Burning Down the House: The Interpretation of Slag-Like Material Remains Recovered from an Earth Lodge Structure Located on Mound V at the Moundville Site

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-INTRODUCTION-

(S1-Title) This paper addresses an unusual slag-like material recovered during ongoing archaeological excavations at the Moundville Site **(S2-Map Slide)**. Specifically, the material was found during excavations on Mound V, which is a large truncated mound located directly behind Mound B. One can consider Mound V to be closely associated with or even an extension of Mound B which is the largest mound on which elites occupied located at Moundville. While not often noticed by park visitors, Mound V is one of the larger mounds located at the site. Pottery excavated from the mound denotes a clear Late Moundville III chronological position. **(S3-4 Fieldwork)**

Excavations began on Mound V in 1999 during the University of Alabama's field school directed by Dr. Jim Knight. The 1999 excavations can be characterized as exploratory as many of the units opened failed to produce intact or significant aboriginal deposits. However, one area located in the northeast portion of the mound was found to contain extensive midden deposits. Excavations during 2000's field school focused on the northeastern quadrant of the mound. It was during this field season that the first elements of the unusual structure were encountered however, they were not recognized as such yet. Not only did unusual structural elements emerge from the excavation units but, numerous pieces of this slag-like material began to appear in and around the structure **(S5-General Fused Silica)**.

During the summer of 2001, the Alabama Museum of Natural History's annual Expedition program was held at Moundville. Worked continued on Mound V and by half way through the summer, we had strong evidence that these unusual structural components were a portion of a large earth lodge. As excavations continued, more of the slag-like material was recovered from in and around the earth lodge structure. While numerous questions still exists about the earth lodge, questions concerning the unusual material are addressed in this paper.

Two working hypothesis concerning this material were generated during the course of fieldwork. The original "rough" hypothesis concerning this material was that it resulted from the smelting of native copper ore. This was a working hypothesis that originated during the initial field investigations on Mound V. At this point we knew that the midden encountered contained large charcoal deposits and sporadic amounts of copper ore in association with moderate quantities of this slag-like material. If this hypothesis held true, this would be the first evidence of smelting technology employed by Native Americans in the southeast. While remaining interested in this idea, we were also very cautious. A second hypothesis was formed when it became apparent that we were dealing with a rather large, burned structure. Could this material be residue from when the earth lodge burned? In order to address this question, a brief look at the literature is necessary.

-BACKGROUND-

While very few in number and generally vague in description, the artifact category of residue from burned Native American structures is not new to archaeologists. Archaeological reports have labeled such a material with a variety of names. These include: "clinkers", silica froth, and fused silica. In this paper, this slag-like material will be denoted as fused silica. An early historic reference to fused silica is provided by Pliny the Elder in his description of Iron Age furnaces in Europe. It indicates that wheat straw was used to increase the firing temperatures in early iron foundries. This practice left behind large quantities of fused silica residue (Jurney and

Bergstrom 2000). The first description of fused silica within an aboriginal context labeled such material as "clinkers" (Ford and Webb 1956:97). Ford and Webb briefly discuss this material as remains which are found in fields were grass has been burned. They suggest that "clinkers" point to the possibility that grass or other similar types of vegetation were used as roofing material for aboriginal structures.

In 1967, similar material was recovered from the Longest Site located on the Red River in Oklahoma. The Longest Site is comprised of an early historic Wichita village in which five circular house structures were excavated. **(S6-Profile)** Within Structure One, a layer of ash and burned soil (stratum B) was found just above the house floor. In this ash zone, a number of "greenish-gray bubbly particles or clinkers resembling glass" were identified (Bell, Jelks, and Newcombe 1967:71). They go on to state that similar substances have been identified in other Wichita houses. They conclude that some of the fused silica found at the site most likely resulted from occasional grass fires that have occurred over time at the site. However, the concentration of fused silica located in stratum B suggests that the houses were quite possibly grass covered.

