NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

May 22, 1996

METALLURGIST'S FACTUAL REPORT — Report No. 96-57

A. ACCIDENT

Place	: Aliquippa, Pennsylvania
Date	: September 8, 1994
Vehicle	: Boeing 737-3B7, N513AU
NTSB No.	: DCA94-M-A076
Investigator	: Thomas A. Haueter

B. COMPONENTS EXAMINED

Three bundles of wires identified as follows:

1. Box 453, E1-2, WB891/W007, D5923;
2. Removed from Box 000422, Crate #35;
3. Removed from Box 533.

C. DETAILS OF THE EXAMINATION

The following party representatives and NTSB specialists participated in an examination of the components on January 1, 1996, at the Safety Board Materials Laboratory in Washington, D.C.:

D. Bruce Skoropinski	Boeing
David M. Haselman	Boeing
Joseph Packingham	USAir
Jeffrey M. Rich	FAA
James F. Wildey II	NTSB, National Resource Specialist - Metallurgy
Merritt M. Birky	NTSB, Toxicology, Chemistry & Fire Science
Vincent M. Giuliana	NTSB, Electrical Engineer
Jean Bernstein	NTSB, Metallurgist

DEPOSIT ANALYSIS

An overall view of the wire bundle listed as No. 1 in the component examined list is shown in figure 1. The plug denoted by arrow "1a" in this figure was heavily damaged and the internal pins were partially exposed. Close up views of this plug are shown in figures 2 and 3. No evidence of blue and/or green color deposits were found on this bundle with the exceptions noted below.

I. **Turquoise colored chunky substance in the plug interior** (see arrow "c" in figure 2). A small portion of this substance was analyzed using a scanning electron microscope (SEM) equipped with an X-ray energy dispersive spectrometer (EDS) system. The EDS analysis produced spectra containing the characteristic peaks of carbon (C), oxygen (O), silicon (Si)[1], magnesium (Mg), aluminum (Al), chlorine (Cl), potassium (K), calcium (Ca), fluorine (F) and iron (Fe). The spectrum is shown as SAMPLE 1 in Appendix.

II. **Turquoise colored fibers adjacent to a plug mounting screw** (see arrow "d" in figure 3). The EDS analysis of a sample of these fibers produced spectra containing the characteristic peaks of silicon (Si), oxygen (O), phosphorus (P), calcium (Ca), carbon (C), magnesium (Mg), aluminum (Al), sulphur (S), potassium (K), barium (Ba), and zinc (Zn) and possibly sodium (Na)[2]. The spectrum is shown as SAMPLE 2 in Appendix.

The plug denoted by arrow "1b" in figure 1 was relatively intact. A close up view of this plug is shown in figure 4. Numerous areas of the external surface of the plug were covered with loose brown deposits of what appeared to be a dried and compacted soil. At some locations, green fibrous material, similar in appearance to the fibers found adjacent to the connecting screw in plug "1a" was embedded into the soil (see arrow "e" in figure 4). EDS analysis of a sample of these fibers produced spectra containing the characteristic peaks of C, O, Mg, Al, Si, S, K, Ca, Fe, Zn, Ba, and possibly Na (see spectrum for SAMPLE 3 in Appendix). Similar fibrous deposits were found in the threads on one side of the connector (see arrow "f" in figure 4). The EDS analysis of these deposits produced spectra containing the characteristic peaks of C, O, Na, Mg, Al, Si, P, S, K, Ca, Zn, Cd, Ba (see spectrum for SAMPLE 4 in Appendix).

A piece of distorted aluminum bracket was attached to plug "1b" (see arrow "i" in figure 4). Blue colored areas were noted on the white painted surface of the piece. The opposite surface of the piece was unpainted and also contained some areas of bluish discoloration. Small chips of the paint containing blue stain were removed for EDS analysis. The EDS analysis of white (not stained) areas of the paint on the chips produced spectra containing the characteristic peaks of C, O, Na, Al, Si, P, S, Cl, Ca, and Ti, (see spectrum for SAMPLE 5W in Appendix). The EDS analysis of blue regions of paint produced spectra containing the characteristic peaks of C, O, Na, Al, Si, P, S, Cl, Ca, and Ti (see spectrum for SAMPLE 5B in Appendix).

Examination of the wire sheathing material revealed that the outside layer of the fibers was colored green, whereas the interior fibers were colored white. A small sample of the sheathing material was obtained from the location denoted by arrow "g" in figure 4. The EDS analysis of this sample produced spectra containing the characteristic peaks of C, O, F, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, and Cd (see spectrum for SAMPLE 6 in Appendix).

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[1]When listing elemental composition, elements with major peaks will be unerlined.

[2]Sodium K-peak coincides with an L-peak for zinc.

An exemplar plug containing the "Blue Water" deposits was submitted by Boeing for comparative analysis. The EDS analysis of a sample of these deposits produced a spectrum containing the characteristic peaks of C, O, Na, Mg, Al, P, Si, S, Cl, K, and Ca (see spectrum for SAMPLE 7 in Appendix).

Three additional samples for EDS analysis were obtained from the aluminum bracket piece attached to plug "1b".

Blue-green color deposit from the edge of white paint
The analysis of this deposit produced the characteristic peaks of C, O, Mg, Al, Si, P, S, CL, Ca, Cd, Ti, and Cr (see spectrum for SAMPLE8-1 in Appendix.)

Light green color deposit from the area of the bracket that had not been painted
The analysis of this deposit produced the characteristic peaks of C, O, Ca, Mg, Al, Si, P, S, Cd, Ca, Ti, and Cr (see spectrum for SAMPLE 8-2 in Appendix).

Two samples of a light blue color deposit from the painted surface
The analysis of the first sample produced a spectrum containing the characteristic peaks of C, O, Ca, Na, Mg, Al, Si, P, S, Cl, Cr, and Fe (see spectrum for SAMPLE8-3A in Appendix).
The analysis of the second sample produced a spectrum containing the characteristic peaks of C, Ti, Al, Si, P, S, and Cl (see the spectrum for SAMPLE8-3B in Appendix).

CONNECTOR "1b" IDENTIFICATION AND DAMAGE

The wires on one side of connector "1b" contained a tape that identified the component as a "D05923J" connector. The "J" at the end of the identification reportedly indicates the side of a connector that is attached to a rack. The "J" side of the connector contained the part number TRW MS24265R16. The opposite side of the connector was expected to be "D05923P", with the "P" indicating the instrument side.

The bracket piece with the blue-green stain was removed from the D05923J/P connector indicated by "1b" in figure 1. One corner of the square mounting plate on the "J" side of the connector was broken off. In general, the connector was in relatively good condition. However, it was noted that the "J" connector clamp end and threaded portion was crushed over a distance of about 0.5 inch.

ELECTRICAL TESTING OF THE D05923J/P CONNECTOR

The wires on the "P" side of the connector were cut about 8 inches from the connector. The wires on both sides of the connector were then spread apart to electrically separate the wires. The connector was determined to be a 24-pin connector, and examination of the back sides of both connector halves showed that each wire entry point cavity was filled with either a wire or a nylon filler rod. On the "P" side of the connector, wires entered positions "1", "2", "3", "6", "7", "10", "11", and "18" through "23". On the "J" side of the connector, wires entered

positions "1" through "14" and "18" through "23".

The resistance between each wire on one side of the connector and each wire on the opposite side was measured by applying 500 volts DC across wire pairs. These measurements showed zero resistance across wire pairs of the same number and a resistance of at least 10^{11} ohms between all pairs with different numbers. The testing revealed an intermittent short (zero ohms) between wires "21", "22", and "23" and the case of the connector. It was noted that the side of the connector with these three wires contained the greatest amount of mechanical damage.

A 1500 volt dielectric test (using 60 hz AC) of 10 second duration was conducted between wire pairs that were adjacent to each other in the connector. The testing instrument indicated a "MAX CURRENT 23V" failure between wires "1" and "2", and a "0 CURRENT" failure between wires "2" and "3". All other wire pairs passed the dielectric test.

