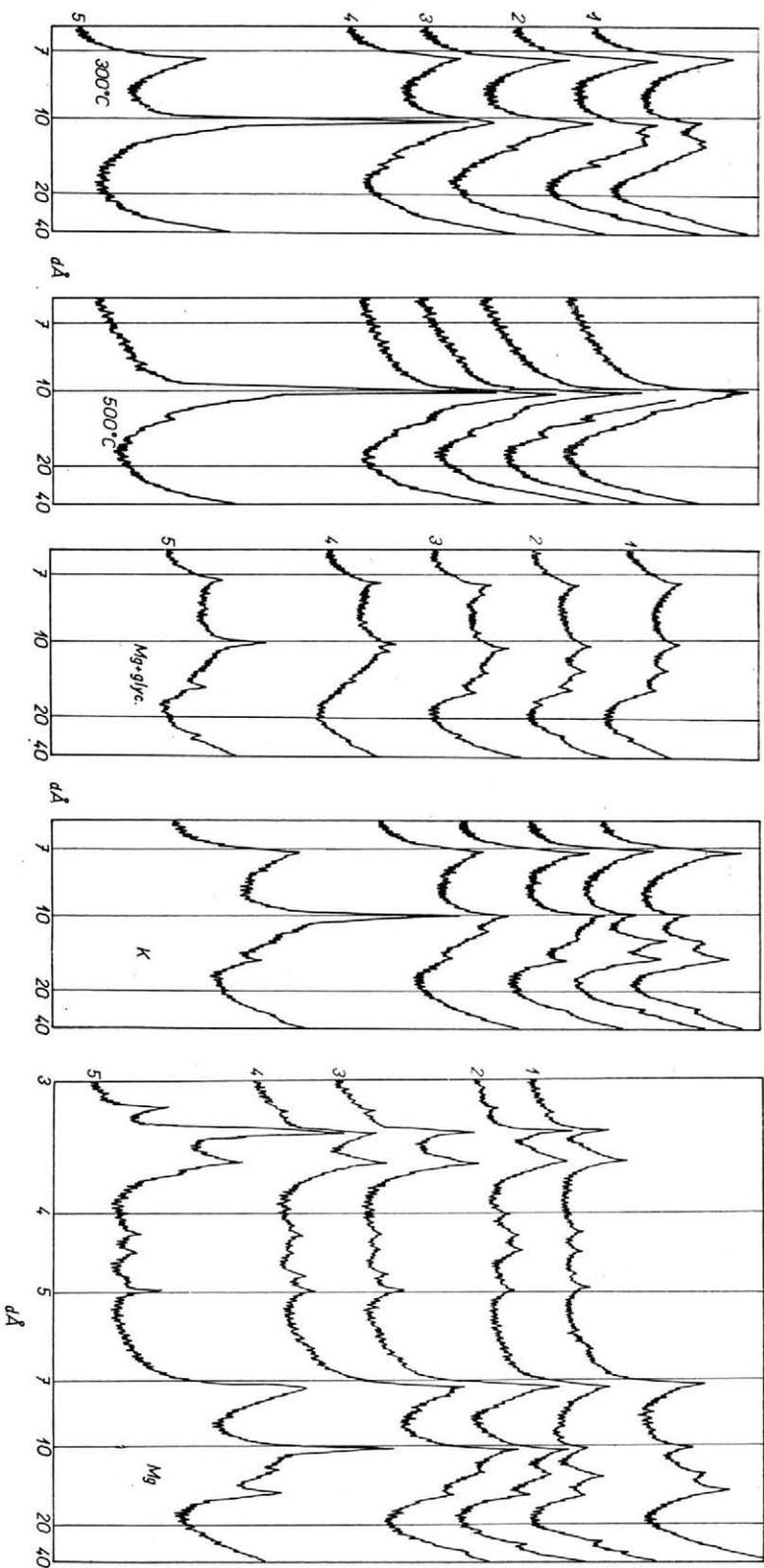
DISCUSSION

When explaining the differences in the clay fraction composition of the two profiles and examining the processes which contributed to them, it is necessary first of all to evaluate the effect of the parent material and the different site conditions.

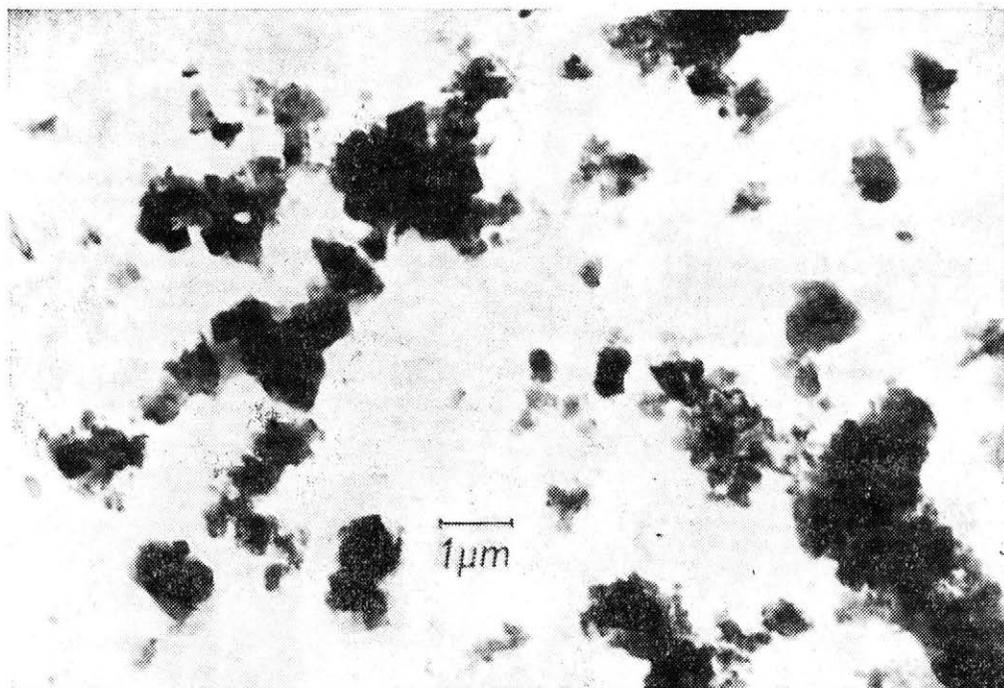
The brown soil at Luhy developed on gabbrodiorite, i. e. a basic rock at a lower altitude above sea level (hence under less humid conditions). Due to this fact, a greater acidification took place only in the upper parts of the profile; in deeper parts the reaction remains only slightly acid. The base saturation changes in keeping with reaction: base saturation increases in the direction to subsoil. The differences in particle size distribution could be also of some importance, to some degree (clearly higher content of fine particles in comparison with acid brown soil). Micaceous minerals occur in the clay fraction as a dominant component. Micaceous minerals might be partially present already in the parent rock and partially developed at an advanced stage of primary mineral weathering. In the parent material, more intensive weathering affects mainly some readily weathering components (dark parts such as pyroxenes, amphiboles, or biotite); montmorillo-



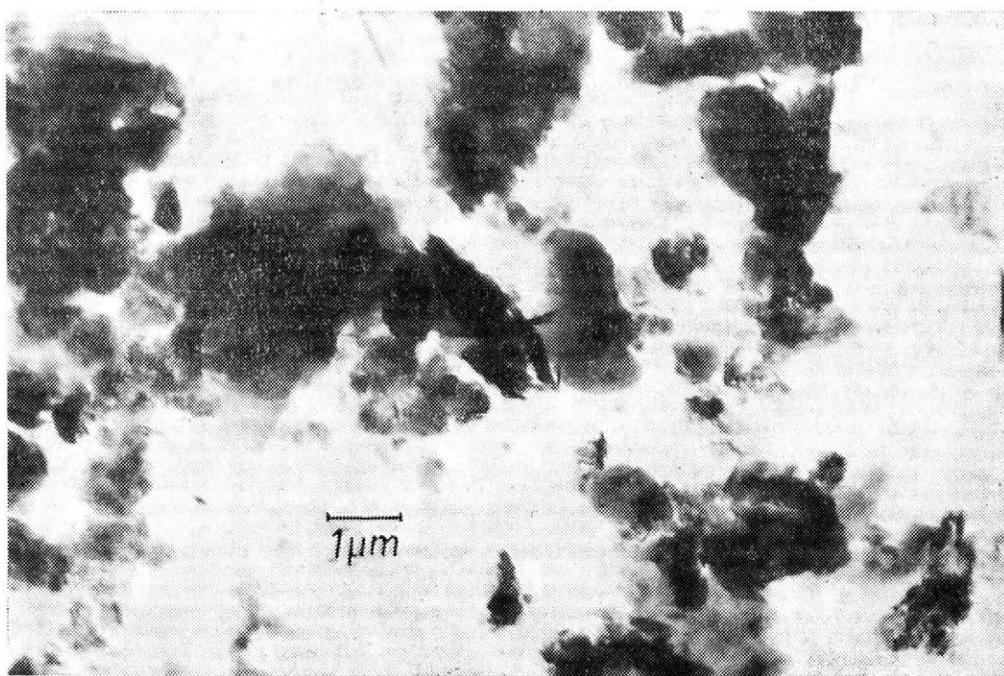
1. X-ray diffractograms of the clay fractions from brown forest soil profile on gabbrodiorite. Depth cm: 1. 0—23; 2. 23—42; 3. 42—67; 4. 67—95; 5. 95—110. — Rentgenogramy jílových frakcí z profilu hnědé půdy na gabbrodioritu. Hloubka vzorků v cm: 1. 0—23; 2. 23—42; 3. 42—67; 4. 67—95; 5. 95—110



2. X-ray diffractograms of the clay fractions from acid brown forest soil profile on granite. Depth cm: 1. 0—20; 2. 20—44; 3. 44—75; 4. 75—100; 5. 100—120. — Rentgenogramy jílových frakcí z profilu hnědé půdy kyselá na žule. Hloubka vzorků v cm: 1. 0—20; 2. 20—44; 3. 44—75; 4. 75—100; 5. 100—120

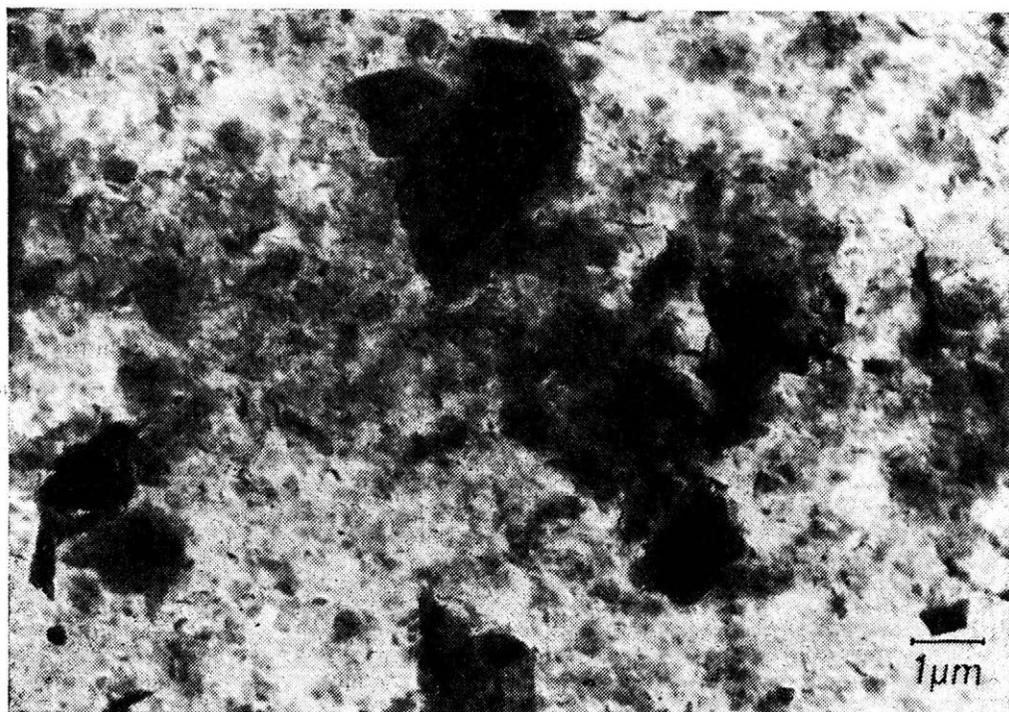


A



B

3. Electron photomicrograph of clay fraction from acid brown forest soil on granite. A. Depth 75—100 cm; B. 100—120 cm. (Photo O. Králík). — Elektronové mikrofotografie jílové frakce z hnědé půdy kyselé na žule. A. Hloubka 75—100 cm; B. 100—120 cm. (Foto O. Králík)

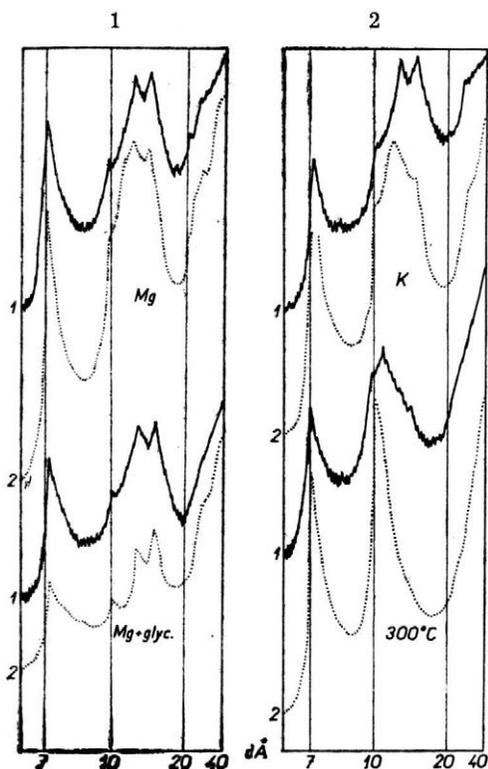


4. Electron photomicrograph of clay fraction from C-horizon of brown forest soil on gabbrodiorite. (Photo O. Králík). — Elektronová mikrofotografie jílové frakce z horizontu C hnědé půdy na gabbrodioritu. (Foto O. Králík)

nite and 10 + 18 Å interstratifications are produced during this process. Vermiculite may also develop from biotite. The non-mica origin of montmorillonite in the substratum is proved also by its morphology, as shown by Fig. 4. Some role in the origin of montmorillonite may be played also by the presence of Ca ions which released at the first stages of the basic plagioclases weathering. The degree of substratum weathering increases in the direction to the surface of soil; this is connected with a decrease in pH and in the base saturation. The formation of mica clay minerals and their mixed layers with montmorillonite becomes prevalent at the same time. It is particularly vermiculite, and probably also the mixed layers 10 + 18 Å, that are partially chloritized here, as suggested by incomplete contraction after heating to 500 °C. It can be assumed that the 18 Å component of interstratified minerals is the product of the alteration of mica clay minerals of a secondary origin, as distinct from montmorillonite in the parent material which probably developed by the synthesis from the products of primary mineral weathering.

The explanation of the changes in the composition of the clay fraction in the acid brown soil profile is much simpler. This soil developed on an acid rock under much more humid conditions than in the profile treated above. Due to this, there is a highly acid reaction in the upper part of the profile; the pH somewhat increases in the desintegrated parent rock where the degree of base saturation also shows some increase. As demonstrated by the sharp reflection of mica minerals and by the presence of feldspars, chemical weathering plays a role of the lowest importance in the deepest part of the profile. Besides kaolinization,

5. X-ray diffractograms of the clay fraction from metamorphic horizon of acid brown forest soil on gneiss. 1. Without any pretreatment; 2. After hot NaOH pretreatment. — Rentgenogramy jílové frakce z metamorfického horizontu hnědé půdy kyselá na rule. 1. Původní vzorek; 2. Vzorek po extrakci horkým NaOH



there is only a slight alteration of micas connected with the production of vermiculite and mica-vermiculite interstratifications. Vermiculite is partially chloritized. The closest upper layer of the substratum considerably differs with its relative decrease of mica content and with a larger proportion of chloritized layers, both in vermiculite as such and in its interstratifications. Chloritized vermiculite reaches its maximum in the humus horizon where the mica content is also at the relatively lowest level. As indicated by the X-ray patterns of heated samples, chloritization reaches the highest degree in the metamorphic horizon and in the upper part of the disintegrated parent rock where a pronounced 14 Å reflection remains even after heating to 500 °C. Here the relative content of the 10 + 14 Å mixed layers also reaches its maximum. A lower content of chloritized layers in the surface horizon may be due to a high content of organic matters. The influence of organic substances on vermiculite dechloritization is mentioned for instance by Lietzke and Mørtland (1973). A high degree of the vermiculite chloritization in the B-horizon and in the upper part of the C-horizon may be combined with an increased content of kaolinite: this can be assumed on the basis of the relative intensity of the 7,12 Å reflection. According to Wilson (1973), complete degradation of minerals leading to the occurrence of kaolinite may take place in these horizons due to a great supply of free aluminium.

The importance of aluminium in the formation of the 14 Å intergrade is demonstrated also by the X-ray diffractogram changes after hot NaOH extraction, removing a larger part of interlayer aluminium. The X-ray patterns in Fig. 5 show that after this extraction there is a great increase in contraction on

K-saturation; after heating to 300 °C, contraction is practically complete, i. e. the 14 and 12 Å reflections correspond after this extraction to the reflections of vermiculite and interstratified mica-vermiculite.

The described two examples demonstrate that in the formation and alteration of clay minerals in soils, a major role is played by the reaction of the medium, conditioned both by the properties of the parent rock and by other site conditions. The formation and alteration as such represent a complex of various processes taking place at the same time; it is considerably difficult to present clear and explicit characteristics of these processes as well as some of their products.

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SIROVÝ V. (Půdoznalecký ústav, Praha - Ruzyně). *Tvorba a přeměny jílových minerálů v některých hnědých půdách*. Rostlinná výroba (Praha) 20 (5): 45-459, 1974.

Na základě srovnání mineralogického složení jílové frakce a jeho změn v profilu hnědé půdy na gabbrodioritu a hnědé půdy kyselé na žule jsou vyvozovány závěry o tvorbě a přeměnách jílových minerálů v závislosti na matečné hornině a reakci prostředí. Charakteristickým procesem tvorby jílových minerálů při zvětrávání v profilu půdy na gabbrodioritu je vznik montmorillonitu z produktů rozpadu primárních minerálů. Současně však vznikají i slídnaté minerály, jejich interstratifikace s montmorillonitem, vermikulit a kaolinit. S postupujícím zvětráváním nabývá převahy tvorba slíd a interstratifikací 10 + 18 Å, která je doprovázena částečnou chloritizací vznikajících minerálů. V hnědé půdě kyselé na žule je počáteční stadium zvětrávání charakterizováno v jílové frakci jen slabou přeměnou slíd na vermikulit a interstratifikace slída—vermikulit. Vermikulit je pouze slabě chloritizován. S postupujícím zvětráváním směrem k povrchu půdy klesá obsah

slíd a zvyšuje se množství chloritizovaného vermikulitu. Maxima chloritizace je dosaženo v podpovrchovém horizontu Bv, kde je také nejvyšší obsah interstratifikací slída—chloritizovaný vermikulit a spolu s vrchní částí C horizontu i kaolinitu. Zvýšený obsah kaolinitu může být podmíněn pedogenními procesy způsobujícími akumulaci volného hliníku v těchto horizontech. V humusovém horizontu se zřejmě částečně uplatňuje dechloritizační efekt vysokého obsahu organických látek.

hnědé půdy; jílové minerály; montmorillonit; vermikulit; slídy; interstratifikace; chloritizace; zvětrávání

СИРОВЫ В. (Почвенный институт, Прага-Рузыне). Образование и преобразование глинистых минералов в некоторых бурых почвах. Rostlinná výroba (Praha) 20 (5) : 451-459, 1974.

На основе сравнения минералогического состава глинистой фракции и его изменений в профиле бурой почвы на габбродиорите и бурой почвы кислой на граните сделаны заключения об образовании и преобразовании глинистых минералов в зависимости от маточной породы и реакции среды. Характерным процессом образования глинистых минералов при выветривании в профиле почвы на габбродиорите является образование монтмориллонита из продуктов разложения первичных минералов. Однако, параллельно образуются и слюдяные минералы, их интерстратификация с монтмориллонитом, вермикулит и каолинит. С возрастающим выветриванием преобладает образование слюды и интерстратификаций 10 + + 18 Å, сопровождаемые частичной хлоритизацией образующихся минералов. В бурой почве кислой на граните начальная стадия выветривания характеризуется в глинистой фракции лишь слабым преобразованием слюды в вермикулит и интерстратификацию слюды — вермикулит. Вермикулит лишь слабо хлоритизирован. С растущим выветриванием по направлению к поверхности почвы понижается содержание слюды и повышается количество хлоритизированного вермикулита. Максимум хлоритизации достигается в подповерхностном горизонте Bv, где также имеется максимальное содержание интерстратификации слюда — хлоритизированный вермикулит и вместе с верхней частью C горизонта и каолинита. Повышенное содержание каолинита может быть обусловлено почвообразными процессами, вызывающими аккумуляцию свободного алюминия в этих горизонтах. В гумусном горизонте, очевидно, частично находит применение деchlorитизационный эффект высокого содержания органических веществ.

бурые почвы; глинистые минералы; монтмориллонит; вермикулит; слюда; интерстратификация; хлоритизация; выветривание

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FORSCHUNGSARBEITEN AUF DEM GEBIETE DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG UND DER DARSTELLUNG DER PEDOSPHERE IN DER ČSSR

Diesem Bereich der Probleme widmete man im vergangenen Zeitraum in der ČSSR bedeutende Aufmerksamkeit im Zusammenhang mit der intensiv vorgenommenen Bodenkartierungen. Man beendete die großmaßstäbliche (1 : 10 000) Kartierung von landwirtschaftlich ausgenutzten Böden sowie von Waldböden im Rahmen der walddtypologischen Untersuchung. Die Bodenkartierung allein gab den Anlaß für die Lösung einer Gesamtheit von methodischen Problemen, von gesamtstaatlicher Gültigkeit. Die sich anhäufenden konkreten Ergebnisse über die Böden des Staates und die entstehenden Probleme wurden Gegenstand der Forschungsarbeiten, deren Resultate eine Reihe von ursprünglichen Vorstellungen korrigierten. Das hohe Tempo der vorgenommenen Kartierung ließ eine Reihe von Fragen offen. Einen wertvollen Beitrag des gesamten Zeitraumes bildet jedoch schon die Anhäufung einer großen Menge des faktischen Materials der Geländebeobachtungen, der Laborkontrolle und der Forschungserkenntnisse, an deren Synthese gearbeitet wird.

Die Bodenkartierung war eng verbunden mit der Entfaltung der Bodenklassifikation und — systematik. Während der anfänglichen Entwicklungsstapen der Jahre 1955—1960 klangen noch einige vereinfachten pedogenetischen Gesichtspunkte ab; man überschätzte die Homogenität der Ausgangssubstrate der Bodenbildung und nahm nur wenig den polygenetischen Charakter der Profile und die Interferenz der Pedogenese mit der Lithogenese, mit geologischen und geomorphologischen Vorgängen in Rücksicht.

Diese Gesichtspunkte wurden nach und nach geklärt in den Arbeiten, die die Ansichten auf den bodenbildenden Prozeß und seine Teil — und elementare Vorgänge, die zur Differenzierung des Bodenprofils führen, zusammenfassen (Jurča, Pelíšek, Hraško, Bedrna, Němeček).

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NĚMEČEK J. (Institute of Soil Science, Praha - Ruzyně). *Cambisols*. Rostlinná výroba (Praha) 20 (5) : 463-474, 1974.

The paper deals with soil units of Cambisols (brown forest soil, pelosols) and soil associations dominated by Cambisols in 59.4% of the entire area of the Czech Socialist Republic. Research in diagnostic characteristics was carried out in 301 soil profiles. They serve to describe the main characteristics of soil profile features within a sequence of Cambisols and their transformations to podzols reflecting the vertical zonality of Czech soils in areas of granitic rocks and crystalline schists and in areas of sedimentary consolidated rocks with respect to profile lithologic discontinuities (Haupt-, Basisfolge). These are humus and its quality, free Fe-Al oxides, amorphous substances, characteristics of soil acidity and exchange complex, chloritization of expansible minerals in acid medium, substrata trophism, parameters of the hydrothermic régime of the soils. Clearly lithologically conditioned units within soil units are described in short.

classification, diagnosis of soils; Cambisols; brown soils; pelosols; podzols; humus; free Fe-Al oxides; amorphous soil components; soil acidity; exchangeable complex — acid medium; alumination (chloritization) of clay minerals

The limitation of this class of soils with relations to podzols, pseudogleys and luvisols and its internal classification is solved on the basis of a study of significant diagnostic soil profile features, and knowledge achieved on their geographic distribution. Results of our studies (ie. 301 profiles) were compared with the widest-spread classification systems, with legends of FAO soil maps, and suggestions of the authors quoted in the previous paper (Němeček 1972).

SOIL UNITS AND THEIR OCCURRENCE IN PEDOASSOCIATIONS OF THE CSR

Cambisols in themselves include the following great soil groups and sub-groups (abbreviations of soil and substrata names are used in the rest of the work).

1. Brown soils, Braunerden, Ochrepts, sols bruns, Brunisols:

1.1. oligobasic, Bo (Dystric Cambisol, D. Brunisol, Dystrochrept, Cryochrept) from oligotrophic transported weathering products of hard and consolidated parent rocks: 1. granites and crystalline schists, 2. consolidated sedimentary rocks; — 1.2. mesobasic, Bm (Dystric C., D. B., Dystrochrept) from oligo- up to mesotrophic transported weathering products of the same rocks as before; — 1.3. eubasic Be (Eutric C., E. B., Eutrochrept) from mesotrophic weathering products, as at 1.2; — 1.4. residual calcareous, Bc (Calcareo-eutric C.) from displaced calcareous rocks; 1.5. eutrophic, Bt (Eutric C., E. B., Erubasbraunerde) from eutrophic weathering products; 1.6. arenic, Ba (Cambic Arenol)

sols → Cambisols, Psammentes → Ochrepts) from oligotrophic sands, gravelly sands (pleistocene, tertiary); — 1.7. pelic and vertic, Bp (vertic C.) from heavy weathered sedimentary rocks; — stagnogleyic, Bg (Stagno-gleyic C., gleyed B., aquic Ochrepts), which interfere with the other mentioned soil units.

2. Pelosols (Pl):

2.1. modal; — 2.2. calcaric; — 2.3. stagnogleyic

The study was carried out to check the limits between Bo and rusty-brown (Rb) soils (brown podzolic soils) and to support the grouping of Rb with podzols.

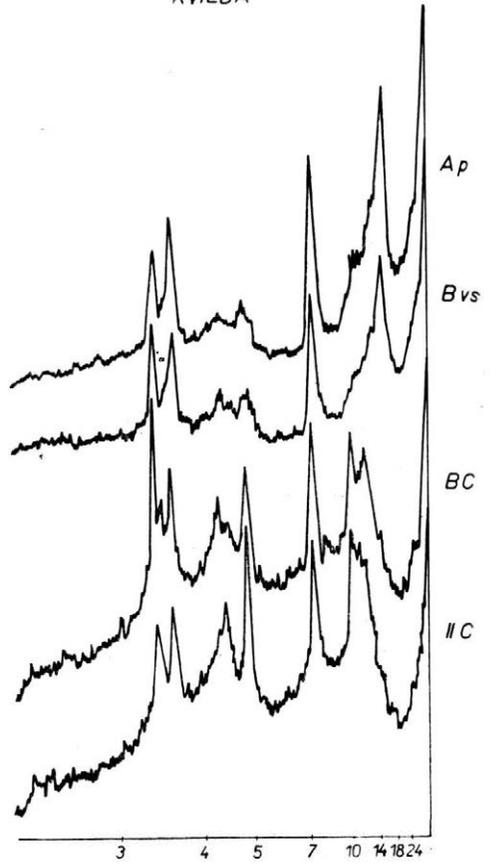
Soil associations dominated by Cambisols cover a great area of C.S.R. — 59.4 % (46.2 % of agricultural land). Associations of the mountain Bo cover 21.5 % of the C.S.R. neighbouring on associations of Rb + Bo with podzols (Pz), representing 6.3 %. Associations determined by Bm and Be are widest-spread, covering 29.0 % of the area. Data on expansion of the mentioned pedo-associations are further corrected by an improved conception of their dominants. Other Cambisols determine the nature of pedoassociations, located in dependence on substrata distribution and limitations of soil drainage. Bt are found on ultra-basic and basic rocks in north-western and northern Bohemia — 1.7 %. Ba are dominant on gravels and sandy-gravels along the Ohře, Elbe, Orlice, in parts of the Lower-Moravian Dale and the Doubrava Plane — 2.2 %. Bp together with Pelosols are spread over on clays and marls in north-western Bohemia and particularly eastern Bohemia (cretaceous marls), and in south-east Moravia (flysh marls) — 2.5 %. Soil associations dominated by Bg cover 1.9 %.

STRATIFICATION OF SOIL-LITHOLOGIC PROFILE OF CAMBISOLS AND ITS PROPERTIES AS A WEATHERING CRUST

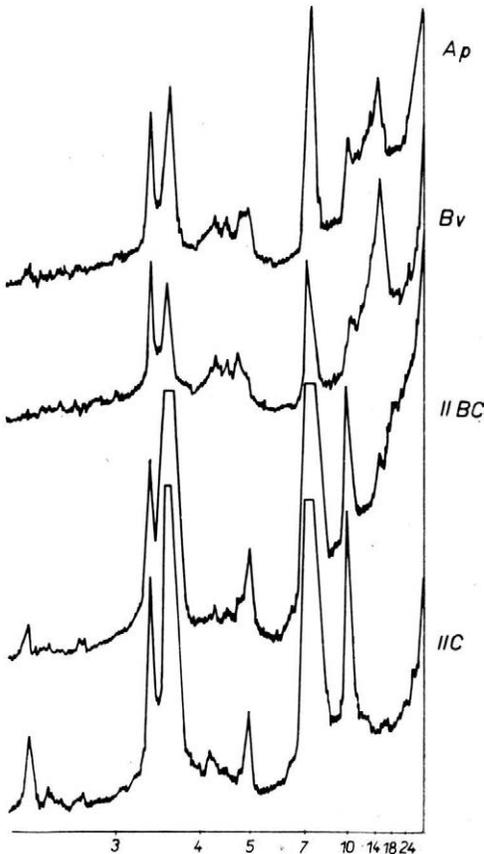
Profiles of Cambisols have developed in lithologic stratified materials, with layers of different age (mainly Haupt — and Basisfolge of German authors) with varying textural and mineralogical composition. In a layer in which the solum of these soils (Ap + Bv) originated, the lateral displacement of the material in natural landscapes or an admixture of the eolian component resulted in some balance in its composition, as compared with the basal layer the composition of which rather reminded of the weathering products of the original rock. This stratification shows itself in the total chemical and textural composition: — by a decrease in the content of fine particles, Fed and "T" values in deep parts of the profile on substrata no. 1 under the conditions of an increasing content of CaO, MgO and primary materials; — it manifests itself in a more balanced or even increased content of fine particles, Fed and T in the basal layer in substrata no. 2. The following cases can be encountered in the mineralogical composition of the clay fraction: — in substrata no. 1 a less apparent mica transformations (Fig. 1) or relics of kaolinitic weathering (Fig. 2) in the basal layer; — in substrata no. 2 a more balanced profile composition or a greater proportion of the minerals inherited from the original rocks (montmorillonite — vermiculite, sometimes kaolinite, see for instance Fig. 4 Ondřejov) in the basal layer. The micromorphological manifestation of stratification: — cutans occurring in gravel and red cutans in the kaolinized weathered material of the basal layer in some cases, — the occurrence of cutanic material around weathering slates in the basal layer.

1. X-ray diffractograms of the clay fraction in the rusty-brown soil profile (gneiss). — Roentgenové difraktogramy jílové frakce v profilu rezivé půdy (rula)

KVILDA



ČERVENÝ POTOK



2. X-ray diffractograms of the clay fraction in oligobasic brown forest soil profile (gneiss). — Roentgenové difraktogramy jílové frakce v profilu hnědé půdy oligobázické (rula)

The reason for the simplification of the grouping of substrata (forming two groups) is the fact that the properties of "substrata", conventionally attached to some rock, are modified by the historical geochemical migration on the acid weathering crusts, and by the mentioned effect of "Hauptfolge" genesis. This is demonstrated also by the total chemical soil analyses and the analyses of the 20 % HCl extract. For instance CaO shows the lowest values in substrata no. 1 in the soils of the podzol class (up to 0.2 %); these values are low also in the Bo solum (about 0.4 %), with an increasing tendency in the lower part of the profile. In Bm the CaO values increase significantly throughout the profile (0.6–0.8 %). As to the substrate under no. 2, the CaO values increase only in Be.

THE IMPORTANT CHARACTERISTICS OF BROWN FORES SOILS AND THEIR TRANSITION TO PODZOLS

The indices of the quantity and quality of organic substances, the release and migration of amorphous components, of the exchange complex and transformations of soil mica in acid medium are treated as important criteria for the differentiation of Rb-Bo-Bm-Be, reflecting the vertical zonation of the natural conditions of the Czech Socialist Republic. The results of the study of 175 completely analyzed profiles were processed by simple statistical methods (arithmetical mean, standard deviations; the differences were evaluated according to the confidence intervals).

Humus generally grows in the Be → Pz sequence. Significant differences are observed in the epipedons and in metamorphic (illuvial) horizons between Pz and Rb, between Rb and Bo, and in epipedons also between Bo and Be (Tab. I). Hence these values indirectly indicate the changes of the hydrothermic régime of the regions with high climate change gradients. In this sequence, the proportion of Ha decreases in the fractional composition (72 profiles), and loosely bonded Ha play a role of increased importance. The proportion of Fa increases, especially the highest-mobility fraction, and an increase is observed also in the degree of the migration of low-molecular organic substances in the soil profile. This takes place in an apparent form already in Rb which are close to Pz, as to these characteristics (Tab. II).

The determination of amorphous components by the method according to Franzmeir *et al.* (1965) in 250 samples demonstrated the specificity of this test for the indication of the spodic horizon. It is present, according to the results of analyses, not only in Pz but also in all Rb which must be included in the class of podzols. The limit values in Ap (≥ 0.20) exceed some Bo (Table III). In all the other soils, particularly luvisols, pseudogleys and gleys (including

I. Humus contents in the main soil horizons (Cox, dichromate oxidation – Pospíšil 1967)

Soils horizons	Pz	Rb	Bo 1	Bo 2
Ap-Ah (0)	± 5	$3.8 \pm 0.38^*$	$2.0 \pm 0.50^*$	2.0 ± 0.33
Bvs-Bhs	$3.1 \pm 1.71^*$	$1.8 \pm 0.79^*$	—	—
Bv-Bm	2.5 ± 1.80	1.0 ± 0.58	$0.7 \pm 0.33^*$	0.7 ± 0.41
N	14	30	30	13

II. Humus fractions (average data) (modification of Tjurin's method). — Humusové frakce (průměrné údaje) (modifikace Tjuriuovy metody)

Soil	Horizon	$\frac{Ha}{Cox}$	Ha : Fa	$\frac{1Ha}{Ha} \cdot 100$	$\frac{2Ha}{Ha} \cdot 100$	$\frac{1aFa}{Fa} \cdot 100$	$\frac{1a+1Fk}{Fk} \cdot 100$
Be	Ap	23	1.0	43	32	14	66
Bm	Ap	20	0.7	63	22	14	77
Bo	Ap	21	0.8	68	16	21	84
Rb	Ap	18	0.6	83	9	26	86
Be	Bv	21	0.8	27	53	24	65
Bm	Bv	14	0.6	43	39	28	70
Bo	Bv	14	0.4	68	23	29	80
Rb	Bvs	12	0.4	74	12	56	85
Be	IIBC	6	0.6	10	—	26	35
Bm	IIBC	9	0.2	16	50	25	60
Bo	IIBC	8	0.2	43	23	37	79
Rb	IIBC	7	0.1	89	6	57	77

Ha ... humic acids, Fa ... fulvic acids, 1a ... free, movable, 1 ... slightly bound, 2 ... strongly bound

acid soils of the humid regions), the indication quotient does not exceed the value of 0.10 below the epipedons.