This material has also been reported at the Spiro Site. Rogers states that fused silica has been found scattered over the site. He goes on to say that "concentrations of this material with house remains can be used to suggest that the structure was burned" (Rogers 1980:175). Richard Weinstein reports finding a limited quantity of fused silica present at the Beau Mire Site, a late Tchula Period site in Louisiana (1978:102). Two pieces of what he terms "clinkers" were excavated and it is unknown if these were recent additions to the site or if they were aboriginal. Martha Rolingson also reports this material present at the Toltec Mound Site in Arkansas (personal communication 2001). Medium sized chunks of possible fused silica were recovered in a surface context near Mound R and are included in this study.

Fused silica has also been found at the Caddoan Mounds State Historic Site in Texas. The materials recovered here resulted from the intentional burning of a reconstructed Caddoan style house. **(S7-Caddo House)** The house was modeled after Domicile 10 found at the same site and was primarily constructed and thatched with giant cane. After repeated damage to the structure, it was decided that the house would be burned. In 1997, archaeologists with the Forest Service returned to the area where the structure once stood and collected numerous samples of fused silica also which are used in this study (Jurney and Bergstrom 2000).

While fused silica has been found at a number of sites, especially in the Midwest, discussions of this material is limited in the archaeological literature. Fused silica has never been fully analyzed by any means in order to determine what constitutes the material. Analysis to this point has remained primarily conjecture based on a few observed tendencies and appearances of fused silica. The chemical makeup is paramount in understanding if it in fact relates to aboriginal structures as the presence of fused silica at an archaeological site simply could point to the fact that the site has been impacted by recent and/or historic intrusions. During recent months, mass spectrometry techniques were utilized in order to determine the chemical composition of these artifacts.

-MASS SPECTROMETRY-

While this paper will in no way discuss the complex processes of mass spectrometry, basic principals are presented. Mass spectrometry has long been used by archaeologists to determine a wide variety of conclusions including chemical composition, artifact dates, and sourcing raw materials. In general terms, a mass spectrometer works by producing charged particles from chemical substances. The mass spectrometer then uses electric and magnetic fields to measure the mass of the charged particles. While there are a variety of mass spectrometers, all are made up of three basic parts. A source is the means in which ions are produced from the chemical substances being analyzed. An analyzer separates the ions according to their mass and a detector produces a signal from the separated ions.

(S8-Mass Spec.) The University of Alabama houses a new Bruker Reflex III time of flight mass spectrometer. A matrix-assisted laser desorption ionization or MALDI was used in conjunction with the mass spectrometer to ionize samples. MADLI allows for the ionization of the sample by illuminating the matrix containing a small proportion of the analyte with a beam of laser generated light. Samples were prepared and analyzed by Dr. Sharon Webb who runs the mass spectrometry facilities at the University of Alabama. A total of six samples were analyzed for this study. **(S9-Provience Chart)**

Sample Name	Provience	Description of Sample	Notes
MMV	MDV-V 75R131	Fused Silica Material	
MMV CuI	MDV-V 79R131	Possible Slag with Copper	Outer portion of sample
MMV CuII	MDV-V 79R131	Possible Slag with Copper	Interior portion of sample
CH	Caddoan Mound burned reconstructed house	Silica Forth	Material recovered from
TMMRI	Toltec Mounds Mound R, Surface	Slag Material	Outer portion of sample
TMMRII	Toltec Mounds Mound R, Surface	Slag Material	Interior portion of sample

All samples were prepared by grinding with a mortar and pestle. Once the sample was ground, methanol was added to form a slurry or paste and then the material was applied to the target. All samples once prepared formed a brownish colored paste with no real differences observed between them. A total of six spectra were taken by the mass spectrometer for each sample. Results from each of the six spectra taken were recorded and inputted into a spreadsheet. Once completed, spectra for each of the samples were compared. Analysis of mass spectrometer data is essential a plot of the mass versus the intensity of each element present in the sample. For each sample, a histogram will be presented which represents the elements presence (m/z) in relationship to the relative abundance or intensity of each (a.i.).

