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GEOCHEMICAL ANALYSIS OF SUSPENSION LOAD OF WHITE KÖRÖS

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ABSTRACT

Few studies are available concerning the Hungarian river load. Previously mainly qualitative measurements were performed and as well as is being performed more recently. In the literature chemical analysis of flapping river load is not common (BALLÓ M. L873: TAKÁTS T- L930: MEZŐSI J-DONÁTH É. 1951: BOGÁRDI J.). More papers are available regarding the characteristics of catchment areas of rivers Berettyó and Körös. Workers of Hydrology Institution are continuously measuring the hydrographic measurement. The complex mineralogical and geochemical analysis of suspension load of the rivers have been never done. During our study we are addressing the following questions:

The quality and quantity of the suspension load of the river

When and why does the river deliver the largest amount of load?

What is the flapping particles roundness?

Which part of the catchment area are these particles coming from?

What difference can be found between the particles in the river and the mineral composite of the catchment area?

To answer these questions we analyze the suspension load.

INTRODUCTION

The river load is composed by organic and inorganic compounds. The organic load comes from urban, industrial and agricultural waste, its appearance is random, and its movements is unorganized. The inorganic load originates from the decomposing of rocks. So it contains different kind of pebble and minerals which can be characteristic of river. The size of the river load varies from hundreds kilograms to very small flapping particles, so most of the time the load is a mixture of particles of different size. Particles over 0.002 mm are considered as a load. Their shape can be sharp or spherical depend on how long way they take in the river.

In the catchment area a complex water erosion produce load. The rocks are eroded, delivered affected by chemical and physical effects.

Two different kind of load can be distinguished by their origin. One comes from the catchment area other comes from the river bed and bank. Thus the development of the load influenced by geological and topographical characteristics of the catchment area, the

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soil (agriculture) and the climate (quantity and distribution of rainfall, yearly and monthly mean temperature, evaporation and specific amount of water). The river load is different in different part of the river and different cross section of the river, so the place of the sample-taking is very important.

The water moves the load as a carrier. Three different kind of load can be distinguish:

1) Rolling or bottom load (rubbing, sliding movements)
2) Suspension load (flapping in the water, moves the same speed as the river)
3) Dissolved salts and colloids (continuously present independent from the movement of the water)

During the study of the load we make two groups:

I. The characteristics of catchment area: studying the geological and topographical conditions, the soil composition, and the climate conditions (rainfall, temperature, evaporation),

II. Characteristics of the water-flow: determination of the quality and quantity of traction and suspension load, and their changes through cross section and depth of the river. Hydrographic measurements (data on water level, fall, speed, seed dispersion, discharge, quality and quantity of water and river channel.

Samples were taking every 3 months (spring and summer flood, low water at the end of fall and flood in spring after snow thaw). We drew 10 liters of sample in the current of the river, form 1-1.5 meters deep using special vessel, and after centrifugation we got g dried material. After special treatment and size measurement the specimens were analyzed by binocular and polarization microscope and x-ray difractoraph and x-ray fluorescent technic.

THE WHITE KÖRÖS

This river originate from south-east side of mountain Apuseni at 980 meters high. The length of the river is 236 kilometers, the catchment area is 4275 km^2. The falls of the river is changing: at the upper course it is a running stream (fall: 17.5 meters/kilometer), slows at the middle course (fall: 1 meter/kilometer), and even slower at the lower course in the plane, It is bordered by Transylvanian Érc Mountains (Mt. Auriferi) and Zarándi (Mt.Highis, Mt. Drocea) Mountains from the south and Béli (Mt. Codru, Mt. Moma) Mountain from north.