Free Feo (Tamm) and Fed (Coffin) oxides as well as their values in relation to the total Fe content (Fet), and the index of Fe "activity" (Feo/Fed) indicate the degree of the brownification of all the soils under study (in Pz-partially Bb — also migration). The data on the proportion of amorphous Feo generally indicate (in all soils) the pedogenetic release throughout the solum, with a decrease in the basal layer (to 0.3–0.5 % in Feo, and 5–10 % in Feo/Fet). The data on the profile distribution of Fed indicate a significant increase in the solum in comparison with the basal part only in Rb and Bo on substrata no. 1, or generally in the Fed/Fet values. In other cases it increases in substrata no. 2 (Fed) in the deeper parts of the profile. In the metamorphic horizons (Tab. IV), significant differences are observed in all indices of free Fe oxides between Rz and Rb and other soils — in Fed/Fet also between Rz and Rb, in Feo/Fet between Bo and Bm. The content of free Al (Alo Tamm) reaches high values

šil 1967). — Obsah humusu v hlavních půdních horizontech (Cox oxidace dvoj-

Bm 1	Bm 2	Be 1	Be 2	Pl	Bt
1.7 ± 0.55	1.6 ± 0.36	1.5 ± 0.37	1.5 ± 0.40	1.7 ± 0.54	1.8 ± 0.54
—	—	—	—	—	—
0.6 ± 0.35	0.6 ± 0.31	0.6 ± 0.29	0.6 ± 0.34	0.6 ± 0.22	0.5 ± 0.23
32	17	14	23	18	18

Soil	Horizon	C %	Fe %	Al %	Σ C+Fe+Al %	$\frac{C+Fe+Al}{< 2 \mu m}$
Be	Ap	0.2–0.4	0.6–0.8	0.10	1.1–1.4	0.06–0.10
Bm	Ap	0.2–0.7	0.3–0.8	0.10–0.3	1.0–1.5	0.10–0.17
Bo	Ap	0.3–1.0	0.3–1.5	0.05–0.4	0.8–2.5	0.05–0.26
Rb	Ap	0.8–1.4	1.0–1.6	0.30–0.6	2.1–3.6	0.28–0.64
Pz	O-Ah	0.7–1.0	0.6–0.9	0.15–2.0	1.6–1.9	0.14–0.24
Be	Bv	0.1–0.3	0.5–0.9	0.10–0.2	0.8–1.2	0.04–0.07
Bm	Bv	0.1–0.4	0.2–0.7	0.05–0.2	0.3–1.0	0.05–0.12
Bo	Bv	0.1–0.4	0.3–1.6	0.05–0.4	0.5–1.9	0.05–0.14
Rb	Bvs	0.4–1.5	1.1–2.3	0.40–1.0	1.9–4.6	0.23–0.70
Pz	Bhs	1.0–1.8	1.0–1.9	0.70–0.9	3.5–4.2	0.62–1.01

throughout the profile of Pz and Rb, and its profile distribution also indicates migration. The low values below the sola are found already in Bo. Significant differences in metamorphic horizons exist between Rb and Bo, on substrata no. 1 also between Bo and Bm (Tab. no. IV).

The pH or the base saturation are generally used as important diagnostic characteristics of Cambisols in all classifications. In pH (Tab. V) significant differences in the cambic horizons can be demonstrated only between Bm and Be. According to the value of V_M , a majority of Rb and Bo is under the margin of 30–40 %; Be is over 60–75 %. The value of T_M in itself represents mostly a potential value depending on the pH conditions of determination. This is proved by the T_R/T_M ratio (Ulrich 1967) or by the $T_M - T_R$ differences (Coleman *et al.* 1965) from Tab. V (Pz 28.5, Rb 17.1, Bo 4.8–5.9, Bm 3.7–4.3). More realistic expression of the conditions in acid soils is provided by the T_R values which are lower in the genetic profile (< 10 mval/100 g); in the substratum they range about 5 mval/100 g. The significant differences in T_R between Bo and Bm, Bm and Be, and in the T_M/T_R ration also between Bo and Rb, correspond to the decrease of the content of low-molecular organic substances (in the main), and to the decreasing importance of Al. The Al saturation value of the exchange complex (related to T_R) with an addition of the T_M/T_R ration provides wider possibilities for the differentiation of the "acidity" scale of acid soils. Significant differences in Al saturation in cambic horizons are observed between Bo and Bm and Be (0). The advantages of the use of the Al saturation are demonstrated by the analysis of the relations between $pH/N \text{ KCl} - Al/T_R \cdot 100$ ($\eta = 0.69^{++}$); it is shown that exchangeable Al occurs at pH 4.8. If the Al saturation is increased up to ca. 15 %, pH quickly drops to 3.9–4.0 and remains unchanged up to the level of the 70 % Al saturation. For current series analyses in 0.2 N KCl this pH value is 4.1–4.3 in Rb, Pz, and 3.8–4.0 for the rest of soils.

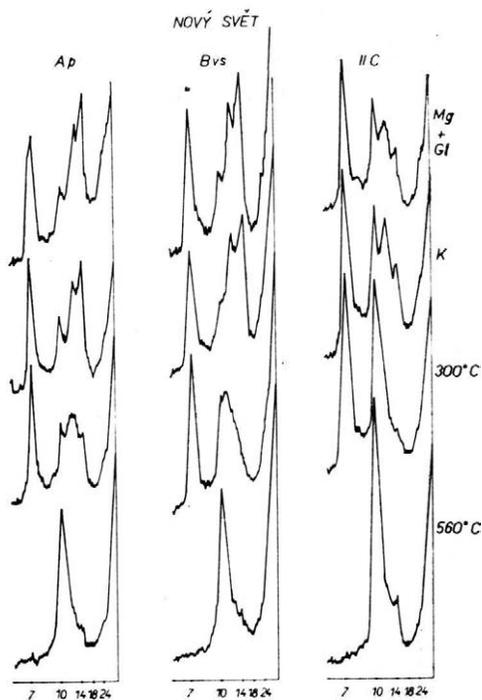
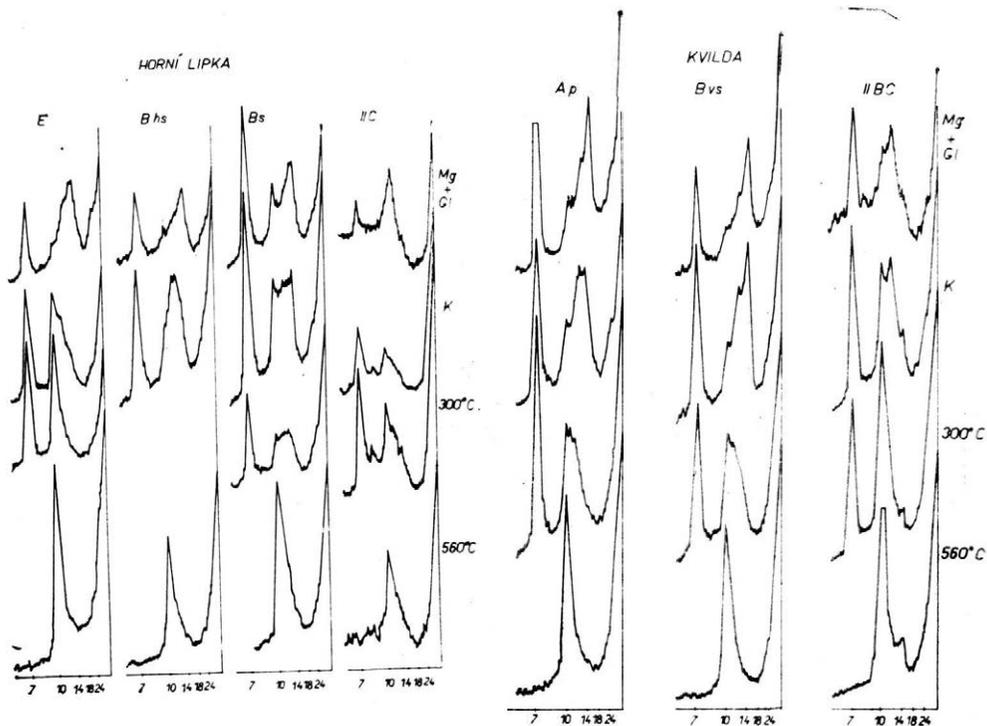
The mentioned indices of soil acidity and Al activity can be empirically correlated with the manifestations of different degrees of expansible clay minerals alumination (chloritized vermiculites and their mica interstratifications). The X-ray diffractograms in Figs. 3 and 4 show that these changes, manifesting

IV. Free iron and aluminium contents (Feo, Alo Tamm; Fed Coffin) in the Bv – Bvs (Bhs) horizons (average data, standard deviation) and their difference significance (I) in the soil units sequence. – Obsah volného železa a hliníku (Feo, Alo Tamm; Fed Coffin) v horizontech Bv – Bvs (Bhs) (průměrné údaje; standardní odchylka) a průkaznost jejich rozdílů (I) ve sledech půdních jednotek

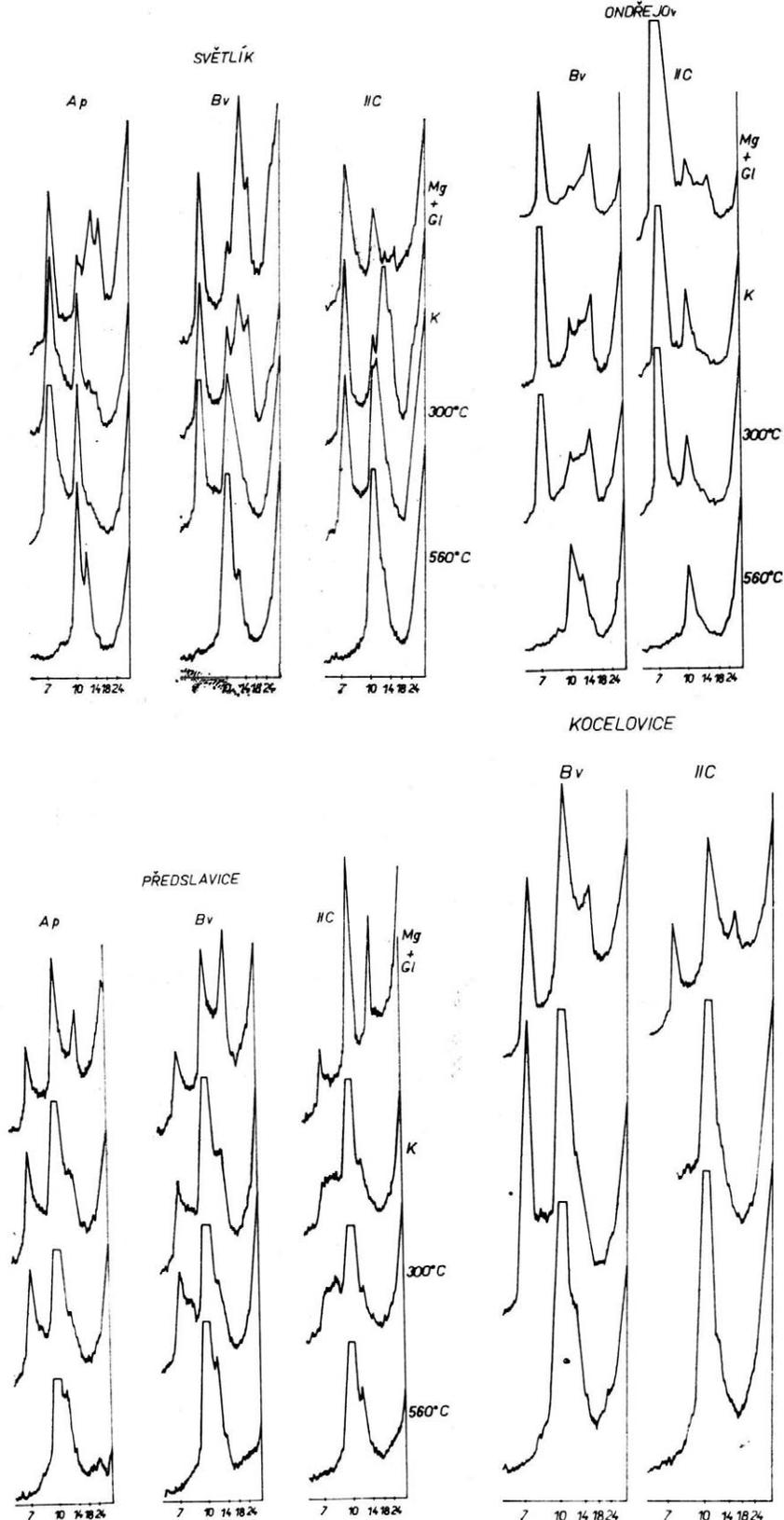
Soil properties	Pz	Rb	Bo 1	Bo 2	Bm 1	Bm 2	Be 1	Be 2	Be	Pl	Bt
Feo	2.1 ± 1.2	1.6 ± 0.7*	0.7 ± 0.2*	0.6 ± 0.2	0.5 ± 0.4	0.5 ± 0.2	0.5 ± 0.1	0.4 ± 0.2	0.5 ± 0.1	0.7 ± 0.3*	1.5 ± 0.6*
Fed	2.9 ± 1.5	2.7 ± 0.9*	1.8 ± 0.7*	1.6 ± 0.5	1.5 ± 0.7	1.9 ± 0.7	2.1 ± 0.6	1.5 ± 0.5*	3.6 ± 0.06*	4.1 ± 1.7*	3.7 ± 1.09
Alo	1.6 ± 0.80	1.3 ± 0.49*	0.4 ± 0.13*	0.4 ± 0.13*	0.2 ± 0.16*	0.3 ± 0.13	0.3 ± 0.07	0.2 ± 0.04	0.1 ± 0.01	0.3 ± 0.08	0.5 ± 0.22
Feo/Fed. 100	69 ± 17	56 ± 12*	37 ± 11*	40 ± 8	34 ± 15	29 ± 8	29 ± 10	29 ± 16	15 ± 6	21 ± 11	41 ± 13
Feo/Fet. 100	44 ± 19	32 ± 11*	15 ± 6*	17 ± 5*	11 ± 7*	12 ± 4	9 ± 3	13 ± 6	9 ± 3	11 ± 5	14 ± 7
Fed/Fet. 100	71 ± 15*	56 ± 11*	40 ± 11*	43 ± 10	32 ± 11	43 ± 10	35 ± 12	41 ± 20*	65 ± 9*	55 ± 11*	31 ± 9*
N	14	31	19	11	21	15	10	13	6	15	8

V. Cation sorption capacity, saturation, acidity, exchangeable cations data (average data, standard deviation) in the Bv – Bvs (podzol Bhs) horizons and their difference significance (I) in the soil units sequence (T_M , V_M , Mehlich's method, T_R = exchangeable cations Ca + Mg + K + Al + H, Al Yuan's method, exchangeable cations in NH_4^+ acetate and in N KCl). – Kapacita sorpce kationtů, nasycenost, kyselost, údaje o výměnných kationtech (průměrné údaje, standardní odchylka) v horizontech Bv – Bvs (podzolové Bhs) a průkaznost jejich rozdílů (I) ve sledu půdních jednotek (T_M , V_M , Mehlichova metoda, T_R = výměnné kationty Ca + Mg + K + Al + H, metoda stanovení Al podle Yuana, výměnné kationty v NH_4^+ acetátu a v N KCl)

Soil properties	Pz	Rb	Bo 1	Bo 2	Bm 1	Bm 2	Be 1	Be 2
< 1 μm	6 ± 3	7 ± 2	8 ± 3	8 ± 3	6 ± 2	10 ± 4	10 ± 5	13 ± 5
< 10 μm	18 ± 6	22 ± 6	21 ± 6	32 ± 8	18 ± 7	30 ± 7	23 ± 8	32 ± 8
pH/KCl	4.1 ± 0.6*	4.6 ± 0.3*	4.6 ± 0.3	4.6 ± 0.3	4.6 ± 0.3	4.7 ± 0.5*	5.6 ± 0.6*	6.0 ± 0.7
V_M %	< 30	< 30	< 30	< 30	50 ± 15	50 ± 14	74 ± 14	76 ± 14
V_R %	37 ± 21	57 ± 27	66 ± 13	64 ± 22*	92 ± 4*	91 ± 8*	100*	100
T_M mval/100 g	34.0 ± 14.3*	21.9 ± 7.9*	10.3 ± 3.2*	9.8 ± 2.9	11.6 ± 4.6	13.2 ± 4.7	13.7 ± 5.9	13.6 ± 4.2
T_R mval/100 g	5.5 ± 2.0	4.8 ± 1.3	4.4 ± 1.2	5.0 ± 1.5*	7.9 ± 3.9*	8.9 ± 5.0	≡ T_M	≡ T_M
T_R/T_M	0.27 ± 0.22	0.23 ± 0.07*	0.45 ± 0.16*	0.49 ± 0.12	0.65 ± 0.15	0.65 ± 0.15	≡ 1	≡ 1
Al/ T_R · 100	52 ± 18	39 ± 25	28 ± 12	30 ± 20*	5 ± 3*	6 ± 7	0	0
exch. Ca + Mg + K mval/100 g	1.6 ± 1.34	2.6 ± 1.7	3.1 ± 1.24	3.3 ± 1.33*	7.3 ± 3.5*	8.1 ± 4.9	11.7 ± 5.9	11.7 ± 5.1
Ca/Σ · 100	75 ± 10	99 ± 9	64 ± 8	82 ± 8	80 ± 5	83 ± 4	85 ± 4	85 ± 4.5
Mg/Σ · 100	11 ± 4	10.1 ± 6.5	10.9 ± 5.7	88 ± 3.9	12.2 ± 4.4	11.0 ± 3.8	12.3 ± 5.1	12.3 ± 5.8
K/Σ · 100	7.7 ± 4.9	8.1 ± 5.6	11.6 ± 7.9	6.7 ± 4.7	4.5 ± 3.8	3.8 ± 2.4	3 ± 1.8	1.8 ± 0.8
N	12	30	29	11	32	17	14	21



3. X-ray diffractograms of the clay fraction in the podzol profile (Horní Lipka — gneiss) and rusty-brown soil profile (Kvilda — gneiss, Nový Svět — gneiss). — Roentgenové difraktogramy jílové frakce v profilu podzolu (Horní Lipka — rula) a rezivých půd (Kvilda — rula, Nový Svět — rula)



4. X-ray diffractograms of the clays fraction in the brown forest soil profile (Světlík — gneiss, Ondřejov — permocarbon: oligobasic; Předslavice — gneiss: mesobasic; Kočelovice — granite: eubasic). — Roentgenové difraktogramy jílové frakce v profilu hnědé půdy oligobázické (Světlík — rula, Ondřejov — permokarbon), mesobázické (Předslavice — rula) a eubázické (Kočelovice — žula)

themselves as the reduction of the contractibility degree of the 14 Å and 12 Å peaks to 10 Å after K⁺ saturation, and heating to 300 °C and 500 °C, are arranged in the following order: — the greatest changes generally occur in the metamorphic (in Rb also epipedons) horizons of Rb, Bo and under Bhs in Pz; — they decrease in the substratum; — they reach a low degree in the eluvial part of podzols and are poor in Bhs; — in Bm they occur only slightly. After preceding exposure to 0.1 N NaOH under cold conditions and in boiling, a full K⁺ contraction can be evoked (Scheffer et al. 1961).

The set of the properties of the organic and mineral components of soil and the conditions of leaching influence the proportions of the exchangeable Ca⁺⁺, Mg⁺⁺ and K⁺ cations in the colloidal complex. There is a significant difference in their sum between Rz + Bo and Bm in which a more balanced profile distribution is observed (in acid weathering crust accumulation in horizons enriched with organic substances). The Be show a maximum in the substratum. The percentual proportion of Ca⁺⁺ in the sum of the mentioned cations ranges between 70 and 85 %, in Mg normally between 8–12 %. In deeper parts of the strong acid soils, the proportion of Mg increases up to 25 %. The quantity and proportion of exchangeables K⁺ reach their maximum values in Bo, especially in substrata no. 1. Its proportion decreases in Be on substrata no. 2.

The results of measurements performed by Glet (1973) at three Rb, Bo and Bm sites in the Bohemian Forest (gneiss) indicate significant differences in the hydrothermic régime of the soils under study. The rate of the filling of soil pores with water ranges between 60 and 90 %, 50 and 60 %, 40 and 60 % in the Bv–Bvs horizons in a prevailing part of the year. In the simple balance, the proportion of water, percolating the mentioned profiles is 73–79 % in Rb, 12–47 % in Bo, and up to 3 % in Be. This expression of percolativity of the water régime with a significantly increasing gradient in the mountain conditions corroborates the preceding conclusions. The following mean annual temperatures were found in the depth of 45–50 cm: Rb 6,4, Bo 6,7, Bm 8,8 °C, proving the Cryochrepts features of Bo.

CHARACTERISTICS OF THE REPRESENTATIVES OF CAMBISOLS WITH SIGNIFICANT LITHOLOGIC FEATURES

Brown forest soils on sandstones and permocarbon siltstones are characterized by increased Fed values at a low value of Fe "activity" (even in Bo!). Characteristic features of Bt on basalts and diabases are a high sorption capacity, a high total content of P and Mg, and a high Mg⁺⁺ saturation of the colloidal complex. Pelosols and Bp, like some soils on tuffs, are saturated soils with a high sorption capacity in all cases (Fig. 3 and 4).

Ba have developed from substrata with apparent oligotrophic characters (CaO + MgO in 20 % HCl 0.2–0.3 %). It is difficult to differentiate Rb and Pz in these substrata. The soils from weathered sandstones have properties reminding of the described soil sequence in substrata no. 2.

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9. 1. 1974

NĚMEČEK J. (Ústav půdoznalecký, Praha - Ruzyň). *Cambisols*. Rostlinná výroba (Praha) 20 (5) : 463-474, 1974.

V práci je podán výčet půdních jednotek cambisolů, zahrnujících hnědé půdy a pedosole a půdních asociací, ve kterých mají na 59,4 % plochy ČSR dominantní zastoupení. Na 301 půdních profilech byl prováděn výzkum diagnostických znaků. Popisují se hlavní charakteristické znaky sekvence hnědých půd a jejich přechodů k podzolům, odrážející vertikální pásmovitost půd ČSR na skupině granitoidních hornin a krystalických břidlic a na skupině sedimentárních zpevněných hornin s respektováním stratifikace profilů (Haupt-, Basisfolge). Jsou to: humus a jeho kvalita, volné kysličníky Fe; Al, aplikace Franzmeierova testu na amorfní látky, charakteristiky půdní acidity a koloidního komplexu, přeměny slídnatých minerálů v kyselém prostředí, trofismus substrátů, parametry hydrotermického režimu půd. Stručně jsou charakterizovány výrazně litogenně podmíněné jednotky v rámci Cambisolů.

klasifikace, diagnostika půd; cambisols; hnědé půdy; pelosols; podzols; humus; volné kysličníky Fe-Al; amorfní půdní složky; půdní kyselost; koloidní komplex — kyselé prostředí; aluminace jílových minerálů

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В статье перечисляются почвенные единицы камбисолов, включающие бурые почвы и пелосолы, а также почвенные ассоциации, в которых они на 59,4 % площади ЧСР доминантны. На 301 почвенном профиле проводилось исследование диагностических признаков. Описываются главным образом характерные признаки последовательности бурых почв и их переходов к подзолам, отражающие вертикальную зональность почв ЧСР на группе гранитоидных горных пород и кристаллических сланцев и на группе седиментарных уплотненных горных пород с учетом стратификации профилей (Гаупт-, Басисfolge); а именно: гумус и его качество, свободные окиси Fe и Al, применение Францмайрова теста на аморфные вещества, характеристики почвенной кислотности и коллоидного комплекса, преобразования слюдястых минералов в кислой среде, трофизм субстратов, параметры гидротермического режима и т. п. Коротко характеризуются явно литогенно обусловленные единицы в рамках камбисолов.

классификация; диагностика почв; камбисол; бурые почвы; пелосол; подзол; гумус; свободные окиси Fe и Al; аморфные почвенные компоненты; почвенная кислотность; коллоидный комплекс-кислые среды; алюминация глинистых минералов

NĚMEČEK J. (Institut für Bodenkunde, Forschungsinstitute der Pflanzenproduktion, Praha - Ruzyně). *Cambisols*. Rostlinná výroba (Praha) 20 (5):463-474, 1974.

In dem Aufsatz wird eine Aufzählung der Bodeneinheiten von Cambisols, die die Braunerden und Pelosols einbeziehen, und die Bodenassoziationen dargestellt, in denen sie auf 59,4 % des CSR-Territoriums einen dominanten Anteil haben. Auf 301 Bodenprofilen wurde die Untersuchung von diagnostischen Merkmalen vorgenommen. Es werden die wesentlichen charakteristischen Merkmale der Sequenz von Braunerden und deren Übergangsformen zu Podsolen beschrieben, die die vertikale Zonalität der Böden der CSR auf der Gruppe von granitoider Gestein und Kristallschiefern und auf der Gruppe von festen Sedimentgesteinen unter der Berücksichtigung der Profilstratifikation (Haupt-, Basisfolge) widerspiegeln. Es handelt sich um: Humus und dessen Qualität, freie Fe-, Al-Oxide, Applikation des Franzmeier-Testes für amorphe Substanzen, Charakteristik der Bodenazidität und Kolloidkomplexes, Umwandlungen von Glimmermineralien in sauerem Milieu, Substratentrophismus, Parameter des hydrothermischen Bodenregimes. Kurz werden die stark lithogenbedingten Einheiten im Rahmen der Cambisols charakterisiert.

Klassifizierung, Bodendiagnostik; Cambisols; Braunerden; Pelosols; Podsol; Humus; freie Fe-, Al-Oxide; amorphe Bodenkomponenten; Bodenazidität; Kolloidkomplex — saueres Milieu; Aluminierung von Tonmineralien

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ON THE GENESIS, OCCURRENCE AND AGE OF THE SOILS OF FERRETO TYPE IN CZECHOSLOVAKIA

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In Czechoslovakia the soils of ferreto type occur on a larger scale as fossil and as relict soils in the Dyje —Svratka Graben. Their occurrence is bound there to the surface of the Vth gravel-sand level (the so-called Tuřany terrace) which corresponds to the „younger gravel covers“ of the circumalpine area and stratigraphically it belongs to the Günz. Hence the formation of these soils falls most probably in the Cromer interglacial (G/M, Early Pleistocene) showing a characteristic warm and damp weather, dry summers and warm rainy winters in its climatic optimum. During this warm period of the first order the soil of *terra rossa* type was formed on the carbonate substrata and the soils of braunlehm (brown-earth soil) and rotlehm type on loesses and volcanites for the last time. There do not exist any analogies of the soils mentioned in younger warm periods which makes it clear that the last weathering giving rise to „red soils“ took place at the junction of the Early and Middle Pleistocene. According to Kubiěna (1964) these strongly weathered and intensively coloured soils correspond to the sub-Mediterranean up to subtropical paleopedological province.

stratigraphic importance of soils; paleogeographic importance of soils; soil micromorphology; ferreto; braunlehm; *terra rossa*

The soils of ferreto type belong to the group of soils formed under the conditions of transient siallitic-allitic weathering. The process of ferretization weathering stands near to the process which gives rise to the soils of *terra rossa* type, yet in contradistinction to *terra rossa*, ferreto always originates on silicate substrata. In weathering rocks of this type an increased amount of Fe_2O_3 (+ Al_2O_3) accumulates, SiO_2 disappears in part and the basic components disappear completely. The reaction (pH) of the course of weathering is alkaline, the reaction of weathering products is acid. Hydrated aluminosilicates and iron silicates and, further, Fe^{++} oxides or Fe^{++} hydrates with lower content of water or water-free are the final products of ferretization weathering. Lower parts of soil profile often bear signs of kaolinization (Stejskal — Pelíšek 1956, Stejskal 1958, Fränzle 1965).

The term „ferreto“ comes from popular language and was introduced into literature for the first time by Taramelli (1876) who mentioned its abundant occurrence on the southern slope of the Alps (in Piedmont, Lombardia etc.). As soon as in 1896 Baltzer spoke against the idea that these soils represent old fluvio-glacial deposits and was the first to refer to them as to the products of old interglacials (comp. also Meyer 1917). Likewise, Penck and Brückner (1909; comp. also Purkyně 1912, 1914) took all the red-coloured interglacial gravel-sandy weathering rocks for ferreto stating that „all lime was leached out, all feldspars were kaolinized and all hydratizable components were hydratized“ in these rocks. — Judging from the intensity of fer-

retization of moraines Penck and Brückner calculated the duration of each interglacial (comp. Woldstedt 1954). According to Fischer (1917) the depth of this weathering is very variable attaining several tens of metres. Dietrich (1920) compared ferreto with bauxites, laterites and rotlehms (red loams) calling attention to the fact that some ferretos can be of Young Tertiary age. According to Gagel (1926) the most intensive ferretization weathering of moraines took place in M/R interglacial; likewise, Fink (1961) mentioned that ferretization in Northern Italy took place in pre-Riss sediments only. Blanck (1930) studied the pedochemical properties of these soils assigning them stratigraphically into Pleistocene interglacials.

Sporadic occurrences of these soils have so far been recorded from the territory of Czechoslovakia, namely from Moravia and Slovakia. The terrace gravels in the region of the Moravian Karst and in the environs of Brno (Moravia) underwent ferretization weathering according to Mohr (1941, 1943). In the territory of Slovakia the so far undescribed layer of kaolinized gravel is thought to correspond to ferreto; it is situated near the road Sloboda running across the Velký Rinčový potok and the Vyšné Hágy. Further, a red-weathered layer overlying the kaolinized gravel near Starý Smokovec (Rehmann 1893, Partsch 1923, Lukniš 1959) and a layer located between Východná and Važec in Vysoké Tatry (Vitásek 1924) belong to the destructed ferreto that has as yet not been described from the point of view of pedology. A pedological revision of these occurrences will have to be made.

The investigation proper dealt with the determination of the extent and stratigraphic position of these soils in the Dyje-Svratka Graben. This classical Quaternary region offers not only a varied scale of early fluvial accumulations but also their correlation with eolian sediments, archeological, paleontological findings etc. The soils of ferreto type occur on extensive areas, namely on the surface of the Vth gravel-sand level (the so-called Tuřany terrace) covering large areas of the Dyje-Svratka Graben (Zeman 1972). This cover corresponding to "younger gravel covers" from the region of the Alps and belonging stratigraphically to the Günz consists of three accumulations while the soils studied are bound to their middle part. The surface of this level was modelled by deflation which repeated many times and by at least two intensive soil-forming process; the soils of ferreto type correspond to the earlier cycle, the soils of braunlehm type correspond to the younger type separated from the preceding cycle by eolian sedimentation. Of the soils of braunlehm type only thick carbonate horizons were preserved (ferretized gravels underlying rotlehms have been described from the circumalpine region also by Fink in Fink, Grill, Kolmann, Küpper 1958).

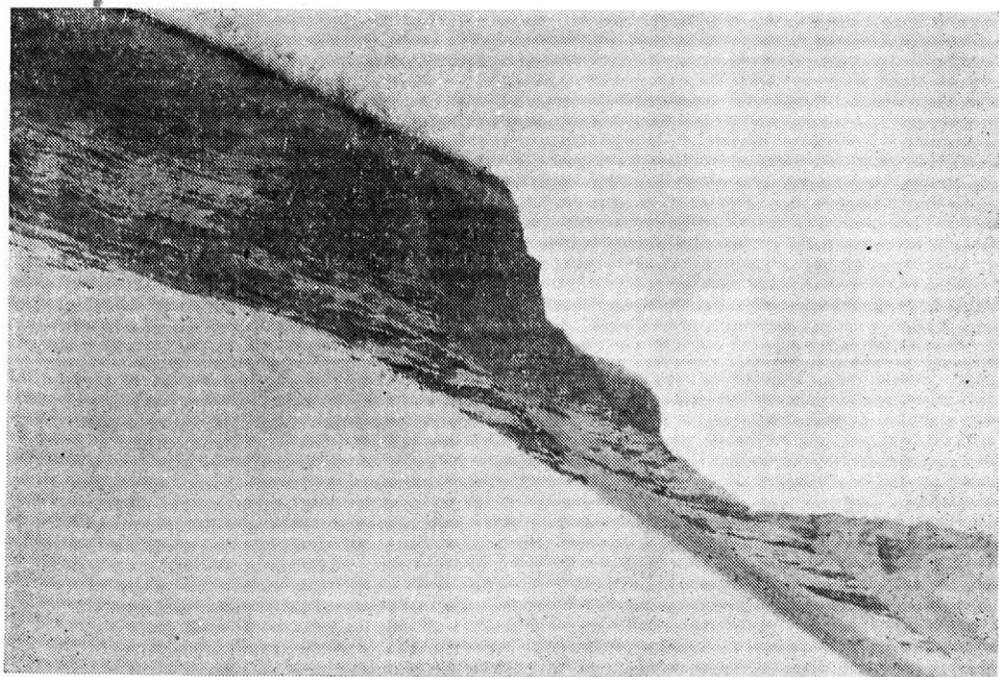
The profiles in Hodonice, Božice, Drnholec, Bratčice, Žabčice and Brněnské Ivanovice*) were subjected to preliminary examination.

In the Hodonice (Fig. 1), Drnholec and Bratčice sand pits (Fig. 2) the soils of ferreto type occur as fossil soils; they are overlain by stony pavement arisen by deflation of fine-grained material, then comes loess (Pl. I/1) or also a torso of braunlehm and its carbonate horizon (Pl. I/2) which is covered

*) The author acknowledges with thanks the kind demonstration of these profiles by Dr. A. Zeman from Geological Survey, Praha.



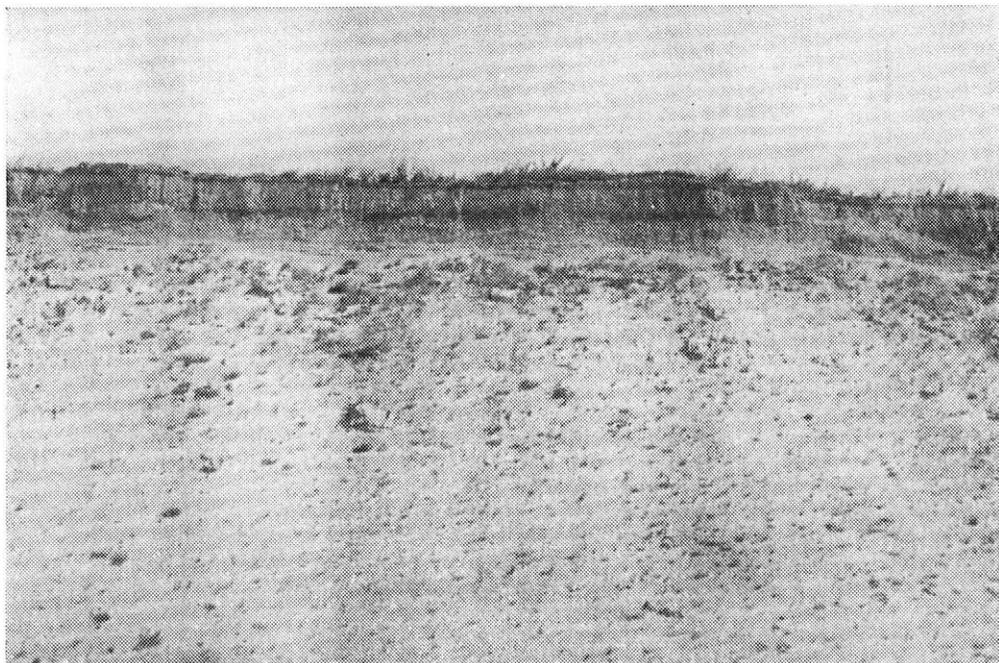
1. Fossil soil of ferreto type covered by loess with Holocene soil of chernozem type. — Hodonice. Photographs were made by L. Smolíková. — Fossilní půda typu ferreto, překrytá spraší s holocenní půdou typu černozemě. — Hodonice. Foto L. Smolíková



2. Ferreto developed in great thickness on the Tuřany terrace; it is covered by loess which is pedogenetically terminated by a typical chernozem. — Bratčice. — Mohutně vyvinuté ferreto na tuřanské terase; je kryto spraší, která je pedogeneticky uzavřena typickou černozemí. — Bratčice



3. Relict soil of ferreto type. Recent parachernozem is developed on a shallow sandy accumulation. — Božice. — Reliktní půda typu ferreto. Na mělké písčité akumulaci je vyvinuta recentní paračernozem. — Božice



4. Characteric stony pavement produced by deflation of fine-grained material on the surface of the relict soil of ferreto type. — Tuřany. — Výrazná kamenná dlažba, vzniklá deflací jemnozrného materiálu, na povrchu reliktní půdy typu ferreto. — Tuřany

by Holocene chernozem soil (Pl. II/1). In Hodonice ferreto passes laterally into braunlehm (the depression in gravels is filled with eolian substratum), and in its roof we found another soil of braunlehm type with thick carbonate horizon. — In Žabčice, Božice (Fig. 3) and Brněnské Ivanovice the soils studied are relict in character (comp. Kubiěna 1956); the stony pavement overlying the soils mentioned displays only a thin layer of Holocene parachernozem (Pl. II/2).