-TOLTEC MOUND R SAMPLE-

(S10-Toltec sample) When the sample first arrived from Martha Rolingson, they were observed to look very different from all of the other samples used in this study. They were large, very dark in color, and heavy in weight. The material collected from the Toltec Mounds were found on the surface and were brought to Dr. Michael Bersch, head of the University of Alabama's Central Analytical Testing Facility. Dr. Bersch took a piece of the sample and used a rock saw to bisect the sample. He observed in the sample what he believed was consistent with raw iron ore encased in a crystalline structure. The material was macroscopically observed to contain metallic inclusions by Dr. Bersch. This was also the case when the material was bisected by the rock saw. The crystalline structure that surrounded the material was most likely the result of the material being crudely smelted in a low temperature furnace. **(S11-Mass Spec graph)** While the mass spectrometer is a poor tool to identify trace metals in a sample, it did detect the presence traces of iron, nickel, and gallium. Interestingly, gallium is an element often found in coal. With early iron smelting technology, coal was the primary fuel used. While initially considered to be silica froth resulting from aboriginal activity, it now seems quite probable that this material is in fact the result of historic iron smelting activities.

-RECONSTRUCTED CADDOAN HOUSE-

(S12- Caddoan Silica) As discussed previously, the reconstructed Caddoan House that was later burned was thought to produce a large quantity of fused silica. The sample was a greenish-gray, irregular bulbous material with a sandy/gritty consistency. These traits are all consistent with traditional descriptions of fused silica. With no previous elemental analysis, one of the goals of this study was to understand the chemical makeup of fused silica for further comparative studies. **(S13- Mass Spec Graph)** Results from the mass spectrometer denote the presence of only sodium and potassium with no traces of metals present. Other chemical compounds are present in the material however; the relative intensities are very low and thus not recognizable.

-MOUND V SAMPLES-

(S14- Mound V Silica) Samples recovered from recent excavations at the Moundville Site matched pervious descriptions of silica froth. All were greenish-gray in color with a bulbous appearance and a sandy/gritty texture. **(S15- Mass Spec Graph)** Again, the samples were analyzed with the mass spectrometer and produced almost identical results in respect to elemental intensity with the samples from the Caddoan house. Sodium and potassium were the only identifiable elements which were present as from the samples tested from the Caddoan house silica froth. Limited identification of elemental composition is probably due to silica forth being primarily composed of silicates comprised of clays, quartzes, and other minerals and organic materials not readily detectable by the mass spectrometer.

Moundville Mound V Copper Samples

The secondary goal of this paper is to address the small quantity of irregular samples of copper excavated from Mound V. **(S16-Cu Samples)** Copper was the only metal utilized by aboriginal inhabitants of southeastern North America. Some prestige items were crafted from native sheet copper procured from the Ducktown geological formation located in Tennessee and

North Carolina. The copper excavated from Mound V did not resembled typical raw material used for the production of copper artifacts recovered from Moundville. The small quantity excavated was located in a portion of daub and had a very irregular, bulbous, melted appearance. It was determined in the field that the copper found was most likely a piece of chalcopyrite ($CuFeS2$), or copper ore. With the copper ore found within an intact cultural feature and in association to what was believed to be possible slag, it was hypothesized that the smelting of copper ore was possibly occurring at the Mound V locality.

(S17- Mass Spec Graph) The mass spectrometer was again used to identify the chemical properties of the recovered copper. When comparing the results from the copper to the other samples utilized for this study, one finds more similarities in peaks and intensity between the copper samples and the slag from the Toltec Mound Site. Many more peaks are present representing the various trace metals present in both samples. In addition, the intensity of such trace elements and various compounds are increased in both samples. However, iron and copper were identified within this sample at a relatively high rate of intensity. With these results, the material recovered can now best be understood as chalcopyrite in an unmodified state.