[redacted]

Jean Bernstein
Metallurgist

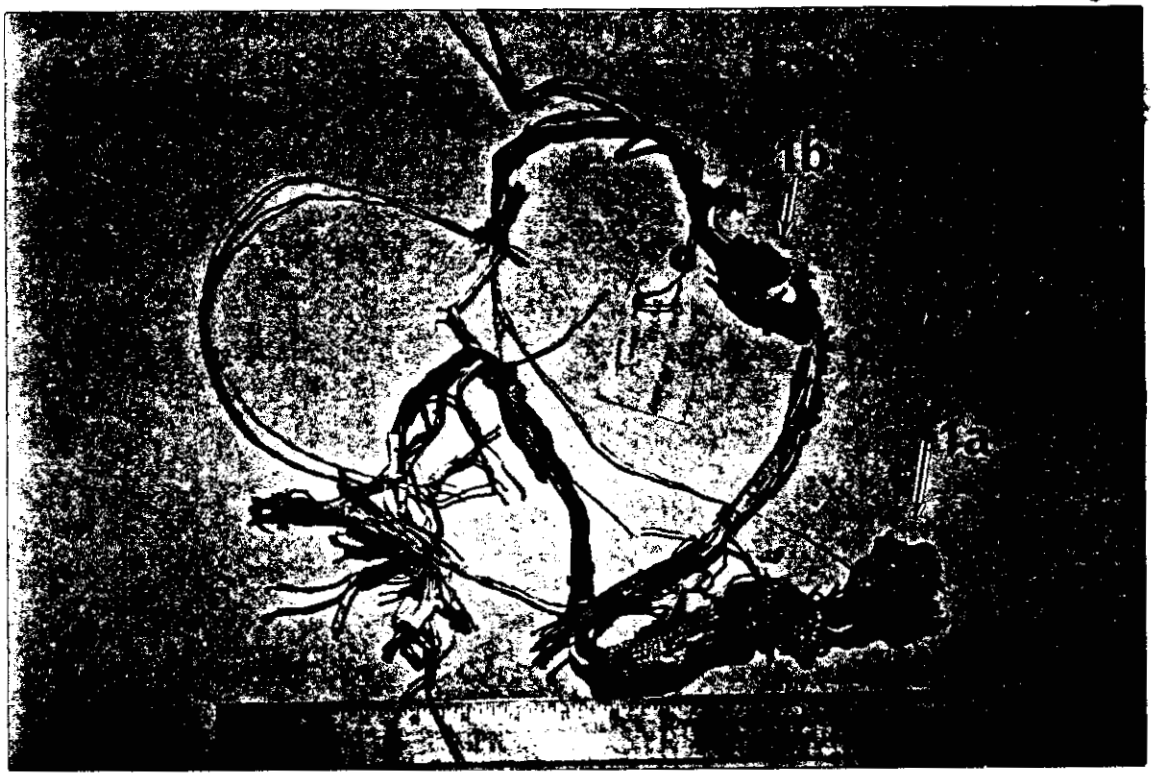


Figure 1. Overall view of one of the wire bundles. Arrows "1a" and "1b" denote the plugs.

Figure 2. Close-up view of the plug denoted by arrow "1a" in figure 1 showing the turquoise color chunky substance in the plug interior by arrow "c".

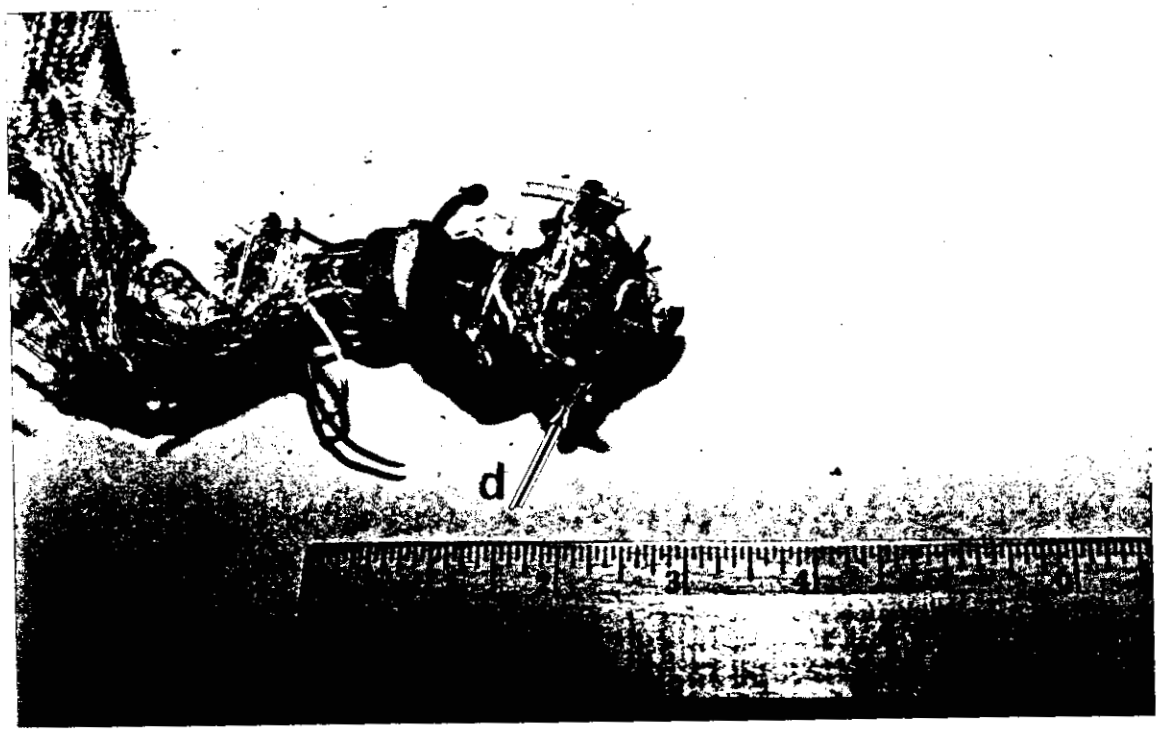


Figure 3. Another view of the plug denoted by arrow "1a" in figure 1, showing the turquoise color fibers adjacent to the mounting screw by arrow "d".