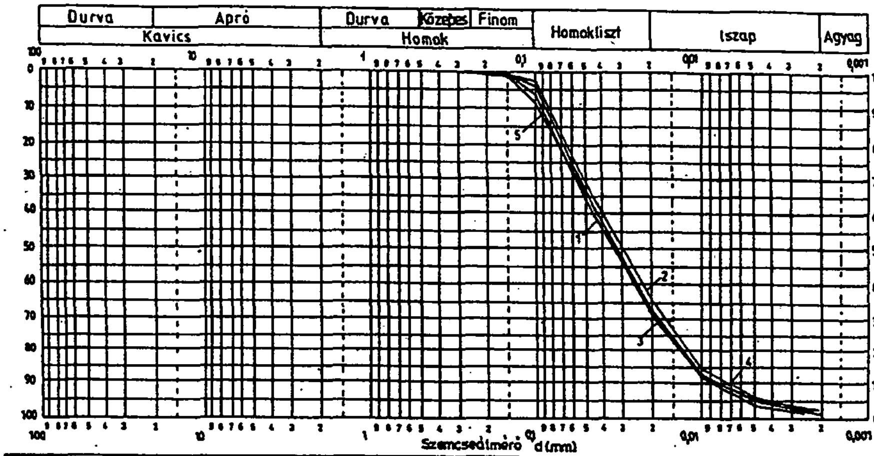
Table 1 shows the hydrographic measurements of White Körös in 1999. This table indicates the correlation of the mean water level, the water discharge and the suspension load in year 1999. During the spring measurements we found average load discharge at 3 centimeters water level and 27,7 m^3/s water discharge. However, sample from the summer flood the suspension load was 13763,93 g/s at the 43,8 m^3/s water discharge.

TABLE 1

Shows the hydrographic measurements of White Körös in 1999.

Date	Mean water level (H) cm	Water discharge (Q) m^3/s	Mean speed (v_k) m/s	Suspension load discharge G. g/s	Suspension mean concentration Ck g/m^3	Average diameter of the load d_g mm
1999.04.15.	3	27.7	0.61	576.256	20.789	0.045
1999.06.24.	151	43.8	0.45	13763.93	314.441	0.044
1999.12.03.	-104	8.12	0.36	87.439	10.771	0.034

Fehér-Körös
Gyula
1999. 06. 24.

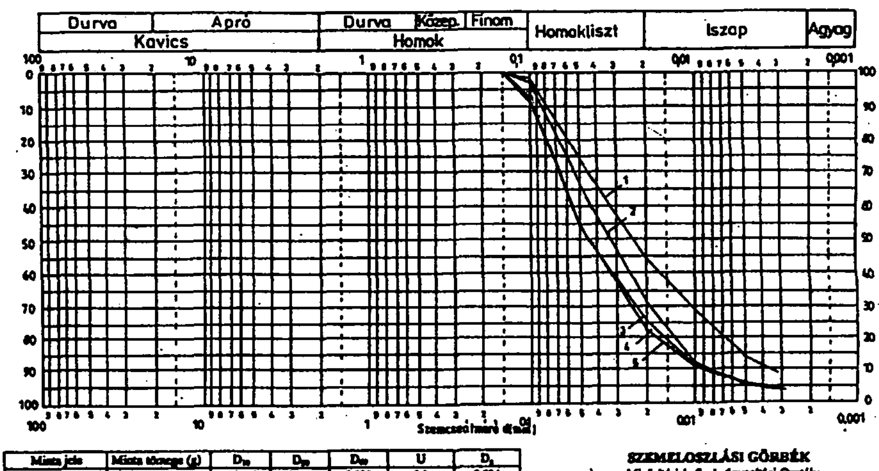


Minta jele	Minta tömege (g)	D_{10}	D_{50}	D_{60}	U	D_s
1. ———	2,691	0,0088	0,034	0,045	5,1	0,045
2. ———	3,760	0,0072	0,029	0,040	5,6	0,040
3. ———	2,589	0,0083	0,033	0,043	5,2	0,043
4. ·	3,290	0,0078	0,032	0,043	5,5	0,043
5. ———	3,661	0,0082	0,033	0,043	5,2	0,046

SZEMELOSZLÁSI GÖRBÉK
Minősítési és Szabványosítási Osztály

VITUKI II. INTÉZET		Témafelelős: Kőszegi László
Témaszám: 714/2/46491		Szerkesztő: Miholics
Rsz:	Bp. 1999. 09.	Rajzoló: Zókáné

Fehér-Körös
Gyula
1999.04.15.



Minta jele	Minta tömege (g)	D_{10}	D_{50}	D_{60}	U	D_s
1. ———	0,103	0,0036	0,024	0,033	9,2	0,034
2. ———	0,171	0,0084	0,032	0,043	5,1	0,042
3. ———	0,175	0,0088	0,044	0,056	6,4	0,051
4. ·	0,191	0,0082	0,045	0,055	6,7	0,050
5. ———	0,367	0,0093	0,044	0,056	6,0	0,051

SZEMELOSZLÁSI GÖRBÉK
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VITUKI II. INTÉZET		Témafelelős: Kőszegi László
Témaszám: 714/2/46491		Szerkesztő: Miholics
Rsz:	Bp. 1999. 05.	Rajzoló: Zókáné

Fig. 1. The results of the size measurements of White Körös in 1999.