The edges of this Vth gravel-sand level show that pronounced periglacial effects were also found on the relics of carbonate horizons, intermingled with variegated relics of underlying soils of ferreto type. Some profiles of these soils bear periglacially kneaded red-violet and rosy lenticles corresponding probably to the material of destructed tropical pseudogleys.

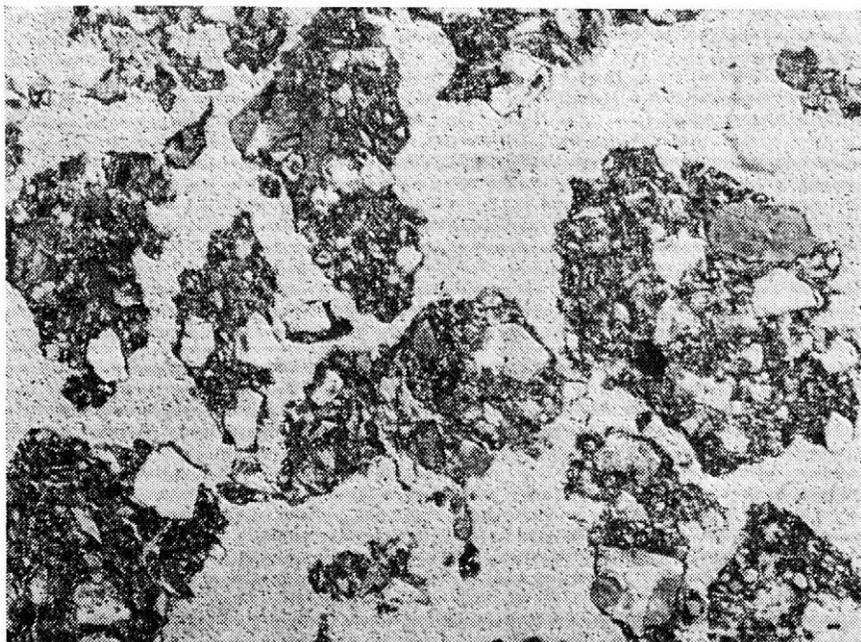
The soils of ferreto type were not found on the surface of Mindel neither Riss and younger terraces. Speaking pedogenetically, these levels are covered by the soils of completely different typology with substantially different and lower degree of weathering. During the Holocene the soils occupying different position (in particular with regard to the relief) in the catena of podzol and ranker soils develop on lithologically equivalent substrata.

A sandy layer 70 to 250 cm in thickness derived from original soil profiles of ferreto type is preserved in the majority of the localities studied. It is humus-free (along roots the humus penetrations from the overlying Holocene soils of chernozem series can be followed in relict occurrences only), red-brown to brown-red in colour (5 YR). The pebbles of less resistant rocks are completely disintegrated. The sandy component is cemented by clayey coats (their origin can be related in some cases to the clay freed during younger braunlehm soil-forming process taking place on the eolian substratum). The intensity of this deep-reaching weathering (exceeding even several m) with a high amount of freed clay and an intensity of colour decreases downwards. This important layer is overlain by a characteristic stony pavement (Fig. 4) in all the profiles available.

BRIEF MICROMORPHOLOGICAL CHARACTERISTIC

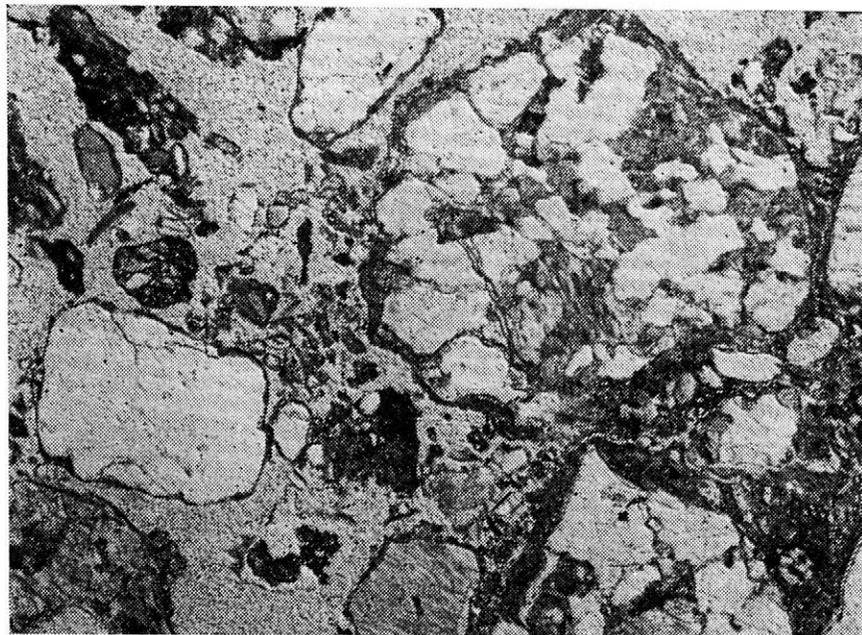
The soil microskeleton consists of the components of the size of sand grains. It is composed of the grains of quartz, quartzites, quartz gneisses and silicified sandstones (Pl. III/1). Other fragments of rocks (different types of granites etc.) and minerals show perfect disintegration due to a high degree of weathering provided they can still be identified (e. g. of dark minerals sphenes).

All these grains are rimmed by braunlehm plasma (Pl. III/2); the outline of the grains of quartz and quartzite is not interrupted (rarely it shows slight corrosion and sporadic lenticles of amorphous clay) by this plasma which, on the other hand, is responsible for the breakdown or complete penetration of other components (penetration along cleavage planes in dark minerals, alteration of fragments of granites in dependence on their mineralogical composition — e. g. replacement of feldspars by plasma etc.). However, nonfloculated braunlehm plasma does not fill all the free spaces between the soil microskeleton but all the spaces between the plasma-accompanied primary soil microskeleton are completely empty which gives rise to an aerated to loose structure of these soils which are rich in empty interspaces (Pl. IV/1). The orange-brown braunlehm microplasma sticks only to grains; in an outward direction it shows a distinct granulation and flocculation and is strongly cracked along the interjoints of accretion zones. It shows preserved striking flow structures and birefringence when observed under crossed nicols. Soil material contains numerous braunlehm concretions of large dimension (Pl. IV/2). Intensive pseudogleying is visible in thin sections of some profiles (Pl. V).

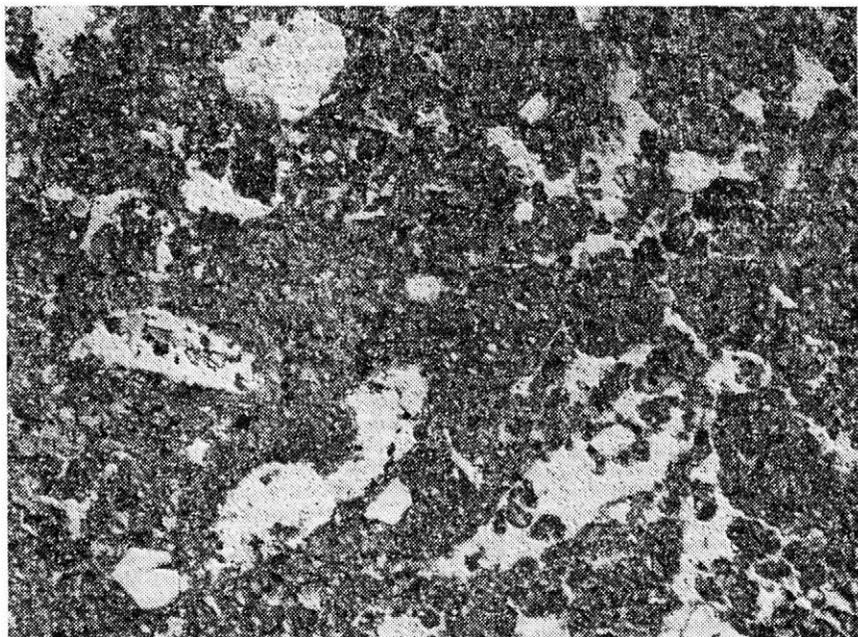


Pl. I/1. Loose structure of loess slightly affected by chernozem soil-forming process from the overlying beds. — Drnholec. — Tab. I/1. Sypká skladba spraše, slabě postižené černozemním půdotvorným pochodem z nadloží. — Drnholec

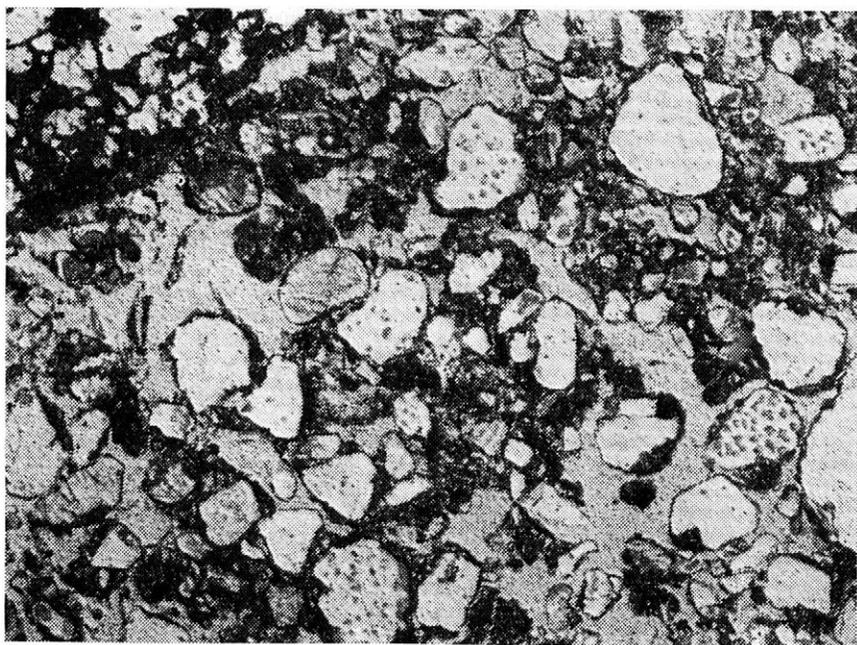
X 22.5. Microphotographs by D. Hejdová. — Zvětšeno 22.5X. Mikrofotomikry D. Hejdová



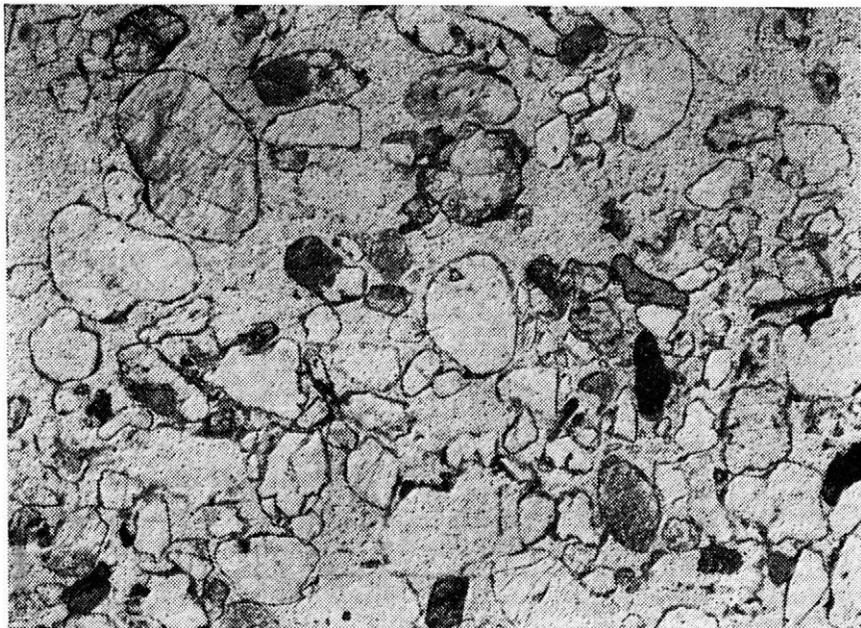
Pl. I/2. Fossil relict of carbonate horizon. — Drnholec. — Tb. I/2. Fossilní relikt karbonátového horizontu. — Drnholec



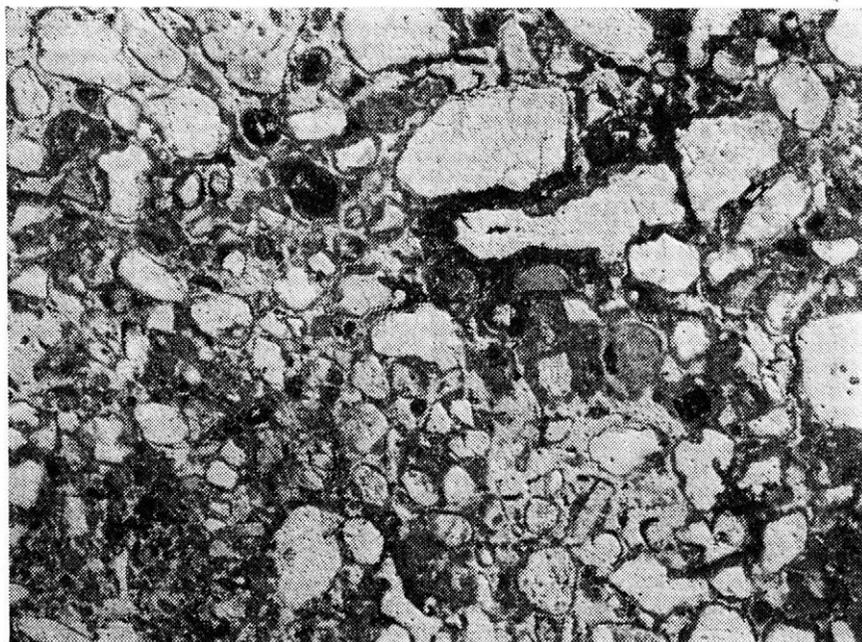
Pl. II/1. Typical spongy structure of A horizon of recent chernozem. — Drnholec. — Tab. II/1. Typická houbovitá skladba horizontu A recentní černozemě. — Drnholec



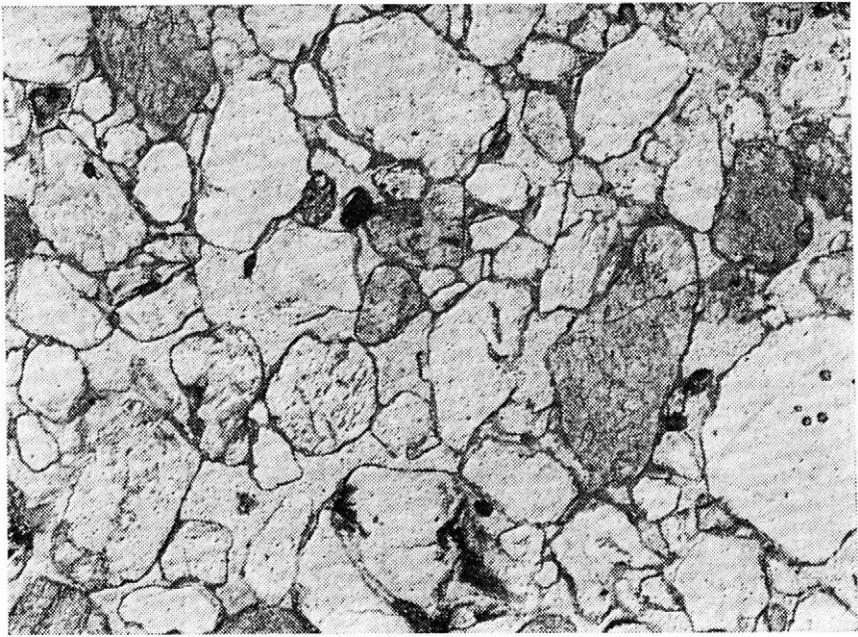
Pl. II/2. A horizon of Holocene parachernozem developed from shallow sandy superficial accumulation. — Božice. — Tab. II/2. Horizont A holocenní paračernozemě, vyvinuté z mělké písčité povrchové akumulace. — Božice



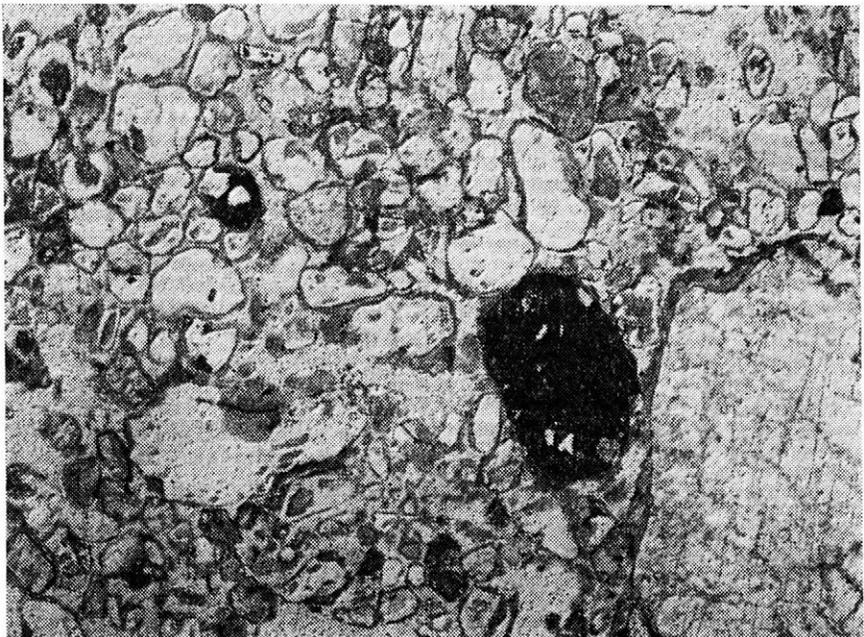
Pl. III/1. Soil sandy microskelton consists dominantly of the grains of quartz, quartzites, quartz gneisses and silicified sandstones. Lower part of the relict soil of ferreto type. — Božice. — Tab. III/1. Půdní písčítý mikroskelet sestává převážně ze zrn křemene, křemenců, křemenných rul a prokřeměných pískovců. Spodní úsek reliktní půdy typu ferreto. — Božice



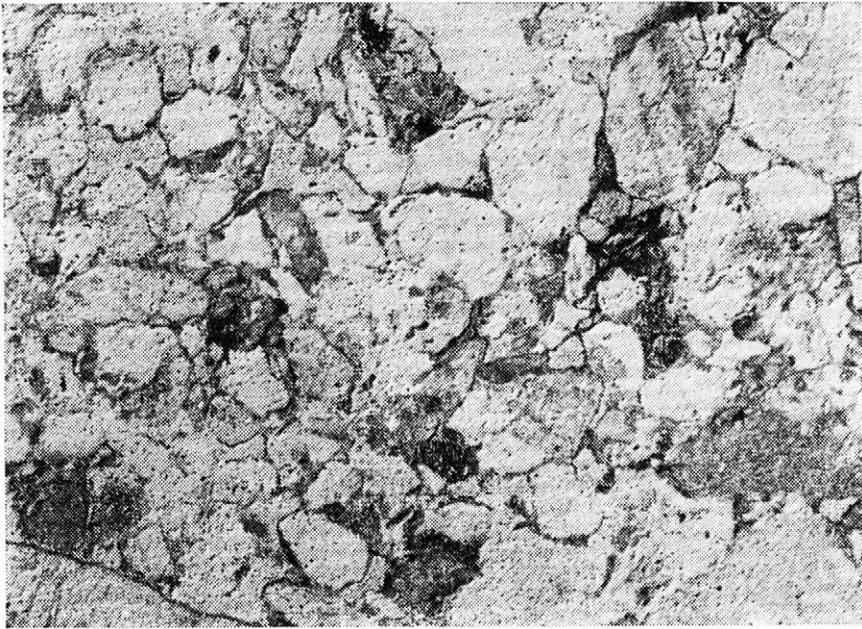
Pl. III/2. Soil microskelton is expressively bordered by the braunlehm plasma, showing in places a conspicuous granulation and flocculation („Vererdung“) (upper right quadrant). Basal part of the relict soil of ferreto type. — Božice. — Tab. III/2. Půdní mikroskelet je bohatě lemován braunlehmovým plasmatem, jevícím místy výraznou granulací a ozemnění (pravý horní kvadrant). Bazální úsek reliktního ferreta. — Božice



Pl. IV/1. Microskeleton is rimmed by braunlehm plasma yet the inter-spaces between the plasma-accompanied primary components are empty. Basal part of fossil ferreto. — Drnholec. — Tab. IV/1. Mikro skelet je lemován braunlehmovým plasmatem, avšak prostory mezi plasmatem doprovázenou primární komponentou jsou zcela prázdné. Bazální část fosilního ferreta. — Drnholec



Pl. IV/2. Large braunlehm concretions in the superficial part of relict ferreto. — Božice. — Tab. IV/2. Velké braunlehmové konkrece v povrchové části reliktního ferreta. — Božice



Pl. V. Traces of pronounced pseudogleying in the superficial part of fossil ferreto. — Drnholec. — Tab. V. Stopy výrazného pseudooglejení v povrchové partii fosilního ferreta. — Drnholec

DISCUSSION ON THE STRATIGRAPHIC ASSIGNEMENT AND PALEOGEOGRAPHIC IMPORTANCE OF THE SOILS OF FERRETO TYPE

Issuing from the fact that the soils of ferreto type of the area under study are bound exclusively to the surface of the Tuřany terrace which is stratigraphically assigned to the Günz, then the formation of these soils falls into the nearest warm period i. e. the Cromer interglacial (G/M, Early Pleistocene). This warm period of the first order with an absolute age 500 000—600 000 years was marked in its climatic optimum by a striking warmth and dampness, dry summers and warm, rainy winters (compared to the present-day state the temperatures were on the average higher by $\pm 4^{\circ}\text{C}$). Of the molluscs of that period still the Banatica-fauna of old type (Ložek 1973) is represented, of vertebrates the fauna of Biharium type. Similarly, flora is highly thermophilic. Under these conditions the soil-forming processes were substantially more intensive than in later warm periods. The soil of terra rossa type (its youngest siallitic variety; in younger interglacials only the soils of *terra fusca* type have been known from the group of *terrae calcis* in Central Europe — comp. Smolíková - Ložek 1962) originated for the last time in the Cromer interglacial on carbonate substrata (limestones, dolomites, travertines etc.).

The loess of this very warm climate which was marked by a sub-Mediterranean character in its culmination phase produced still intensively weathered soils of braunlehm and rotlehm type (basal members of ore complexes VII—XI, in older conception PK VI—VIII — comp. Smolíková 1967); these soils do not have any analogy in younger interglacials. The soils of braunlehm type of Early Pleistocene age were also established on the

substrata of volcanic origin in the České středohoří Mountains (Smolíková 1972a). In volcanic areas these soils have not been known so far to derive from younger warm periods.

All these strongly weathered and intensively coloured (red, red-brown or deep-brown) soils mentioned (i. e. of ferreto type, braunlehm type developed on loess and volcanites and of *terra rossa* type) do not have any analogy in Middle and Late Pleistocene which indicates that the last weathering leading to the origin of "red soils" ("varied weathered rocks") took place at the junction of Early and Middle Pleistocene. The hitherto investigation has revealed that the degree of weathering and the thickness of these soils increase towards the Earliest Pleistocene and Tertiary whereas in reverse direction these processes abruptly terminate (not speaking about some exceptions conditioned by a special substratum — e. g. the occurrence of earthy braunlehm in M 2/PR complex — comp. Smolíková 1972 etc.). With regard to its large areal distribution these soils are of primordial paleogeographic importance because they permit us to use time as well as other criteria also in the places where no further sedimentation took place (i. e. if they appear as relict soils in the areas of a certain age (Smolíková 1974).

According to Kubiěna (1964) all these soils correspond to the sub-Mediterranean to subtropical paleopedological province.

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9. 1. 1974

SMOLÍKOVÁ L. (Katedra geologie přírodovědecké fakulty UK, Praha). *Ke genezi, výskytu a stáří půd typu ferreto v Československu*. Rostlinná výroba (Praha) 20 (5) : 475-487, 1974.

Půdy typu ferreto se v Československu vyskytují ve větším měřítku v Dyjskosvrateckém úvalu, a to jednak jako půdy fosilní, jednak jako reliktní. Jejich výskyt je zde vázán na povrch V. šterkopískové úrovně (tzv. tuřanské terasy), která odpovídá „mladším šterkovým pokryvům“ cirkumalpské oblasti a stratigraficky spadá do gúnzu. Tvorba těchto půd spadá tedy s největší pravděpodobností do cromerského interglaciálu (G/M, starý pleistocén), vyznačujícího se ve svém klimaoptimu výrazným teplem a vlhkem, suchými léty a teplými, deštivými zimami. V tomto tepším období I. řádu se také ještě naposledy tvořila na karbonátových substrátech půda typu terra rossy a na spraších a vulkanitech půdy typu braunlehm a rotlehm. Uvedené půdy nemají analogie v mladších teplých obdobích, z čehož vyplývá, že poslední větrávání, vedoucí ke vzniku „červených půd“ probíhalo na rozhraní starého a středního pleistocénu. — Ve smyslu Kubišny (1964) pak tyto silně zvětralé a intenzivně zbarvené půdy odpovídají submediteránní až subtropické paleopedologické provincii.

stratigrafický význam půd; paleogeografický význam půd; půdní mikromorfologie; ferreto; braunlehm; terra rossa

СМОЛИКОВА Л. (Кафедра геологии естественного факультета КУ, Прага). *К вопросу генезиса, появления и возраста почв типа ферreto в Чехословакии*. Rostlinná výroba (Praha) 20 (5) : 475-487, 1974.

Почвы типа ферreto в Чехословакии встречаются в большом количестве в Дыйско-свратецкой долине, а именно как окаменелые, так и реликтные (оставшиеся с древних времен). Их появление в данном месте связано с поверхностью V щебнепесчаного уровня (так наз. туржанской террасы), которая отвечает «молодым щебневым покровам; циркумалпской области стратиграфически относятся к гунзу. Следовательно, образование этих почв с большой вероятностью относится к cromersкому интерглюциалу (G/M старый плейстоцен), отличающийся по своему климаоптимуму явным теплом и влажностью, засушливыми го-

дами и теплыми дождливыми зимами. В этот теплый период I порядка также еще последний раз образовывалась на карбонатных субстратах почва типа terra rossa и на лессах и вулканитах почвы типа браунлем и роглем. Приведенные почвы не имеют аналогии в более молодых теплых периодах, откуда вытекает, что последнее выветривание, ведущее к образованию «красных почв», протекало на границе старого и среднего плейстоцена. Согласно Кубиену (1964) эти сильно выветренные и интенсивно окрашенные почвы отвечают субсредиземной и даже субтропической палеопочвоведческой провинции.

стратиграфическое значение почв; палеографическое значение почв; почвенная микроморфология; феррето; браунлем; terra rossa

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FORSCHUNGSARBEITEN AUF DEM GEBIETE DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG UND DER DARGESTELLUNG DER PEDOSPHERE IN DER ČSSR

Die Bodenklassifikation und ihre Applikation entwickelte sich in nachstehenden Richtungen:

1. Die Systematik der Waldböden wurde von Pelíšek ausgearbeitet; dieser geht heraus aus der Klassifikation von einfachen und kombinierten bodenbildenden Prozessen, von denen der wichtigste den Bodentyp und die Bodenklasse, die Nebenprozesse, die Subtypen und Bodenformen bestimmen. Dabei wird aus der Vorstellung über die verhältnismäßig schnellen Veränderungen der Bodentypen während der Zeit herausgegangen.

2. Im Verlaufe der walddtypologischen Kartierung wurde von Houbá für unsere Bedingungen eine Bodenklassifikation adaptiert und eingeführt; diese geht aus den Arbeiten von Kubišna und Mückenhausen heraus. Die Klassifikationsysteme von Kubišna und Mückenhausen wurden von Geologen und Geobotanikern verwendet.

3. Die bei der Kartierung von landwirtschaftlichen Böden verwendete Klassifikation begann mit den Arbeiten von Jurča, man konfrontierte sie mit den Erkenntnissen der Rekognoszierung der ČSSR, mit Analysen ausländischer Erkenntnisse (Němeček, Jurča) und man faßte sie zusammen in drei Ausgaben der Kartierungsmethodik — die letzte vom Jahre 1967 von Němeček und Mitarbeitern. Man geht heraus aus einer Gesamtheit diagnostischer Horizonte und Merkmale, bei Berücksichtigung des polygenetischen Charakters der Bodenprofile. Die Signatur der Horizonte ging heraus aus der Arbeit von Jurča mit einer weiteren Ergänzung und Vertiefung. Die Klassifikation löst die Auffassung und Diagnostik der grundlegenden Stützeinheiten — Bodentypen und der niedrigeren Subtypen-Einheiten (im Grunde Zwischentypen), Varietäten, Erosionsformen und lithogenen Varianten, die die Klassifikation von Waldböden der Slowakei.

Šály löst im engen Kontakt mit der angeführten Richtung der Forschungsarbeiten über die landwirtschaftlichen Böden die Klassifikation von Waldböden der Slowakei.

Zur Vertiefung der Problematik der Bodenklassifikation und Bildung von Voraussetzungen ihrer gesamtstaatlichen Vereinheitlichung trugen konkrete Studien der Bodeneigenschaften, der Bodenareale und der bodengeographischen Beziehungen sowie Analysen der ausländischen Konzeptionen bei. Diese Arbeiten und die anwachsenden Anforderungen auf die Verbreitung der Klassifikationsproblematik auf die Bodenareale, bodenökologische und agronomisierte Standortseinheiten richteten die Aufmerksamkeit auf die Problematik der Bodensystematikgrenzen.

Die Forschungsarbeiten wurde in nachstehenden Richtungen eingestellt:
1. Diagnose der Homogenität des Ausgangssubstrates der Bodenbildung und der Ergebnisse von langfristigen Teilvorgängen der Umwandlung und Migration von Stoffen im Bodenprofil, 2. Charakteristik der einzelnen Bodengruppen, Substrate und der Bodendecke einzelner Gebiete, 3. Gewinnung von Grunderkenntnissen über die Feuchtdynamik der Böden und weitere dynamische Parameter, 4. Bewertung von Strukturen der Bodendecke und Zusammenstellung von Bodenkarten 1 : 200 000, 1 : 500 000 und 1 : 1 Mill., 5. Zusammenfassung der gewonnenen pedogenetischen Erkenntnisse, ihre Konfrontation, Arbeiten an der einheitlichen Klassifikation und Bodenkarte der ČSR.

Dr. Jan Němeček, CSc.

TECHNOLOGISCHE EIGENSCHAFTEN DER BÖDEN DER WICHTIGSTEN SUBSTRATGRUPPEN

Z. FACEK

FACEK Z. (Institute of Soil Science, Praha-Ruzyně). *Technological Characteristics of the Soils of the Main Substratum Groups*. Rostlinná výroba (Praha) 20 (5): 489-498, 1974.

More than 600 special probes from Bohemian and Moravian districts were evaluated with respect to the technological properties of the soil horizons I and II, as expressed by boundaries according to Atterberg. The following factors were evaluated: the effect of the granularity spectre, especially the content of the clay particles, the effect of the organic component, specificity of the substratum, and soil development. Correlation coefficients were sought and some anomalies were pointed out. In soils of a majority of substrata, the content of humus increases with the content of clay particles. Humus content is in a positive correlation with the values of the sticky limit. The clay particles are in a negative correlation with the sticky limit up to the content level of 30 %, and with a higher humus content up to the clay content of 23 %. From this limit, the negative correlation becomes positive with an increase in the clay content. Some results were also tested and compared with more exact methods using rotatory viscosimeter and osmometer.

technological properties; limits of consistency; soil; soil-forming substrata; humus; shearing stress; osmometry

Durch technologische Eigenschaften — Bodenkonsistenz — wird die Erscheinung der physikalischen Kräfte, d. h. Kohäsion und Adhäsion, die im Boden bei verschiedenem Feuchtigkeitsgehalt gemeinsam mit der Wirkung der unmittelbaren Gravitation und Tendenz der Bodenmasse an fremde Substanzen anzuhaften wirken, ausgedrückt. Die einzelnen Konsistenzgrenzen werden im Wesen durch den Wassergehalt im Boden (in der Erdart) charakterisiert; nach diesem verändern sich die physikalisch-mechanischen Eigenschaften des Bodens. Diese Veränderungen sind bei schweren und mittleren Böden spezifisch, wogegen sie bei leichten Böden nur beschränkt zum Vorschein kommen.

Eine sehr eingehende Einteilung der Methoden und Überprüfung ihrer Anwendbarkeit wurde von B o d m a n (1949) vorgenommen, wobei er im Grunde aus Atterberg's Konsistenzgrenzen, die weiter von einer Reihe der Autoren vervollkommen wurden, herausging. Durch die Entwicklung der Rheologie, die einen Bestandteil der Physik bildet und sich mit Deformationen und mit dem Fluß der Masse befaßt, bietet sich die Applikation einiger Erkenntnisse und Methoden in der Bodenphysik, denn die Bodenkonsistenz kann für einen Bestandteil des breiten Bereiches der allgemeinen Rheologie gehalten werden.

MATERIAL UND METHODEN

Zu Analysen verwendete man Proben spezieller Sonden der Kreise Böhmens und Mährens (600), u. zw. den I. und II. Horizont und zwecks Illustration auch das Bodensubstrat allein. Von den Proben beseitigte man den Teil des Mittelsandes (über 0,5 mm) und bestimmte die Grenze der Bindefähigkeit, Klebefähigkeit,

die obere und untere Verflüssigungsgrenze, die Geschmeidigkeitsgrenze und die Plastizitätszahl (F a c e k 1966).

Bei ausgewählten Proben bestimmte man die Schubspannung mit dem Gerät „Rheotest II“ bei der Konzentration der Wassersuspension von 10, 40, 50, 70 und 80 % und vier Geschwindigkeiten von 1, 9, 81 und 243 Umdrehungen (Min^{-1}), ausgedrückt in Dyn cm^2 . Gleichzeitig maß man den osmotischen Druck mittels des Gerätes „Semimikroosmometer“, u. zw. aus 40 % der Wassersuspension. Nach 24 Stunden Ruhepause wurde mit der Laborzentrifuge der Extrakt abgesondert, von dem man 0,2 ml abpipettierte, fügte 1,5 ml 0,1 N NaCl bei, schüttelte durch und zwecks Messung pipettierte 0,15 ml in eine kryoskopische Küvette ab. Die Ergebnisse werden in m osm mol^{-1} ausgedrückt. Die osmotisch aktiven Stoffe setzen den Taupunkt proportionell zur Konzentration herab. Aus dieser Herabsetzung kann demnach der osmotische Wert berechnet werden, der ansonsten in Atmosphären angeführt wurde. Die Herabsetzung um $0,01^\circ\text{C}$ = Erhöhung des osmotischen Druckes um 0,021 Atü.

Bei der ersten mehr zusammenfassenden Bearbeitung der technologischen Bodeneigenschaften (F a c e k 1966) bewerteten wir das Material, neben der Spezifität der Substrate, hauptsächlich mit Rücksicht auf den Bodenentwicklung. Wenn auch die Ergebnisse sehr interessant waren, konnte man wegen der relativ geringen Anzahl der Bodenrepräsentanten in den ermittelten Werten keine gegenseitigen Zusammenhänge und Begründung ihrer Frequenzen ausfindig machen. Die gegenwärtigen, verhältnismäßig reichen Materialien gestatteten uns die Sortierung nach der Zusammensetzung des Spektrums je nach der mechanischen Zusammensetzung, vor allem nach den Tonpartikeln und ferner nach dem Gehalt der organischen Bodenmasse innerhalb der einzelnen Substratgruppen. Die Einreihung geschah nach dem ansteigenden Gehalt an Tonpartikeln (unter 0,001 mm) und an feinem und mittelmäßigem Schluff (0,001—0,01 mm) prozentisch geregelt nach der Zählung der abgesonderten Körner von 0,5—2,0 mm. Im Diagramm (1) werden Durchschnittswerte von zwei Frequenzen — niedrigerer und höherer Gehalt der Tonkomponente — angeführt. Bei der Teilung dieser zwei Bereiche erwogen wir nicht nur die Anzahl der Fälle, aber auch hauptsächlich Veränderungen des Spektrums je nach der mechanischen Zusammensetzung, des Humusgehaltes und der Werte technologischer Grenzen auf die Weise, damit die Ergebnisse repräsentativ im Rahmen der einzelnen bodenbildenden Substrate sind. Weitere gröbere Komponenten des Körnungsspektrums zeigten sich durch ihren Gehalt — ihr gegenseitiges Verhältnis — als weniger entscheidend bis vernachlässigbar. Die Verteilung wurde vorgenommen nach den im Ackerkrumenhorizont gewonnenen Werten und nach diesen wird auch der sinkende Trend des Humusgehaltes und mit diesem korrespondierende Folge im II. Horizont eingereicht.