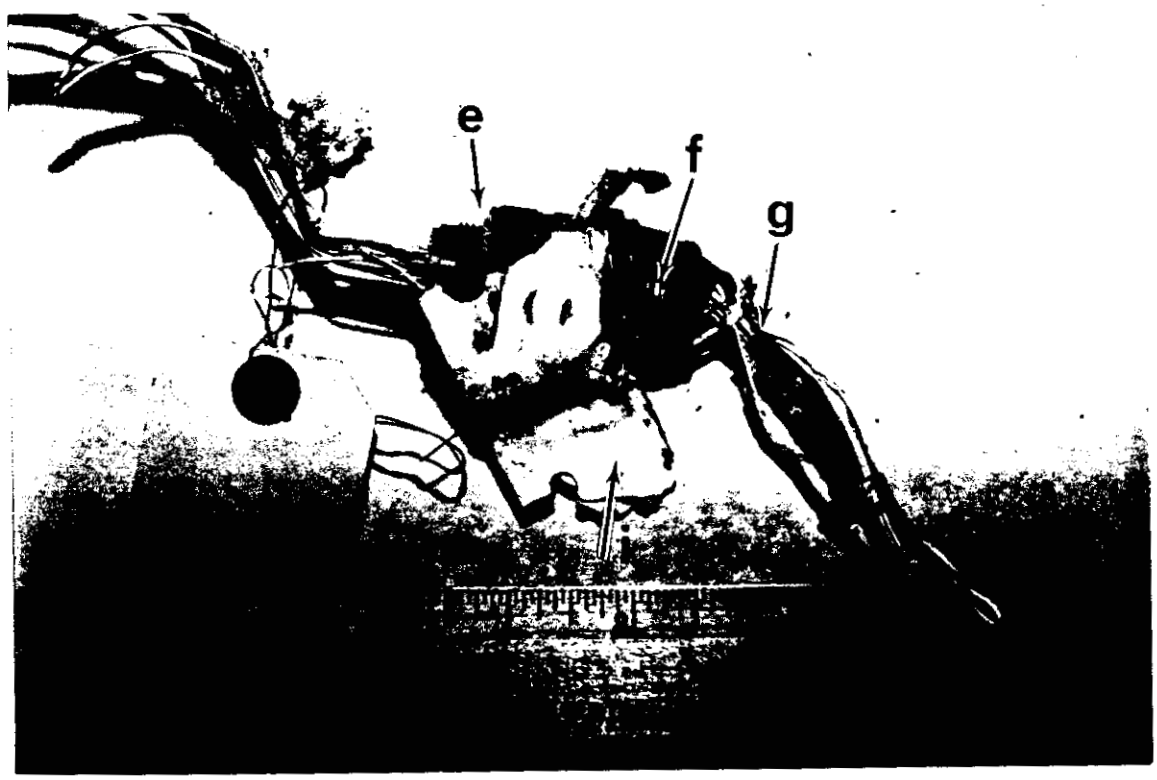
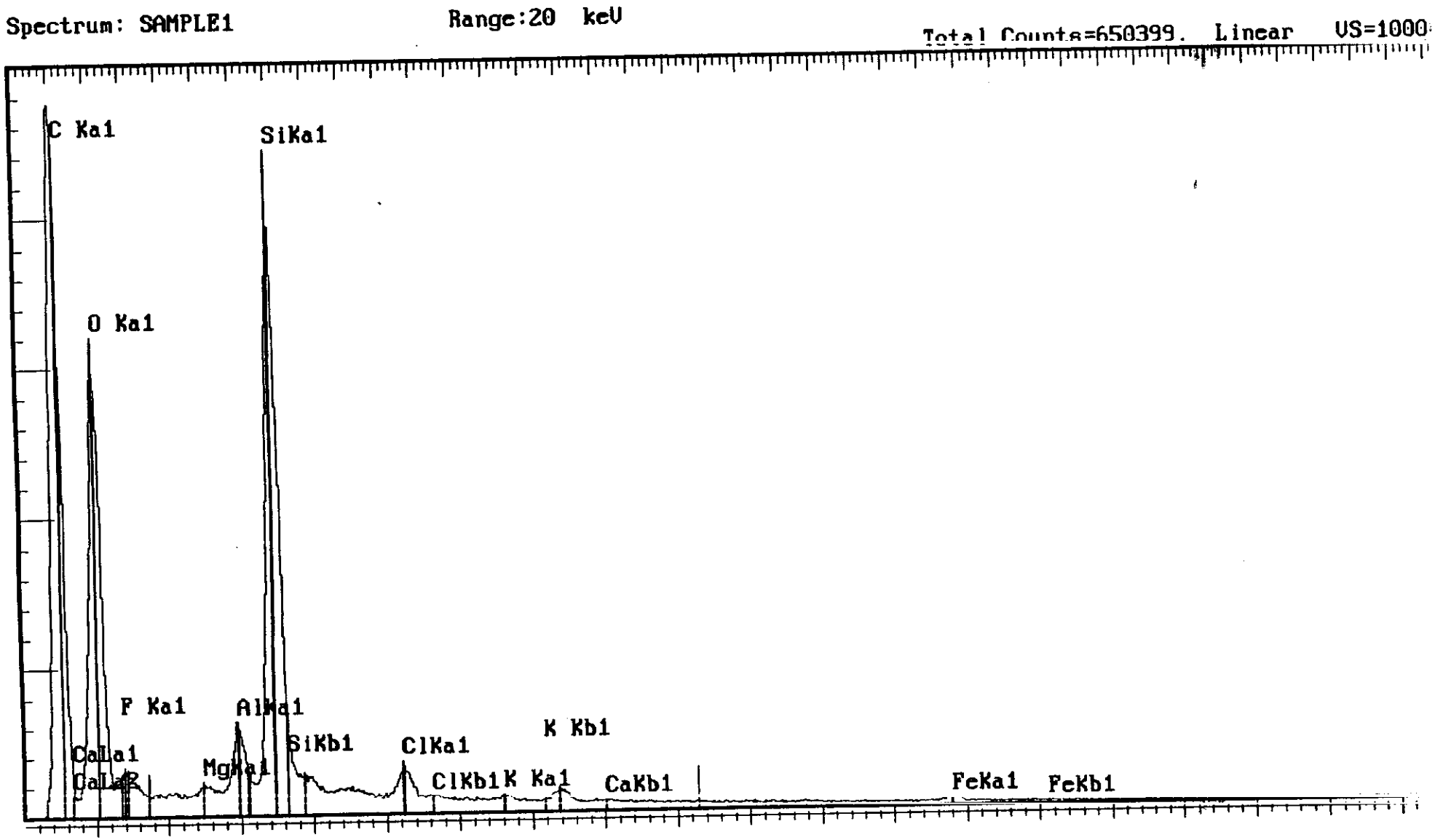


Figure 4. Close-up view of the plug denoted by arrow "1b" in figure 1, showing the locations of samples for the EDS analysis by arrows "e", "f", "g", and "i".

APPENDIX


Spectrum: SAMPLE1
Range:20 keV
Total Counts=650399. Linear VS=1000
C Ka1
SiKa1
O Ka1
F Ka1
AlKa1
SiKb1
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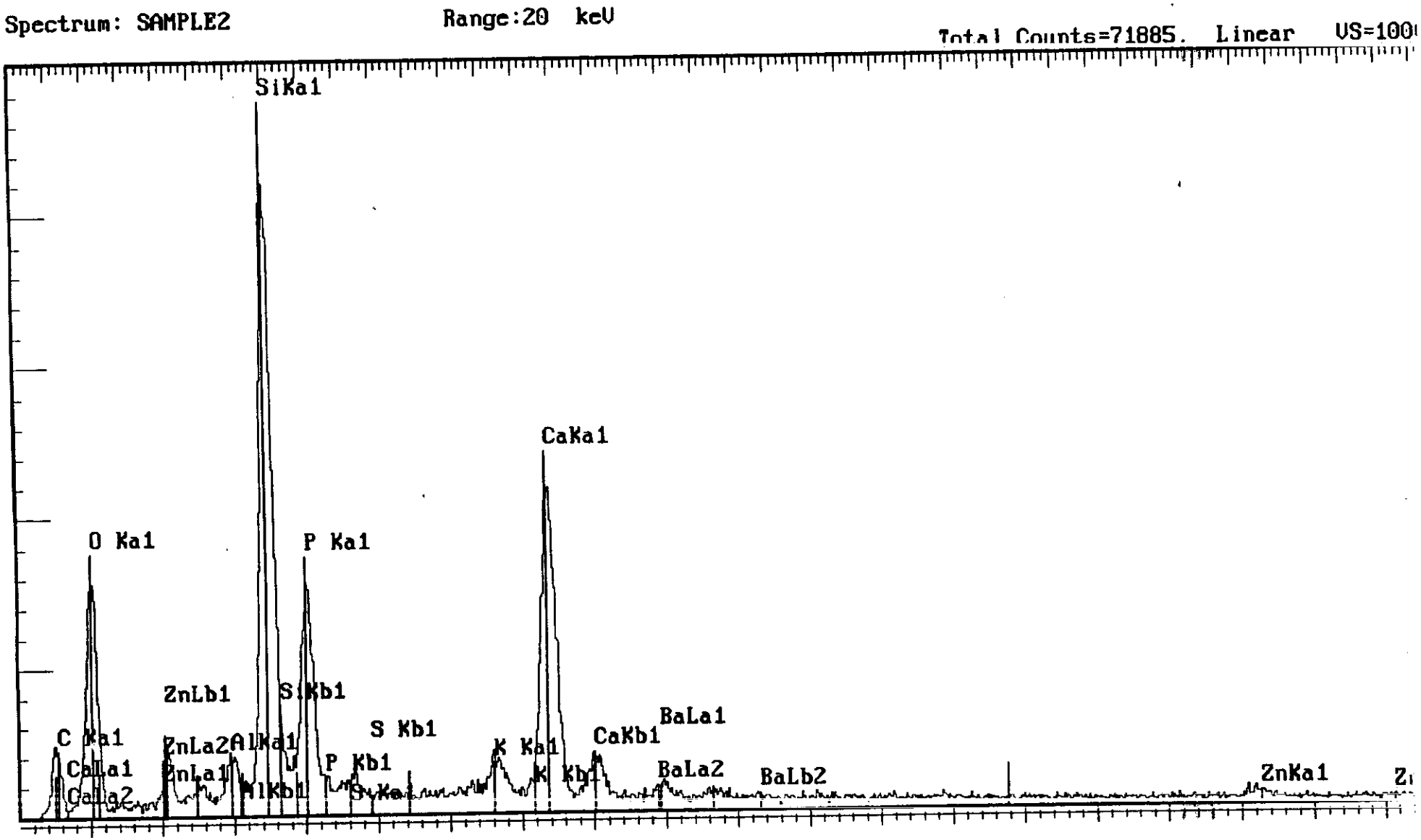
CaLa1
CaLb1
MgKa1
ClKb1
K Ka1
CaKb1
FeKa1
FeKb1