The river comes through different geological strata. It originates from Mesozoic limestone, then come through crystalline slate and granite for a while and then rum through Paleozoic, Mesozoic volcanic area at the end. Between Brad, Honctő and Borossebes it runs through Neogene (Badenian-Sarmatian) andesite area. The only barrage can be fond at Körösbökény, so the water coming from the mountains delivers the load continuously. After reaching the Plane the river slows down (after Borosjenő and Kisjenő) and delivers smaller load, but during the flood it can deliver sandy load up to Gyula.

The results of the size measurements were the following. The suspension load of the river at Gyula does not contain gravel. The suspension load contains 68.1% sand, 28.9% silt and 3% clay. Samples taken different season (spring, summer, fall) are different (*Fig. 1.*). In spring (subside rivers, smaller water discharge, but higher mean speed) the river load contains 69.8% sand, 26.2% sandy-silt and 3% clay. The load size of the blank and the current is different, the curve is changing. The samples from the bank indicates that the river delivers more fine slit and sand there then in the current, where the faster waterflow delivers greater sandy load coming from distant cachment area. Samples from the summer flood, the river load is more uniform, 66.4% sand, 32.1% silt and only 1.5% clay. Thus at lower water level, lower water discharge, but faster mean speed the White Körös has much more sandy load in the current. While at higher water level, at greater water discharge, but slower mean speed the load size is more unified in the cross section of the river, and delivers relatively less sandy sediment. We conclude that like other plane rivers (Tisza, Maros) average size of suspension river load decrease with the elevation of water level.

During the sediment-petrography measurements, minerals greater then 2. 75 specific gravity were separated by bromophormic procedure. The suspension loads of the river can be distinguished by the light (95-99%) and heavy (1-5%) fraction of minerals. In the samples from the White Körös the heavy fraction minerals are the following: pyroxene , hyperstene (30%), brown amphibole (25%), hematite-magnetite-ilmenite (13%), augite (7%), green amphibole (7%), and garnet (6%). The rest is made up by chlorite, biotite, epidote, rutil and limonite minerals. The most of the minerals remain in their original shape, which means that the time while the minerals take their way from the geological layers to Gyula is short, and there was no time for shaping. The amphiboles can be found in every flood. Their shape are columnar and less shaped. Brown and green version can be found either. Amphiboles are probably products of Neogene andesite volcanoes around Brad. Between the pyroxenes the hyperstene a general component with columnar shape. Sometimes its color changes to greenish. The quantity of iron-contain minerals (hematite, magnetite) is not significant, their shape are roundest. The monoclinic shape of augite can recognize easily. It is common in samples from flood. The heavy mineral content of the suspension load originates from decomposing the basic-intermediate rocks. That is indicated by the components mentioned above. The garnet are rare, they are spherical in shape, pink or colorless in color. The garnet is probably originated from the Crystal slate, granite belt at the origin of the river. The epidote and biotite are rare, and originate also from the Crystal belt (Bihar South). The quantity of the lighter specific gravity compounds (quartz, feldspar, mica) and clay granule) is much higher then heavy minerals. The quartz, feldspar, muscovite content are likely elevated in the summer samples. The feldspar are much less common, they are spherical in shape and hard to differentiate in microscope. They are supposed to be plagioclase. Calcium and chlorite can be found in the base material and hard to separate them. The most common mineral is the quartz. It is present in all flood samples and samples from lower level water also.