Gleichzeitig wurde die Auswertung einiger Beziehungen mit Hilfe von Korrelationskoeffizienten (R o d, V á g n e r o v á 1958) durchgeführt.

ERGEBNISSE UND DEREN DISKUSSION

Bei der Bearbeitung der Teildiagramme der technologischen Eigenschaften und entsprechenden Werten des Gehaltes an Tonpartikeln und weiteren Komponenten des Spektrums nach der mechanischen Zusammensetzung fanden wir oft Ungleichmäßigkeiten und von diesem Gesichtspunkt unbegründete Veränderungen innerhalb der einzelnen Substratgruppen. Auch gelang es nicht, Zusammenhänge mit der Bodengenese zu finden. Diese progressiven Veränderungen wiesen jedoch auf einen sehr engen Zusammenhang mit dem Gehalt der organischen Bodenkomponente, u. zw. nicht nur im I., sondern auch im II. Horizont, bei einem relativ niedrigen Humusgehalt hin.

Von diesem Standpunkt gesehen zeigte sich auch — siehe Diagramm 1 — die Beziehung des Gehaltes an Ton oder der Tonpartikeln zum Humusgehalt. Bei der Mehrheit der Böden steigt der Humusgehalt mit dem Tongehalt an. Ein entgegengesetzter Trend erscheint bei Böden auf Glimmerschiefern und Phyllitten (42), Schieferschichten des älteren Paläozoikums und Kulm (44), auf sauren

Gesteinen von der Granitgruppe (37), algonkischen Schiefeln und Grauwacken (43), kalkfreien bis schwach kalkhaltigen Auen-Sedimenten (62) und auf Karbonat-Hängen (63). Wir sind der Meinung, daß die Begründung nicht immer nur in verschiedenen klimatischen Bedingungen und in der Höhe über dem Meeresspiegel zu suchen ist (leichtere Böden des gegebenen Substrates in höheren Höhen, niedrigere Temperatur, höhere Feuchtigkeit, weniger intensive Veränderungen der organischen Masse), sondern in der Spezifität des hydrothermischen Haushaltes.

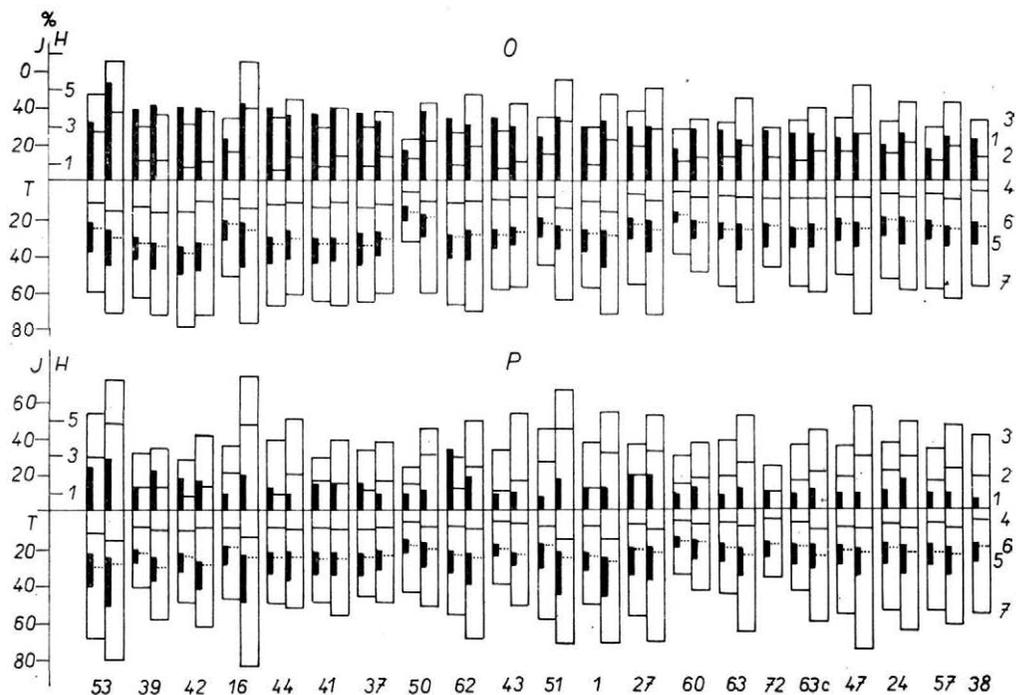
Es ist interessant, daß z. B. bei Böden auf Paragneis (41) und Hängen aus saurem Material (63c) ein bedeutender Humusgehalt bei einem sehr niedrigen Tongehalt besteht; es folgt eine Herabsetzung des Humusgehaltes bis zu 35 bis 37 % der Tonpartikel und von hier an nimmt der Humusgehalt zu. Ähnlich verhält es sich bei Böden auf Glazifluvialen Schotter (60) und kalkfreien Auen-Sedimenten (62). Bei Böden auf algonkischen Schiefeln und Grauwacken (43) ist zu Beginn mit zunehmendem Tongehalt eine Herabsetzung zu verzeichnen und mit weiterem Anwachsen des Tons wird der Humusgehalt praktisch nicht verändert. Der Verlauf des Humusgehaltes entspricht auch dem Verlauf des Feuchtigkeitsgehaltes aller Konsistenzgrenzen.

Eine umgekehrte Kurve, d. h. zu Beginn ein niedriger, zur Mitte ansteigender und wiederum sich senkender Humusgehalt besteht bei Böden auf Orthogneisen (39) und beeinflußt ebenfalls in demselben Masse die Konsistenzgrenzen. Dasselbe Bild ergeben auch Böden auf Perm (47), jedoch kommt es bei den ersten drei Grenzen fast zu keinen Veränderungen und im Gegenteil bei den Verflüssigungsgrenzen werden diese nach und nach mit ansteigendem Tongehalt erhöht. Eine weitere Unregelmäßigkeit des Humus und der Grenzen besteht bei Böden auf dem Paläozoikum und Kulm (44), wo mit dem sich senkenden Humusgehalt und ansteigendem Tongehalt die Werte der Konsistenzgrenzen ansteigen, ausgenommen die Klebefähigkeitsgrenze, die im Gegenteil herabgesetzt wird. Ähnlich verhält es sich bei Karbonat- und basischen Hangböden (63). Auch beim limnischen Tertiär (51) und Kreidematerialien (16) und stark kalkhaltigen Gesteinen (1) wachsen die Werte der Konsistenzgrenzen in einem höheren Maße mit dem Tongehalt an und allein die Klebefähigkeitsgrenze wächst sehr langsam.

Die Beziehung des Humus zu Werten der Klebefähigkeit wird im Diagramm 2 (H) veranschaulicht. Im Ackerkrumenhorizont (O) bei einem niedrigeren Tongehalt (1) ist die Abhängigkeit höher; dies bedeutet, daß der Tongehalt die Klebefähigkeitsgrenze herabsetzt. Dasselbe, allerdings weniger ausgeprägt, bestätigt auch das Bild im II. Horizont bei einem insgesamt niedrigeren Humusgehalt und höheren Tongehalt (2—P). Demnach kann eine fast lineare Abhängigkeit gefunden werden.

Das Diagramm 2 (J) weist auf die Abhängigkeit des Tongehaltes von der Klebefähigkeitsgrenze hin. In beiden Fällen senken sich im I. Horizont (O) und im II. Horizont (P) mit zunehmendem Tongehalt die Werte der Klebefähigkeit. Bei einem niedrigeren Tongehalt (1) geschieht dies viel früher (allgemein niedrigere Humuswerte — mehr Fälle — der Ton mehr entblößt), aber bei rd. 23 % Ton wendet sich die Kurve in positiver Korrelation, wogegen im II. Horizont (P) erst dann, wenn der Tongehalt die Grenze von 30 % übersteigt.

Es besteht eine sehr signifikante Abhängigkeit der Klebefähigkeitsgrenze vom Humusgehalt bei Böden auf Lößlehm (57) (jedoch nicht auf Löß), auf dem Kristallinikum, Hangböden, Perm und basischen Eruptionen. Auch die übrigen



1. Durchschnittswerte des Humusgehaltes, der Partikel unter 0,001 mm, 0,001—0,01 mm und der Konsistenzgrenzen nach Atterberg.

O = I. Bodenhorizont,
 P = II. Bodenhorizont,
 J = Ton,
 H = Humus,
 T = Konsistenzgrenzen.

Obere Kolonnen:

Die erste Kolonne vom Paar bedeutet den niedrigeren Durchschnittsgehalt an Tonpartikeln;

schwarz ausgefüllte Kolonne = Humusgehalt in %;

erster Teil der leeren Kolonne + Gehalt an Tonpartikeln (< 0,001 mm in %);

zweiter (oberer) Teil der Kolonne = Gehalt an Partikeln des feinen und mittleren Schluffes (0,001 — 0,01 mm) in %.

Untere Kolonnen:

erster Teil der leeren Kolonne = Binfefähigkeitsgrenze in % der Feuchtigkeit;

zweiter Teil (unterbrochene Linie) = Klebefähigkeitsgrenze in % der Feuchtigkeit;

schwarz ausgefüllte Kolonne = Geschmeidigkeitsgrenze + untere Verflüssigungsgrenze = Umfang der Plastizitätszahl in % der Feuchtigkeit;

unterer Teil der leeren Kolonne = obere Verflüssigungsgrenze in % der Feuchtigkeit;

Deckungszahlen der Substrate:

27 — Terrassen aus überwiegend Karbonat - Material,

38 — neutrale Gesteine der Granitgruppe,

50 — neogene Terrassen — Schottersande,

53 — Karpaten - Flysch,

72 — äolische Sande;

die übrigen Substratzahlen werden im Text-Teil erläutert.

Průměrné hodnoty obsahu humusu, částic menších než 0,001 mm, 0,001—0,01 mm a konzistenčních mezí podle Atterberga.

O = I. půdní horizont,
P = II. půdní horizont,
J = jíla,
H = humus,
T = konzistenční meze.

Horní sloupce:

prvý sloupce z dvojice značí nižší průměrný obsah jílnatých částic;
černě vyplněný sloupeček = obsah humusu v %;
prvý díl prázdného sloupce = obsah částic jílu (< 0,001 mm) v %;
druhý (vrchní) díl sloupce = obsah částic jemného a středního prachu (0,001—0,01 mm) v %.

Dolní sloupce:

prvý díl prázdného sloupce = mez spojivosti v % vlhkosti;
druhý díl (přerušovaná čára) = mez lepivosti v % vlhkosti;
černě vyplněný sloupeček = mez vláčnosti + dolní mez ztekucení = rozsah čísla plastičnosti v % vlhkosti;
poslední díl prázdného sloupce = horní mez ztekucení v % vlhkosti.

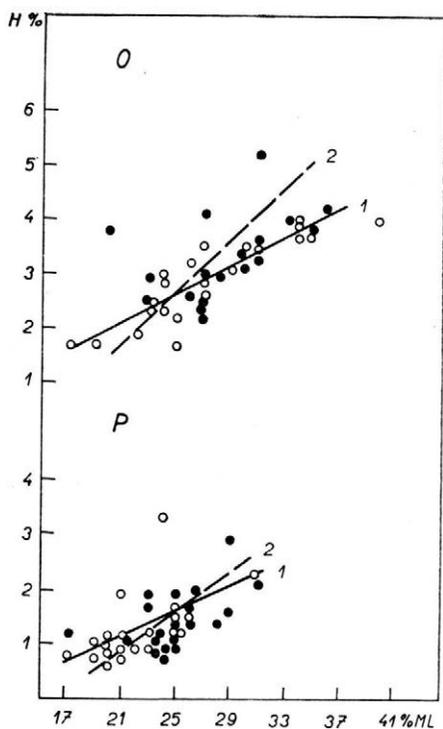
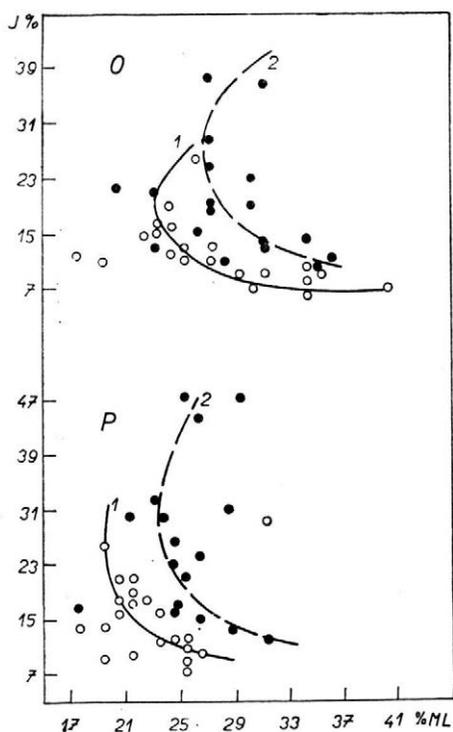
Krycí čísla substrátů:

27 = terasy z převážně karbonátového materiálu,
38 = neutrální horniny skupiny žul,
50 = neogenní terasové štěrkopísky,
53 = Karpatský flyš,
72 = váte písky;

ostatní čísla substrátů jsou vysvětlena v textové části

Grenzen stehen in enger Beziehung zum Humusgehalt, vor allem die Geschmeidigkeitsgrenze, weniger die Plastizitätszahl, wo ähnlich wie bei der Bindefähigkeitsgrenze und oberen Verflüssigungsgrenze sich auch der höhere Tongehalt durchsetzt. Auch Tschapowskij (1958) führt an, daß die Verflüssigungsgrenzen und die Plastizitätszahl die mineralische Zusammensetzung, den Dispersionsfähigkeitsgrad u. ähnl. aufzeigen. Die Bestimmung der Plastizität parallel mit der Bestimmung des Tongehaltes gestattet, bestimmte Kennwerte zu gewinnen, die die Hydrophilität der Tonfraktion und ihre kolloidale und physikalisch-chemische Eigenschaften charakterisieren. Keen und Coutts (Baver 1956) führen im Gegenteil eine positive Korrelation zwischen der Klebefähigkeit und dem Tongehalt an. Bei Böden mit einem Gehalt an organischer Masse gelangten sie zum Korrelationskoeffizienten 0,317 (dies ist eine niedrige Korrelation) und nach ihrer Beseitigung (durch Oxydation) erhöhte sich der Koeffizient bis auf 0,675. Wir sind der Meinung, daß diese Abhängigkeit— wie wir feststellen konnten— siehe Diagramm 2, bei einem Gehalt an Tonpartikeln über 30 % gültig ist.

Zwecks Illustration führen wir Korrelationskoeffizienten bei Böden von drei charakteristischen Substratgruppen an; siehe Tafel I. Böden auf Kreidemergel (16) und Paragneisen (41) haben einen annähernd denselben Humusgehalt, jedoch das Substrat 16 besitzt einen fast dreifachen durchschnittlichen Tongehalt. In beiden Fällen steht der Humusgehalt zur Höhe der einzelnen Grenzen in einer hoch signifikanten positiven Korrelation, ausgenommen, wie höher angeführt, die Bindefähigkeitsgrenze und Plastizitätszahl, die bei der Gruppe 16 im II. Horizont sogar eine unsignifikante negative Korrelation aufweisen. Die Beziehung des Tongehaltes zu den Konsistenzgrenzen ist beim Substrat 41 signifikant nur bei sehr niedrigen Tonwerten (I. Horizont), u. zw. nur bei der



2. Die Abhängigkeit der Werte der Klebefähigkeit vom Gehalt an Ton (J) und Humus (H).

O = I. Horizont,

P = II. Horizont,

1 = niedrigerer Durchschnittsgehalt an Tonpartikeln,

2 = höhere Durchschnittsgehalt an Tonpartikeln,

ML = Klebefähigkeitsgrenze in % der Feuchtigkeit.

Závislost hodnot meze lepidivosti na obsahu jílu (J) a humusu (H).

O = I. horizont,

P = II. horizont,

1 = nižší průměrný obsah částic jílu,

2 = vyšší průměrný obsah částic jílu,

ML = mez lepidivosti v % vlhkosti

unteren Verflüssigungsgrenze, Klebefähigkeitsgrenze und Plastizitätszahl, wogegen die übrigen Grenzen sogar in negativer Korrelation stehen. Bei der Gruppe 16 — relativ hohem Tongehalt — besteht eine hoch signifikante Übereinstimmung, wie erwartet werden konnte, bei der oberen Verflüssigungsgrenze, Bindefähigkeitsgrenze und bei einem höheren Tongehalt als 30 % auch bei der unteren Verflüssigungsgrenze und signifikante Übereinstimmung bei der Klebefähigkeitsgrenze. Bei der Plastizitätszahl wird die Korrelation nicht bestätigt. Dies hängt mit dem Umstand zusammen, daß die beiden Verflüssigungsgrenzen sich mit dem Gehalt an Ton im großen und ganzen gleichmäßig erhöhen.

Bei Böden auf Löß (24) besteht infolge des insgesamt relativ geringen Humusgehaltes und hauptsächlich des Unterschiedes zwischen den einzelnen Repräsentanten eine Abhängigkeit von den Konsistenzgrenzen nur im I. Ho-

I. Korrelationsbeziehungen des Humus, Tons und der Konsistenzgrenzen. — Korelační vztahy humusu, jílu a konzistenčních mezí

Böden auf Kreidemergel im Böhmischem Massiv (16)

Korrelationskoeffizient r 0,42 hoch signifikant = v
 r 0,33 signifikant = p

	Horizont Humus in % Durchschnittsgehalt Umfang		HMZ	DMZ	ML	MV	MS	ČP
I	3,22	5,5–1,2	0,54 v	0,55 v	0,45 v	0,96 v	0,24	0,05
II	1,44	2,9–0,4	0,48 v	0,50 v	0,40 p	0,35 p	0,36 p	0,18
	Ton-Durchschnittsgehalt in %							
I	27,5		0,54 v	0,29	0,29	0,21	0,81 v	0,30
II	34,4		0,92 v	0,73 v	0,36 p	0,27	0,45 v	0,22

Böden auf Paragneis (einschließlich Glimmerschiefer-Gneis) (41)

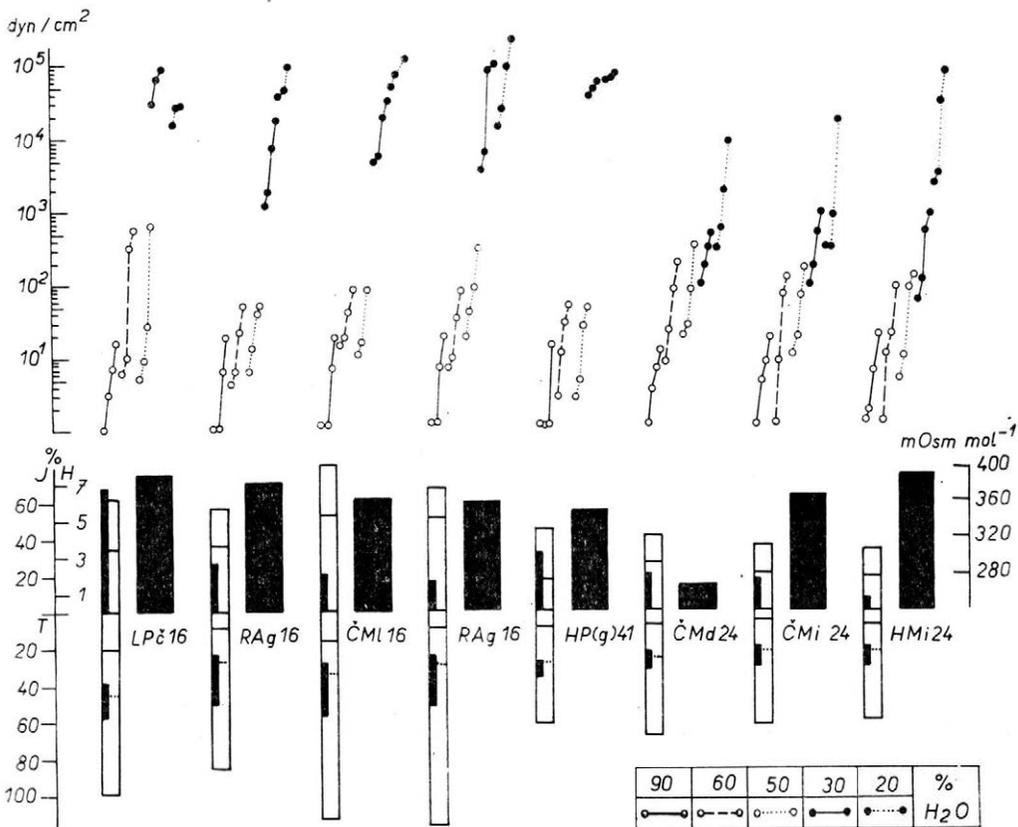
Korrelationskoeffizient r 0,36 hoch signifikant = v
 r 0,28 signifikant = p

	Horizont Humus in % Durchschnittsgehalt Umfang		HMZ	DMZ	ML	MV	MS	ČP
I	3,78	7,6–1,9	0,36 v	0,71 v	0,71 v	0,71 v	0,34 p	0,16
II	1,48	3,7–0,6	0,75 v	0,50 v	0,70 v	0,68 v	0,23	0,38 v
	Ton-Durchschnittsgehalt in %							
I	10,8		–0,18	0,29 p	0,32 p	–0,28 p	–0,33 p	0,38 v
II	12,6		–0,15	0,13	0,08	0,09	0,12	–0,10

Böden auf Löß (24) – Korrelationskoeffizient r 0,54 hoch sign. = v
 r 0,42 sign. = p

	Horizont Humus in % Durchschnittsgehalt Umfang		HMZ	DMZ	ML	MV	MS	ČP
I	2,31	3,4–1,3	0,27	0,49 p	0,36	0,52 p	0,70 v	0,44 p
II	1,48	2,4–0,4	–0,16	–0,07	0,22	0,12	–0,16	0,08
	Ton-Durchschnittsgehalt in %							
I	20,1		0,48 p	0,77 v	0,30	0,25	0,62 v	0,77 v
II	26,7		0,61 v	0,79 v	–0,08	–0,14	0,42 p	0,80 v

HMZ = obere Verflüssigungsgrenze; DMZ = untere Verflüssigungsgrenze; ML = Klebefähigkeitsgrenze; MV = Geschmeidigkeitsgrenze; MS = Binfefähigkeitsgrenze; ČP = Plastizitätszahl.



3. Schubspannung und osmotischer Druck.

Oberer Teil der Kolonne:

schwarz ausgefüllte Kolonne + Gehalt an Humus in $\%$;

erster Teil der leeren Kolonne + Gehalt an Tonpartikeln (0,001 mm) in $\%$;

zweiter (oberer) Teil der Kolonne = Gehalt an Partikeln des feinen und mittleren Schluffes (0,001—0,01 mm) in $\%$;

breite, schwarz ausgefüllte Kolonne = osmotischer Druck.

Unterer Teil der Kolonne:

erster Teil der leeren Kolonne = Binfähigkeitsgrenze in $\%$ der Feuchtigkeit;

zweiter Teil (unterbrochene Linie) = Klebefähigkeitsgrenze in $\%$ der Feuchtigkeit;

schwarz ausgefüllte Kolonne = Geschmeidigkeitsgrenze + untere Verflüssigungsgrenze = Umfang der Plastizitätszahl in $\%$ der Feuchtigkeit;

unterer Teil der leeren Kolonne = obere Verflüssigungsgrenze in $\%$ der Feuchtigkeit.

ČMd = degradierte Schwarzerde,

HMi = illimerisierte Parabraunerde (Fahlerde),

LPč = Schwarzerde — Auenboden,

RAg = Rendzine — Pseudoglei,

ČMi = illimerisierte Schwarzerde (Fahlerde),

HP(g) = brauner Boden, schwacher Pseudoglei,

16 = Kreidemergel im Böhmischem Massiv,

41 = Paragneis,

24 = Löß.

Smykové napětí a osmotický tlak.

Horní část sloupce:

černě vyplněný sloupeček = obsah humusu v $\%$;

první díl prázdného sloupce = obsah částic jilu ($< 0,001$ mm) v %;
druhý (vrchní) díl sloupce = obsah částic jemného a středního prachu (0,001 až 0,01 mm) v %.
Široký, černě vyplněný sloupec = osmotický tlak.

Dolní část sloupce:

první díl prázdného sloupce = mez spojitosti v % vlhkosti;
druhý díl (přerušovaná čára) = mez lepivosti v % vlhkosti;
černě vyplněný sloupeček = mez vláčnosti + dolní mez ztekucení = rozsah čísla plastičnosti v % vlhkosti;
poslední díl prázdného sloupce = horní mez ztekucení v % vlhkosti.

ČMd = černozem degradovaná,
HM_i = hnědozem illimerizovaná
LPč = lužní půda černozemní,
RAg = rendzina oglejená,
ČMi = černozem illimerizovaná,
HP(g) = hnědá půda slabě oglejená,
16 = křídové slíny v Českém masivu,
41 = pararuly,
24 = spraše.

rizont, u. zw. größtenteils eine nur signifikante. Viel ausgeprägter ist die Abhängigkeit vom Tongehalt, besonders zur Plastizitätszahl und zur unteren Verflüssigungsgrenze. Die Beziehung zur Klebefähigkeitsgrenze, wie erwartet werden konnte, zeigt sich auch zum Humusgehalt nicht.

Die Tatsache, daß den technologischen Eigenschaften der Böden in den letzten Jahrzehnten eine stets geringere Aufmerksamkeit gewidmet wird, ergibt sich daraus, daß durch die Konsistenzgrenzen nicht immer ihr objektiver Wert nachgewiesen werden kann. Aus diesem Grunde verwendeten wir orientierungsmäßig eine exaktere Methode, u. zw. die Bestimmung der Schubspannung, die wir, um Werte bei höheren Konzentrationen besser beurteilen zu können, durch die Ermittlung des osmotischen Druckes ergänzt haben. Im Diagramm 3 führen wir, um Werte bei höheren Konzentrationen besser beurteilen zu können, durch sich senkenden Humusgehalt (16, 24). Bei niedrigeren Konzentrationen der Suspension (90, 60, 50 % Wasser) zeigt sich eine sehr ähnliche Tendenz der Werte mit Konsistenzgrenzen (obere und untere Verflüssigungsgrenze). Durch höhere Konzentrationen differenzieren sich die einzelnen Substrate ziemlich deutlich. Besonders ausgeprägt unterscheiden sich Böden auf Löß (24) — durch bedeutet niedrigere Widerstandswerte mit dem Anwachsen von Löß bei herabsetzendem Gehalt und Qualität von Humus (von ČMd = degradierte Schwarzerde — zu HM_i = illimerisierte Parabraunerde) unter gleichzeitigen Anwachsen des osmotischen Druckes. Innerhalb der einzelnen Bodenrepräsentanten bei der Gruppe Nr. 16 sind die Werte sowohl vom Tongehalt, als auch von der Höhe des osmotischen Druckes abhängig. Der hohe Humusgehalt macht sich positiv geltend nur bei maximalen — kritischen Zuständen der Gleitreibung. Bei der Gruppe Nr. 41 ist bereits der sehr hohe anfängliche Gleitwiderstand äußerst charakteristisch.

Diese einige Überprüfungs-Ermittlungen gestatten uns, die Hypothese aufzustellen, daß durch diesen Vorgang — bei geeigneten Konzentrationen und Schnelligkeiten — die Möglichkeit bestehen könnte, bis zu einem bestimmten Maße die technologischen Bodeneigenschaften zu objektivieren und zu quanteln.

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9. 1. 1974

FACEK Z. (Půdoznalecký ústav, Praha-Ruzyně). *Technologické vlastnosti půd hlavních substrátových skupin v ČSR*. Rostlinná výroba (Praha) 20 (55) : 489-498, 1974

Bylo vyhodnoceno více než 600 speciálních sond okresů Čech a Moravy s ohledem na technologické vlastnosti I. a II. půdního horizontu, vyjádřené mezemi podle Atterberga. Byl posuzován vliv zrnitostního spektra, především obsahu částic jílu, vliv organické složky, specifita substrátu a vývoj půdy. Byly hledány korelační vztahy a bylo poukázáno na některé anomálie. U půd většiny substrátů stoupá obsah humusu s obsahem částic jílu. Obsah humusu je v pozitivní korelaci s hodnotami meze lepivosti. Částice jílu jsou v negativní korelaci k mezi lepivosti do obsahu 30 % a při vyšším obsahu humusu do 23 % obsahu jílu. Odtud se vzestupem obsahu jílu se mění negativní korelace v pozitivní. Některé výsledky byly ověřovány a srovnávány též s exaktnějšími metodami pomocí rotačního viskozimetru a osmometru.

technologické vlastnosti; konzistenční meze; půda; půdotvorné substráty; humus; smykové napětí; osmometrie

ФАЦЕК З. (Почвенный институт НИИР Прага-Рузыне). *Технологические свойства почв главных субстратных групп*. Rostlinná výroba (Praha) 20 (5) : 489-498, 1974.

Обратывалось свыше 600 специальных зондов районов Чехии и Моравии с учетом технологических свойств I и II почвенного горизонта, выраженных пределами согласно Аттербергу. Также оценивалось влияние зернистого спектра, прежде всего содержания частиц ила, влияние органического компонента, специфичность субстрата и развитие почвы. Искались корреляционные отношения; отмечается некоторое несоответствие. У почв большинства субстратов повышается содержание гумуса с содержанием частиц ила. Содержание гумуса находится в положительной корреляции со значениями предела клейкости. Частицы ила находятся в отрицательной корреляции к пределу клейкости до 30 % содержания и при более высоком содержании гумуса до 23 % содержания ила. Отсюда с ростом содержания ила отрицательная корреляция переходит в положительную. Некоторые результаты были проверены и сопоставлены также с более точными методами — при помощи вращательного вискозиметра и осмометра.

технологические свойства; консистентные пределы; почва; почвообразовательные субстраты; гумус; напряжение при сдвиге; осмометрия

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INFILTRATION AS THE TWO PHASE IMMISCIBLE FLOW IN A SWELLING SOIL

V. KURÁŽ, M. KUTÍLEK

KURÁŽ V., KUTÍLEK M. (Department of Hydro-Amelioration, Technical University, Praha). *Infiltration as the Two Phase Immiscible Flow in a Swelling Soil*. Rostlinná výroba (Praha) 20 (5) : 499-507, 1974.

The comparison of the infiltration of water and of the infiltration modelled as the two phase (water and air) immiscible flow in swelling bentonite has been accomplished. The soil moisture profiles have a regular form; however, the front of wetting was diffuse when the air pressure increased ahead of the wetting front. In both cases, the variation of bulk density inside of the soil column was observed. In the soil column provided with the free escape of air ahead of the wetting front (infiltration as the one phase flow), the increase of bulk density roughly on the position of wetting front was less significant, while this increase was well pronounced in the soil column where the increase of the air pressure developed during the infiltration. The phenomenon is formulated as the moving barrier which is characterized by the rate roughly identical with the rate of advance of the wetting front and by the gradually increasing hydraulic resistance. The extent of this phenomenon will probably depend upon the overburden pressure in addition to the soil properties.

infiltration; bulk density; air pressure; swelling soil

Until recently, an ever increasing attention has been paid to the flow of water in inert unsaturated soil and to the endeavour of the analytical solutions of flow and their experimental tests in that inert materials. Flow of water and thus induced change of the soil moisture was formulated as the one-phase transport or at least as the transport of water vapour and liquid water while the transport of the soil air as the immiscible gaseous phase was usually neglected. While the theory of flow of water in the inert stable soil has been well developed, if formulated as the one-phase transport, many problems arise when the two phase immiscible flow (water and air) in swelling soils is considered.

Regarding the two phase immiscible flow in the inert soil, Young and Peck (1964) discussed infiltration supposing the increasing air pressure ahead of the wetting front. The analytical solution of the problem in the homogeneous soil was done by Brustkern and Morel — Seytoux (1970). The analytical results of the dependence of the infiltration rate upon the time including rate minima due to the increased air pressure and "peaks" owing to the air escape (when the air entry value was reached) was confirmed by the experimental results of Kuráží and Kutílek (1970). The two-phase immiscible infiltration in the layered soils was experimentally tested by Vachaud et al. (1972).

Terzaghi (1925) formulated the problem of the swelling of soils, Smiles and Rosenthal (1968) and more generally Philip (1969) dealt with the flow of water in swelling soils while the last author discussed in detail the hydrostatics and the concept of the potential in swelling soils, too. Philip's (1969) definition of the potential in swelling soil was confirmed by Groenewelt and Bolt (1972) while Kutílek (1973) included the additional term to the potential. Some physical principles of flow of water

in swelling as well as in shrinking soils have been discussed by Doležal and Kutílek (1972) while Doležal (1973) tried to extend the problem of flow in the swelling soil to the two-phase flow. The experimental tests of flow — mainly infiltration — in swelling soils were performed by Collis-George and Lal (1970) and by Collis-George and Laryea (1971). However, the combined phenomena, i. e. the increased air pressure ahead of the wetting front in swelling soils have not yet been studied and it is the object of this paper to present the first experimental results on the problem.

THEORY

In deriving the description of flow of water and air in the swelling soil, we start with flow in the inert, stable soil. The Darcy's equation is expressed in the form

$$v_i = \frac{K_i(C_i)}{\rho_i g} \frac{\partial}{\partial z} (p_i - \rho_i g z) \quad (1)$$

where v_i is the flow rate of the i -th phase

K_i is the i -th phase conductivity functionally dependent upon C_i

C_i is the concentration of the i -th phase

p_i is the partial pressure of corresponding phase

ρ_i is the density of i -th phase

g is acceleration due to gravity

z is the vertical coordinate positive downward

The equation of continuity for compressible fluid is

$$\frac{\partial}{\partial t} (\rho_i C_i) + \frac{\partial}{\partial z} (\rho_i v_i) = 0 \quad (2)$$

where t is time.

Instead of Euler's coordinate system, the Lagrangian material coordinates are used

$$dm = \int_{z_0}^z (1 - n) dz \quad (3)$$

where z_0 is the reference point outside the system

n is the porosity

Further on, the total pressure σ and the effective pressure σ' together with the overburden potential Ω (Philip 1969) are introduced and the set of five equations describing the flow is obtained (Doležal 1973) in the form:

$$\sigma = \sigma' + p_1 \quad (4)$$

$$(p_1 - p_2 - \Phi \rho_1 g) \frac{\partial C_1}{\partial t} = \sigma \frac{\partial n}{\partial t} \quad (5)$$

$$\frac{\partial C_1}{\partial t} = (1 - n) \frac{\partial}{\partial m} \left[K_1 (1 - n) \left(\frac{\partial p_1}{\partial m} + \rho_1 g \right) \right] - \frac{C_1}{1 - n} \frac{\partial n}{\partial t} \quad (6)$$

$$\frac{\partial (p_2 n)}{\partial t} - \frac{\partial (p_2 C_1)}{\partial t} = (1 - n) \frac{\partial}{\partial m} \left[p_2 K_2 (1 - n) \frac{\partial p_2}{\partial m} \right] - \frac{p_2 C_2}{1 - n} \frac{\partial n}{\partial t} \quad (7)$$

$$\sigma = \sigma_i + g \rho_s m + g \rho_1 \int_0^m \frac{C_1}{1 - n} dm \quad (8)$$

where index 1 denotes water

index 2 denotes air

index s denotes solid phase

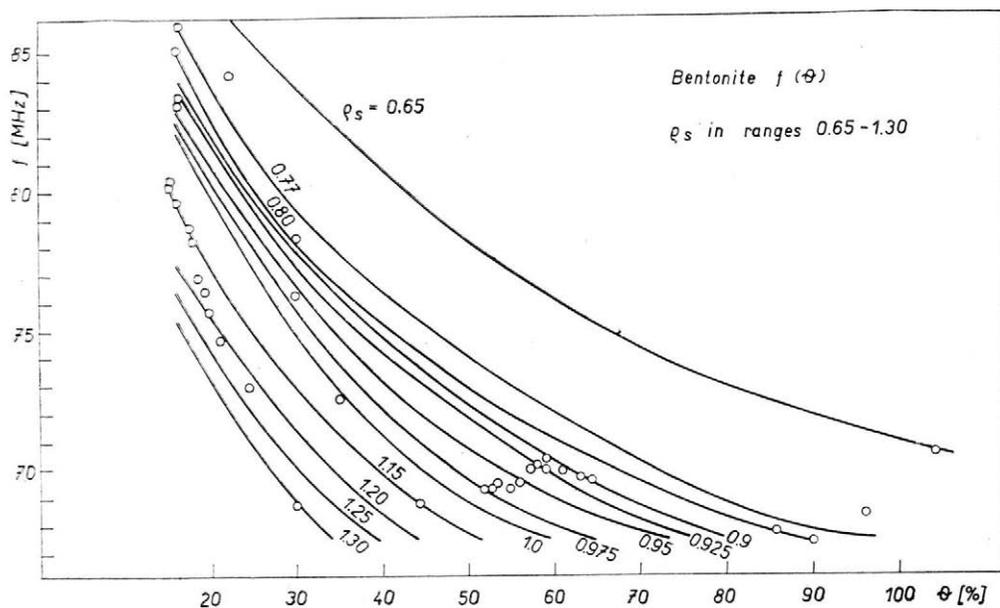
Φ is the soil water potential as developed for inert materials

σ_i is the surface load

Further on, instead of C_1 the symbol Θ will be used to denote the soil moisture in accordance with soil physics. Even if some simplified assumptions were used in the development of the equations (4) to (8), the use of these equations for further analytical procedure is not possible. Because of the complexity of the solution of the problem, and considering the lack of experimental data in this field, we decided to perform the experiments where the following data were read: the air pressure $p_a(t)$, soil moisture $\Theta(t, z)$, bulk density $\rho_s(t, z)$, position of wetting front $z_f(t)$, cumulative infiltration $I(t)$ from which the infiltration rate can be obtained, $v_t = dI/dt$.