Spectrum: SAMPLE2
Range:20 keV
Total Counts=71885. Linear
SiKa1
CaKa1
O Ka1
P Ka1
ZnLb1
SiKb1
S Kb1
BaLa1
C Ka1
ZnLa2
AlKa1
P Kb1
K Ka1
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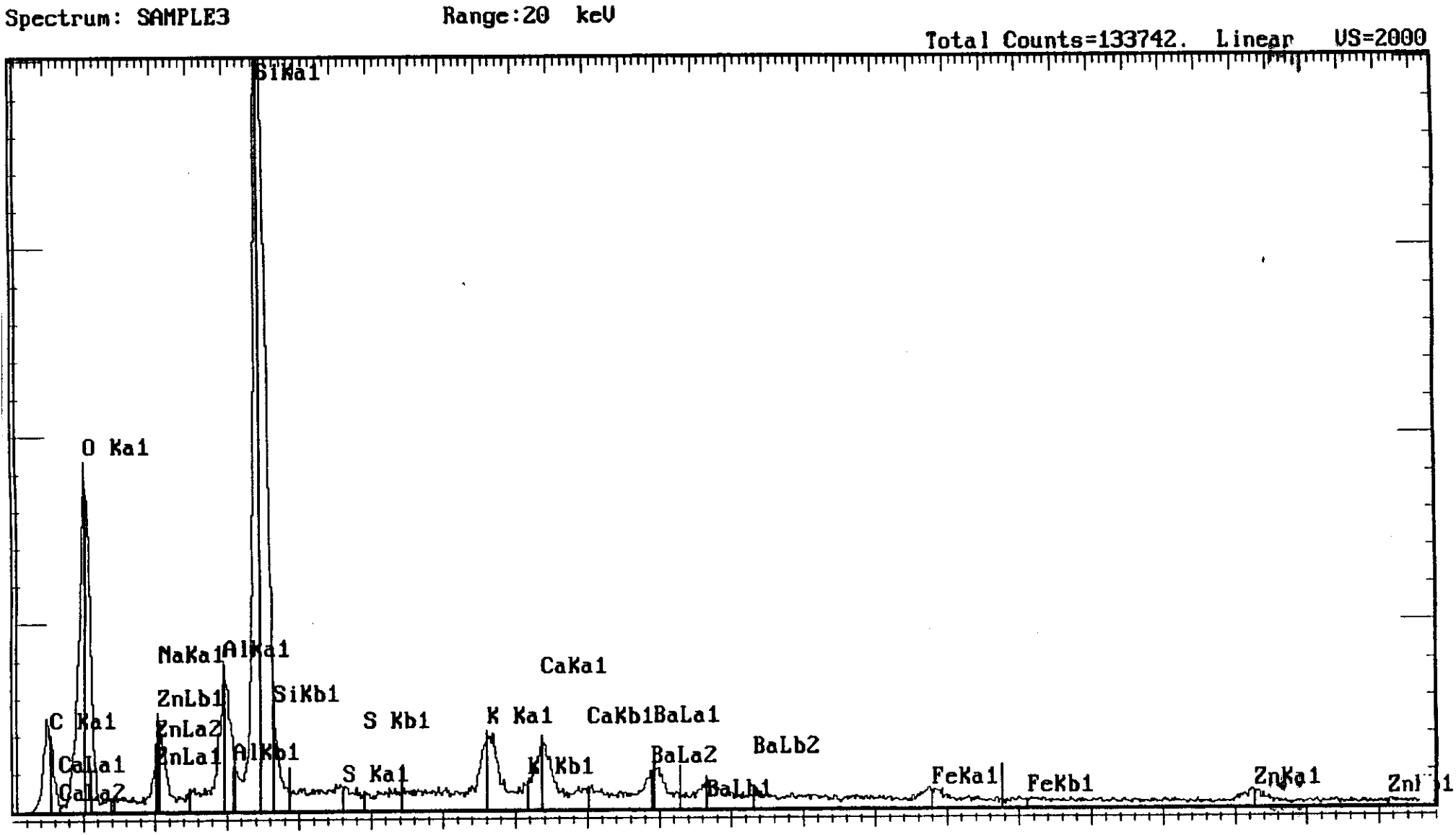