-CONCLUSIONS-

In order for the craftsman of Moundville to smelt copper ore into a usable form, an extremely hot fire would have to be produced. The melting point of pure copper is roughly 1,083 degrees Celsius. Ethnographic accounts of utilizing pipes to blow oxygen into a fire in order to increase its temperature have been recorded for various portions of Europe and South America. If this was achieved here at Moundville, and copper ore was introduced, metallic slag consisting of an amalgamation of impurities leaching out of the copper ore would be produced. During excavations of the earth lodge structure it was initially believed that a slag-like material was being recovered from intact, aboriginal cultural features. By utilizing mass spectrometry techniques, it has been discovered that this slag-like material is actually fused silica. Instead of the copper ore being purposely fabricated into a workable material, it seems far more plausible that the melted appearance of the copper was the result of the actual structure burning or other post depositional forces.

But how was the silica froth produced? **(S18-Okmulgee Lodge)** Let us use the reconstructed earth lodge at the Okmulgee Site as a model to draw clues from. At Okmulgee, the earth lodge is a large, circular structure with four large vertical poles supporting a thick cane roof. The interior of the structure is covered with tightly woven cane matting and the exterior of the earth lodge is completely covered with clay and then grass thatch. Based on the excavations at Mound V, it appears that the two structures resembled one another very closely. So far, excavations have revealed the northeast corner of the earth lodge at Moundville. While the details of the structure fall outside of the scope of this paper, it is important to note that the structure met its demise by fire and maintained a similar appearance to the Okmulgee lodge. As the outer walls of the structure burned, the grass thatched roof caved in and burned as well. Once the roof fell in, a seemingly closed environment was created which in effect created a presumably hot, intense fire. With the grass, earth, and cane combined together with a high temperature fire, the conditions were right for the formation of fused silica.

Silica is an essential element in clay leading to the process of lithification. The silica combines with several possible substances that act as flux. They combine with the silica in the same chemical reaction by which glass is produced. The fused silica from grass thatch most likely comes from opal phytoliths or pure quartz that occurs in grasses. In addition to the grass thatch roof that covered the structure, daub recovered from the earth lodge was found to contain far more grass then cane. This grass tempered daub is different from other daub recovered from Moundville. Typically the daub maintains strong cane impressions with limited grass inclusions. All of the grass and cane present within the earth lodge structure introduce the necessary quartz for the process to take place. The combination of a grass thatched roof, clay and earth covered superstructure, and an intense fire produced the crucial prerequisites for the creation of fused silica.

Fused silica is not a typical artifact category listed in excavation reports. I feel that this is due to the problem of recognition. When the material was first encountered during excavations of Mound V, we had no immediate clues as to what we had collected. When the samples were presented to other archaeologists they were often identified as historic slag material. Many of the buildings constructed by the Native Americans inhabiting the Southeastern region utilized similar materials. Posts, woven cane, cane and grass thatched roofs are all similar construction characteristics. With these materials present, the basic "recipe" for fused silica is created.

It is hoped that other archaeologists will become aware of this type of material. Furthermore, other geo-chemical tests such as XRF techniques should be utilized in the future to further understand the trace elements and organic compounds present in fused silica. Using these results in a comparative sense to the findings in this study could increase our understanding of this material. In addition, possible experimental, middle range research should be conducted in order to discover the temperature at which fused silica is created at. This could illuminate just how intense fires were when aboriginal structures burned. What often would be tossed out of the screen can now be understood as an important tool for the identification of aboriginal structures.