MATERIAL AND METHODS

The air dry commercial ground bentonite from Vysoké Třebušice (39% of particles < 0.01 mm) has been used. Bentonite was uniformly packed in glass tubes of $ID = 4,0$ cm and of 100 cm length. The initial bulk density was $\rho = 1.18 \text{ g} \cdot \text{cm}^{-3}$ in all columns, initial uniform moisture was $\Theta_i = 17\%$ (the air dry moisture). The uniformity of the bulk density was controlled by the resonance — capacitance soil moisture meter (Kuráž *et al.* 1971). Two types of experiments were performed. In the first type, the bottom of the column was closed thus not allowing the free escape of the soil air. The air pressure inside of the column, particularly at the lower end, was measured by the differential manometer. In the second type, the free escape of the soil air was allowed through the free contact of soil at the bottom of the column with the atmosphere. It was supposed in this case, that the air pressure ahead of the wetting front was negligibly different from the atmospheric air pressure. Distilled water with toluene was used for infiltration test. The infiltration was performed at zero head on the top surface using Mariotte — burettes. The inflow was provided with the sintered glass No 2 of negligibly low hydraulic resistance and it was loaded to prevent the upheaval of the surface during experiments. The cumulative infiltration, the advance of the wetting front and the air pressure were measured continuously during the experiments. The soil bulk density and soil moisture were obtained using the combination of the gravimetric and resonance — capacitance methods: As the indirect methods of the soil moisture measurements are very sensitive against the soil bulk density, the moisture was determined gravimetrically, and the combined effect of bulk density and soil moisture was read during infiltration using the re-



1. Calibration curves of the dependence of moisture Θ (% by weight) upon the resonance frequency f (MHz) for bentonite at bulk density ρ_s in ranges from $0.65 \text{ g} \cdot \text{cm}^{-3}$ to $1.3 \text{ g} \cdot \text{cm}^{-3}$. — Kalibrační křivka — závislost vlhkosti Θ (% váh.) na rezonanční frekvenci f (MHz) pro bentonit objemové hmotnosti ρ_s v rozmezí od $0,65 \text{ g} \cdot \text{cm}^{-3}$ do $1,3 \text{ g} \cdot \text{cm}^{-3}$

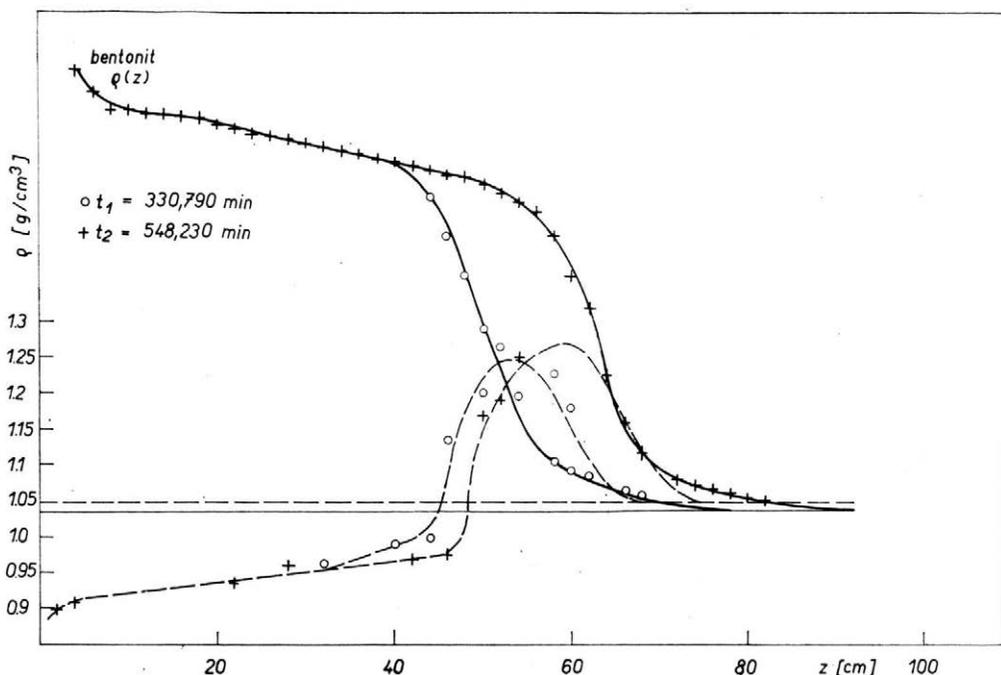
sonance — capacitance soil moisture meter. Soil moisture distribution was determined gravimetrically after the end of each experiment when the columns were cut. For the resonance — capacitance method, eight calibration curves were prepared using bulk density in ranges from $0.650 \text{ g} \cdot \text{cm}^{-3}$ to $1.3 \text{ g} \cdot \text{cm}^{-3}$ (Fig. 1). Using the soil moisture data from the gravimetric method, the bulk density according to the resonance — capacitance reading was determined.

DISCUSSION

Infiltration in the swelling soil studied as the two-phase immiscible flow shows certain deviations from the one phase flow in the inert stable soils. To demonstrate these deviations, we shall distinguish — according to the experiments — between infiltration when the air flow can be neglected (as the working approximation) and the infiltration when the escape of soil air ahead of the wetting front is hindered.

a. INFILTRATION WITHOUT ESCAPE OF AIR AHEAD OF THE WETTING FRONT

Results of experiments are plotted in Fig. 2, 3, 4 and 5. As it follows from Fig. 3, curve a, no discontinuity was observed in the dependence of the cumulative infiltration I upon time t . It is due to the fact, that the air pressure p_2 ahead of the wetting front was continuously increasing during the infiltration and did not reach the air entry value of bentonite during the experiment, see Fig. 5. The slight fluctuations of experimental

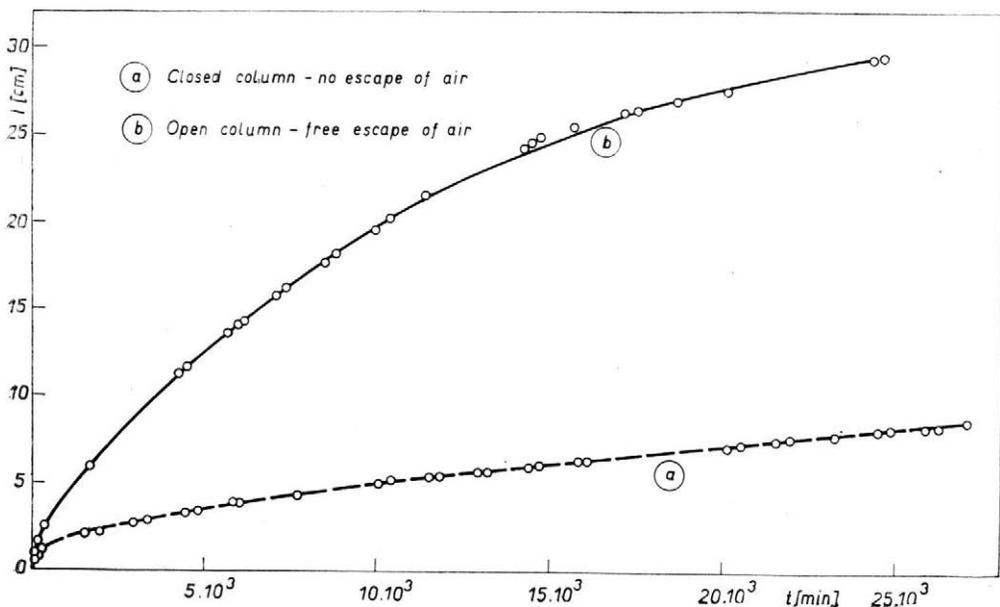


2. Distribution of moisture θ ($\%$ by weight) and of the bulk density ρ_s ($\text{g} \cdot \text{cm}^{-3}$) along the z -axis at two time intervals during the vertical infiltration of water in the bentonite column with the closed bottom end, i. e. no escape of the soil air ahead of the wetting front occurred. — Rozdělení vlhkosti θ ($\%$ váh.) a objemové hmotnosti ρ_s ($\text{g} \cdot \text{cm}^{-3}$) podél osy z pro dva časy během vertikální infiltrace vody v sloupci bentonitu s uzavřeným koncem sloupce, tzn. bez možnosti úniku půdního vzduchu před čelem zvlhčení

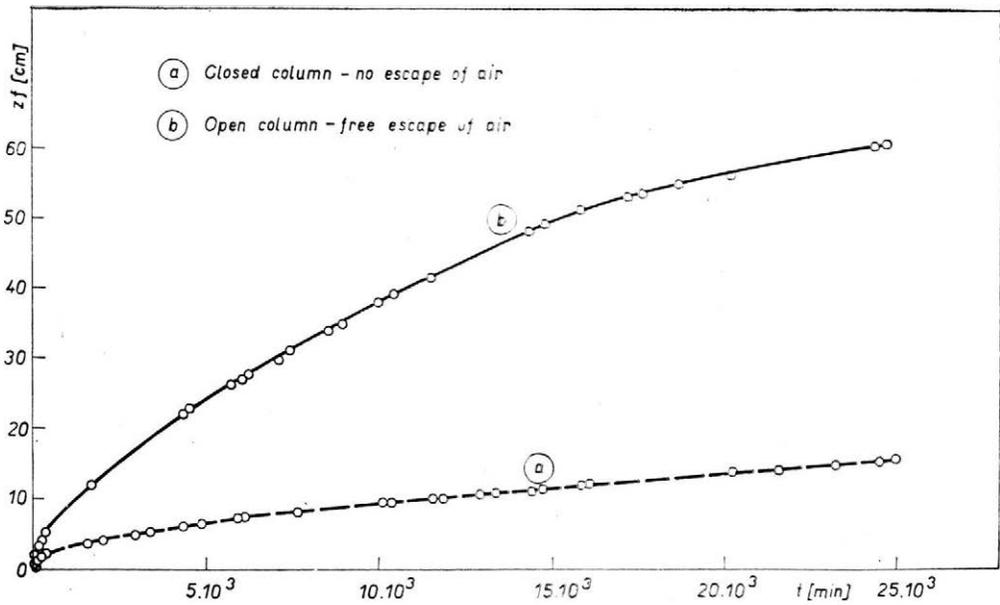
points $p_2(t)$ are owing to the fluctuations of the atmospheric pressure during the experiments. The curve of the position of the wetting front z_f in dependence upon time t (Fig. 4, curve a) has a similar shape as the curve of the cumulative infiltration.

In Fig. 2, the distribution of the moisture θ and of the soil bulk density ρ_s along the z -axis at the two time intervals ($t_1 = 330.790$ min. and $t_2 = 584.230$ min.) are plotted. Even when the surface was loaded to avoid the upheaval, the surface moved upwards due to the swelling during the initial period of infiltration, practically in time period between zero and 10 cm position of the wetting front. The upheaval was 0,9 cm and later on the surface was kept on the constant elevation. The distribution of the bulk density is very instructive and surprising, since roughly at the position of the wetting front, the bulk density reaches its maximum value higher than the initial bulk density. The increase of bulk density is apparently the result of two factors, the swelling of the soil above the wetting front and the overburden pressure (weight of the overlaying soil, surface load and friction at the walls of the cylinder) which hinders the upheaval of the wet soil.

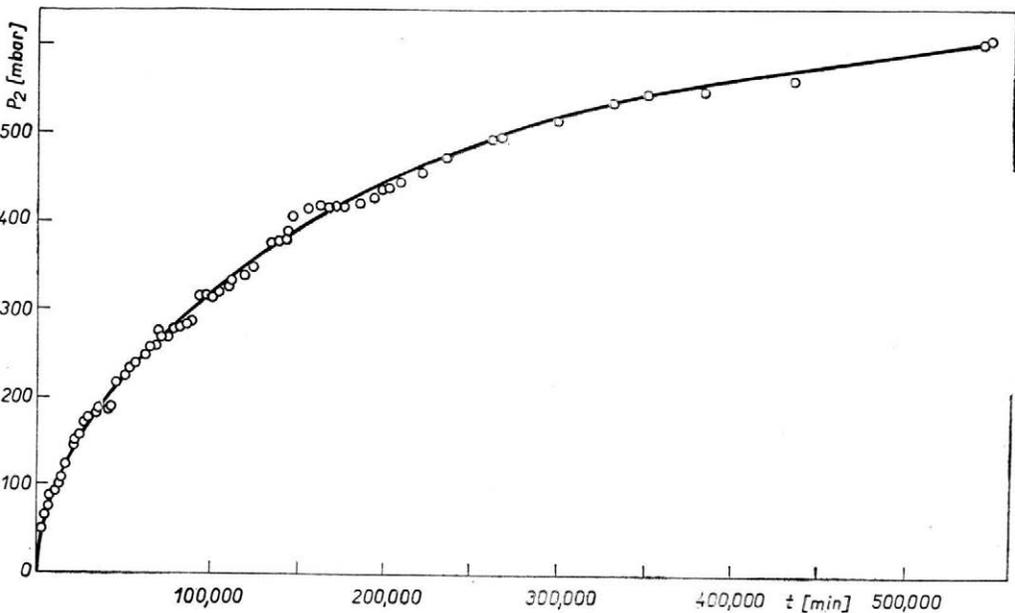
Let us consider the element of the height dz of the three-phase system at a sufficiently great distance below the wetting front. The bulk density of this element is equal to the initial bulk density, ρ_{si} . When the wetting front approaches, the outside part of the systems performs work $\Delta w'$ upon the element increasing its bulk density up to the maximum value $\rho_{s \max} > \rho_{si}$. Wetting front reaches the element and the gradually increasing swelling pressure is acting against the forces causing the compression of the element. The element's bulk density starts to decrease and the element performs work $\Delta w''$ upon the outside part of the system. As the overburden pressure prevents the wet soil from the upward lift and the swelling pressure prevents the upper wet part of the soil from the compression, work $\Delta w''$ acts upon the compression of the next lower elements.



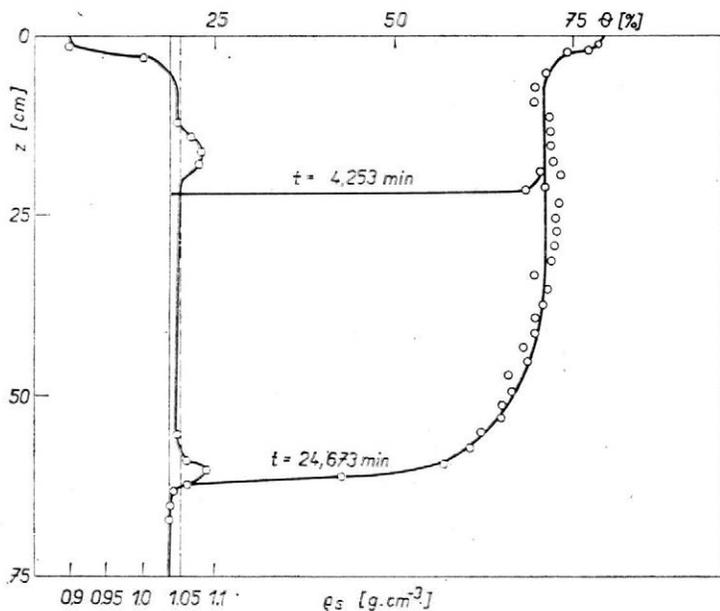
3. Cumulative infiltration I (cm) against time t (min.) in bentonite. a. without the escape of soil air (closed bottom end), b. with free escape of soil air (open bottom end of the column). — Závislost kumulativní infiltrace I (cm) na čase t (min.) v bentonitu. a. bez možnosti úniku půdního vzduchu (uzavřený spodní konec sloupce), b. s volným únikem půdního vzduchu (otevřený spodní konec sloupce)



4. Position of the wetting front z_f (cm) in time t (min.) during the infiltration in bentonite; a. without the escape of soil air (closed bottom end), b. with the free escape of soil air (open bottom end of the column). — Závíslost postupu čela zvlhčení z_f (cm) na čase t (min.) během infiltrace v bentonitu; a. bez možnosti úniku půdního vzduchu (uzavřený spodní konec sloupce), b. s volným únikem vzduchu (otevřený spodní konec sloupce)



5. Air pressure p_2 (mbar) ahead of the wetting front in time t (min.) during the infiltration in bentonite with the closed bottom end of the column. — Tlak vzduchu p_2 (mbar) před čelem zvlhčení v závislosti na čase t (min.) během infiltrace v bentonitu s uzavřeným koncem sloupce



6. Distribution of moisture θ (% by weight) and of the bulk density of soil ρ_s ($\text{g}\cdot\text{cm}^{-3}$) along the z axis at two time intervals during the infiltration of water in bentonite column with the open bottom end, i. e. free escape of the soil air existed. — Rozdělení vlhkosti θ (% váh.) a objemové hmotnosti ρ_s ($\text{g}\cdot\text{cm}^{-3}$) podél osy z pro dva časy během infiltrace vody do sloupce bentonitu (s otevřeným koncem sloupce), za předpokladu existence volného úniku půdního vzduchu

The bulk density of element in consideration decreases to the minimum value, $\rho_{s \min} < \rho_i$ which seems to be kept constant during further infiltration. Note that $\Delta w' < \Delta w''$ and that the "peak" in bulk density has the increasing value with depth, $d \rho_{s \max} / dz > 0$.

Rate of advance of this bulk density "peak" is roughly identical with the rate of advance of the wetting front and the increased bulk density results in the decreased hydraulic conductivity on the wetting front. The phenomenon can be formulated as the moving barrier which is characterized by the rate roughly identical with the rate of the advance of the wetting front and by the gradually increasing hydraulic resistance $R(z)$.

For the quantitative description we lack, however, the directly measured data on friction of soil on the walls of the cylinder and on the distribution of air pressure and suction along the z -axis.

b. INFILTRATION WITH FREE ESCAPE OF AIR

Results of experiments are plotted in Fig. 3, 4 and 6. When compared with the above described infiltration without the escape of air ahead of the wetting front, following conclusions are formulated:

The infiltration rate and the advance of the wetting front are extremely retarded owing to the action of the compressed air ahead of the wetting front, see the Fig 3 and 4. The profiles of the soil moisture distribution resemble the classical "box" profile in case (b), while in the first type of experiments with compressed air, the wetting front was diffused, compare the Fig. 2 and 6. The variation of bulk density, especially the

increase of ρ_s roughly at the position of the wetting front was less pronounced than in the case (a) and the maximum value of ρ_s is above the wetting front. It means that the phenomenon of the moving barrier of increased hydraulic resistance still exists, but in a less distinct form and its significance can be considered as negligible in practical applications.

CONCLUSIONS

If the infiltration of water in swelling soils is formulated as the two phase immiscible flow with rising air pressure ahead of the wetting front, a new effect of variation of bulk density inside of the soil column has to be considered in addition to the effects described by the theory of the two-phase immiscible flow in inert materials. Owing to the increased bulk density, a moving "barrier" of the increased hydraulic resistance develops near the position of the wetting front. This "barrier" is supposed to influence the retardation of the infiltration rate in addition to the rising air pressure ahead of the wetting front. This phenomenon of the increased bulk density is less pronounced when the free escape of air ahead of the wetting front exists.

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KURÁŽ V., KUTÍLEK M. (ČUT, katedra hydromeliorací, Praha). *Infiltrace jako dvoufázové nemísitelné proudění v bobtnavé půdě*. Rostlinná výroba (Praha) 20 (5) : 499-507, 1974.

Bylo provedeno srovnání infiltrace vody a infiltrace modelované jako dvoufázové (voda, vzduch) nemísitelné proudění v bentonitu. Profily vlhkosti vykazují pravidelný tvar avšak v případě, kdy tlak vzduchu vzrůstal před čelem zvlhčení, bylo čelo zvlhčení difusní. V obou případech byly pozorovány změny objemové hmotnosti uvnitř sloupce půdy. Jestliže vzduch mohl volně unikat před čelem zvlhčení (infiltrace formulovaná jako jednofázové proudění), byl vzrůst objemové hmotnosti na úrovni čela zvlhčení méně výrazný. Naopak ve sloupci, kde docházelo ke vzrůstu tlaku vzduchu před čelem zvlhčení (dvoufázové proudění) byl tento vzrůst hmotnosti zřetelný. Jev je formulován jako pohybující se bariéra charakterizovaná jednak rychlostí totožnou s rychlostí postupu čela zvlhčení, jednak postupně vzrůstajícím hydraulickým odporem. Rozsah jevu bude pravděpodobně záviset kromě půdních vlastností na zátěžovém tlaku.

infiltrace; objemová hmotnost; tlak vzduchu; bobtnavá půda

КУРАЖ В., КУТИЛЕК М. (Политехнический институт, кафедра гидромелиорации, Прага). Инфильтрация в качестве двухфазного несмешивающего течения в набухшей почве. Rostlinná výroba (Praha) 20 (5) : 499-507, 1974.

Проводилось сравнение инфильтрации воды и инфильтрации модельного как двухфазного (вода, воздух) несмешивающегося течения в бентоните. Профили влажности показывают регулярную форму однако в случае, когда давление воздуха росло перед волной увлажнения волна увлажнения была диффузная. В обоих случаях наблюдались изменения объемной массы внутри столбца почвы. Если же воздух мог свободно уходить перед волной увлажнения (инфильтрация, формулированная как однофазное течение), рост объемной массы на уровне волны увлажнения был менее явным. Наоборот, в столбце, где росло давление воздуха перед волной увлажнения (двухфазное течение), этот рост массы был явным. Явление формулировано как перемещающийся барьер, характеризуемый, с одной стороны, скоростью, тождественной со скоростью движения волны увлажнения, с другой стороны, постепенно возрастающим гидравлическим сопротивлением. Объем явления, вероятно, будет зависеть, помимо почвенных свойств, от загрузочного давления.

инфильтрация; объемная масса; давление воздуха; бентонит

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FORSCHUNGSARBEITEN AUF DEM GEBIETE DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG UND DER DARSTELLUNG DER PEDOSPHERE IN DER ČSSR

Arbeiten über die Heterogenität des Bodenprofils, Bilanzierung der Bildung und Migration von Ton (Sirovy, Pavel, Eaquab, Bedrna, Bezvodova) bei Boden, die sich auf Lo und Staublehm entwickelten und uber die gesetzmaige Stratifikation des bodenlithologischen Profils der Braunerden und Podsole (aly, aly mit Ciesarik), beeinflussten die Interpretation der Profilangaben uber Boden. Bei Boden aus loartigen Substraten uberprufte man die maximale Tonbildung in unmittelbarer Nahe der Bodenoberflache; auf Grund der unausgeglichene Bilanz wurde die oft vorkommende Heterogenitat an der Grenze von Lo und Solum, eine erhohte Verwitterung im Bt-Horizont der Parabraunerden und die Aufschichtung von Material, in dem sich der E-Horizont von Fahlerden bildet, nachgewiesen. Bei Braunerden und Podsolen konnte man mittels der Methoden der Untersuchung der Korngroezusammensetzung, der chemischen und mineralogischen Eigenschaften die Gultigkeit der Ansichten deutscher Autoren uber die Entwicklung dieser Boden aus den das Anstehende uberlagernden Deckschichten, gebildet durch die Basis-, Haupt- (A- und Bv-Horizont) und Deckfolge, nachweisen. Am ausgepragtesten erscheinen Unterschiede im bodenlithologischen Profil bei Boden aus dem Material das von granitoiden und metamorphischen Gesteinen stammt. Einen bedeutenden Beitrag der Arbeiten von aly bilden Pollenanalysen, die die Entwicklung der Hauptfolge im warmeren Klima, als der Basisfolge nachweisen. Ergebnisse dieser Studien werden appliziert bei der Bearbeitung des umfangreichen analytischen Materials, bei der Interpretation der Profilangaben und Vertiefung der Konzeption diagnostischer Horizonte, denn die genetische Kontinuitat des Bodenprofils kann in einer auerst einfachen Form fur die Grundlage Diagnostik von Boden nicht angenommen werden (Nemeek).

Die Ergebnisse der Umwandlungs- und Migrationsprozesse von Stoffen im Bodenprofil wurden mittels einiger Methoden untersucht. Die Forschung der Eigenschaften und der Stratigraphie der Tonmineralen im Bodenprofil der landwirtschaftlichen Boden (Sirovy, Pavel, Hrako) und der Waldboden (aly, Mihalik) ermoglicht eine Unterscheidung von vererbten Eigenschaften aus den Substraten und der charakteristischen pedogenen Veranderungen der Tonmineralien, eventuell eine Beeinflussung ihrer Profilsstratigraphie durch die Migration von Ton, oder durch die Profilstratifikation. Von den Erkenntnissen, die fur die genetische Interpretation wichtig sind, kann Folgendes angefuhrt werden: Nachweis der Bildung von sekundaren Chloriten in den Bv- Bvs-Horizonten der Rosterden und der oligobasischen Braunerden und im konkretionaren Bleichhorizont der versauerten Pseudogleye (Sirovy, Nemeek), Anhaufung von Hemiexpanditen und Expanditen in den Bt-Horizonten, Bildung von Lepidokrokite bei Pseudogleyboden (Sirovy), das Vorkommen einer anderen, eventuell intensiveren chemischen Verwitterung in der Basisfolge (aly, Nemeek). Bedeutungsvoll ist die Feststellung eines hohen Anteils an Alophan in den Boden des Gebietes von Andesiten in der Slowakei, die die Berechtigung gestattet, dies den andosolischen Braunerden zuzuordnen (aly, Mihalik).

Dr. Jan Nemeek, CSc.

CARBON CYCLING IN THE ECOSYSTEM OF LOWLAND FOREST IN LEDNICE NA MOR.

E. KLIMO

KLIMO E. (Agricultural University, Brno). *Carbon Cycling in the Ecosystem of Lowland Forest in Lednice na Mor.* Rostlinná výroba (Praha) 20 (5) : 509-517, 1974.

The problem of nutrients cycling within a lowland forest ecosystem was investigated within the framework of the International Biological Programme. Basing on preliminary results a scheme of carbon cycling was developed. The total reserve of carbon in the epigeal biomass of the forest stand was 192 700 kg per hectare, that in the hypogeal biomass 11 515 kg per hectare. The input of carbon from the atmosphere was 211 kg per hectare per year, the amount of carbon falling onto the soil surface was 3699 kg per hectare per year. The maximum carbon reserves on the soil surface were 4211 kg per hectare. Altogether 129.5 kg of carbon per hectare were released into the soil within one year; 82.5 per cent of this amount were accumulated in the surface soil layer (1-8 cm). Within one year 1807 kg of carbon per hectare were released into the atmosphere in form of carbon dioxide.

Within the framework of studies on function, productivity, and structure of the ecosystem of a lowland forest (a project of the International Biological Programme in Lednice na Moravě) the cycling of carbon, nitrogen, and mineral nutrients was investigated. The aim of these studies was a quantification of inputs, flows, and outputs of individual substances within the ecosystem. However, it is known that studies on geochemical cycles of a certain ecosystem contribute significantly to the explanation of the character of recent soil processes. For that reason attention was paid to these problems, too, especially to the distribution of products of the decomposition of organic matter within mineral layers of the soil profile.

In recent years this problem was investigated intensively by many authors. Especially within the framework of IBP many papers have been published dealing with the cycling of nutrients in forest ecosystems (Duvigneand, Denayer de Smet 1964, Gessel, Cole 1965, Bazilevič, Rodin 1966, Carlisle, Brown, White 1967, Bernhard 1970, Rapp 1971).

This study represents a preliminary report on the cycling of carbon; results presented were obtained in the IBP Project Lednice na Moravě.

For the circulation of carbon reserves in individual components of the forest stand data on the primary production of the ecosystem investigated were used; Vyskot (personal communication) studied the primary production of trees and Vašíček (personal communication) that of shrubs and herbs. The measured amount of ash was subtracted from the dry matter weight of biomass and the resulting value of organic matter was divided by a factor of 1.724. Carbon content in lysimetric waters and precipitations was determined according to Tyurin (1937). The content of carbon within the soil profile was estimated according to

a method Walkley — Black (modification Novák — Pelíšek). Lysimetric waters occurring in the soil profile were collected by means of a flat PVC lysimeter (Silovová 1955).

BRIEF CHARACTERISTIC OF THE RESEARCH OBJECT

The research station Lednice na Moravě is situated on the alluvium of the Dyje river in a well preserved lowland forest with a prevalence of summer oak (*Quercus robur* L.). The parent material consists of alluvial deposits. Soils are classified as a semigley (Pelíšek 1970). The forest stand is 100 years old and individual tree species are represented as follows: *Quercus robur*, *Fraxinus excelsior*, *Tilia cordata*, *Carpinus betulus*, and *Alnus glutinosa* by 79, 21, 3, 1, and 1 per cent, resp. There is a strong undergrowth of shrubs in the forest stand; dominating is the species *Cornus sanguinea* (76 per cent of the shrub biomass). The latitude of the station is 48°48'22", the longitude 16°46'32", and the altitude 161 m. Average annual precipitations are 524 mm, precipitations under the forest stand 343 mm. The average annual temperature is 8.8°, that under the forest stand is 8.4°C (Vyskoč 1972).

As shown in Tab. 1 reserves of individual elements (excepting carbon) were as follows: potassium, calcium and phosphorus 297, 896; 121, 185 and 10 038 kg per hectare, resp. Similar series was observed also in eluates of 1 per cent citric acid; the only exception was that the content of available nitrogen was higher than that of potassium.

I. Total reserves of nutrients in the soil profile (kg per hectare). — Celková zásoba živin v kg/ha v půdním profilu

Depth (in cm)	N	P	K	Ca	C
1—8	4 297	853	12 159	6 226	50 335
8—50	10 549	4110	109 205	38 638	96 365
50—75	3 774	1637	51 431	22 835	34 106
75—95	2 687	1393	49 340	25 855	27 155
95—115	2 632	2055	75 761	27 631	18 896

RESULTS AND DISCUSSION

RESERVES OF ORGANIC CARBON IN THE EPIGEAL AND HYPOGEAL BIOMASS AND THE VALUE OF CARBON IN THE ANNUAL INCREASE IN THE BIOMASS

As shown in Tab. II the greatest carbon reserves were found in the epigeal part of the tree component of forest stand (93 per cent). The same was true for the ratio between annual increments of carbon in individual components of the stand biomass. In general it is possible to say that the value of the increment corresponded with the extent of biomass reserves. Only for herbs this increment was unproportionally higher because a predominant part of the epigeal herb biomass was regenerated annually.

When comparing data presented in Tab. 2 with those published by Rapp (1971) for the ecosystem of an oak stand at Rouquet a rather identic exchange of organic matter may be observed in the epigeal part of biomass (i. e. 192.7 tons per hectare in Lednice and 153 tons per hectare in Rouquet). However, a

II. Carbon content in the aerial and underground part of plant biomass and carbon content in the annual biomass increment. — Obsah uhlíku v nadzemní a podzemní části rostlinné biomasy a obsah uhlíku v ročním přírůstku biomasy

		Carbon in the biomass of forest stand (kg per hectare)	Carbon in the annual increment of biomass (kg per hectare)
Epigeal part	Trees	189741	9894
	Shrubs	2302	620
	Herbs	656	597
	epigeal part	192700	11111
Hypogeal part	Trees	10516	752
	Shrubs	745	47
	Herbs	254	219
	hypogeal part	11515	1018
Total content of carbon in the forest stand biomass		204.215	12.129

III. Input of carbon into the ecosystem with precipitations. — Vstup uhlíku do ekosystému z atmosféry a zdroje akumulace na půdním povrchu

Month	1	2	3	4	5	6	7	8
Carbon concentration (mg per liter)	4.0	7.0	18.2	6.0	99.6	101.4	107.4	12.9
kg of carbon per hectare	1.5	1.4	0.4	5.9	60.0	25.0	99.9	3.3

considerable difference may be observed in the hypogeal biomass; Rapp's estimation (29 tons per hectare) is much higher than that observed in Lednice (11.5 tons per hectare).

INPUT OF CARBON INTO THE ECOSYSTEM FROM THE ATMOSPHERE AND SOURCES OF ITS ACCUMULATION ON THE SOIL SURFACE

As shown in Tab. III the input of carbon into the ecosystem investigated is rather unbalanced and it is generally rather high. This may be explained by the fact that this lowland forest ecosystem forms an isolated part of a large agricultural area and the high carbon input at the beginning of summer might be associated with a high content of pollen grains occurring in the atmosphere over the forest stand. This problem requires a more detailed analysis especially from this point of view.

IV. Amount of carbon in water falling onto the soil surface in the canopy drip and in the stem flow (kg per hectare). — Množství uhlíku ve vodě propadlé přes zápoj porostu a ve stoku po kmenech (kg/ha)

Month	Canopy drip	Stem flow	Month	Canopy drip	Stem flow
1	0.7	0	7	39.2	0.26
2	0.7	0	8	2.4	0.04
3	0.2	0.01	9	2.7	0
4	3.5	0.67	10	4.1	0.02
5	26.1	0.16	11	0.7	0.04
6	12.2	0.05	12	0.7	0.0
				93.2	1.25

V. Concentration of carbon in the canopy drip and in the stem flow (mg per liter).
Koncentrace uhlíku ve vodě propadlé přes zápoj porostu a ve stoku po kmenech (mg/1 liter)

Month	Canopy drip	Stem flow	Month	Canopy drip	Stem flow
1	2.8	29.2	7	33.6	74.2
2	5.2	62.9	8	11.8	63.1
3	13.5	76.3	9	—	—
4	4.1	85.0	10	31.0	69.4
5	55.8	68.6	11	21.0	52.7
6	60.2	94.5	12	12.4	—

VI. Concentration of carbon in the stem flow in individual tree species (mg per liter). — Koncentrace uhlíku ve stoku po kmenech u jednotlivých dřevin porostu (mg/1 liter)

Month	Oak	Ash	Lime-tree	Month	Oak	Ash	Lime-tree
1	20.2	53.8	13.6	7	64.4	95.8	62.4
2	84.7	64.9	39.0	8	95.2	58.4	35.6
3	85.2	99.4	44.4	9	—	—	—
4	89.9	134.8	30.4	10	62.6	78.8	66.6
5	88.3	70.0	47.4	11	51.0	69.0	38.0
6	89.5	97.6	96.3	12	—	—	—

As shown in Tab. IV the carbon content decreases after the canopy drip; the annual amount of carbon coming to the soil surface in this way was 93 kg per hectare. The stem flow contributed annually with 1.25 kg per hectare only.

A relatively low content of carbon in the stem flow may be explained on the one hand by the character of the rough outer bark of a 100-year-old oak-ash forest stand and by the conversion of a relatively low absolute value of precipitations (interfering only with the ring around trees) for the whole forest stand area

on the other. A different situation may be observed when comparing carbon concentrations in the canopy drip and in the stem flow. In the latter case the concentration is considerably higher and it influences to a great extent the range of heterogeneity of soil properties of the surface soil layer.

As shown in Tab. V the concentration of carbon in the canopy drip does not exceed that in the stem flow for any month of the year.

Individual tree species play a rather important role in the stem flow carbon concentration (Tab. VI).