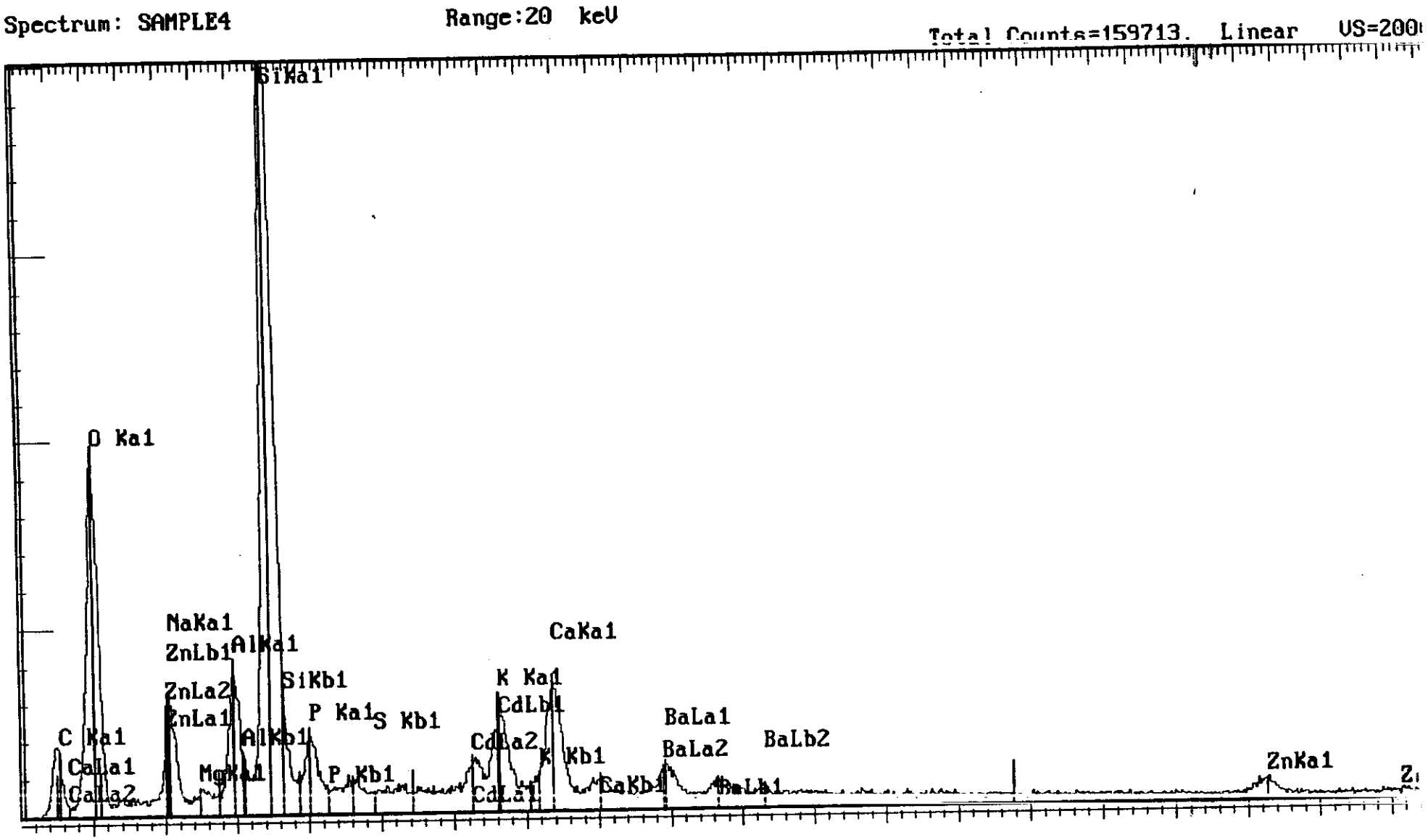
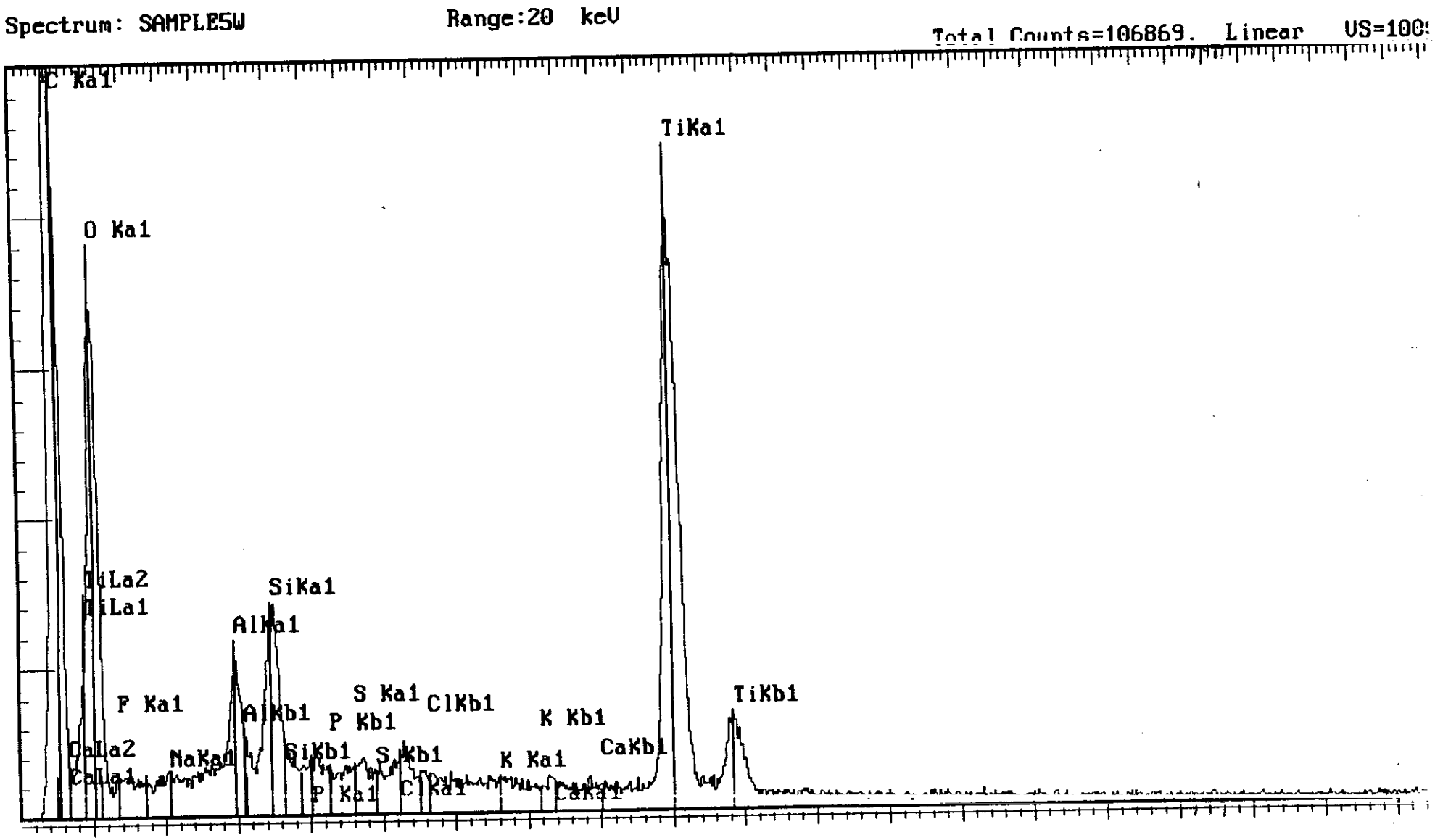
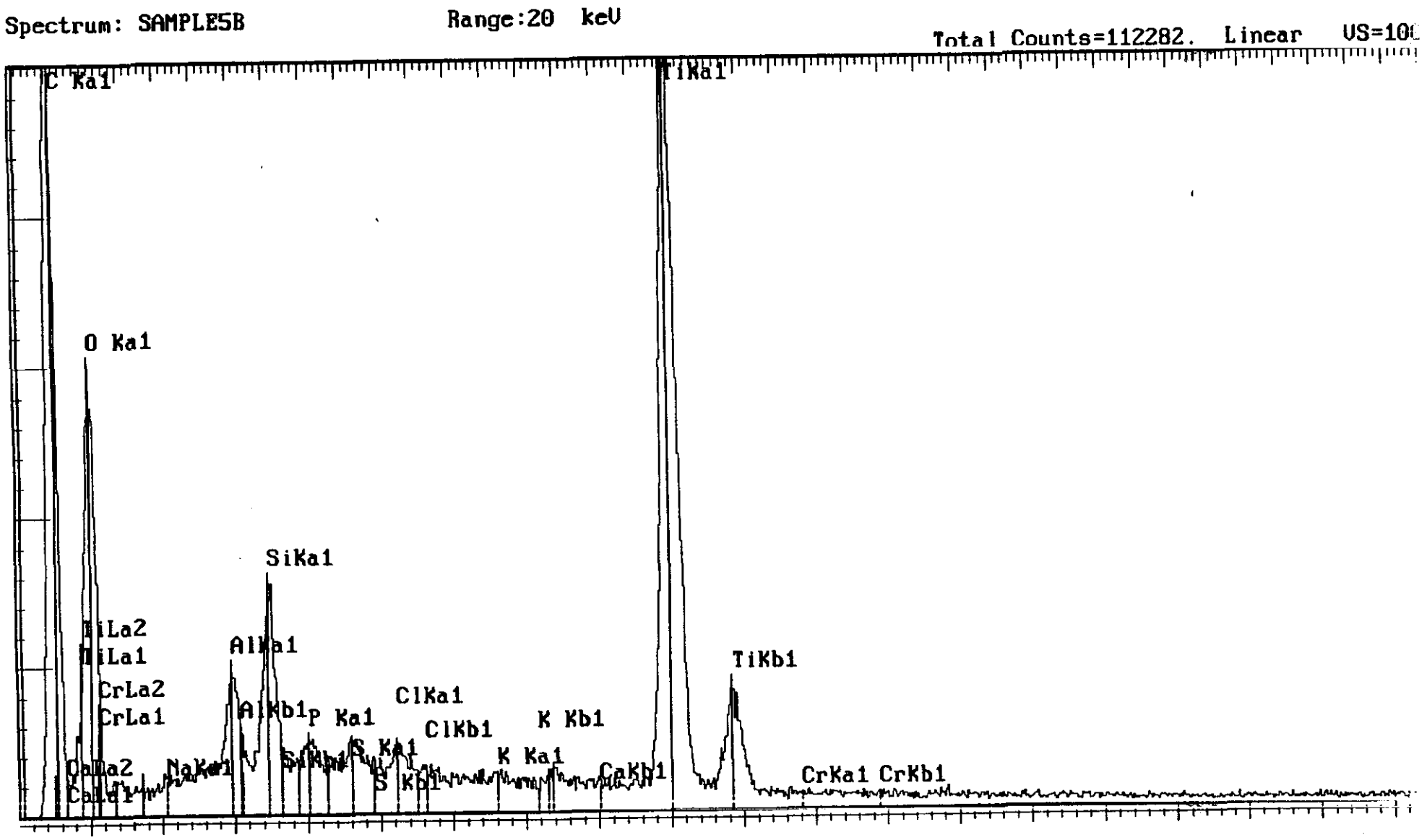
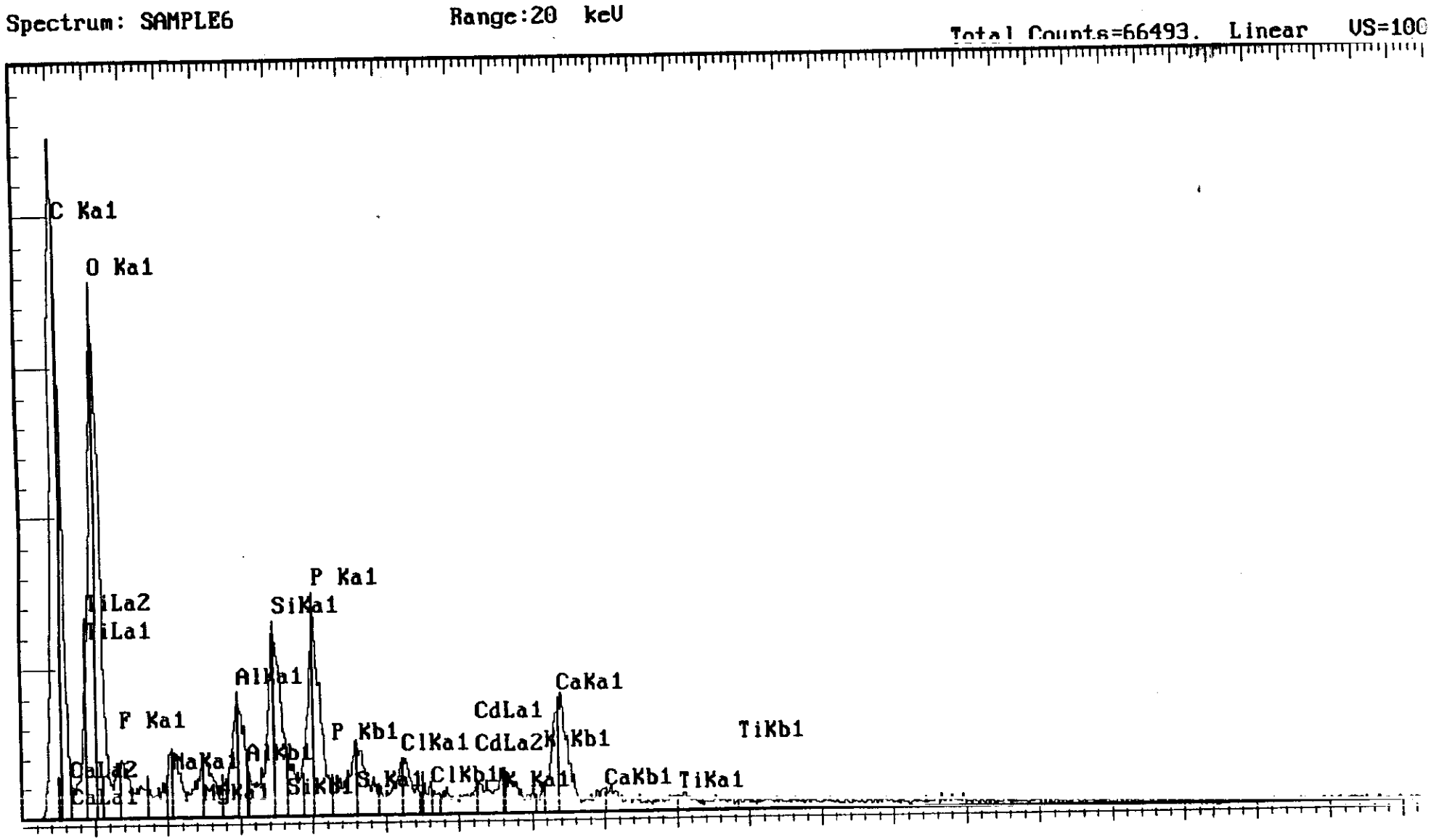
BaLb2
ZnKa1
CaLa2
AlKb1
SiKa1