Acknowledgements

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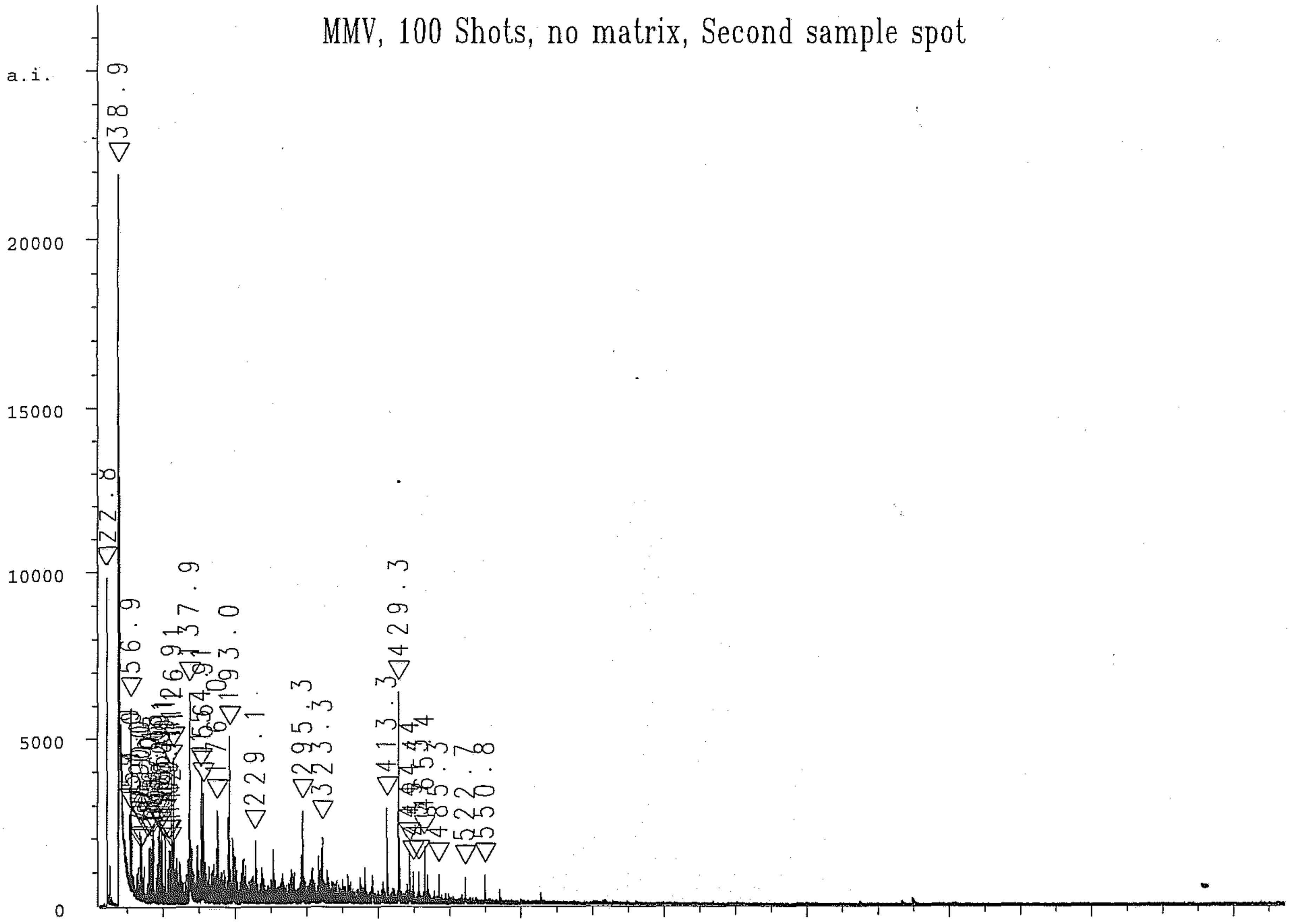