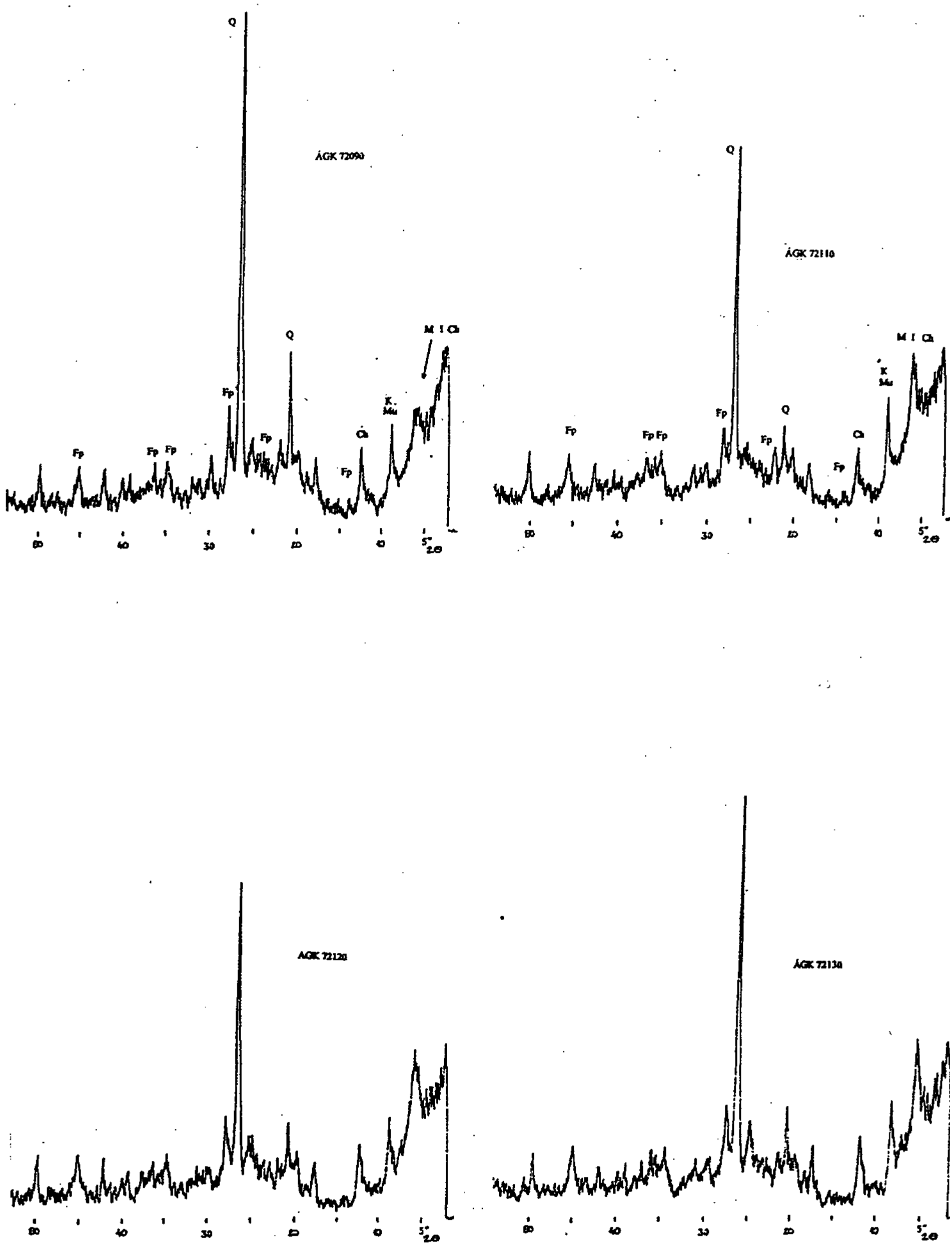

Fig. 2. X-ray difractograms (AGK 7209-7215) of the suspension load are reflect their mineral contents

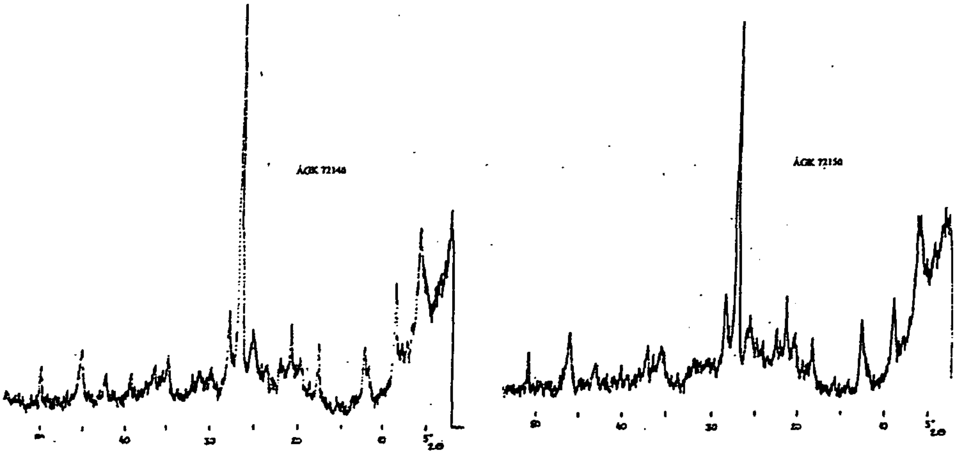

Fig. 2b.