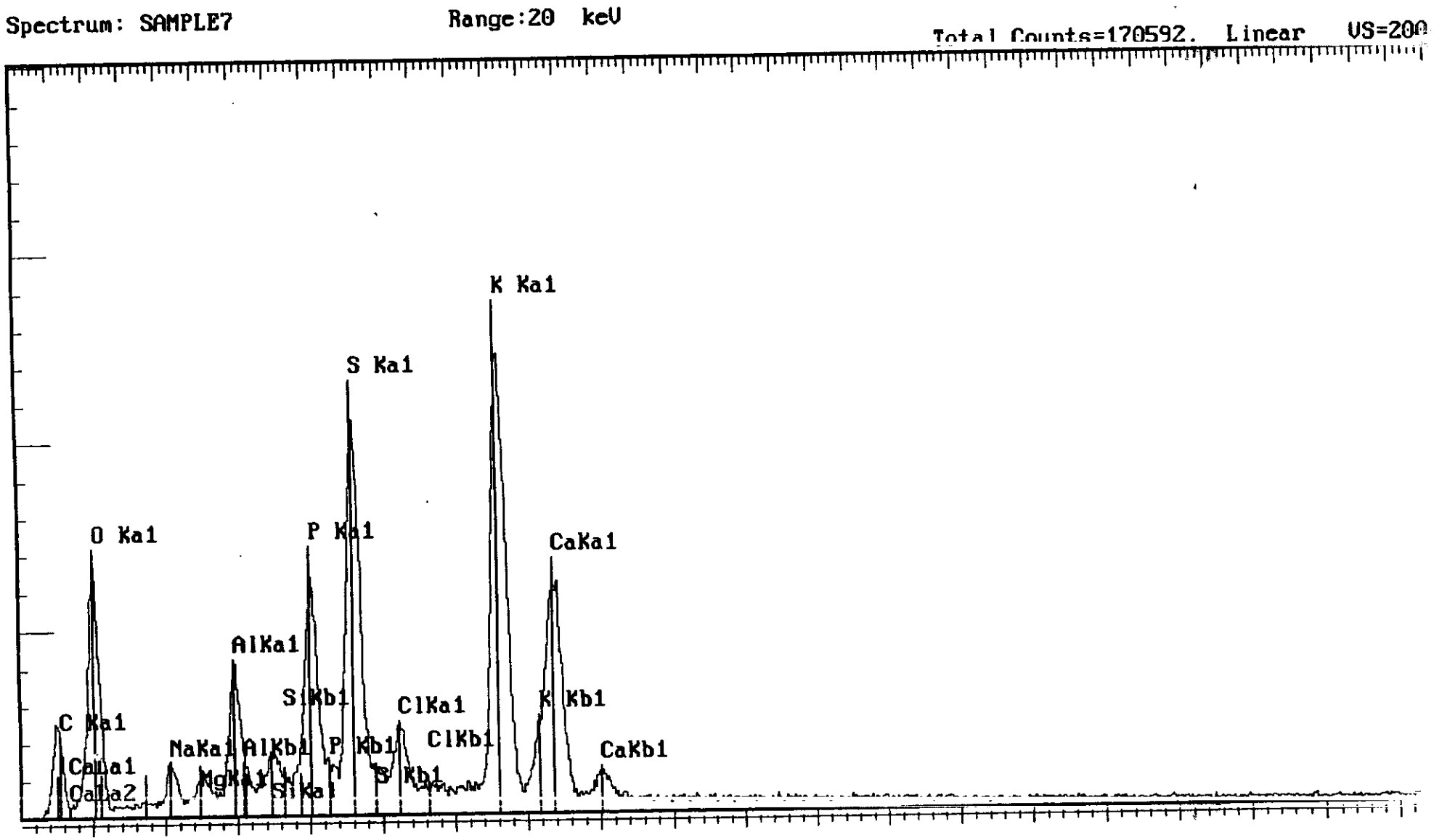

Spectrum: SAMPLE3
Range:20 keV
Total Counts=133742. Linear VS=2000
SiKa1
O Ka1
NaKa1
AlKa1
ZnLb1
SiKb1
C Ka1
ZnLa2
S Kb1
K Ka1
CaKa1
CaKb1
BaLa1
ZnLa1
AlKb1
BaLa2
BaLb2
CaLa1
S Ka1
K Kb1
BaLb1
FeKa1
FeKb1
ZnKa1
CaLa2