As shown in Tab. VI the highest concentration of carbon occurred most frequently in the ash stem flow (7 among 10 measurements) while in the lime-tree stem flow the lowest carbon concentration occurred in 8 cases from 10 measurements. Among others this was associated with the morphology of the rough outer bark; the lime-tree had a smooth bark with the lowest proportion of epiphytes and organic matter and in this case the stem flow was obviously the most rapid.

The most important source of carbon falling onto the soil surface represents the leaf fall from individual components of the forest stand. The leaf fall from trees and shrubs forms the major part (3008 kg) of this factor; secondly it is the fall from the dying herbaceous component of the stand (597 kg). The total carbon input consists of the following parts:

Canopy drip	93	kg per hectare per year
Stem flow	1.25	kg per hectare per year
Tree and shrub leaf fall	3008	kg per hectare per year
Dying herbs	597	kg per hectare per year
Total	3699	kg per hectare per year

The soil surface represents the place of the greatest exchange of organic matter and of its distribution into the soil profile. To find out changes occurring during the year (as well as their relationship to certain diversities of the ecosystem investigated in the species composition of the forest stand) the total reserves of organic matter on the soil surface were estimated at the moment of their maximum (December 1) value and the decrease in these reserves was followed during the year (Tab. VI).

As shown in this table a considerable decrease (by 48 per cent) occurred already within the winter season (from December 1 till April 1); this was obviously associated with the nature of a mild and wet winter. The total decrease was 64 per cent (including leaves and litter). The average amount of wood on this area was 2000 kg per hectare; unfortunately, the rate of its decomposition has not yet been estimated.

VII. Decrease in carbon reserves in the leaf fall on the soil surface within one year. — Úbytek zásoby uhlíku v odpadu na půdním povrchu během jednoho roku

Reserves	Dec. 1, 1972	3051 kg/ha	—	100 %
	April 1, 1973	1598 kg/ha		52 %
	July 1, 1973	1356 kg/ha		44 %
	Oct. 1, 1973	1114 kg/ha		36 %
Total decrease		1937 kg/ha	—	64 %

VIII. Comparison of the decrease in the organic matter content on the soil surface under the forest stand with the majority of oak (Plot 1) and of ash (Plot 2) during the year (kg of dry matter per hectare). — Srovnání úbytku organické hmoty na půdním povrchu pod porostem s převahou dubu (Plocha 1) a s převahou jasanu (Plocha 2) během roku (kg sušiny/ha)

	Plot 1			Plot 2		
	Layer L	Layer F	Total L + F	Layer L	Layer F	Total L + F
Dec. 1, 1972	2600	1700	4300	4800	2500	7300
April 1, 1973	1600	1600	3200	2800	1400	3200
July 1, 1973	1300	1900	3200	0.0	2100	2100
Oct. 1, 1973	1100	2000	3100	0.0	800	800

IX. Comparison of carbon amounts washed off in lysimetric waters from the A₀ horizon on plots with oak (Plot 1) and ash (Plot 2) prevalence. — Srovnání množství uhlíku vyplaveného v lyzimetrických vodách z horizontu A₀ v kg/ha za 11 měsíců na ploše s převahou dubu (Plocha 1) a na ploše s převahou jasanu (Plocha 2)

	Plot 1	Plot 2
Washed off from A ₀	103.0	145.5
Accumulated in A	78.9	131.4
Washed off from A	24.1	14.1

The value of wood fall was not considered as the wood decomposed more slowly; its total overage reserves were 1160 kg of carbon per hectare.

Within the ecosystem studied a relatively high heterogeneity of the forest stand may be observed (the combination of principal tree species as well as the intensity of undergrowth). For that reason the process of fall decomposition was followed on several plots. As an example the comparison may be presented of decreases in the organic matter content at two plots within one year (Tab. VIII).

As shown in Tab. VIII the litter (leaf) decomposition was faster in forest stands with a prevalence of ash than in stands with an oak majority. This phenomenon was manifested also by the amount of carbon washed off into the mineral layer of the soil profile (Tab. IX). In this case 103 kg carbon per hectare from the oak fall were collected in lysimetric waters within 11 months, while on the plot with a prevalence of oak this value reached 145 kg per hectare per year.

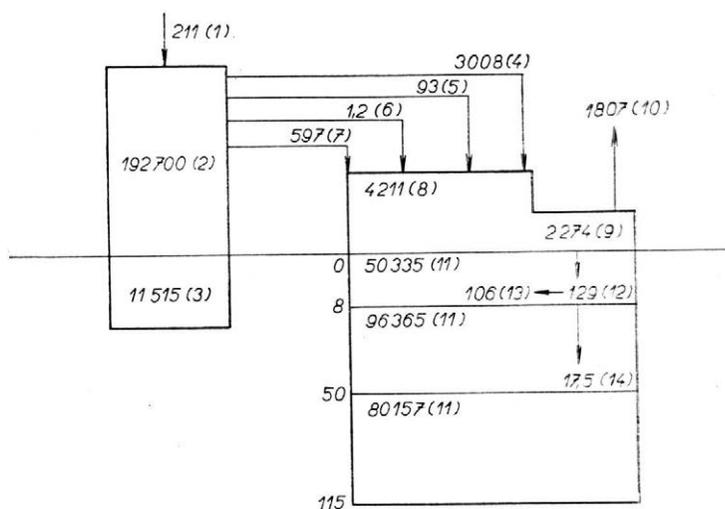
The average value of carbon washed off from the litter was 129.5 kg per hectare per 11 months. However, a considerable part of this amount was accumulated within a relatively shallow layer of the A horizon (1–8 cm), i. e. 106.9 kg per hectare (82.5 per cent of the amount released from the A₀ horizon). Only 22.6 kg of carbon per hectare were washed off into lower mineral horizons (17.5 per cent).

When comparing the amount of carbon washed off from the A₀ horizon (129.5 kg per hectare) with decrease in the organic matter content on the soil surface (1937 kg per hectare) a considerable difference (ca. 1807 kg of

carbon per hectare) may be observed. It is possible to conclude that major part of organic matter was mineralized and this great loss may be explained by means of the release of CO₂ into the atmosphere. Similar results were obtained also in respiration measudings carried out on the area by Grunda (personal communication) who found that the carbon respiration from soil (including the A₀ horizon) corresponded to 5878 kg per hectare per year. This means that the percentage of carbon in lysimetric waters was 4.2 per cent of the total carbon content on the soil surface of the lowland forest ecosystem.

In a hilly-land mixed forest (beech, oak, fir) with carbon reserves of 7656 kg per hectare this value was 3.03 per cent and in a hilly-land fir forest (larch admixture) with carbon reserves of 16 995 kg per hectare it was 1.4 per cent.

This problem is important also from the viewpoint of studies on the course of recent soil processes. Hu, Youngbag and Gilmour (1973) held the amount of released CO₂ and that of water-soluble carbon for suitable indices of the fall decomposition and humification.



(1) Carbon input into the ecosystem from the atmosphere. (2) Carbon reserves in the epigeal part of biomass. (3) Carbon reserves in the hypogeal part of biomass. (4) Carbon content in the leaf fall. (5) Carbon content in the canopy drip. (6) Carbon content in the stem flow. (7) Carbon from dying herbs. (8) Maximum carbon reserves in the litter on the soil surface. (9) Minimum carbon reserves in the litter on the soil surface. (10) Amount of carbon released into the atmosphere in the form of carbon dioxide. (11) Carbon reserves in humus of the soil profile. (12) Amount of carbon washed off from the A₀ horizon in lysimetric waters. (13) Amount of carbon accumulated in the surface mineral soil layer. (14) Amount of carbon washed off in lysimetric waters into lower soil layers. — Schéma koloběhu uhlíku (kg/ha). (1) Vstup uhlíku do ekosystému z atmosféry, (2) zásoba uhlíku v nadzemní části biomasy, (3) zásoba uhlíku v podzemní části biomasy, (4) množství uhlíku v opadu, (5) množství uhlíku ve vodě propadlé přes zápoj porostu, (6) množství uhlíku ve stoku po kmenech, (7) množství uhlíku z odumřelých bylin, (8) maximální zásoba uhlíku v opadu ležícím na půdním povrchu, (9) minimální zásoba uhlíku v opadu ležícím na půdním povrchu, (10) množství uhlíku uvolněného do ovzduší jako CO₂, (11) zásoba uhlíku v humusu v půdním profilu, (12) množství uhlíku vyplaveného z A₀ horizontu lyzimetrickými vodami, (13) množství uhlíku akumulované v povrchové půdní vrstvě, (14) množství uhlíku vyplaveného v lyzimetrických vodách do spodních půdních vrstev

The scheme (Fig. 1) of carbon cycling within the ecosystem of lowland forest developed on the base of preliminary results illustrates only a certain part of the ecosystem evolution. In further studies it will be necessary to explain other similar moments, especially changes in the ecosystem resulting from human activities (lumbering, afforestation, artificial decrease in the ground water level). In this manner it will be possible to define parameters for a mathematical model of the ecosystem. At first it will be necessary to develop some submodels; the most important of them would be that of accumulation, decomposition, humification, mineralization, and distribution of organic substances within the surface soil layer.

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9. 1. 1974

KLIMO E. (Vysoká škola zemědělská, Brno). *Koloběh uhlíku v ekosystému lužního lesa v Lednici na Moravě*. Rostlinná výroba (Praha) 20 (5) : 509-517, 1974.

V rámci programu MBP je řešena otázka koloběhu živin v ekosystému lužního lesa. Na základě dosavadních výsledků bylo sestaveno schéma koloběhu uhlíku. Celková zásoba uhlíku v nadzemní biomase porostu je 192 700 kg, v podzemní biomase 11 515 kg. Vstup uhlíku z atmosféry činí 211 kg/ha/rok, množství uhlíku, které se dostane na půdní povrch činí 3699 kg/ha/rok. Maximální zásoba C na půdním povrchu byla zjištěna 4211 kg/ha. Do půdy bylo během ročního období uvolněno 129,5 kg/ha, z toho ve svrchní půdní vrstvě (1—8 cm) bylo akumulováno 82,5% uvolněného uhlíku. 1807 kg/C/ha/rok bylo uvolněno do ovzduší jako CO₂.

КЛИМО Е. (Сельскохозяйственный институт, Брно). *Круговорот углерода в экосистеме пойменного леса в Ледници в Моравии*. Rostlinná výroba (Praha) 20 (5) : 509-517, 1974.

В рамках программы МБП (Международная биологическая программа) решается вопрос круговорота питательных веществ в экосистеме пойменного леса. На основе полученных результатов была составлена схема круговорота углерода. Общий запас углерода в надземной биомассе насаждений составляет 192 700 кг, в подземной биомассе 11 515 кг. Из

атмосферы углерода попадает в почву 211 кг/га/год, количество углерода, достигшее поверхности почвы, составляет 3699 кг/га в год. Максимальный запас С на почвенной поверхности равнялся 4211 кг/га. В почву в течение года освободилось 129,5 кг/га, в том числе в верхнем почвенном слое (1—8 см) было накоплено 82,5 % освобожденного углерода 1807 кг/га углерода в год было освобождено в атмосферу как CO₂.

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FORSCHUNGSARBEITEN AUF DEM GEBIETE DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG UND DER DARSTELLUNG DER PEDOSPHERE IN DER ČSSR

Durch mikromorphologische Untersuchungen (Smolíková, Sirový, Bedrna — Kuševa — Čurlík — Košťálek, Ciesarič, Němeček, Hraško, Novák) wurde umfangreiches Material sowohl über fossile Böden der Löß-Serien als auch über rezente Böden gesammelt. Es handelt sich um deskriptiv mikromorphologische Material, das in bedeutendem Masse zur Bewertung der Formung und Polygenese des Bodenprofils beiträgt. Die Bedeutung der mikromorphologischen Methode steigt durch die Ausnutzung der Mikrosonde (Kozák). Man konnte nachweisen die Beimengung von äolischem Material bei Böden aus Umlagerungszonen über festem Gestein, die Beimengung von Silikatanteil in den humosen Horizonten der Rendzinen und im ganzen Profil der Terrae calcis. Man studierte das Vorkommen und die Lokalisierung von Agrillans im Profil der Parabraunerden und der Fahlerden, ihr Vorkommen im Bv-Horizont der Braunerden und in den Basisfolgen (Materiale aus Schiefen und auch aus Granit), die Transformation von Agrillans bei Pseudogleyböden und ihre Zerstörung im oberen Teil der Tonhäutchen Horizontes, die Unterscheidung von Druckschlieren bei Smonitza und Pelosolen. Man verfolgte die Problematik der Neubildungen bei den semihydromorphen und hydromorphen Böden und nutzte sie bei der Präzisierung ihrer Diagnostik aus. Man ermittelte den spezifischen Mikroaggregatenbau der Bvs-Horizonte der Rosterden und die mikromorphologischen Merkmale der Podsole. Die Karbonatformen in den Böden wurden untersucht. Mráz verwendete die mikromorphologische Methode in Kombination mit weiteren Methoden zur Charakteristik und Klassifikation von Humusformen der Waldböden.

Die Humusforschung vom Gesichtspunkt der Quantität und Qualität trug zur Charakteristik der allgemeinen Trends der Anhäufung von organischen Stoffen in den Böden in Abhängigkeit vom Substrat, von der Gesamtheit der bioklimatischen Bedingungen des Hydromorphismus und Veränderungen bei der Kultivation bei (Pospíšil, Pospíšil-Hrubcová, Němeček-Pospíšil, Šály, Bedrna, Pelíšek). Zwei extreme Bodengruppen unterscheiden sich in ausgeprägtem Masse voneinander: Tschernoseme mit Wiesenböden und Griserden und die Gruppe der stark saueren Braunerden, Rosterden und Podsole. Bei übrigen anhydromorphen Böden einschließlich der Rendzinen ist die Zusammensetzung der Humus sehr nahe, mit einer Differenzierung nach der Basensättigung. Man widmete Aufmerksamkeit auch dem Alter der organischen Stoffe der Schwarzerden mit Hilfe von C^{14} (Němeček). Bei begrabenen holozänen Schwarzerden ermittelte man im A/C-Horizont Werte um 6—10 Tausend Jahre, im Vergleich zu 3—5 Tausend Jahren der Schwarzerden an der gegenwärtigen Oberfläche, ferner niedrige Werte bei Schwarzerden auf Mergel. Bedeutsame Informationen über die Stabilität der organischen Stoffe im Profil der wichtigen Bodeneinheiten, im Einklang mit den übrigen Methoden, boten Forschungen der Respiration (Damaška, Knotková, Novák).

Als bedeutende Differenzierungsmerkmale der Pedogenese bewährten sich freie Oxide des Fe und Al, bestimmt nach Tamm und Coffin (Kulíková-Němeček, Němeček-Kulíková) sowohl bei einer Reihe der Lößböden, als auch der semihydromorphen und hydromorphen Böden, vor allem jedoch bei Braunerden, Rosterden und Podsolen. Mittels der Franzmeier-Methode (Kulíková-Němeček) konnte bestätigt werden, daß das Kriterium für die „spodic“ Horizonte nur für Rosterden und Podsole spezifisch ist. Bei saueren Böden bewährte sich als Differenzierungs-Kriterium die Al-Sättigung des Kolloidkomplexes, bezogen auf die Austauschkapazität, errechnet durch die Summation der Austausch-Kationen (incl. Al + H) und der Vergleich dieses Wertes zu dem T-Wert nach Mehlich (Němeček-Kulíková).

Dr. Jan Němeček, CSc.

THE EFFECT OF MOISTURE ON THE DEGREE OF NITRIFICATION, CO₂ PRODUCTION AND DECOMPOSITION OF CELLULOSE IN SOIL

J. SEIFERT

SEIFERT J. (Department of Plant Physiology and Soil Biology of Natural Sciences of Charles University, Praha). *The Effect of Moisture on the Degree of Nitrification, CO₂ Production and Decomposition of Cellulose in Soil*. Rostlinná výroba (Praha) 20 (5) : 519-526, 1974.

Proceeding from three previously derived expressions for the intensity of nitrification in soil as a function of incubation moisture ($\Sigma N = b\Psi_i^A$), as a function of initial moisture ($\Sigma N = d\Psi_v^C$), as a function of time ($\Sigma N = A \cdot t^n$) and their logarithmic form ($\log \Sigma N = A pF_i + B$; $\log \Sigma N = C \cdot pF_v + D$; $\log \Sigma N = k \cdot \log t + Q$) it was shown, that the nitrification as a function of time, incubation moisture and initial moisture may be expressed by multilinear function $\log \Sigma N = a \log t \cdot pF_i \cdot pF_v + b \log t \cdot pF_i + c \log t \cdot pF_v + d pF_i \cdot pF_v + e \log t + f pF_i + g pF_v + h$. This function is valid for all incubation moistures lying between pF_i 3.0 and wilting point (WP) and for all initial moist ures between pF_v 3.5 and 6.0, provided that the incubation temperature remains constant. The CO₂ production and decomposition of cellulose as a function of the above - mentioned variables may be expressed by the same multilinear equation.

NO₃; CO₂; cellulose; pF

In order to find out in what way certain ecological factor affects microorganisms in the soil, we have to comprehend the essence of its effect. If the subject of our interest is soil moisture, we have to turn our attention not only to the amount of water in soil, as it is usually done, but to the forces which bind water to the solid phase of soil. We have to do this because physical bonds between the solid and liquid phases of soil determine the accessibility of water for organisms which employ water from the soil. For this reason, there are limiting factors for employment of water even for soil microorganisms. The measure of forces which bind water to the solid phase of soil is the potential of soil water. The soil water potential (ψ) expresses the total specific free energy of soil water related to the total specific free energy of pure water. Hence it is a measure of the forces that bind the water to the solid particles of the soil and expresses the work required for drawing moisture units from soil. The magnitude of the soil water potential is expressed either in units of free energy (joule $\cdot g^{-1}$) or as soil suction tension in units of pressure i. e. in bars or, according to the original method, by the length of the water column in cm. In view of the fact that the absolute value of the soil water potential rises exponentially with the decrease of the content of soil water it is advantageous to express its magnitude in a logarithmic form as pF (Schofield 1935).

Potential of soil water as a measure of effect of soil moisture on soil organisms was used recently by a number of authors (Benko, Bizík 1970, Dommergues 1962, Fitts et al. 1955, Johnson, Guenzi 1963, Johnson, Miller 1964, Sabey, Johnson 1971, Wetsellar 1968). These authors presented much interesting and useful information in their works. However, no one has tried to express the intensity of processes studied as a function of potential of soil water, which would be expressed either in graphical or mathematical form. We tried it and results of our work on this problem are presented in this paper.

MATERIAL AND METHODS

Soil samples from Czechoslovakia were used in this study. The samples included rendzina soil, brown soil and illimerized soils. In addition, we used rendzina soil from Yugoslavia, unclassified soil from the Nile delta and laterite soils from Zambia. The fraction 0–2 mm was used in our experiments. In the case of structured soils, fractions of higher degree with gradations of 1 mm were used, too. When pF was lower than 3.2, potential of soil water (ψ) was determined by centrifugation of soil samples saturated with water. For pF between 3.2 and 4.2, was determined by cryoscopical method and for pF greater than 4.2, by dessication. The effect of soil moisture on microbial processes in the soil was studied using the nitrification process as a model.

RESULTS

In the first part of this work, we studied the effect of incubation moisture, that is the moisture present during incubation. Soil with a known content of nitrates was divided into cultivation vessels in amounts of 20 g. The moisture of samples was adjusted to produce a sequence of regularly increasing moistures. After moistening, samples were transferred to an incubator, where they were kept for 7 days at 22 °C. After this period the total amount of nitrates was determined and the increment of nitrates was calculated. The graphical method was used for evaluation of results. ψ of individual samples in bars was plotted against the amount of nitrates (or increments in content of nitrates) after incubation.

The shape of the curve obtained was hyperbolic in character. For this reason, we used a numerical method in the following step in order to test if the variables fit the equation

$$\Sigma N = \frac{K}{\psi} \quad (1)$$

where ΣN is the amount of nitrates after incubation, ψ is the potential of soil water corresponding to the incubation moisture and K is constant. Besides the content of nitrates after incubation, the increments in the content of nitrates after incubation as variables were also tested. It was found, however, that equation (1) does not express the relation between the variables, so we substituted the variable R_ψ for ψ which was in agreement with the equation. Using the numerical graphical method, we looked for the relationship between R_ψ and ψ . We found, that R_ψ is a function of ψ which is expressed by the equation

$$\log R_\psi = A \log \psi + q \quad (2)$$

Using equation (2) we obtained the function expressing the dependence of nitrate production on the potential of soil water

$$\Sigma N = b_{1,2} \psi^{A_{1,2}} \begin{cases} b_1, C_1 & \text{when } \psi \text{ is in the} \\ & \text{range 1 bar-WP} \\ b_2, C_2 & \text{when } \psi \text{ is in the} \\ & \text{range WP-400 bars} \end{cases} \quad (3)$$

We observed that the value of the constants b and C is affected by the initial moisture, length of incubation and incubation temperature. This fact limits, for example, the use of equation (3) for practical purposes. Therefore we tried to express the dependence of nitrification on incubation moisture by a function in which at the same time the factors affecting the value of constants would be included in the variables. We searched for a means of expressing nitrification as a function of incubation moisture, initial moisture, length of incubation and, if possible, even incubation temperature.

We first focussed our attention on initial moisture. The concept of "initial moisture" is a new one introduced on the basis of our previous works (Seifert 1969a, b) where it was shown that nitrate production in soil changes in dependence on soil moisture at the moment when the soil is moistened for incubation. The moisture contained in the soil normal storage conditions just prior to wetting for incubation is called initial moisture. Initial moisture changes during soil drying and air soil dried has the lowest initial moisture. The effect of initial moisture has not attracted the attention of soil microbiologists till now despite the fact that it is as large as the effect of incubation moisture. The effect of initial moisture is demonstrated most clearly when drying soil is sampled at intervals and samples with lower and lower amounts of moisture are adjusted to the same incubation moisture, and when the samples are incubated for the same length of time. The lower is the initial moisture, the larger is the amount of nitrates in the sample after incubation. As we succeeded in proving, it is possible to express nitrification as a function of initial moisture using the following equation:

$$\Sigma N = \left(\frac{\psi_v}{\psi_i} \right) q^c = d \psi_v^c \quad (4)$$

where ΣN is the amount of nitrates in the soil after incubation, ψ_v is ψ corresponding to initial moisture, ψ_i is ψ corresponding to incubation moisture and d and c are constants. Even in this case the value of constants is affected by length of incubation, incubation temperature, and in contrast to constants in eq. (3), also by incubation moisture. Equation (4) also expresses the dependence of increment of nitrates on initial moisture, but only in cases when during the drying of soil the initial content of nitrates does not substantially increase.

Expressing the potential of soil water in bars is not particularly convenient; (Fig. 1) it is more expedient to express it as pF . Because pF is a negative logarithm of ψ , it was necessary to convert eqs. (3) and (4) to logarithmic form. Two linear equations were thus obtained. The first expresses the dependence of nitrification on incubation moisture

$$\log \Sigma N = A_{1.2} \cdot pF_i + B_{1.2} \begin{cases} A_1, B_1 \text{ for } pF_i < WP \\ A_2, B_2 \text{ for } pF_i > WP \end{cases} \quad (5)$$

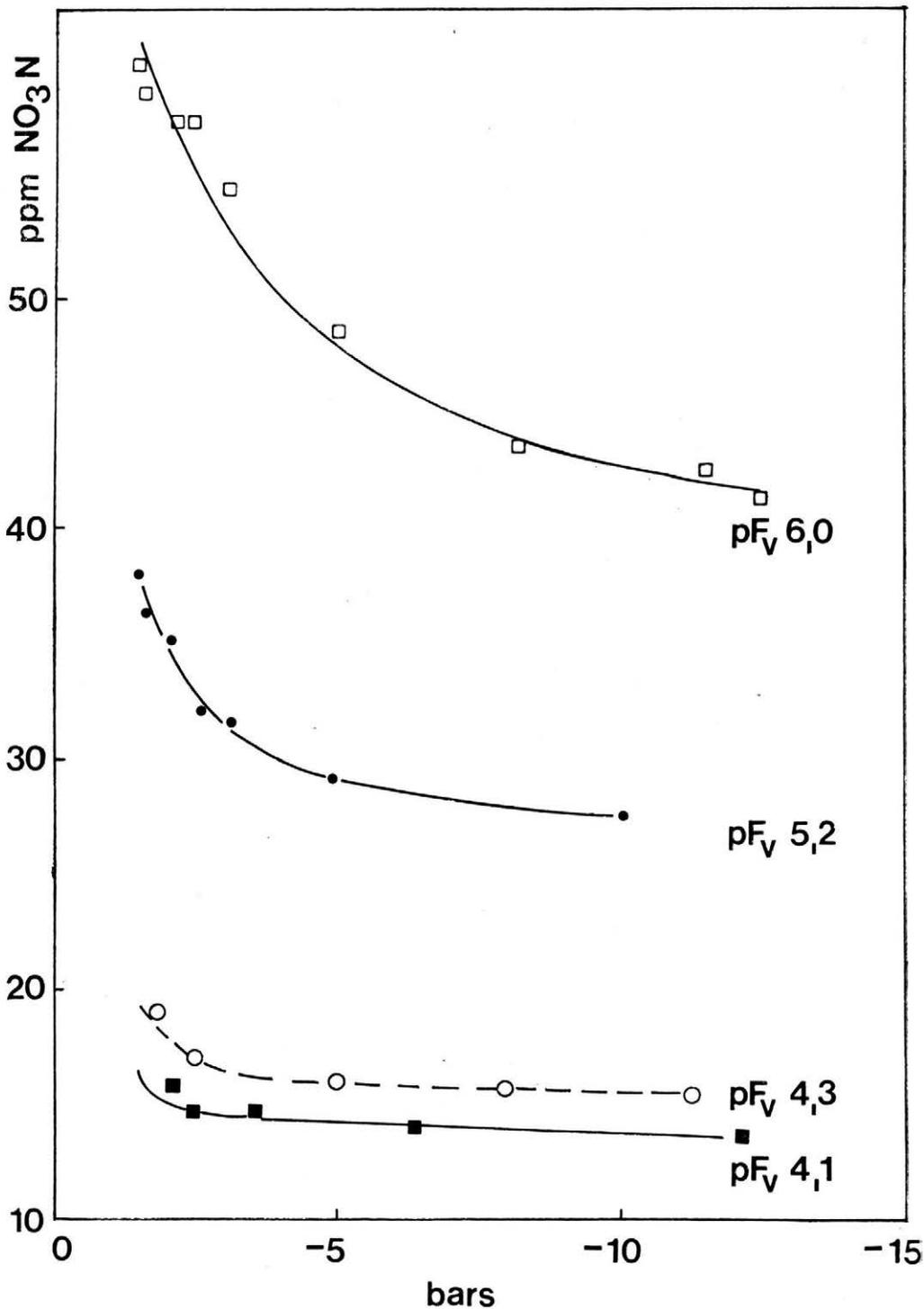
the second expresses the dependence of nitrification on initial moisture

$$\log \Sigma N = C \cdot pF_v + D \quad (6)$$

The fact that we succeeded in expressing both functions in the form of linear equation opened the way for expressing nitrification as a function of initial and incubation moisture using a bilinear equation

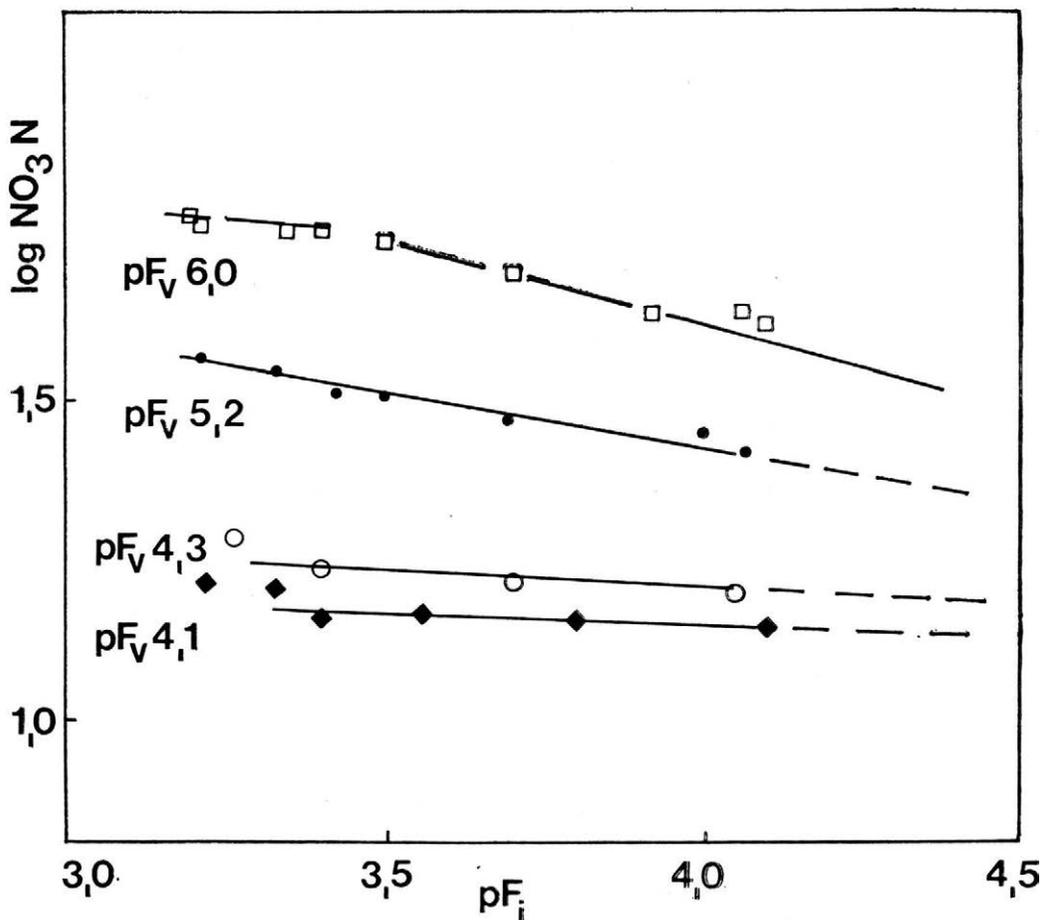
$$\log \Sigma N = a \cdot pF_i \cdot pF_v + b \cdot pF_i + c \cdot pF_v + d \begin{cases} a_1 - d_1 \text{ for } pF_i < WP \\ a_2 - d_2 \text{ for } pF_i > WP \end{cases} \quad (7)$$

where a , b , c and d are constants. Equation (7) is an equation of a plane which can be graphically represented either with the aid of axonometric projection or as a parametric family of straight lines, where the variables are pF_i and parameters pF_v or *vice versa* (Fig. 2 and 3). The derivation of eq. (7) has not only a theoretical but also a practical significance. It enables one to obtain a general picture of nitrification occurring at different incubation moistures in soil with different initial moisture, even in the case when a small number of nitrification measurements are performed. We are usually interested in incubation moisture in the range pF 3.0 — WP . In order to obtain a general idea about the dependence of nitrification on incubation and initial moisture in a particular soil, it is sufficient to determine intensity of nitrification for 2 values of pF_v and 2 values



Dependence of degree of nitrification on incubating moisture expressed graphically as the function $\Sigma N = b \cdot \Psi_i^A$ for different initial moisture.

Závislost intenzity nitrifikace na inkubační vlhkosti, vyjádřena graficky jako funkce $\Sigma N = b \cdot \Psi_i^A$ pro různé výchozí vlhkosti



Dependence of degree of nitrification on incubation and initial moisture expressed graphically with the aid of the function (7) as a parametric family of straight lines. Lines — calculated values; points — established values. —

Závislost intenzity nitrifikace na inkubační a výchozí vlhkosti vyjádřena graficky pomocí funkce (7) jako parametrická skupina přímek. Čáry — vypočítané hodnoty; body — stanovené hodnoty

of pF_i . These 4 values permit calculation of constants a , b , c , d and therefore even calculation of nitrification intensity at any combination of pF_v and pF_i in a given range. It was observed that there is good agreement between the measured and calculated values (Seifert 1973a, b).

Expression of nitrification as a function of time by equation

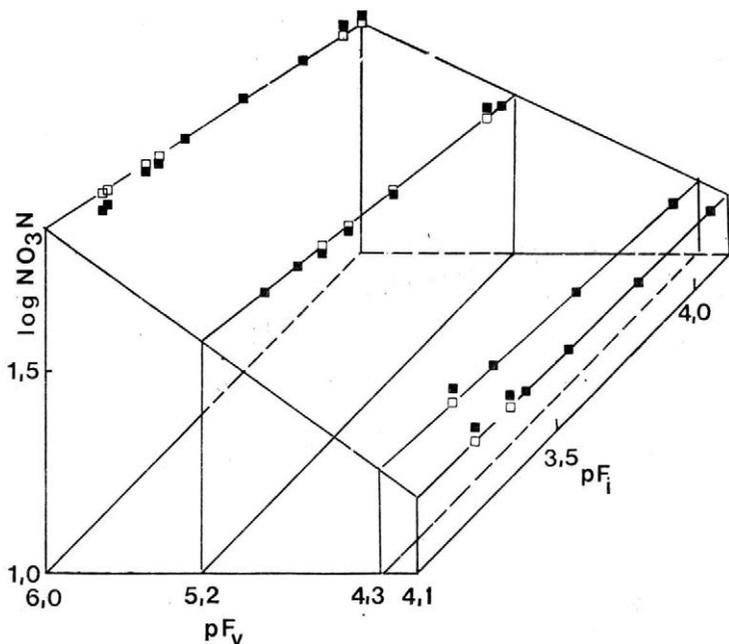
$$\Sigma N = A_{1.2} \cdot t^{n_{1.2}} \begin{cases} A_1, n_1 \text{ for } t \in (T_1, T_2) \\ A_2, n_2 \text{ for } t \in (T_2, T_3) \end{cases} \quad (8)$$

and conversion to logarithmic form

$$\log \Sigma N = K_{1.2} \cdot \log t + Q_{1.2} \begin{cases} K_1, Q_1 \text{ for } t \in (T_1, T_2) \\ K_2, Q_2 \text{ for } t \in (T_2, T_3) \end{cases} \quad (9)$$

made it possible to express nitrification not only as a function of incubation moisture and time

$$\log \Sigma N = a pF_i \cdot \log t + b pF_i + c \log t + d \quad (10)$$



Dependence of degree of nitrification on incubation and initial moisture expressed graphically as the function (7) with the aid of axometric method. Black squares — established values; Blank squares — calculated values, if different from established.

Závislost intenzity nitrifikace na inkubační a výchozí vlhkosti, vyjádřené graficky jako funkce (7) pomocí axometrické metody. Černé čtverečky — stanovené hodnoty. Bílé čtverečky — vypočtené hodnoty, pokud jsou odlišné od stanovených

or as a function of initial moisture and time

$$\log \Sigma N = a pF_v \cdot \log t + b pF_v + c \log t + d \quad (11)$$

but also as a function of time, incubation moisture and initial moisture

$$\log \Sigma N = a \log t \cdot pF_i \cdot pF_v + b \log t \cdot pF_i + c \log t pF_v + d pF_i \cdot pF_v + e \log t + f pF_i + g pF_v + h \quad (12)$$

The correctness of all derived functions was verified in a number of experiments. It was established that nearly in 80th per cent of cases the deviation between calculated and experimentally gained values was lower than 5 per cent.

Equation (12) has a particularly theoretical significance, proving that even in ecology of soil microflora it is possible to express the effect of ecological factors on microflora in an exact way. In comparison with bilinear equations which can be used for calculation of nitrification because they permit combination of graphical and numerical methods, the practical significance of multilinear equation (12) is less owing to the more complicated and time-consuming calculations involved.

When we determined the effect of moisture on nitrification in soil, we were interested in finding to what extent it is possible to apply this knowledge to such basic indices of life of microorganisms in soil as production of CO_2 and intensity of decomposition of cellulose.

We found that both production of CO_2 and intensity of cellulose decomposition are governed by the same laws as those governing nitrification; therefore all the above derived equations can be used in adapted form without restriction. The correctness of these conclusions was verified in two ways. The first was based on the following

approach: with the aid of a minimal number of data of intensity of the studied processes, determined in the usual way, the intensity of nitrification and other processes for different incubation and initial moistures and different times of incubation were calculated using the equations derived above. At the same time, the intensity of processes for these combinations of incubation and initial moisture and length of incubation were determined in the usual way. The theoretical and experimental values were compared. By comparing of established values with calculated ones a good agreement was reached (Seifert 1973a, b, 1974).