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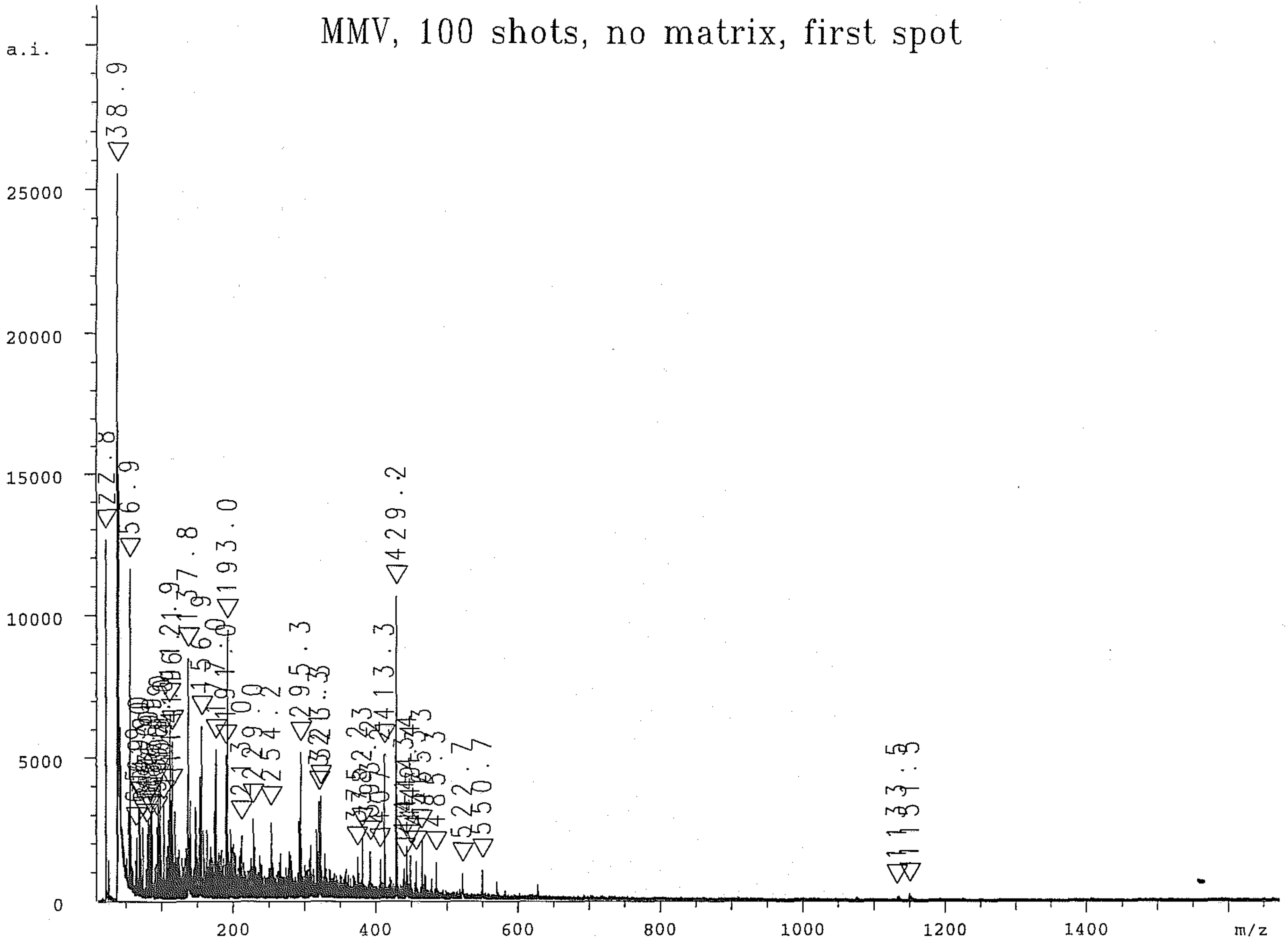