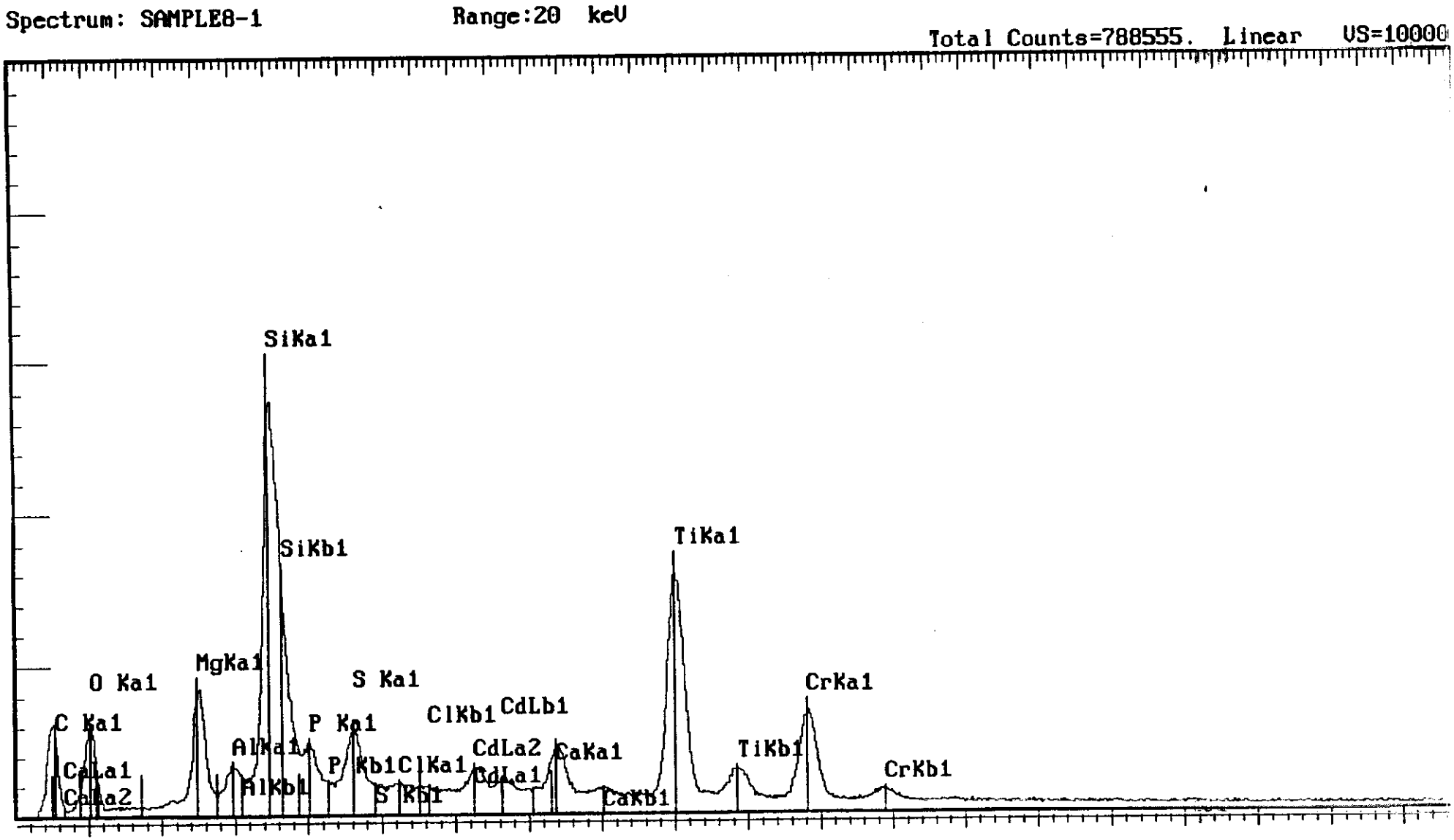

Spectrum: SAMPLE4
Range:20 keV
Total Counts=159713. Linear US=200
SiKa1
O Ka1
NaKa1
ZnLb1
AlKa1
SiKb1
ZnLa2
ZnLa1
P Ka1
S Kb1
C Ka1
AlKb1
CaLa1
CaLa2
MgKa1
P Kb1
CdLa2
K Ka1
CdLb1
CaKa1
K Kb1
CdLa1
BaKb1
BaLa1
BaLa2
BaLb2
BaLb1
ZnKa1

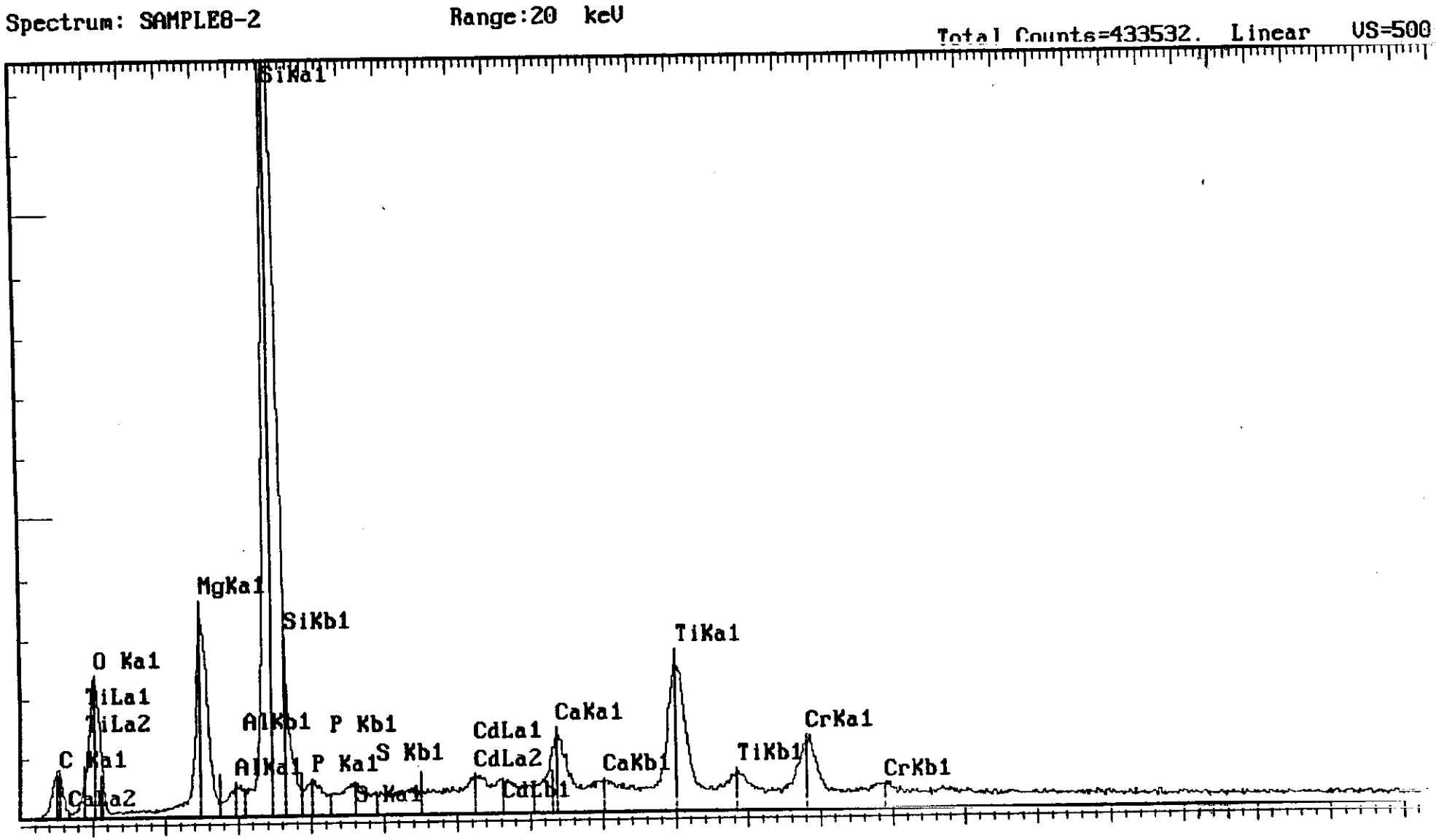

Spectrum: SAMPLE5W
Range:20 keV
Total Counts=106869. Linear US=100
C Ka1
O Ka1
TiKa1
TiLa2
TiLa1
SiKa1
AlKa1
P Ka1
AlKb1
S Ka1
ClKb1
P Kb1
K Kb1
TiKb1
CaLa2
NaKa1
SiKb1
S Kb1
K Ka1
CaKb1
CaLa1
P Ka1
Cl Ka1
CaKa1

