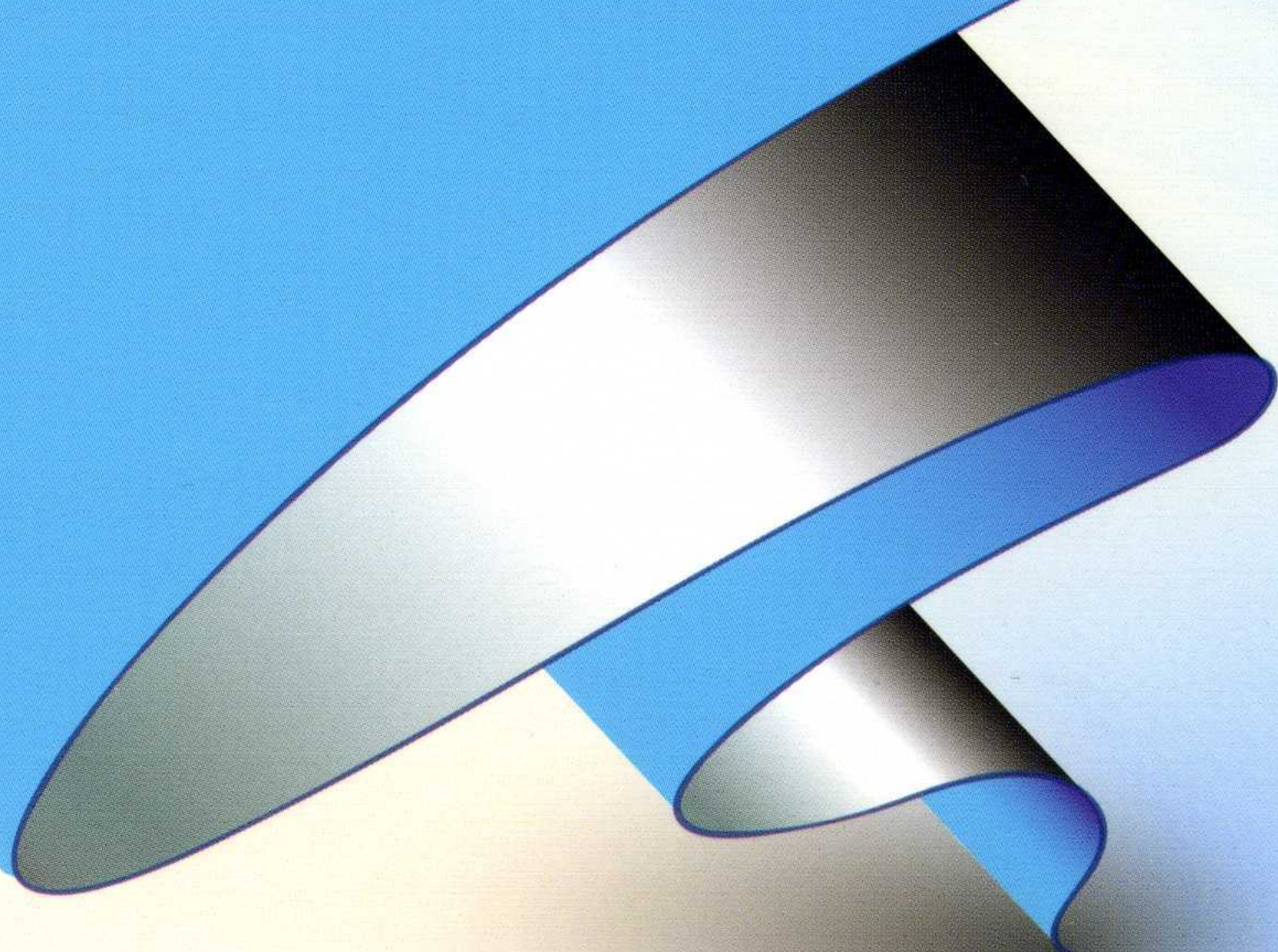


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SPECTROGRAPHIC CHARACTERISTICS OF CHUVASH REPUBLIC ZONAL SOILS WITH DIFFERENT EROSION DEGREES

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ABSTRACT

Hereby the results of spectrographic approach research of zonal soils with different erosion degree (podzolic chernozem, dark grey forest soils, typical grey forest soils and light grey forest soils) in the territory of Chuvash Republic are given. Spectroradiometer HandHeld2 ASD used obtain the spectral characteristics of soils. In the points of spectrographic research the soil specimens were taken and they were agrochemically tested. The results of agrochemical inspection were analyzed along with spectrographic curves of the given soils. Consequently, a strong correlation between humus content in soils and characters of spectrographic curves was elicited. Furthermore, all the types of spectrographic curves in the analyzed soils were categorized into 2 types: slightly humic and strongly humic. The results of this work can be used in express erosion analysis of those soils.