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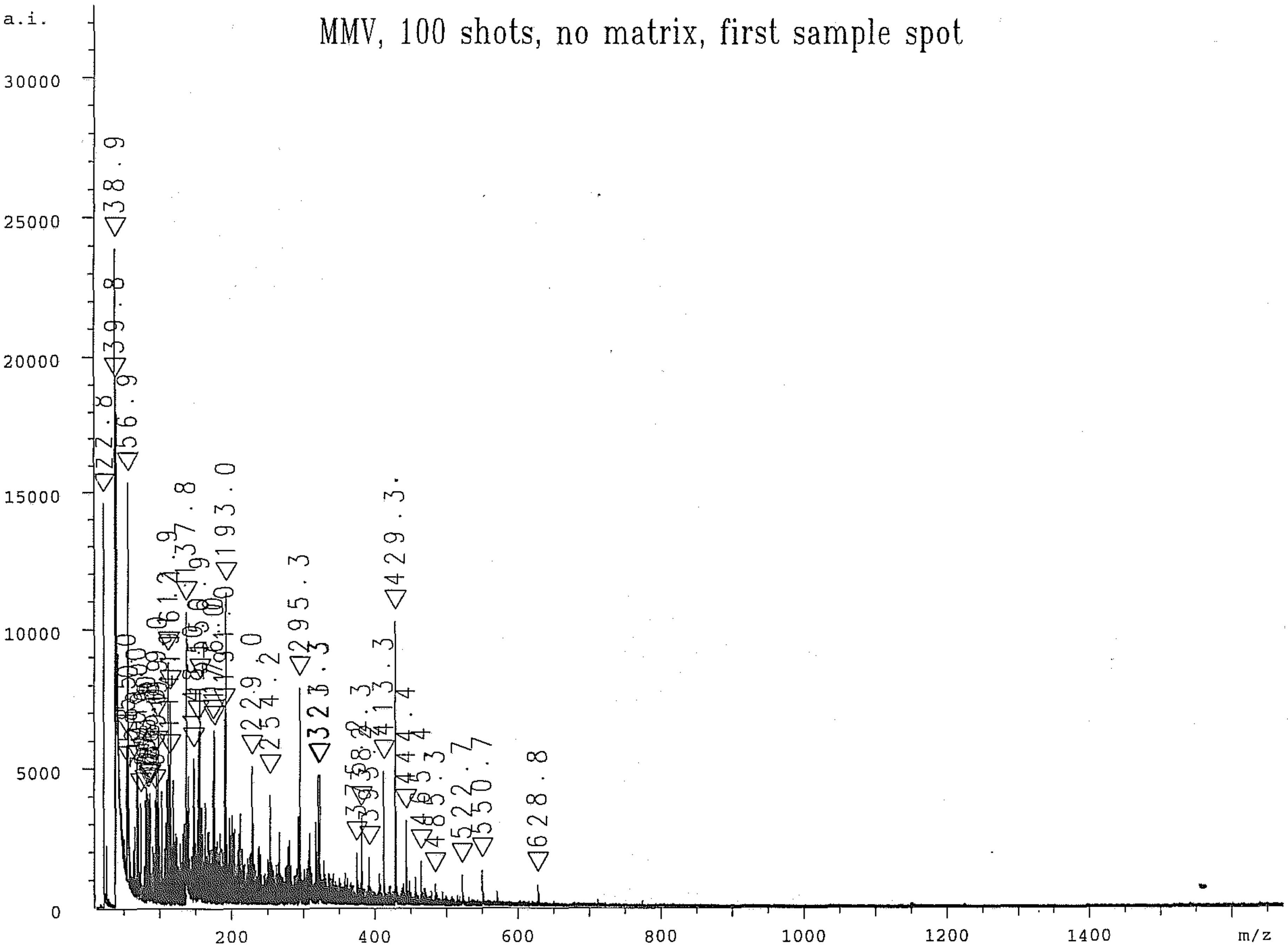