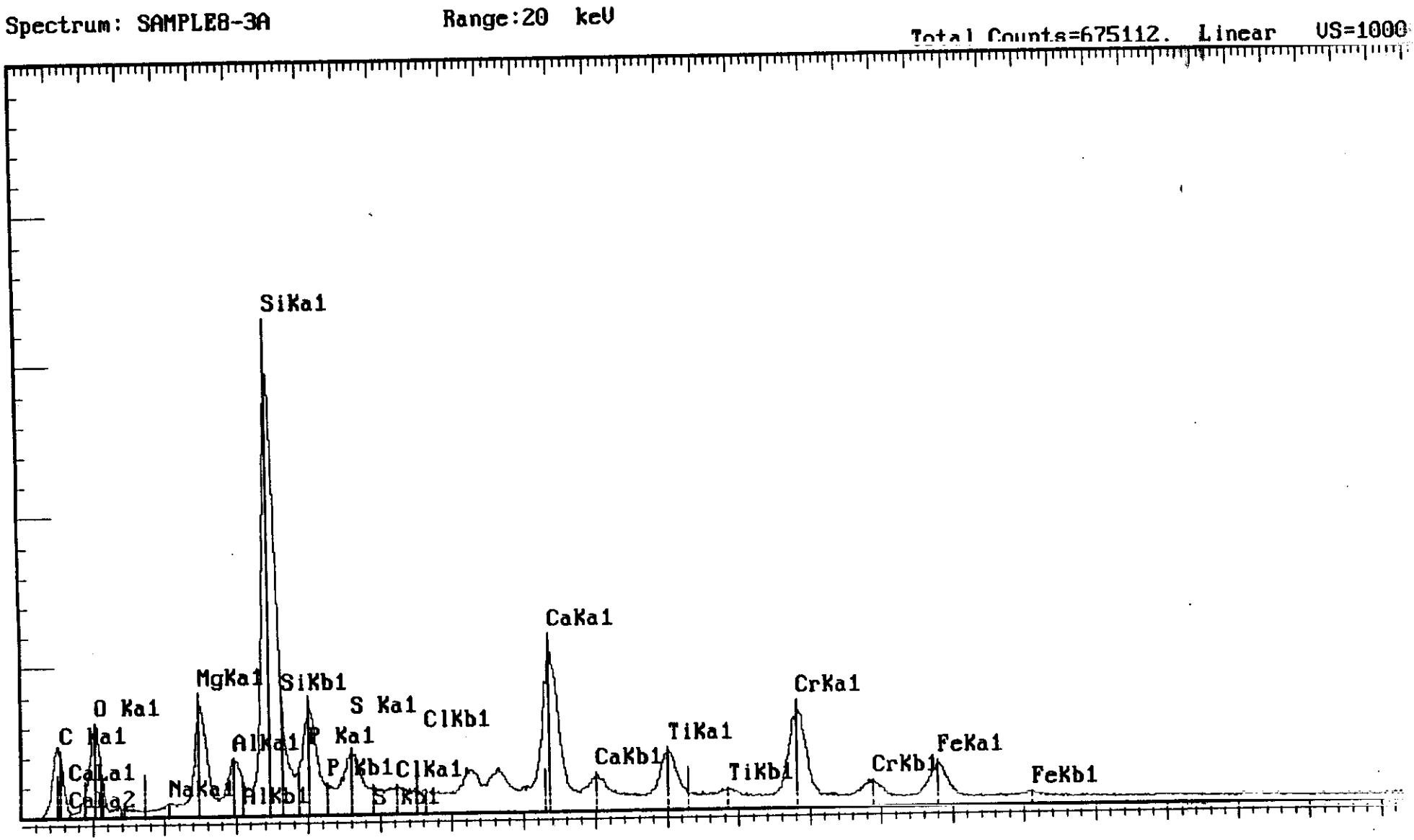

Spectrum: SAMPLE5B
Range:20 keV
Total Counts=112282. Linear
C Ka1
O Ka1
TiLa2
TiLa1
CrLa2
CrLa1
NaKa1
SiKa1
AlKa1
AlKb1
P Ka1
S Ka1
ClKa1
ClKb1
K Ka1
K Kb1
CaKb1
TiKa1
TiKb1
CrKa1 CrKb1


Spectrum: SAMPLE6
Range:20 keV
Total Counts=66493. Linear VS=100
C Ka1
O Ka1
TiLa2
TiLa1
P Ka1
SiKa1
AlKa1
F Ka1
P Kb1
CaKa1
CdLa1
ClKa1
CdLa2
K Kb1
TiKb1
CaLa2
CaLa1
NaKa1
AlKb1
MgKa1
SiKb1
Si Ka1
ClKb1
K Ka1
CaKb1
TiKa1


Spectrum: SAMPLE7
Range:20 keV
Total Counts=170592. Linear VS=200
K Ka1
S Ka1
O Ka1
P Ka1
CaKa1
AlKa1
SiKb1
ClKa1
K Kb1
C Ka1
ClKb1
NaKa1
AlKb1
P Kb1
CaKb1
CaLa1
MgKa1
S Kb1
CaLa2
SiKa1


Spectrum: SAMPLE8-1
Range:20 keV
Total Counts=788555. Linear VS=10000
SiKa1
SiKb1
TiKa1
MgKa1
O Ka1
S Ka1
CrKa1
C Ka1
ClKb1
CdLb1
P Ka1
CdLa2
CaKa1
TiKb1
AlKa1
ClKa1
CrKb1
CaLa1
P Kb1
CdLa1
AlKb1
S Kb1
CaKb1
CaLa2


Spectrum: SAMPLE8-2
Range:20 keV
Total Counts=433532. Linear US=500
SiKa1
MgKa1
SiKb1
O Ka1
TiLa1
TiLa2
C Ka1
CaLa2
AlKb1
P Kb1
AlKa1
P Ka1
S Kb1
S Ka1
CdLa1
CdLa2
CdLb1
CaKa1
CaKb1
TiKa1
TiKb1
CrKa1
CrKb1


Spectrum: SAMPLE8-3A
Range:20 keV
Total Counts=675112. Linear US=1000
SiKa1
MgKa1
SiKb1
O Ka1
S Ka1
C Ka1
ClKb1
CaKa1
AlKa1
P Ka1
TiKa1
CrKa1
CaKb1
FeKa1
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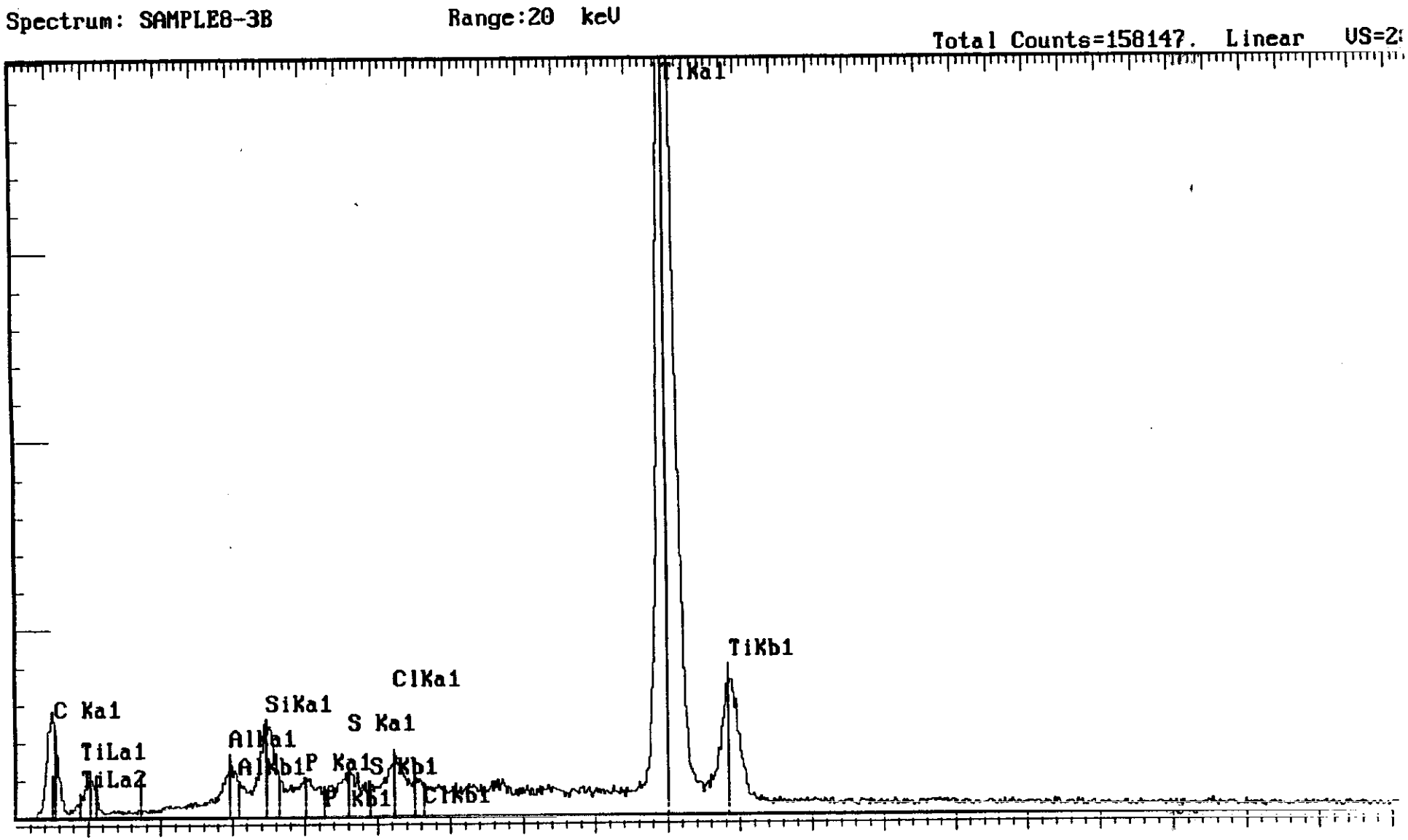
Ca La2
Na Ka1
Al Kb1
S Kb1
FeKb1


Spectrum: SAMPLE8-3B
Range:20 keV
Total Counts=158147. Linear
TiKa1
TiKb1
ClKa1
SiKa1
S Ka1
C Ka1
TiLa1
TiLa2
AlKa1
AlKb1
P Ka1
S Kb1
P Kb1
ClKb1