Keywords: Zonal soils, erosion, spectrographic analysis, humus content

INTRODUCTION

There are many classifications of eroded soils, but all variety of erosion determination methods can be reduced to four large groups:

1. Based on morphological differences of eroded soils, including taking into account the character of relief.
2. Methods considering humus content in the eroded soils.
3. Methods based on other chemical, biological or physicochemical changes in eroded soils.
4. Techniques that use multiple parameters listed above.

In the Soviet Union standard classification of eroded soils was considered, published in the "Union-wide instructions on soil surveys and making of large-scale soil maps of land use", according to which the value of soil horizons runoff was taken as the basis for determination of soils erosion degree. The exception was the classification of eroded sod-podzolic and light-gray forest soils, where agricultural soils erosion degree determined by their type, by pedologic horizons under the arable layer, by steepness territory, etc. [1]. Some classifications use the relief characteristics (inclination, length, exposure, slope dissection), type of soil-forming rocks, erosion resistance of soils [2] [3]. Currently, several common field methods for soils erosion determination applied for

Chuvash Republic territory. The most famous is visual morphological classification developed by S. Sobolev [4], and specifically to the conditions of Chuvashia – by S.I. Andreev and F.Y. Mikhailov [5], [6]. S.I. Andreev put a set of features at the base of classification and diagnostic of eroded arable soils: inclination, degree of humus layer removal, reducing of genetic horizons depth, arable layer color, presence and quantity of rills, humus content (for loamy sod-podzolic and light gray forest soils), growth and development of agricultural crops. F.Y. Mikhailov developed given diagnostic features of eroded soils for soil types and took into account erosion degree [6].

It should be noted that these data of Chuvash Republic soil research received at the first time since 1980s, are still used in cadastral evaluation of agricultural lands, as the basis for the tax accruals, calculation of land plots redemption price, determining the size of penalties. In addition, the given criteria of soil cover used to determine a significant reduction of agricultural land fertility and can be the probable cause for compulsory removal of agricultural land plots from the owners in accordance with the Russian legislation [7], [8].

In contrast to the geomorphological indicators that are easily described using GIS technology, and external features of erosion, that can be identified by analysis of remote sensing data, agrochemical parameters of soils (humus content, acidity, phosphorus and potassium content, etc.) are very dynamic and require directly field definition.

As the network of representative sampling points should be sufficiently dense, development of accessible, low-cost and fast methods for determining of agrochemical attributes of soil changes is required [9], [10] [11], [12]. This paper presents the results of spectrographic studies of zonal soils in the territory of the Chuvash Republic.

METHODS

To obtain the spectral characteristics of soils spectroradiometer HandHeld2 ASD used. With the help of this hardware spectral brightness of ground surface measured with subsequent comparison with the physical characteristics of studied soil. This procedure allows to calibrate the spectroradiometer and to get information about studied soil properties by spectral data [13].

In this work reference points of the Federal Organization "State Center of Agrochemical Service "Chuvashskiy" organized in the well-studied soil areas with different soil varieties have been used (Table 1). Hydrophysical study of basic soil types with automorphic aerodynamic method [14], [15] (aerodynamic method for determining of specific surface of solid and condensed phase, coefficient of hydraulic conductivity, water potential for homogeneous porous materials) have been carried out simultaneously with the spectroradiometric indicators determination. Changes in received spectrograms were analyzed in soils subtypes context.

RESULTS

Light-gray forest soils. The character and form of spectrographic curve of lightly and medium washed soil varieties are generally similar and have asymmetrical parabolic curve form with three clearly defined peaks of spectral brightness for wavelengths approximately 250 nm (small peak) and 400 and 460 nm (high peaks) and one trough at 358 nm. Apparently, this character of curve is typical for a light-gray forest soils in general (Fig. 1., spectrogram 00019, 00020, 00191, 00192).