In addition, the correctness of the derived equations was verified using data on dependence of nitrification intensity, evolution of CO₂ and cellulose decomposition on soil water potential, published by other authors (Dommergues 1962, Johnson, Guenzi 1963, Miller, Johnson 1964, Reichmann et al. 1966, Sabey 1969, Sabey, Johnson 1971, Wetsellar 1968). The values of soil water potential and corresponding data on intensities of above-mentioned processes satisfied our equations. We believe that both means of verification sufficiently prove that our conclusions are correct.

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SEIFERT J. (Katedra fyziologie rostlin a biologie půdy přírodovědecké fakulty university Karlovy, Praha). *Vliv vlhkosti na intenzitu nitrifikace, produkce CO₂ a rozklad celulózy v půdě*. Rostlinná výroba (Praha) 20 (5) : 519-526, 1974.

Základem práce jsou již dříve odvozené výrazy pro nitrifikaci jako funkci inkubační vlhkosti ($\Sigma N = b\Psi_i^A$), jako funkci výchozí vlhkosti ($\Sigma N = d\Psi_v^C$), jako funkci času ($\Sigma N = A \cdot t^n$). Logaritmování těchto funkcí ($\log \Sigma N = A pF_i + B$; $\log \Sigma N = C pF_v + D$; $\log \Sigma N = K \log t + Q$) umožnilo vyjádřit nitrifikaci jako funkci času, inkubační vlhkosti a výchozí vlhkosti pomocí multilineární funkce $\log \Sigma N = a \log t \cdot pF_i \cdot pF_v + b \log t \cdot pF_i + c \log t \cdot pF_v + d pF_i \cdot pF_v + e \log t + f pF_i + g pF_v + h$. Tato funkce platí pro všechny inkubační vlhkosti ležící v rozmezí pF_i 3,0 – bod vadnutí a pro všechny výchozí vlhkosti ležící mezi pF_v 3,5 – 6,0 za předpokladu, že inkubace probíhá při téže teplotě. Dále jsme zjistili, že také produkce CO₂ a intenzita rozkladu celulózy jako funkce shora uvedených proměnných mohou být vyjádřeny pomocí uvedené multilineární rovnice.

pF půdy; nitrifikace; produkce CO₂; rozklad celulózy

САЙФЕРТ Й. (Кафедра физиологии растений и биологии почвы естественного факультета КУ, Прага). *Влияние влажности на интенсивность нитрификации, продукции CO₂ и разложение целлюлозы в почве*. Растlinna výroba (Прага) 20 (5) : 0-0, 1974.

Основой работы являются уже ранее выведенные выражения для нитрификации, как функция инкубационной влажности ($\Sigma N = b\Psi_i^A$), функция исходной влажности ($\Sigma N = d\Psi_v^C$), как функция времени ($\Sigma N = A \cdot t^n$). Логарифмирование этих функций ($\log \Sigma N = A pF_i + B$; $\log \Sigma N = C \cdot pF_v + D$; $\log \Sigma N = K \log t + Q$) позволило выразить нитрификацию как функцию времени, инкубационной влажности и исходной влажности, как мультилинейную функцию $\log \Sigma N = a \log t \cdot pF_i \cdot pF_v + b \log t \cdot pF_i + c \log t \cdot pF_v + d pF_i \cdot pF_v + e \log t + f pF_i + g pF_v + h$. Эта функция справедлива для всех инкубационных влажностей, находящихся в диапазоне pF_i 3,0 – точка увядания и для всех исходных влажностей, находящихся между pF_v 3,5–6,0 при условии, что инкубация протекает при той же температуре. Далее нами было установлено что также продукция CO₂ и интенсивность разложения целлюлозы в качестве функции вышеприведенных переменных могут быть выражены при помощи приведенного мультилинейного уравнения.

NO₃; CO₂ целлюлоза; pF

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THE EFFECT OF NITROGEN ON THE MINERALIZATION OF STRAW IN THE SOIL

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NOVÁK B. (Research Institutes of Plant Production, Praha - Ruzyně). *The Effect of Nitrogen on the Mineralization of Straw in the Soil*. Rostlinná výroba (Praha) 20 (5) : 527-531, 1974.

The soil amended with increased dosis of straw and inorganic nitrogen was incubated at 28 °C for 60 days. The remained C was determined. The absolute amount of mineralized carbon increased with the increasing dosis of added straw. The relative mineralization (the percentage of mineralized carbon of the amount added), on the other hand, decreased with the increased straw concentration. The nitrogen additions increased the carbon mineralization up to the C:N ratio of twenty. The further increase of nitrogen concentration (C:N < 20) did not affect the carbon mineralization rate on the given level of straw addition.

Inorganic nitrogen has been proved to enhance the decomposition of straw added into the soil (Salter and Green 1933, Kirkham and Bartholomew 1955, Jansson et al. 1955, Stewart et al. 1963, Broadbent 1968, Novák 1972, Novák et al. 1974, and many others). The mutual effect of increasing dosis of straw and of ammonia nitrogen on the transformation of organic matter has been studied in present paper.

MATERIALS AND METHODS

The model experiments were carried out under laboratory conditions. The arable layer of chernozemic clay-loam soil — the aggregates of 1 mm to 2 mm — was used.

The 500 g portions of soil (on the oven dry matter calculated) were enriched with finely ground wheat straw (12 % water, 38.6 % C, 0.54 % N) in the amount of 0, 210, 420, 840, 1680, and 3360 mg % C. Each of those variants were amended with 0, 21, 42, 84, and 168 mg % nitrogen in the form of (NH₄)₂SO₄. The soil

I. The extent of carbon mineralization during the incubation (mg % C). — Mineralizace uhlíku (mg % C)

mg % C added	mg % NH ₄ ⁺ -N added				
	0	21	42	84	168
0	15.6	16.7	17.1	16.8	16.9
210	102.2	114.9	116.4	116.7	115.7
420	154.4	176.8	183.7	179.2	181.7
840	197.1	241.2	276.8	280.1	279.8
1680	208.3	294.6	349.7	401.3	412.4
3360	223.6	307.3	376.4	588.7	641.8

itself contained 1.48 % C and 0.142 % N. 11.4 mg % N was in the form of ammonia salts and 0.96 mg % N in the form of nitrates.

Distilled water was added to make the soil moisture to 20 % w/w; 2 ml of H₂O were additionally added to every gram of added straw. The soil portions were put into the glass cylindrical vessels with the glass pearls at the bottom and with the central glass funnel enabling the gas exchange between the subsample space and the environment. The vessels were incubated in a moist air chamber at 28 °C for 60 days. The moisture was adjusted twice a week.

After the incubation, carbon, total nitrogen, ammonia — and nitrate nitrogen were determined.

Carbon was determined after the depriving the sample of CO₂ by means of phosphoric acid action and after the wet combustion in chromic — sulphuric mixture as the CO₂ by means of interferometer (Novák 1956).

RESULTS AND DISCUSSION

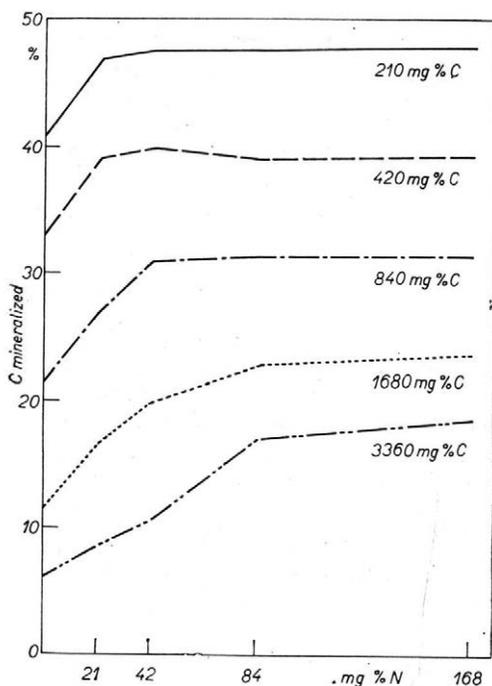
The control soil (check — non amended) lost 15.6 mg % C during the whole incubation (Table I). That makes of about 1 per cent of the original soil organic carbon. The soil carbon mineralization increased not too much if inorganic nitrogen was added into soil. This increase made not the whole 10 % of the mineralization in the check. The increased amounts of nitrogen added were without any effect on the carbon mineralization in the variants lacking in organic matter enrichment (Table I).

II. The mineralization of straw added into the soil (mg % C). — Mineralizace uhlíku přidané slámy (mg % C)

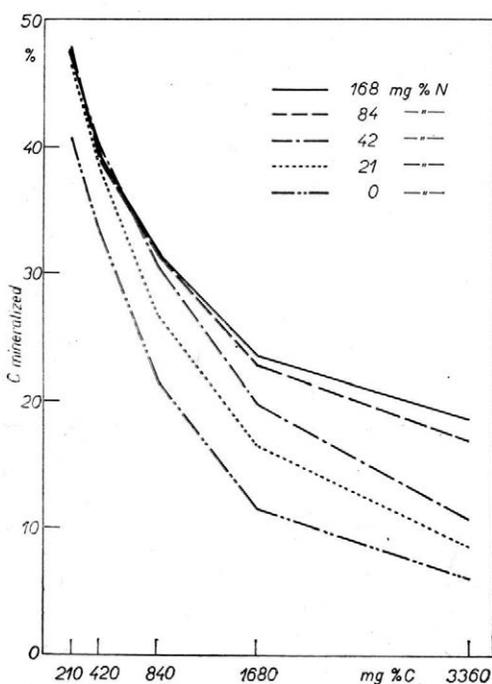
mg % C added	mg % NH ₄ ⁺ -N added				
	0	21	42	84	168
210	86.6	98.2	99.3	99.9	98.8
420	138.8	160.1	166.6	162.4	164.8
840	181.5	224.5	259.7	263.3	262.9
1680	192.7	277.9	332.6	384.5	395.5
3360	208.0	290.6	359.3	571.9	624.9

The straw-amended soil evolved the CO₂ in increased quantity according to the amount of straw supplied to soil (Table I and II). If we subtract the check mineralization 86.6, 138.8, 181.5, 192.7, and 208.0 mg % of mineralized C was found from the 210, 420, 840, 1680, 3360 mg % straw-C variants. The decreased percentage of C mineralized increasing the straw dosis is evident. 40.8 % of added C were mineralized in the 210 mg % C — variant whereas 6.2 % only was mineralized in the 3360 mg % C — variant. The lack of nitrogen is evidently the essential reason of the small extent of carbon mineralization in the high concentration variant.

Fig. 1 shows the effect of increased nitrogen amendments at the individual straw-carbon levels expressed as the percentage of the added carbon mineralization. The first nitrogen dose (21 mg %) exerted the full effect in the lowest carbon dose (210 mg %) variant. It was relatively the most effective in all the other carbon rate amendments too, with the exception of the highest dose where the further two N dosis had almost the same relative effect.



1. Percentage of the straw carbon mineralized. The individual straw dosis as influenced by increased nitrogen additions. — Procento mineralizovaného C přidané slámy. Vliv stupňování dávek N na mineralizaci jednotlivých dávek slámy



2. The percentage of the straw carbon mineralized. Increased straw dosis as influenced by different levels of nitrogen amendments. — Procento mineralizovaného C stoupajících dávek slámy při různých přídávkách N

In spite of the absolute increase of the carbon mineralization with the increasing amount of straw added the relative mineralization rate decreased even in the variants enriched in inorganic nitrogen.

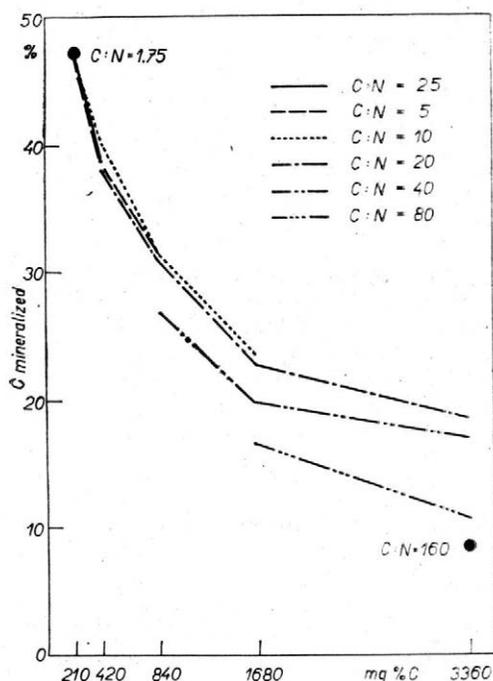
The shape of the curves expressing the dependence of the mineralization rate on the increasing amounts of carbon added are very similar one to each other regardless on the nitrogen levels (Fig. 2).

The inflection points of the curves in Fig. 1 allow to suggest there is a dependence of the mineralization rate on the C : N ratios of added amendments. Fig. 3 demonstrates this dependence. The mineralization rates at the distinct C-amendment variant coincide at the C : N ratios between 2.5 — 20.0. The relations of the mineralization rates as influenced by substrate concentrations remain the same. There is a concentration effect that approximately correspond to the Monod equation (1942). These findings are also in a good agreement with the Haldane (1930) presentations dealing with the inhibition of enzymes by high substrate concentration.

The C : N ration of 40 (and more) evidently reduce the mineralization rate of added straw (Fig. 3). The carbon concentration effect remains, however, very little changed.

III. Exploratory data: — Číselné údaje:

C added	210	420	840	1680	3360
C : N levels					
1.75	47.1	—	—	—	—
2.5	47.6	39.2	—	—	—
5.0	47.3	38.7	31.3	—	—
10.0	46.8	39.7	31.3	23.5	—
20.0	—	38.1	30.9	22.9	18.6
40.0	—	—	26.7	19.8	17.0
80.0	—	—	—	16.5	10.7
160.0	—	—	—	—	8.6



3. Percentage of the straw carbon mineralized. The effect of increased carbon amendments at the constant C:N levels. — Procento mineralizovaného C. Vliv stoupající koncentrace C při stálých hodnotách C:N

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9. 1. 1974

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Zemina obohacená stoupajícími dávkami slámy a minerálním N byla inkubována 60 dní při 28 °C. Po inkubaci byl stanoven zbylý uhlík. Absolutní množství mineralizovaného uhlíku stoupá se stoupající dávkou slámy. Relativní mineralizace (% mineralizovaného C z původně přidaného množství) při stoupající dávce slámy klesá. Přídavek N zvyšuje mineralizaci C pokud poměr C : N je 40 a větší. Další zvyšování přídavků N (na poměr C : N 20) již mineralizační rychlost slámy nemění.

НОВАК Б. (Научно-исследовательские институты растениеводства, Прага-Рузыне). *Влияние азота на минерализацию соломы в почве*. Rostlinná výroba (Praha) 20 (5) : 527-531, 1974.

После обогащения растущими дозами соломы и минеральным азотом грунт инкубировали в течение 60 дней при 28 °C. После инкубации определяли оставшийся углерод. Абсолютное количество минерализованного азота растет с увеличением дозы соломы. Относительная минерализация (% минерализованного C с первоначального количества) понижается по мере роста соломы. Добавка азота повышает минерализацию C, если отношение C : N равно 40 и более. Дальнейшее повышение добавок азота (при отношении C : N 20) не меняет скорости минерализации соломы.

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**FORSCHUNGSARBEITEN AUF DEM GEBIETE
DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG
UND DER DARSTELLUNG DER PEDOSPHERE IN DER ČSSR**

Eine große Menge der Arbeiten wurde gerichtet auf das Studium der einzelnen Bodentypen, der topographischen Reihen der Bodeneinheiten und auf charakteristische Bodengebiete. Diese Arbeiten widmete man der Spezifität der Schwarzerden der Donauniederung (Hraško, Hraško-Bedrna), den Tschernitzaböden, den hydromorphen Böden und den Auenböden slowakischer Niederungen (Hraško, Bedrna, Džatko), der Sequenz der Böden auf Löß und lößähnlichen Substraten (Němeček, Bedrna, Džatko, Šály), den Braunerden (Němeček, Šály, Tomášek), den Hochgebirgsböden (Šály, Linkeš), den Smonitza-Böden (Zuska, Tomášek), den Fahlerden bis Pseudogleyen (Němeček, Hraško-Bedrna, Zuska, Džatko, Kikuc, Pelíšek, Šály), den Salzböden (Hraško), den hydromorphen Böden (Němeček, Zuska), den Böden der ostslowakischen Niederung (Bedrna, Kikuc), den Podsolen (Šály, Houbá). Zusammenfassende Charakteristiken der Böden wurden von Šály (Waldböden der SSR), Němeček (Böden der ČSR) veröffentlicht. Zahlreiche Arbeiten veröffentlichte Pelíšek, und zwar sowohl über die einzelnen genetischen Bodengruppen, als auch namentlich über die Gesetzmäßigkeiten der vertikalen Zonalität in den einzelnen orographischen Systemen der ČSSR. Jurča widmete seine Arbeiten und die zusammenfassende Bearbeitung den Auenböden der Elbe und ihrer Nebenflüsse.

Die Kultivierung von landwirtschaftlichen Böden studierten und einen Vergleich der landwirtschaftlichen Böden und der Waldböden durchführten Vaculík, Bedrna, Džatko, Damaška-Němeček, Pelíšek. Bedrna bewertet den Einfluß der Erosion auf die Profile der einzelnen Bodentypen.

Dr. Jan Němeček, CSc.

DISTRIBUTION OF MINERAL ELEMENTS IN SOME SEMINATURAL ALLUVIAL MEADOW ECOSYSTEMS

B. ÚLEHLOVÁ

ÚLEHLOVÁ B. (Institute of Botany CAS, Brno). *Distribution of Mineral Elements in Some Seminatural Alluvial Meadow Ecosystems*. Rostlinná výroba (Praha) 20 (5): 533-541, 1974.

Inputs of mineral elements by rain and flood water as well as uptakes of mineral elements by plant stands of three alluvial meadow ecosystems with different water supply of their habitats and different plant biomass production were studied in southern Moravia, Czechoslovakia. Simultaneously, the amounts of mineral elements in plant litter returned to the soil and the mineral element concentrations in soil solutions, as well as rates of decomposition processes were estimated. An attempt was made to estimate the factors affecting the distribution of mineral elements and their cycling within the ecosystems studied. In the present paper only preliminary results are given.

alluvial meadow ecosystems; distribution of mineral elements; decomposers; decomposition processes

The ecosystem concept of Tansley (1935) and the parallel biogeocenosis concept of Sukachev (1944) stimulated integrated studies, wherein the soil, the plants, and the animals occurring in a given area, were being regarded as a complex whole, characterized by a number of processes and mutual interactions. Jenny (1958) emphasized the importance of such studies for the understanding of the dynamics of recent pedogenetic processes and the quantification of pedology. The study of energy flow, water cycle and nutrient cycles is typical for the holological, ecosystemic approach (Odum 1971).

Important work on the distribution of plant biomass and the mineral elements it contains was presented by Remezov (1963) and Rodin and Basilevich (1968). Duvigneaud and Denayer-de Smet (1964), Ovington (1968) and Rapp (1971) advanced data on the distribution of mineral elements and the dynamics of biogeocycles in ecosystems of forest type.

In southern Moravia, Czechoslovakia, concurrent studies of the alluvial woodland ecosystem and of the substitutionary meadow plant communities have been performed by workers of the University of Forestry in Brno and the Botanical Institute of the Czechoslovak Academy of Sciences in Brno as the Czechoslovak contribution to the IBP. The studies aimed to describe the distribution and pathways of some mineral elements in the most important structural units of both ecosystems. The results on the alluvial forest are given by Klimo (1973).

The present contribution gives some results on the distribution of mineral elements in seminatural alluvial grassland ecosystems of the meadow complex at the confluence of the Morava and the Dyje rivers and on some factors effecting

I. Structure of the Ecosystem under Study. — Struktura studovaných ekosystémů

Ecosystem	(I) dry	(II) mesic	(III) wet
Plant stand	<i>Festuca</i>	<i>Alopecurus</i>	<i>Glyceria</i>
Dominant species	<i>sulcata</i>	<i>pratensis</i>	<i>maxima</i>
Other species (number)	47	36	9
Primary prod. abovegr. g . m ⁻² . year ⁻¹	480	780	1145
Biomass undergr. g . m ⁻²	1560	1280	2857
Litter g . m ⁻² . year ⁻¹	200	180	900
Habitat			
Average litter moist. %	23	39	89
Average soil moisture %	33	55	78
Soil org. matter cont. %	4.5	5.6	9.0
Org. matter in humus %	98.2	74.8	59.4
Soil N content %	0.27	0.28	0.34
N in humus %	96.3	96.4	97.1
Soil microflora			
Bacteria number/gDW	2–12 . 10 ⁷	2–22 . 10 ⁷	2–30 . 10 ⁷
Micromyc. number/gDW	0.3–2.0 . 10 ⁵	0.4–3.4 . 10 ⁵	0.3–0.8 . 10 ⁵
Actinomyc. number/gDW	0.3–8.7 . 10 ⁶	0.3–2.7 . 10 ⁶	0.3–2.0 . 10 ⁶
Biomass of Bact. g . m ⁻²	1.5	2.6	4.1
Humus composition			
C cont. in humus %	4.4	4.2	5.3
C cont. in FHS %	1.6	2.6	2.6
C cont. in SHS %	0.8	0.3	0.9
C cont. in BHS %	2.1	1.3	1.9
N cont. in humus %	0.26	0.27	0.33
N cont. in FHS %	0.10	0.11	0.08
N cont. in SHS %	0.04	0.05	0.10
N cont. in BHS %	0.12	0.11	0.13

FHS = free humic substances, SHS = sorbed humic substances, BHS = bound humic substances

it. The phytosociological characteristics of the respective plant communities were presented by Balátová-Tuláčková (1966). The data on primary production by Hájková-Masná (1967) and Jakrllová (1967, 1968, 1970, 1972) and the results of the studies on decomposition processes by Tesařová (1971) and Úlehlová (1973a, b). The complete bibliography and summary of about 80 papers concerned with the ecosystems mentioned above is given in IBP PT-PP Report 2 edited by Rychnovská (1972).

III. Distribution and movement of mineral elements within the ecosystems under study. — Rozložení a pohyb minerálních prvků ve studovaných ekosystémech

Rainfall: $g \cdot m^{-2} \cdot year^{-1}$

Ca	Mg	K	Na	N	PO ₄
3.8	0.0	0.8	1.0	0.8	0.01

Import:

by wind, animals, etc.
?

Flood: $g \cdot m^{-2} \cdot year^{-1}$

	Ca	Mg	K	Na	N	PO ₄
I.	1.2–2.2	0.6–0.9	2.8–3.5	1.5–1.8	10–13	0.4
II.	2.6–2.9	0.9–2.3	0.1–0.5	0.2–0.6	8–10	0.1–0.3
III.						

Export:

by wind, animals, etc., ?

Harvest: $g \cdot m^{-2} \cdot year^{-1}$

	(I)	(II)	(III)
Ca	1.7	5.3	
Mg	0.5	0.5	
K	2.8	10.6	
Na	0.1	0.4	
N	4.6	10.4	
PO ₄	1.0	2.8	

Plants: $g \cdot m^{-2} \cdot year^{-1}$
aboveground

	(I)	(II)	(III)
Ca	3.0	9.2	8.3
Mg	0.7	0.5	0.6
K	5.6	15.1	13.7
Na	0.2	0.6	0.8
N	7.7	13.4	20.0
PO ₄	1.7	3.4	4.3

Litter: $g \cdot m^{-2} \cdot year^{-1}$
aboveground

	(I)	(II)	(III)
Ca	1.0	2.7	7.1
Mg	0.2	0.1	0.5
K	1.6	0.8	4.2
Na	0.1	0.1	0.7
N	2.4	1.2	12.2
PO ₄	0.4	0.3	3.5

Roots: $g \cdot m^{-2}$

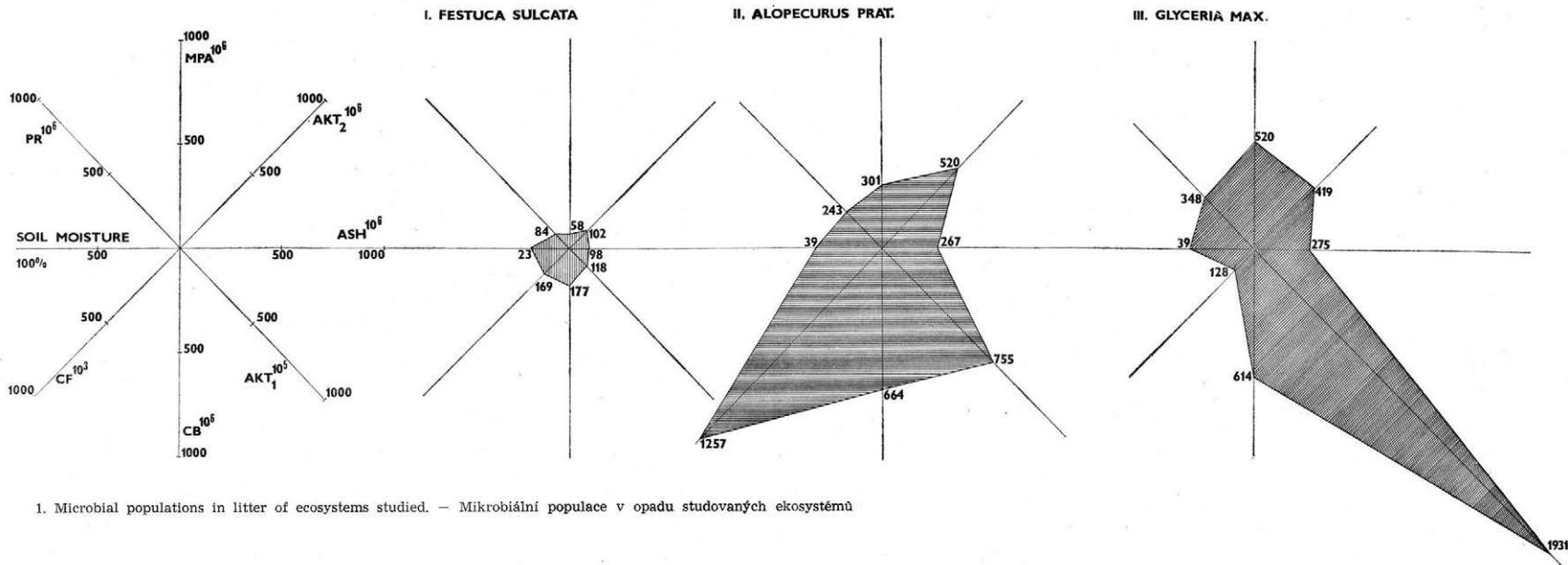
Ca	13.6	12.2	14.0
Mg	0.6	0.5	0.5
K	11.7	12.8	22.8
Na	1.4	1.6	1.4
N	13.6	10.4	38.3
PO ₄	2.5	3.5	5.7

Litter: $g \cdot m^{-2} \cdot year^{-1}$

Ca	3.3	2.7	3.6
Mg	0.1	0.1	0.1
K	2.4	3.2	5.5
Na	0.3	0.4	0.4
N	3.2	2.2	9.7
PO ₄	0.6	0.6	1.7

Soil solutions
 $g \cdot m^{-2}$

0–5 cm	Ca	Mg	K	Na	N	PO ₄
(I)	0.69	0.27	0.27	0.23	0.01	0.002
(II)	1.21	0.36	0.11	0.35	0.12	0.008
(III)	3.24	0.81	0.21	1.57	0.07	0.016
7–20 cm						
(I)	0.88	0.37	0.02	0.31	0.02	—
(II)	1.50	0.40	0.01	0.46	0.02	0.002
(III)	4.96	1.22	0.27	1.56	0.16	0.020



1. Microbial populations in litter of ecosystems studied. — Mikrobiální populace v opadu studovaných ekosystémů

soil; the transfer of nutrients through the animal food chain starting with the ingested living or dead plant material; the movement and chemical transformations of mineral substances within the soil.

Table III presents some available data on the distribution of mineral elements in the ecosystem under study. These data are intended to be further supplemented and refined.

As shown by the table, important amounts of minerals can be brought into the ecosystems by means of rain and flood water. Some of the elements as for example Mg, Na, but also nitrogen, in the case of plant community with the dominant species of *Festuca sulcata*, contained in the biomass produced per year, can be fully accounted for by the inputs mentioned above.

Plants of different species vary according to their ability to produce and accumulate organic matter and their organs contain different concentrations of mineral nutrients. The distribution of mineral nutrients in the plant stands of grassland ecosystems depends on the environmental conditions as well as on the composition of individual plant species.

The contents of K, N, and PO_4 in $g \cdot m^{-2} \cdot year^{-1}$ in the plant covers increase in plant communities with increasing soil moisture of the habitats and with increasing biomass production. This is not true as to the other elements.

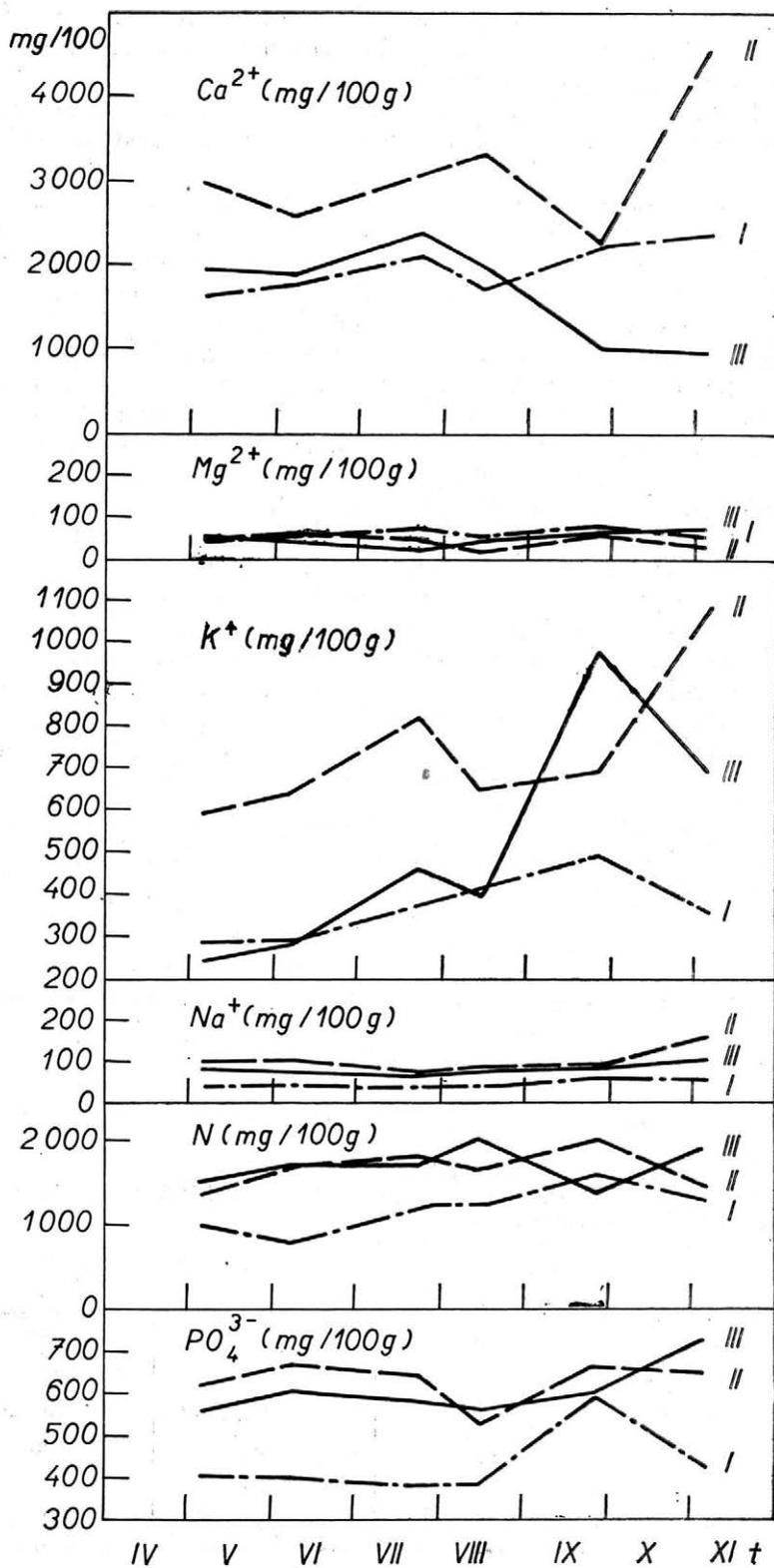
The main pathways by which mineral nutrients can be transported from plant to soil are: the exchange in rhizosphere, root exudates; leaching of minerals from the surface of the aboveground plant parts by rain; transfer of nutrients accompanying the dying-off and decomposition of biomass. Similarly, as in the case of the rhizosphere, the exchange of substances and nutrients exists in the aboveground plant parts. Air-borne dust particles and the soil particles carried by

IV. The rates of cellulose and litter decomposition in ecosystems under study (according to Tesařová 1971, Jakrllová 1972). — Rychlosti rozkladu celulózy a opadu ve studovaných ekosystémech

Ecosystem	CDR $mg \cdot g^{-1} \cdot day^{-1}$	LDR $mg \cdot g^{-1} \cdot day^{-1}$
(I) dry	6.5	1.5–4.0
(II) mesic	7.7	2.0–4.5
(III) wet	10.2	3.0–5.5

V. Litter and soil bacteria in ecosystems under study. — Bakterie v opadu a bakterie půdní ve studovaných ekosystémech

Ecosystem	(I) dry	(II) mesic	(III) wet
Litter moisture %	23	39	89
Litter bacteria no. per 1 g DW	$0.1-4.7 \cdot 10^8$	$0.2-13.6 \cdot 10^8$	$3-70 \cdot 10^8$
Soil moisture %	33	55	78
Soil bacteria no. per 1 g DW	$2-12 \cdot 10^7$	$2-22 \cdot 10^7$	$2-30 \cdot 10^7$



2. Fluctuations of mineral element concentrations in litter of ecosystems studied during 1972. — Kolišání v obsahu minerálních prvků v opadu studovaných ekosystémů v průběhu vegetačního období 1972

floods sediment on the plant surfaces and may be washed down into the soil by rain. The amounts of minerals retained during floods by the aboveground plant parts can be high and depend on several factors, such as: the height of the water level, flood duration, surface area of the plant stands per unit area of soil surface, rheological conditions, concentration and quality of material carried by flood.

The transport of nutrients through the litter pathway into the soil is affected by a different type of processes. The fall of litter to the ground results in grasslands in the formation of a nutrient-rich mat of dead organic matter covering the soil. The thickness of this layer depends above all on the amount of standing dead produced each year and on the rate of standing dead to litter and litter to humus transformations and decompositions, the quality and structure of the layer being dependent on the properties of the original plant material.

The dying-off of the aboveground parts and the change into standing dead and finally into litter follows a pronounced yearly periodicity. Although dependent also on the type of ecosystem and on respective soil and moisture conditions, the amount of standing dead reaches its maximum in all ecosystems towards the end of the vegetative period in the autumn.

Table IV gives the rates of cellulose and litter decomposition in ecosystems under study. The rate of the litter decomposition per unit of soil surface, non-uniform in course of the vegetative period, is affected above all by moisture, temperature, concentration and properties of the plant material, on the previous occurrence of flood, resulting in increased levels of mineral nutrients, as well as on the characteristics of the participating microbial populations. The composition and diversity of microbial populations of litter from the ecosystems under study is given in Fig. 1. The figure shows that the numbers of microorganisms per unit weight of dry litter increase from the dry to the wet plant community. Differences in counts due to the type of litter are also evident in different groups of microorganisms.

Data on the numbers of bacteria in litter and soils are presented in Tab. V. It can be seen that the density of the microbial population of the litter is much higher than that of the soil. It can be concluded that the mat of plant litter is the site of rapid changes at biological, chemical and physical levels controlling the rate and point of entry into new biological cycles of the mineral constituents present in the original plant material. Changes in mineral element concentrations in litter of studied ecosystems during the vegetation period 1972 are demonstrated by Fig. 2.

The movement of nutrients in the soil was studied in lysimetric experiments. When a flood comes suddenly and the soil profile is relatively dry, then the soil becomes gradually wetted from the soil surface downwards and also downward movement of nutrients takes place. Conversely, when the water level rises slowly the soil profile can be wetted from below by the rising underground water and the movement of soluble salts follows the upward direction of water movement (Úlehlová 1973a). Occasional occurrence of mineral salts on the soil surface during dry periods indicates that the movement of salts towards the soil surface can also take place as a result of evaporation and concurrent capillary water movement.

The horizontal movement along concentration gradients towards the absorbing regions of roots can be expected with easily diffusible ions. This type of movement can be closely related to the actual soil moisture and therefore can be similarly variable with depth and time.