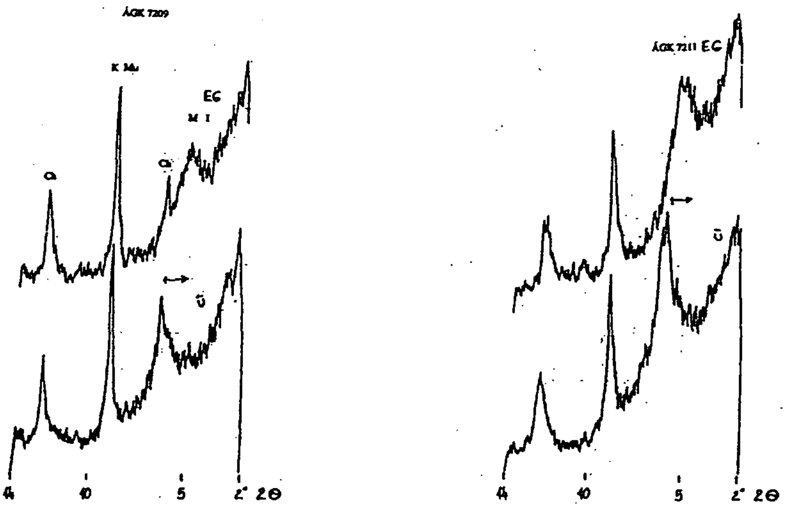

Fig. 3. X-ray difractograms shows the clay mineral fraction in normal case (AGK 7209) and shows the different clay minerals in ethylene-glycol case.

The x-ray difractograms of the suspension load are reflect their mineral contents well as shown in *Fig. 2*. Differences of the composition were found in spring samples (snow thaw 12 March, 2000) flood samples and summer flood samples (rainy flood). The summer sample AGK 7209 contains much more quartz and feldspar (approximately 1/3 more) then spring sample AGK 7211). However the contents of the clay-minerals smaller then 10 micron (between 5-10 on the 2 φ scale) (illite-montmorillonite-chlorite) is lower in the spring samples. Thus the x-ray difractograms shows that mineral composition of the river does not change significantly in the summer and spring samples, but the quantity of the minerals is different. While the Q and Fp contents are higher in the summer flood samples, the proportion of clay mineral contents (I,M, Ch) is increased.

In the spring flood samples (March 12, 2000) we studied the load in the current throughout the deepness of the river. We analyzed 5 samples (AGK 7211-7215) in every meter from the surface to the river bed. Between the samples, the Q contents show small differences, but no conclusion can be drawn from the mineral composition. The Fp and clay mineral part are almost the same too. The x-ray difractograms of the samples indicate in the current of White Körös there is no differences in the composition of suspension load in the upper 5-6 meters of the water. Thus the composition of suspension load is relatively stable.

We also examined the clay-mineral fraction (size under 10 micron, from the fine silt to the fine clay). On the difractogam (scale 2 φ) the 14 and 7.08 peaks indicate chlorite (Ch), 9.96 peak indicate muscovite, caolinite (K, Mu), 15.5 and 4.5 peaks indicate montmorillonite-illite (M,I) as shown on *Fig. 3*. The different clay minerals can be separated by ethylene-glycol (EG). Samples treated with EG, the muscovite chlorite and kaolin peaks are stable while the peaks of montmorillonite-illite are shifted. So the samples treated with ethylene-glycol the differences between the summer and spring load can be easily recognized. While in the summer samples concentration of chlorite and muscovite is higher and illite-montmorillonite is lower, in the spring samples contain mainly montmorillonite-illite and lower concentrations of muscovite and chlorite.

The chemical elements of the load were analyzed by energy-disperse x-ray methods (*Fig 4.*). In the summer samples (7209) the concentration of SI, Fe are higher and K, Ca, Ti, Mn are lower then in the spring samples (7211). In the sample 7211 and 7215 the distribution of the elements are difference. When the Si concentration is higher the K, Ca, Ti is lower and vica versa. The Fe and Ca concentration is high constantly. The trace elements are pushed into the background. The levels of Rb, Sr, Y, Zn are negligible. However in the 7214 sample we detected low concentrations of Si, K and Ca and high levels Ti, Fe, Cu, Cuβ and Sr. It is likely that a mineral particle with high concentration of Ti, Cu and Sr was detected by chance. The differences between the main and trace element of summer spring samples caused by alteration of minerals in the suspension load.