Table 1. Description of the different soil types in reference points

Point number	Soil type	Granulometric texture	Sampling site	Washout by..., t /ha/yr			Washout degree
				heavy rain	snowmelt runoff	Total	
1	light grey forest	heavy loam	arable	13,502	2,708	16,210	light
2	light grey forest	heavy loam	arable	8,247	1,061	9,309	medium
3	dark grey forest	heavy loam	arable	3,375	0,306	3,681	light
4	typical grey forest	heavy loam	arable	7,314	1,152	8,466	medium
5	podzolic chernozem	heavy loam	arable	3,884	0,358	4,242	light
6	podzolic chernozem	heavy loam	arable	2,749	0,338	3,087	light
7	podzolic chernozem	heavy loam	arable	3,095	0,308	3,403	light
8	podzolic chernozem	heavy loam	arable	3,095	0,308	3,403	light
9	podzolic chernozem	heavy loam	arable	3,111	0,239	3,350	light
10	typical grey forest	heavy loam	perennial grasses	0	0	0	—
11	light grey forest	medium loam	arable	1,793	0,120	1,913	light
12	typical grey forest	heavy loam	arable	5,243	0,753	5,996	light

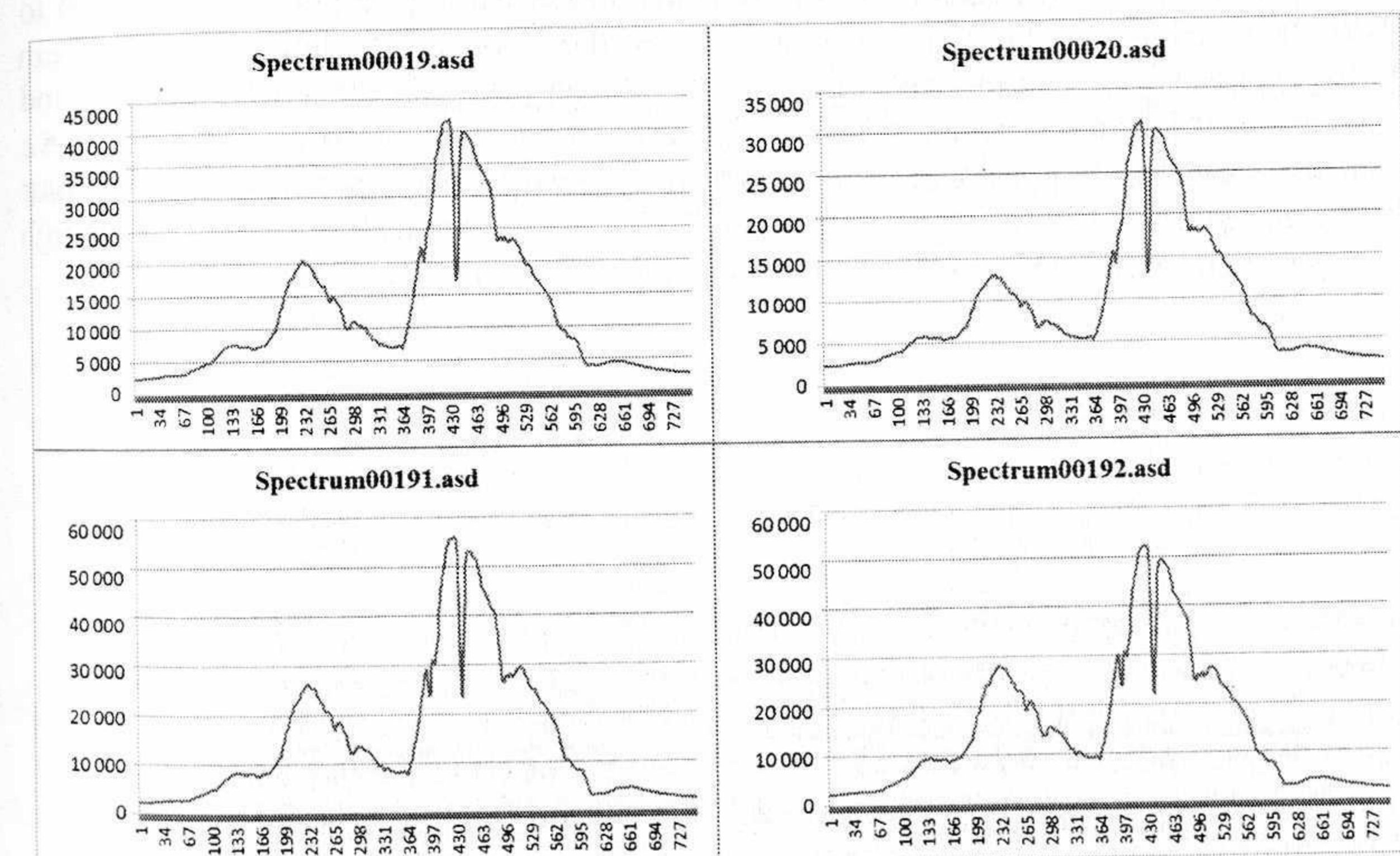


Figure 1. Spectrographic curves for slightly humic soils
X axis – wavelength, nm; Y axis – spectral brightness, DN