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ÚLEHLOVÁ B. (Botanický ústav ČSAV, Brno). *Rozložení a koloběhy minerálních prvků v některých polopřirozených aluviálních lučních ekosystémech*. Rostlinná výroba (Praha) 20 (5) : 533-541, 1974.

V oblasti Jižní Moravy, Československo, byly studovány vstupy minerálních prvků deštěm a záplavovou vodou a odběry minerálních látek porostem u tří aluviálních lučních ekosystémů s různým vodním režimem stanoviště a s různou produkcí rostlinné hmoty. Zároveň byla stanovena množství minerálních prvků vracejících se do půdy opadem a koncentrace prvků v půdních roztocích, právě tak jako rychlosti dekompozičních procesů. Byl učiněn pokus určit faktory ovlivňující rozložení minerálních látek a jejich koloběhy ve studovaných ekosystémech. Předložená práce uvádí předběžné výsledky.

aluviální luční ekosystémy; rozložení minerálních prvků; rozkladači; rozkladné procesy

УЛЕГЛОВА Б. (Ботанический институт АН ЧССР, Брно). *Разложение и кругообороты минеральных элементов в некоторых полуприродных аллювиальных луговых экосистемах*. Rostlinná výroba (Praha) 20 (5) : 533-541, 1974.

В области южной Моравии изучали вкрапления минеральных элементов посредством дождя и наводнений и усвоение минеральных веществ насаждением в 3 аллювиальных луговых экосистемах с разным водным режимом участков и с разной продукцией растительной массы. Одновременно определяли количество минеральных элементов, возвращающихся в почву в виде опада и концентрацию элементов в почвенных растворах, а также скорость декомпозиционных процессов. Сделана попытка определить факторы, обуславливающие разложение минеральных веществ и их кругообороты в изучаемых экосистемах. В работе приводятся предварительные результаты.

аллювиальные луговые экосистемы; разложение минеральные элементы; разложители; процессы разложения

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**FORSCHUNGSARBEITEN AUF DEM GEBIETE
DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG
UND DER DARSTELLUNG DER PEDOSPHERE IN DER ČSSR**

Ein dynamisches Herantreten an das Studium des Bodens wird in einem anderen Bericht bewertet. An dieser Stelle ist zu bemerken, daß der Wasser- und Wärmehaushalt einen unumgänglichen Parameter bei der Lösung der Bodenklassifikation und um so mehr der Klassifikation der Standorte bildet. Die bisherigen Studien von Glet, Bedrna und Džatko betreffs der landwirtschaftlichen Böden und von Pelíšek und Šály betreffs der Waldböden bestätigen, daß sich die Haupteinheiten der Klassifikation von Böden in diesen Feuchteregimes signifikant unterschieden. Gleichzeitig weisen sie auf die Notwendigkeit der langfristigen Messungen zwecks Erfassung der langfristigen Periodizität der jährlichen Bodenzyklen.

Obzwar man der Bodenkartierung im vergangenen Zeitraum große Kapazität widmete, wandte sich die Aufmerksamkeit auf die Problematik der Struktur der Bodendecke erst in den letzten Jahren zu; es wurden interessante Studien von Linkeš, Hraško-Linkeš über die Struktur der Bodendecke der Gebirgsgebiete der BRD und Arbeiten von Bedrna veröffentlicht. Eine Analyse der Problematik der Beziehungen zwischen den Einheiten der Bodensystematik, den Kartierungseinheiten und den Einheiten der Bodendeckestructur und den analogischen pedo-ökologischen und agronomisierten Einheiten wird von Němeček und Damaška angeführt. Die Mesokombinationen der Bodenformen werden konsequent erst bei der Bearbeitung von Bodenkarten 1:200 000 (Němeček, Zuska, Tomášek), die wichtigen Kombinationen in den Karten 1:500 000 und 1:1 000 000 (ČSR Němeček, SSR Hraško, Linkeš, Šály) gelöst.

Dr. Jan Němeček, CSc.

CHEMICAL COMPOSITION OF THE LAYERS IN A SOIL THIN SECTION AND IN AN IRON-MANGANESE CONCRETION AS DETERMINED BY TWO MICROANALYTICAL METHODS

L. PAVEL, J. KOZÁK

PAVEL L., KOZÁK J. (Agricultural University of Prague, Prag-Suchdol). *Chemical Composition of the Layers in a Soil Thin Section and in an Iron-Manganese Concretion as Determined by Two Microanalytical Methods*. Rostlinná výroba (Praha) 20 (5): 543-550, 1974.

A ferromanganiferous soil concretion and a surface coating in a soil thin section were analysed for the main chemical constituents in neighbouring thin layers with the use of the laser spectrographic and electron microprobe micro-analytical methods. The agreement between the results obtained by means of the two different methods was found to be quite satisfactory. The distribution of the chemical elements in the surface coating in the thin section indicated the presence of a soil montmorillonite with different isomorphous substitutions and an accumulation of excess free silica in the subsurface layer. The micro-analysis of the layers in the concretion with a concentric structure showed that the central and surface parts were composed of aluminosilicate with considerable amounts of iron and manganese. Iron content increased several times from the surface to the centre of the concretion. The dark-coloured subsurface layer contained mainly Mn-minerals with a considerable accumulation of barium and calcium.

soil thin sections; ferromanganiferous concretions; electron microprobe; laser spectrographic method

The sensitive chemical microanalytical methods may give, in some cases, very valuable data even for such heterogenous bodies as represented by soils. This is particularly true for the analysis of soil thin sections and stratified soil concretions.

Soil micromorphology founded by Kubiěna (1938) developed in the course of last years in an important branch of pedology, providing an extremely useful information about the processes of soil formation and development.

Several attempts were made to supplement the micromorphological observations on soil thin sections with the data on the chemical composition of the coatings deposited on soil grain surfaces. The variation in the chemical composition of the coatings from the commencement of the deposition on the grain surface towards the youngest layer of the coating on its surface should reflect the historical changes in the soil development. However, microanalytical chemical data on the composition of the layered surface coatings are not available.

Brewer (1964) was the first to indicate a possibility to analyse very thin layers of a coating, with the use of an electron microprobe. Cescas et al. (1968) enumerated the possible applications of the microprobe and thought it improbable to analyse soil thin sections because of their low thermal stability. However, they employed the electron microprobe to analyse iron — manganese soil concretions. Qureshi et al. (1969) and Hill and Sawhney (1971) deemed it possible to analyse even the thin sections, under certain conditions.

In soils with a hydromorphic or semihydromorphic development and in soils with a high rate of percolation of water, secondary exclusions-concretions (Fe, Mn, Ca) are formed. When stratified, the layering indicates a gradual, often discontinuous, growth. Chemical microanalyses of the layers in soil concretions may, therefore, also yield a valuable information about the variation in soil chemical processes in the course of the soil profile development. The first to analyse soil concretions in this way by means of the electron microprobe, were C e s c a s and T y n e r (1967). Several papers appeared since then, dealing with the application of the electron-microprobe method to soil analyses.

In the present paper, an attempt is described to analyse the thin layers both in a soil thin section and in a soil concretion, with the use of two microanalytical methods, i. e. the electron microprobe and the laser spectrographic methods; reasonably comparable results could be obtained.

B r e c h and C r o s s (1962) first used a laser as an excitation source in the spectrographic analysis. The main advantage is in the possibility to analyse very small objects down to 10^{-6} gms. in weight and 10^{-3} cm. in diameter; the objects need not be electrically conductive.

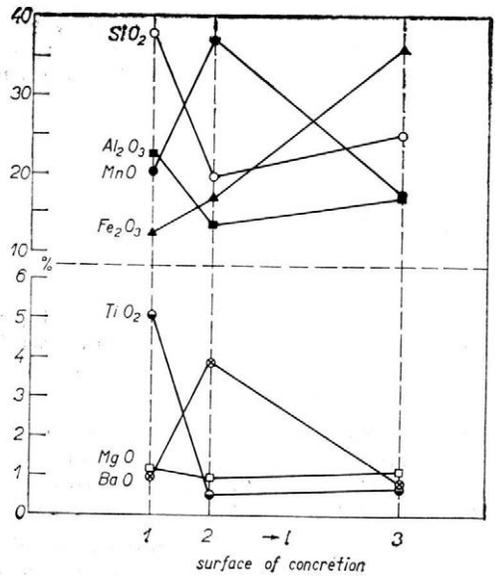
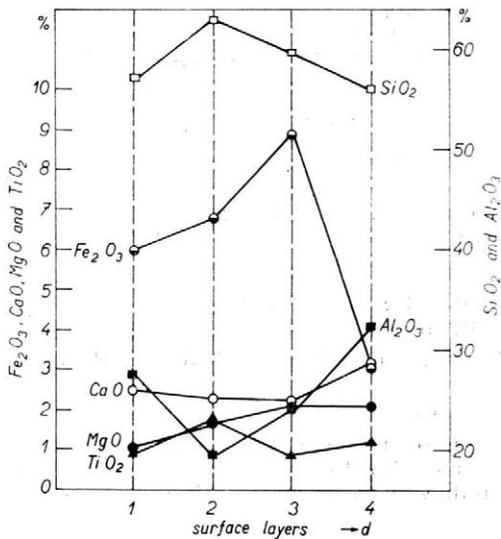
Compared with an electron microprobe, the laser spectrographic method offers some advantages: the price of the equipment is much lower; elements with a low atomic number (such as Na, Mg, Al) may be determined comparatively accurately; the object surface need not be highly polished and made electrically conductive. The disadvantages lie mainly in a lower reproducibility of the results and in a strong inherent influence of the matrix effect. These are affected by the transparency or coloration of the specimen, by the variable amount of the vaporized mass from the crater, by the variable intensity of the laser pulses, by the properties, processing and measurement of the photographic plate, etc.

The principle of the method: the coherent beam of monochromatic light from a solid-state laser is focussed by a microscope objective on a very small area of the specimen surface (10–100 μm . diameter). The laser pulse evaporates and partly excites a small amount of the material from a small crater. The ionisation in the cloud of the vaporized sample initiates a simultaneous electric spark discharge between two pointed carbon electrodes, placed above and close to the specimen surface. Thus, a higher degree of excitation is obtained. The characteristic light radiation of the elements present in the cloud is projected on the slit of a spectrograph and recorded in the form of spectral lines. The intensity (blackening) of the analytical lines is proportional to the element concentration.

The comparison of the two methods showed that the analysis by means of the laser microprobe is less laborious and the results are easier to evaluate than by means of the electron microprobe; in the latter case, even such soil objects as described, are too heterogeneous for an electron beam 5 μm . in diameter.

MATERIALS AND METHODS

The soil thin section originated from the B₂ horizon of a buried soil classified by Smolíková (Faculty of Nat. Sciences, Charles University, Prague) as "braun-lehmartige Parabraunerde". The soil concretion was from an allitic *terra rossa*. The following main constituents were determined in the thin section: SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, TiO₂; in addition, MnO and BaO were determined in the concretion.



1. Composition of the surface coating. — Složení povrchového povlaku

2. Composition of the concretion. — Složení konkrce

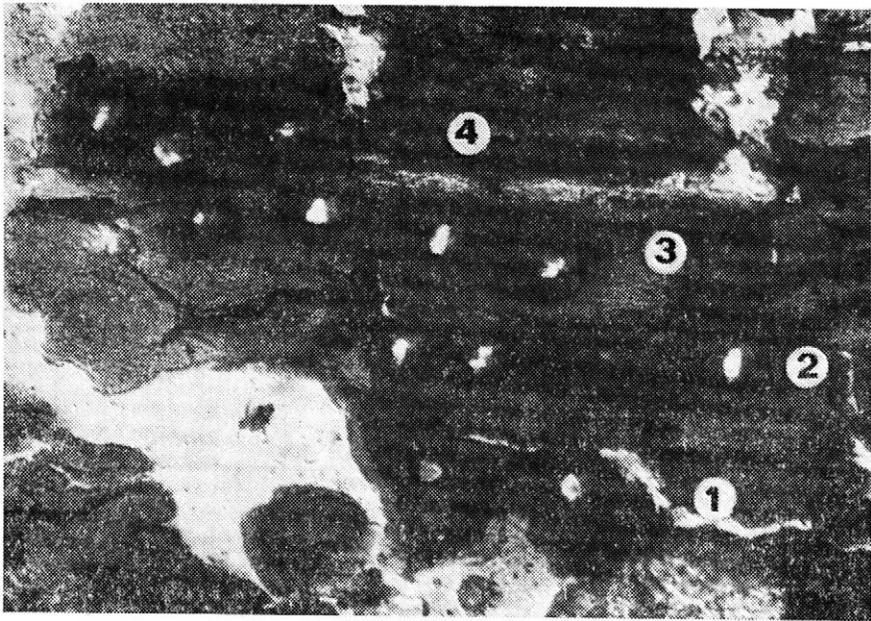
the heterogeneities in the coating, by the difficulty to determine Mg at low concentration because of its low atomic number, by a strong matrix effect in Al determination (metallic standard) which cannot be quite eliminated by a computed correction. The results obtained by the two methods are quite acceptable for the given purpose.

Mean values of the individual element oxide contents obtained by the two methods were used to illustrate the distribution of these oxides within the coating, from its surface inwards (Fig. 1).

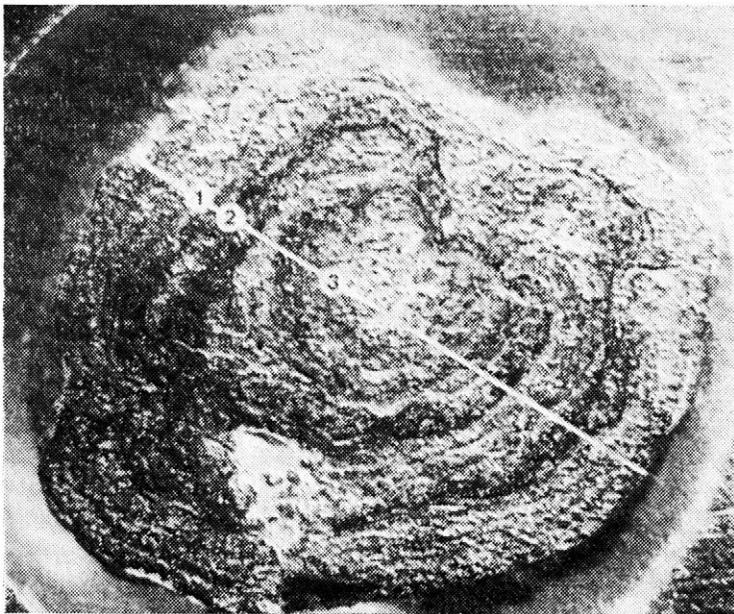
The distribution of silica and alumina is remarkable. The silica content increases from the surface layer 1 to a maximum in the subsurface layer 2 and then decreases to a minimum in the innermost layer 4, while the distribution of alumina presents an approximately inverse pattern. The distribution of ferric oxide is somewhat similar to that of silica but for the maximum (layer 3). The silica: sesquioxide molecular ratio is approximately 3:1 in the layers 1,3 and 4; in the layer 2 it is 4.4:1. It indicates the presence of a substituted soil montmorillonite in the surface coating, with an accumulation of excess free silica in the subsurface layer 2. The presence of a 14-Å mineral was confirmed by the X-ray diffraction from the thin section. It is difficult in this case to explain the nature of the distribution of SiO₂ — Al₂O₃ — Fe₂O₃ in the cross section through the coating, because the thin section comes from a buried soil. More comparative studies are called for, with recent soil profiles. A probable explanation could be found in different isomorphous substitutions in the 14-Å mineral deposited at different time periods and in free silica ancient deposition or recent diffusion into the coating.

The microphotograph (Fig. 2) of a part of the thin section shows the laser craters as dark-framed light spots formed in the layers of the coating (4 craters in each of 4 layers).

Fig. 3 shows the microphotograph of the section of the ferromanganiferous soil concretion. The indicated cross section bears three spots 1, 2 and 3, which



3. Microphotograph of a part of the soil thin section. Figures denote layers of the coating starting from its surface. — Mikrofotografie výbrusu, ukazující kráterky po laserových zásazích jako skvrny ve vrstvách povlaku (4 kráterky v každém povlaku)



4. Microphotograph of the ferromanganiferous soil concretion. Figures denote the analysed layers. — Mikrofotografie řezu konkréci a tři vyznačená místa, kde byla prováděna analýza

II. The analysis of a layered concretion. — Analýza vrstev v konkreci

Layer No.	1		2		3	
Oxide	LMA 1	EMX	LMA 1	EMX	LMA 1	EMX
SiO ₂	40.0	35.0	20.3	18.5	25.2	23.0
Al ₂ O ₃	22.1	23.0	13.4	14.2	17.3	18.0
Fe ₂ O ₃	12.6	12.5	18.3	15.5	35.2	37.0
MnO	20.1	21.5	33.1	40.5	17.3	19.5
CaO	2.50	2.03	5.00	4.15	2.75	3.20
BaO	0.98	1.02	3.70	4.00	0.65	1.03
MgO	1.10	not det.	0.90	not det.	1.17	not det.
TiO ₂	5.10	5.00	1.05	0.59	1.00	0.55

were analyzed for the above-mentioned elements. The analytical data are in table II.

The concretion has a concentric structure, as can be clearly seen from the microphotograph of the polished surface of its section. The dark-coloured layer 2 contains much manganese, has an increased content of calcium and remarkably much barium. Gallaher, Perkins and Radcliffe (1973) also found the dark-coloured portions of soil concretions to be high in manganese. The high content of barium besides manganese is apparently related to the presence of psilomelane (Hewett and Fleischer 1960). McKenzie and Taylor (1968) investigated concretions isolated from a great number of Australian soils and could identify lithiophorite, birnessite and hollandite as crystalline constituents, containing 3.6–4.5 per cent BaO and a number of important metal elements (Co, Ni, V, Pb, Cr, Zn). Torodokite and pyrolusite were also identified in individual cases.

The agreement between the results obtained by the two methods is quite satisfactory for this purpose. The differences may be again accounted for, considering particularly the matrix effect due to the use of chiefly metallic standards in the electron microprobe analysis. The determination of one or less per cent magnesium by this method is difficult and was not done.

The mean values obtained by the two methods were plotted in diagram 2 against the relative position of the analyzed spot on the cross section through the concretion. The quantitative distribution of the elemental oxides from the surface of the concretion inwards indicates certain interrelations. Silica, alumina and titanium dioxide exhibit the same tendency of distribution, while that of MnO, CaO and BaO is approximately inverse. The first group (SiO₂ — Al₂O₃ — TiO₂) apparently participates in the formation of the aluminosilicate part of the concretion, the second group (MnO — CaO — BaO) in the formation of Mn — minerals. The iron oxide content increases several times from the surface inwards and does not seem to be in any connection with the manganese oxide accumulation.

We feel justified to conclude that the two methods give sufficiently identical results when applied to the microanalysis of the aforesaid soil objects.

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PAVEL L., KOZÁK J. (Vysoká škola zemědělská, Praha-Suchbátov). *Chemické složení vrstev v půdním výbrusu a v železitomanganičitě konkreci, stanovené dvěma mikroanalytickými metodami*. *Rostlinná výroba (Praha)* 20 (5) : 543-550, 1974.

Železomanganičité půdní konkrece a povrchové povlaky v půdních výbrusech byly analyzovány na hlavní chemické složky v sousedních vrstvách laserovou spektrální analýzou a elektronovou mikrosondou. Souhlas mezi výsledky získanými těmito dvěma odlišnými metodami byl dostatečný. Rozdělení jednotlivých vrstev v povrchových povlácích v půdním výbrusu ukazuje na přítomnost montmorillonitu s různou izomorfní substitucí a akumulací nadbytečného volného kyslíčnicku křemičitého v jednotlivých vrstvách. Mikroanalýza jednotlivých vrstev v konkreci s koncentrickou strukturou ukazuje, že vnitřní a povrchové vrstvy jsou složeny z aluminosilikátů se značným obsahem železa a manganu. Obsah železa se několikrát zvyšuje směrem od povrchu do středu konkrece. Tmavě zbarvené vrstvy pod povrchem obsahují především Mn - minerály se značnou akumulací baria a vápníku. půdní výbrusy; železitomanganičité konkrece; elektronová mikrosonda; laserová spektrální analýza

ПАВЕЛ Л., КОЗАК Й. (Сельскохозяйственный институт, Прага-Сухдол). *Химический состав слоев в почвенном шлифе и в железно-марганцовых конкрециях, определенный двумя микроаналитическими методами*. *Rostlinná výroba (Praha)* 20 (5) : 543-550, 1974.

Железно-марганцовые почвенные конкреции и поверхностные налеты почвенных шлифов анализировали на главные химические компоненты в соседних слоях с помощью лазерного спектрального анализа и электронного микросонда. Результаты этих двух разных методов достаточно схожи. Распределение элементов в поверхностных налетах почвенного шлифа свидетельствует о присутствии монтмориллонита с разной изоморфной субституцией и накоплением избыточного свободного кремнезема в отдельных слоях. Микроанализ слоев в конкреции с концентрической структурой показывает, что как внутренние, так и поверхностные слои составлены из алюмосиликатов, содержащих в большом количестве железо

1. марганец. Содержание железа многократно возрастает по направлению от поверхности к центру конкреции. Окрашенные в темный цвет слои под поверхностью содержат, главным образом, Mn-минералы со значительной аккумуляцией бария и кальция.

почвенные шлифы; железно-марганцовые конкреции; электронный микроскоп; лазерный спектральный анализ

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MOLECULAR WEIGHT OF SOIL HUMIC ACIDS FROM THEIR DIFFUSIVITY IN THE AGAR GEL

M. VALLA, A. GUCKERT, F. JACQUIN, L. PAVEL

VALLA M., GUCKERT A., JACQUIN F., PAVEL L. (Agricultural University of Prague, Agricultural University of Nancy). *Molecular Weight of Soil Humic Acids from their Diffusivity in the Agar Gel*. Rostlinná výroba (Praha) 20 (5) : 551-555, 1974.

The diffusivities in the agar gel of humic acids and polyphenols isolated from the Bg horizon of an illimerized brown soil were investigated. The very broad range of the diffusivity values indicated a high degree of heterogeneity — as regards molecular weight (size) — of the soil polyphenol fraction and, particularly, of the humic acid fraction. This was so regardless of the fact that the humic acids were represented by a single fraction obtained by gel filtration with the use of Sephadex G 25.

humic acids; diffusivity; soil polyphenols; soil organic matter; gel filtration

The molecular weight of soil organic compounds and, particularly, of humic acids, is one of many criteria, which can be used to estimate the nature of biochemical and soil-forming processes in soils. In the case of high-molecular-weight compounds and the more so, of their mixtures, the determination of the molecular weight is difficult and uncertain. The result represents often a mean value, without giving any information about the presence of other constituents of different molecular weights in a complex system.

The common methods applicable to the compounds of a low molecular weight, based on the vapour density measurement, or on the depression of vapour tension above the solution, cannot be used. The cryoscopic method could be used in the case of a suitable solvent with a very high cryoscopic constant, yielding a quite homogeneous melt. Schnitzer and Desjardins (1962) reported a successful result. The Rast (camphora) method was found to be quite unreliable. The osmometric determination is highly influenced by the presence of low-molecular-weight compounds which pass the membrane along with the solvent. The viscosimetric method yields too small differences in viscosity coefficients. Solutions of high optical purity are needed for the optical methods, based on the dispersion of light. The remaining methods, applicable to soil humic compounds, are: gel filtration (molecular sieves), sedimentation in an ultracentrifuge, and diffusion.

The Sephadex method is widely used because of its simplicity; however, the gel filtration does not lead to a high purity segregation. Ultracentrifugation of compounds with the molecular weight of less than $2 \cdot 10^4$ is strongly disturbed by diffusion; a specially designed cuvette is needed to form the boundary. The aforesaid difficulties lead us to the determination of the molecular weight of humic acids from diffusion coefficients.

MATERIAL AND METHODS

The diffusivity was measured in glass tubes 10 cm. high and 1.6 cm. in diameter. A 3.6 cm. high column of 1 per cent agar gel (7.3 ccm.) was overlaid by a 4 cm. high layer (8.0 ccm.) of aqueous solution of humus compounds from the Bg horizon of an illimerized brown soil, with ^{14}C (Guckert, Nussbauer and Jacquin 1970).

The solution contained 0.75 gm. lyophilized humus compounds per litre. The Sephadex G 25 fraction of humic acids (Valla, Guckert and Jacquin 1972) and the polyphenol fraction (Guckert 1972) were used, respectively.

The diffusion coefficients were computed from the non-steady-state diffusion equation following the procedure as described by Lindstrom, Boersma and Gardiner (1968). The diffusion experiments were carried out at 30 °C, for two time intervals: $t_1 = n \cdot \Delta t$ and $t_2 = (n + 1) \cdot \Delta t$, where $n = 3$ and $\Delta t = 0.792 \cdot 10^4$ sec. The agar gel column was then cut into discs 0.13 cm. thick (volume 0.27 cc.), i. e. $\Delta x = 0.13$ cm. The amount of humus compounds was determined in each disc from the ^{14}C activity by a scintillation counter (Guckert, Roger and Jacquin 1968).

RESULTS AND DISCUSSION

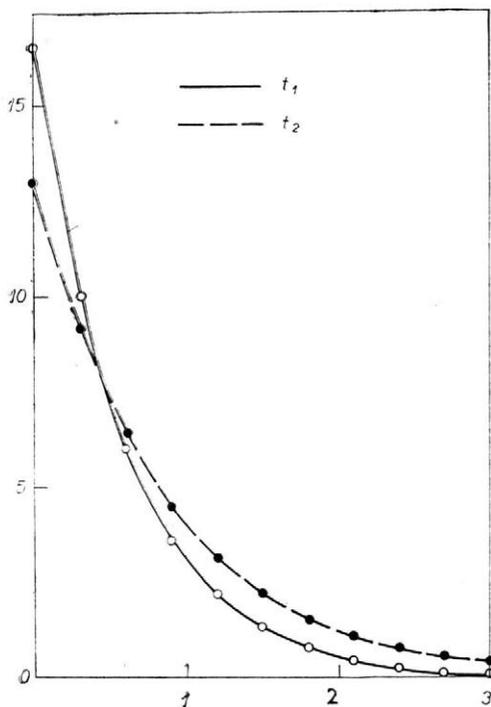
The measured values were rectified in semilogarithmic and plotted in linear coordinates as exponential curves (diagrams 1 and 2). Three points from the curve t_1 and one from t_2 were used to evaluate the apparent diffusion coefficients D_p from the equation (Lindstrom, Boersma and Gardiner 1968):

$$D_p = \frac{\Delta x^2}{\Delta t} \left(\frac{c_j^{n+1} - c_j^n}{c_{j+1}^n - 2 \cdot c_j^n + c_{j-1}^n} \right), \quad (1)$$

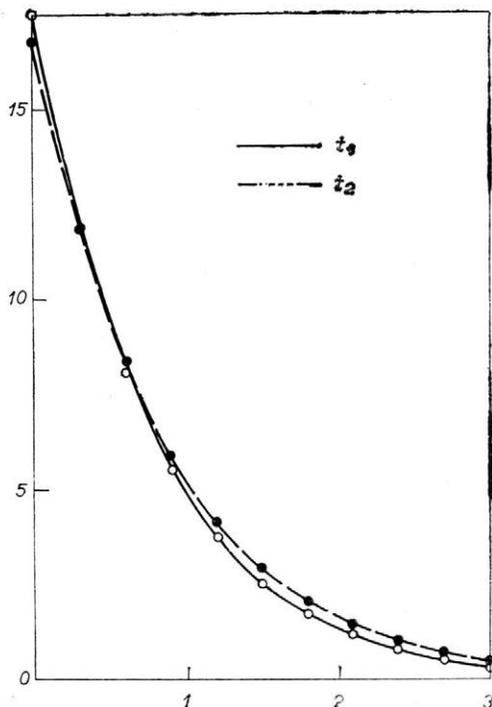
where c = humus compounds, gms. per disc,

j = space interval,

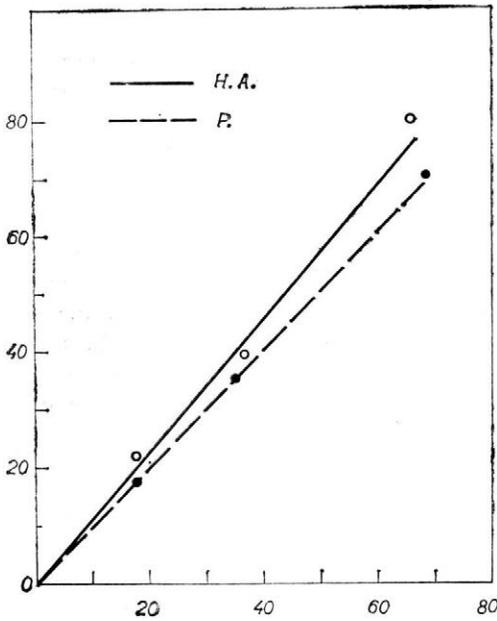
n = time interval.



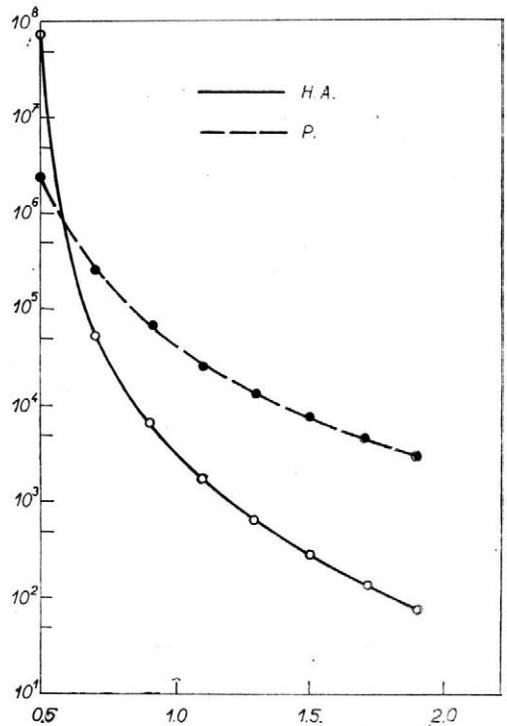
1. Diffusion curves of humic acids. Ordinate — humic acid concentration, $\times 10^{-5}$ gms. per disc; abscissa — distance from boundary, cm. — Difúzní křivky huminových kyselin. Ordináta — koncentrace huminových kyselin, $\times 10^{-5}$ g na 1 disk; abscisa — vzdálenost od rozhraní, cm



2. Diffusion curves of soil polyphenols. Ordinate — polyphenols concentration, $\times 10^{-5}$ gms. per disc; abscissa — distance from boundary, cm. — Difúzní křivky půdních polyfenolů. Ordináta — koncentrace polyfenolů, $\times 10^{-5}$ g na 1 disk; abscisa — vzdálenost od rozhraní, cm



3. Adsorption isotherms. Ordinate — adsorbed humus compounds, $\times 10^{-5}$ gms. per ccm. agar gel; abscissa — equilibrium concentration, $\times 10^{-5}$ gms. per ccm. — Adsorpční izotermy. Ordináta — adsorbované humusové sloučeniny, $\times 10^{-5}$ g na 1 ccm agarového gelu; abscisa — rovnovážná koncentrace $\times 10^{-5}$ g na 1 ccm



4. Distribution of mean molecular weights of humus compounds. Ordinate — molecular weight; abscissa — distance from boundary, cm. — Rozdělení molekulové váhy humusových sloučenin. Ordináta — molekulová váha; abscisa — vzdálenost od rozhraní, cm

The D_p values were transformed into D values (free diffusion) with the use of the Henry coefficient H (Timofeev 1962), determined from the linear adsorption isotherm (diagram 3)

$$a = H \cdot c, \quad (2)$$

where a = weight of adsorbate per unit weight of adsorbens, and
 c = equilibrium concentration, gms. per ccm.

D may be calculated from the equation (Crank 1967):

$$D_p = \frac{D}{H + 1}. \quad (3)$$

The molecular weight M can be obtained from the following equation (Vavruch 1959):

$$M = \frac{k}{\bar{v}} \left(\frac{T}{\eta D} \right)^3, \quad (4)$$

where k = constant ($= 0.99 \cdot 10^{-27}$),
 \bar{v} = partial specific volume, ccm. per gm.,
 T = temperature, $^{\circ}\text{K}$,
 η = viscosity coefficient;

$\bar{v} = 0,65$ (the value recommended by Cameron *et al.* 1972).

The diffusion coefficients increase with the increasing distance from the boundary and the molecular weight of the diffusing constituents decreases. It is an indication of a fractionation of the humus compounds by hindered diffusion in the agar gel. Cameron et al. (1972) used the agar gel in the fractionation of humic acids.

The humic acid fraction is evidently more heterogeneous than the fraction of soil polyphenols.

It may be concluded, that the original complex fraction of humic acids is differentiated (continuous fractionation) according to the rate of diffusion caused by different molecular weight (size) of the constituents. It should be pointed out, that the humic acid fraction had the molecular weight range from five to ten thousand, as determined by gel filtration. Diffusivity measurements indicated however the presence of molecule which exceeded considerably this range. The diffusivity of some low-molecular-weight constituents of the humic acid fraction approaches the order of diffusivity of simple ions.

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VALLA M.* GUCKERT A.** JACQUIN F.** PAVEL L.* (Vysoká škola zemědělská, Praha-Suchbát, * Vysoká škola zemědělská, Nancy**). *Stanovení molekulové váhy huminových kyselin pomocí difúze v agarovém gelu*. *Rostlinná výroba (Praha)* 20 (5) : 551-555, 1974.

Byla zkoumána difusivita huminových kyselin a polyfenolů, vyizolovaných z Bg horizontu hnědozemě. Velké rozdíly v difusivitě indikovaly vysokou heterogenitu molekulové váhy (velikosti částic) půdních polyfenolů a zejména huminových kyselin. Tento fakt byl zvláště pozoruhodný u huminových kyselin, kde se jednalo o frakci vyseparovanou na Sephadexu G 25.

humínové kyseliny; difusivita; půdní polyfenoly; půdní organická hmota; gelová filtrace

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Изучали диффузность гуминовых кислот и полифенолов, изолированных из Вg-горизонта бурозема. Большие различия диффузности указывают на высокую гетерогенность молекулярного веса (размера частиц) почвенных полифенолов и особенно гуминовых кислот, у которых этот факт примечателен тем, что вопрос касается фракции, сепарированной на Сефалексе G 25.

гуминовые кислоты; диффузность; почвенные полифенолы; органические вещества почвы; гелевая фильтрация

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FORSCHUNGSARBEITEN AUF DEM GEBIETE
DER BODENENTWICKLUNG, DER BODENPROFILFORMUNG
UND DER DARGESTELLUNG DER PEDOSPHERE IN DER ČSSR

Im allernächstem Zeitraum ist ein großer Wert zu legen auf eine einwandfreie Auswertung und Synthese der angesammelten Angaben über die Bodendecke und Bodeneigenschaften, die zu einer vollkommenen Vereinheitlichung des umfangreichen Materials über die Bodendecke der ČSSR führen würde. Man faßte bereits zusammen die gegenwärtige pedogenetischen Erkenntnisse, Ansichten auf die diagnostischen Horizonte (einschließlich ihrer Signatur) und den gegenwärtigen Stand der Klassifikations-Weltsysteme (Němeček), damit dieser Stand bei sämtlichen Regelungen respektiert werden kann. Es wurde ein System der Bodenklassen vorgeschlagen mit der Betonung, daß in diesem die Kriterien der hydrothermischen Régimes und der Merkmale, die mit diesem in Korrelation stehen, mehr ausgeprägt geltend gemacht werden.

Unumgänglich ist die numerische Bearbeitung des Analysenmaterials und seine Rückprojizierung in die Karten, mit der Vornahme von Korrekturen aufgrund der Korrelationen mit den Faktor der Bodenbildung und die Ergänzung der auf diese Weise überprüften Lücken in unserer Erkenntnis.

Man muß feststellen, daß die Ergebnisse der auf diese Weise orientierten Etappe der Pedosphäreforschung für eine längere Zeit eine wertvolle Unterlage der weiteren wissenschaftlichen Arbeiten und der praktischen Applikationen bilden werden. Sie repräsentieren jedoch die Periode der Konzentrierung der maximalen Aufmerksamkeit auf die statischen Parameter der Pedosphäre; diese muß ersetzt werden durch konkretes Studium der dynamischen Zyklen in den Böden und Modellierung ihrer Kulturumwandlung, durch konsequente Transformation gegenwärtiger Ergebnisse auf die Standortunterlagen, durch das Studium der Reaktionen und Verhalten der Standorte in der landwirtschaftlichen Produktion mit Berücksichtigung des Landschaftschutzes.

Dr. Jan Němeček, CSc.

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