During the spring thaw of the snow the continuos erosion deliver enormous amount of rubble from the catchment area. Since the upper and middle reaches, the river runs through mainly basic-intermediate rock-layer (Neogene andesite: around Brád and Honctő-Borosjenő), the composition of minerals, main and trace elements reflects composition of this area. During the continuos physical chopping minerals from heavy mineral containing rock are released into the load of the river. This phoneme course higher Ti, Fe, Cn, K, Ca (amphibole, pyroxene, biotite) in spring. Flood caused by summer rainfall does not reflect the composition of andesite-rich area. Because the river is short and low number of bend low amount of rain can course flood in the plane. The sudden rain can elevate the water levels in streams and river, but does not result such a hard physical chopping then ice, snow and water in winter. So the river delivers less primer load. The fast water stirs up the sandy river bed and wash its sediment from the bank. This is indicated by the composition of sandy, high levels of Q and Fp in the summer samples.

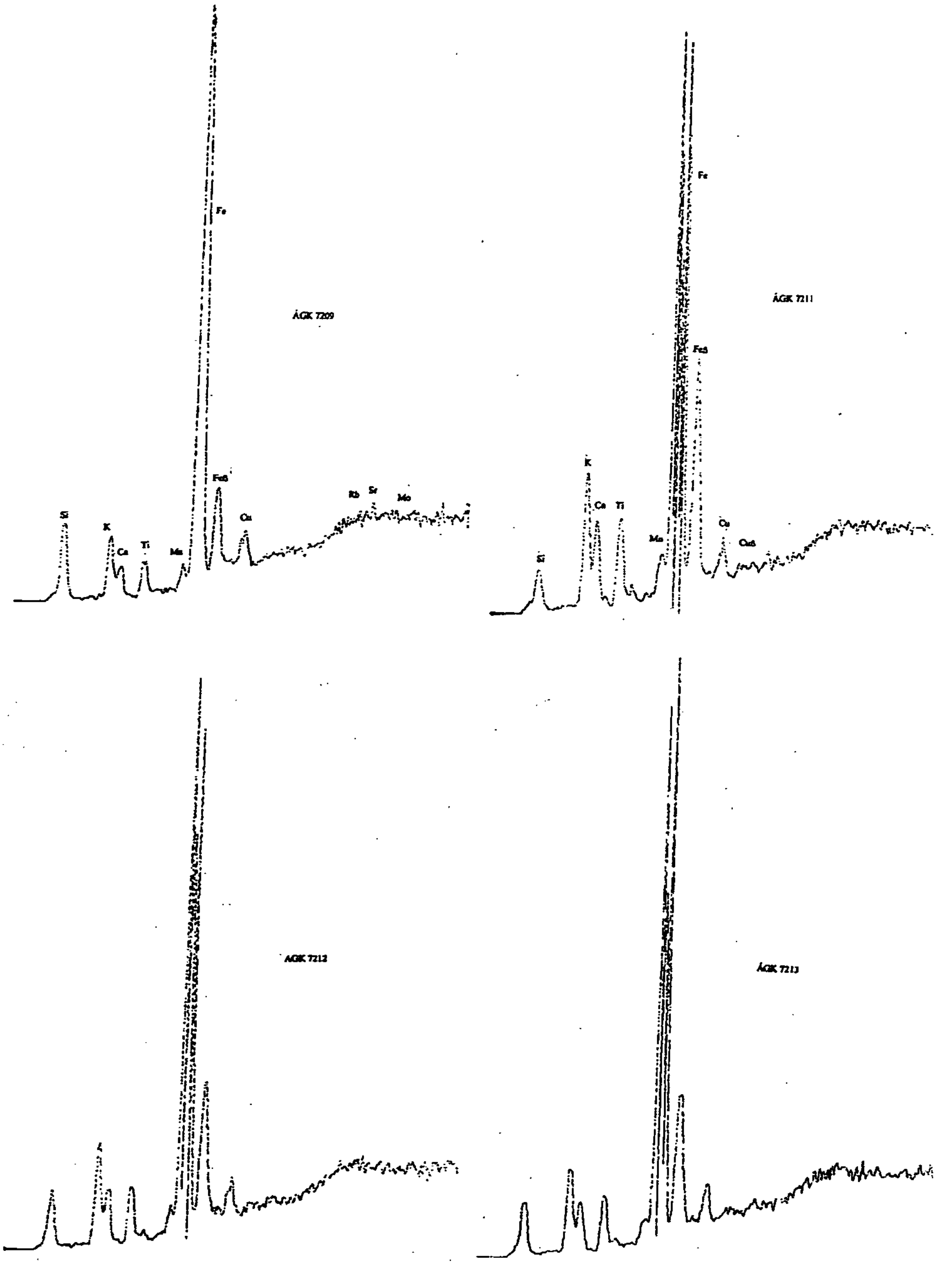

Fig. 4a. The chemical elements of the load (AGK 7209-7215) were analyzed by energy-disperse x-ray methods

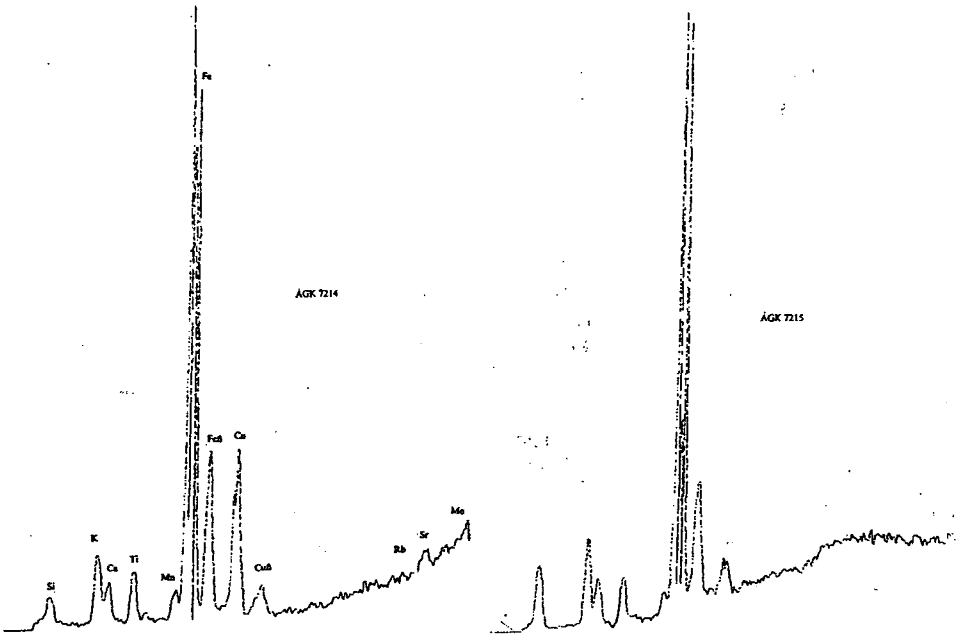

Fig. 4b

SUMMARY