Comparing curves for soils with various degree of erosion, following regularity reveals: for lightly washed soils spectral brightness of "small peak" is 25,000 DN, and for medium – 20000 DN, the value of the big peaks for lightly washed soils is about 50,000 DN and for medium only 40,000 DN. The value of curve trough for lightly washed varieties is about 10,000 DN, for medium washed – 5000 DN. Thus, with an increase of erosion there is a decrease in the spectral brightness by 5000-10000 units.

Typical gray forest soils. Because the sample included only lightly washed typical gray forest soils, it was not possible to track the trends with erosion degree change. The general character of spectrographic curve almost identical to curve for light gray forest soils. The first peak (250 nm) reaches spectral brightness 15000-20000 DN. Trough from 250 nm to 400 nm reaches the minimum values at the 5000 DN, falling on 10000-15000 DN. The spectral brightness of two peaks (400-460 nm) reaches values 35000-30000 DN. Probably for typical gray forest soils the tendency of spectral brightness change with increase of erosion degree would be similar to light gray forest soils.

Dark gray forest soils. The general character of the curve for given soil subtype differs from a light-gray and typical gray forest soils (Fig. 2., spectrogram 00171, 00172). This curve also has three peaks, but the 250 nm peak is primary, while 400 and 460 nm peaks are not so evident. There is no trough between these peaks, but a general curve drop between 250 and 400 nm, with four small hollows and four small peaks. In addition, there is a small forepeak at a wavelength of 130 nm with flat shape in spectrograms that describes the typical gray and light gray forest soils. When analyzing the curves for soils with varying degrees of erosion the following regularities can be noted: 130 nm forepeak spectral brightness falls with an increase of erosion from 8000 DN (unwashed) to 7000 DN (medium washed); the main peak (250 nm) falls on 3,000 DN – from 11500DN to 8500 DN; peaks (400-460 nm) decreased from 10,000 DN (unwashed) to 6500 DN (medium washed). The trough between the peaks of 250 nm and 400-460 nm is also changes – with an increase of erosion it falls on 2000 DN for unwashed soils, and just on 1,000 DN for medium washed. The general tendency of spectrographic curve changes is spectral brightness decrease with an increase of erosion, but it is uneven over the entire length of the spectrum – from 1,000 DN in the forepeak (130 nm) and trough (250-400 nm) to 3000-3500 DN on the main peaks (250nm, 400-460 nm).

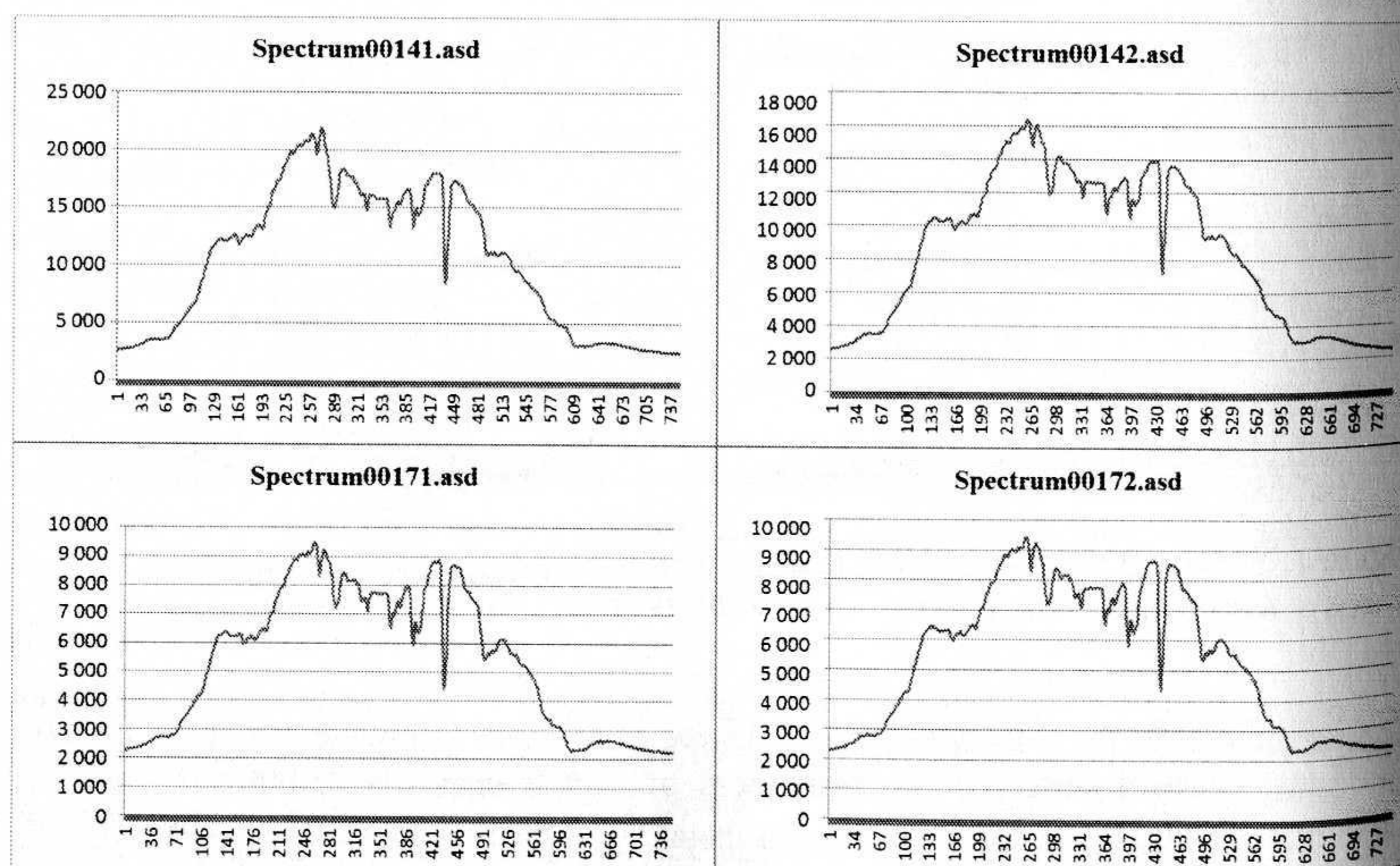


Figure 2. Spectrographic curves for strongly humic soils
X axis – wavelength, nm; Y axis – spectral brightness, DN

Podzolic chernozem. The overall view of spectrographic curve is similar to the dark gray forest soils, but there are definite differences. 130 nm forepeak is much more expressed and represented by extremum with 1,000 DN height. The main peak (250 nm) is most significant throughout the spectrogram and reaches 16000-20000 DN, two other peaks (400-460 nm) is much smaller – 15000-13000 DN (Fig. 2., spectrogram 00141,00142). There is no trough 250-400 nm, but a general curve drop between 250 and 400 nm, with four small hollows and four small peaks with general falling trend on 1000-2000 DN. Because the sample included only lightly washed podzolic chernozems, it was unable to track erosion degree trends. Nevertheless, due to the fact that general view of spectrographic curve for podzolic chernozems is similar to the dark gray forest soils, it can be assumed that the regularities relating to the change in erosion degree will also be similar.