From the study of the suspension load of the White Körös can be concluded that the river deliver relatively constant alluvial deposits either in the spring and summer. The highest levels of flapping contents was at the summer flood (1999): 13763.93 g/s. Calculating this to one year (with the same discharge) it delivers 434059296.5 kg alluvial deposits, which far less then the average discharge of river Maros (715236480 kg in 1951, MEZŐSI) or river Tisza (7978608000 kg in 1936, MIHÁLTZ) Thus the White Körös is not saturated even at highest discharge. The size of the suspension load is decreased parallel to the water level. In the samples the heavy minerals are the following: pyroxene (hyperstene), brown amphibole, hematite, magnetit-ilmetit, muscovite, augit, green amphibole and garnet. The minerals can be found in their original shape, which means that the speed of the transfer from the original geological layer to Gyula is fast and there was no time to reshape. The x-ray difractogram indicates that the mineral compositions do not change in the summer and spring samples, just the quantity of the minerals are different. While in the summer flood samples contains more Q and Fp, the in the spring samples the concentrations of clay minerals are (I, M, Ch) are higher. In the current of the river, in the upper 5-6 meters there is no significant differences in the mineral composites of suspension load. So the vertical composition of the load is identical. In the suspension load andesite can be found which probably product of the Neogene andesite volcano of Brad. The lower content of garnet-epidot-biotit complex originate from Crystal slate and granite of the source of the river (Bihar South).

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