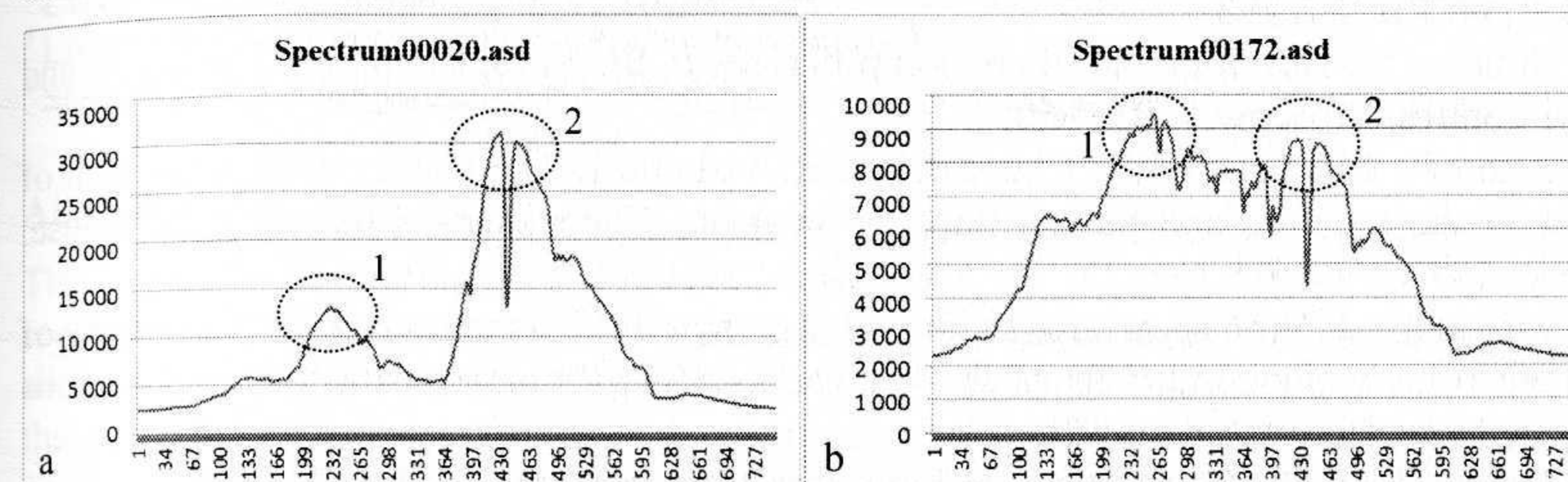


Figure 3. Differences in the graph lines for slightly (a) and strongly (b) humic soils
The numbers are the types of peaks

CONCLUSION

When comparing the spectrograms for all types and subtypes of soils with various degree of erosion with the results of agrochemical research a rather distinct regularity revealed – the change in the type of spectrographic curve when degree of soil humus content changes.

In the context of the studied soils, two main types of spectrographic curve can be identified conventionally – for slightly humic (Fig. 1) and strongly humic (Fig. 2) soils. Main peak with a 250 nm wavelength is actually a marker of humus content, thus it is necessary to compare it with two peaks of 400 nm and 460 nm (Fig. 3). It is also important a forepeak (130 nm) presence or flat spot instead of it. The tendency here is: the less humic soil is, the more two peaks rise above the peak of 250 nm. Differences in height can reach up to 2-2,5 times (spectral brightness in DN) for light-gray forest soils. Conversely, the more humic the soil is, the more the main peak rises above the two peaks of 400-460 nm. Here, the differences can reach up to 1,15-1,3 times for podzolic chernozems.

For the purposes of further research it is necessary to increase the number of observation points to determine the nature of the relationships between the spectrographic curves and chemical and hydro-physical parameters of soils.

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TECHNOGENIC POLLUTION OF SOIL DUE TO MINING AND CHEMICAL ENTERPRISES

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ABSTRACT

The presence of mining and chemical enterprises in Western Ukrainian industrial regions has led to challenges in terms of the utilisation, recycling and disposal of wastes. The Rozdil state mining and chemical enterprise, *Sirka*, is included in a list of the top 100 companies for causing environmental pollution. In particular, it has produced more than 3 million tons of phosphogypsum as a byproduct of its activities, which is a major cause of environmental disruption. Therefore, this work focuses on the soil pollutants influenced by phosphogypsum dumps in the region.

This work has established qualitative and quantitative composition of chemical elements in the soils near to dumpsites of phosphogypsum using the X-ray fluorescent analyzer *EXPERT 3L*.

The heavy metal content in soils near phosphogypsum dumps was found to include: Zinc, Arsenic (Class 1, high risk); Nickel, Copper (Class 2, moderate risk); Iron, Manganese (Class 3, low risk); in addition to Silicon, Sulfur, Calcium, Titanium, Strontium, Yttrium, Cerium, Rubidium, Niobium, and Rhodium. Laboratory tests revealed that the level of heavy metal contamination in soil decreases with distance from the dump sites. The tests of the soil samples collected near the phosphogypsum dump sites showed that the maximum allowed concentration of phosphorus, cadmium, lead and non-polar hydrocarbons is exceeded by 8.25, 1.65, 1.42 and 3.83 times respectively. The traces of the maleic acid anhydride were also detected. It was noted that the presence of harmful elements in phosphogypsum reduced over time due to weathering.

This paper therefore demonstrates a number of recommendations which have been developed to improve industry practice, including the recycling of phosphogypsum. The impact of this will be better quality of soil in the medium- to long-term for the affected region.

Keywords: mining and chemical industry, phosphogypsum, soil pollution, heavy metals, X-ray fluorescence analysis.