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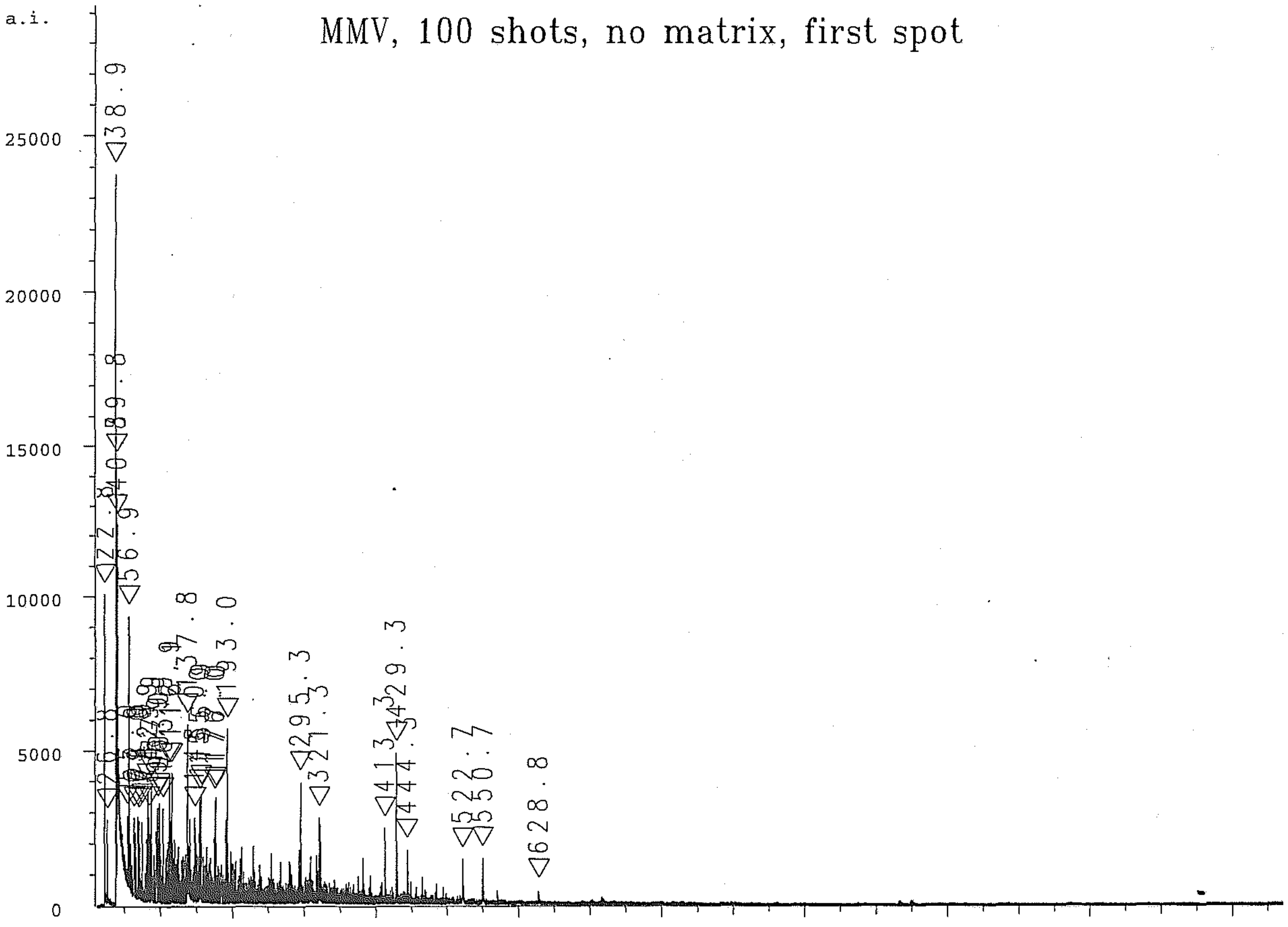
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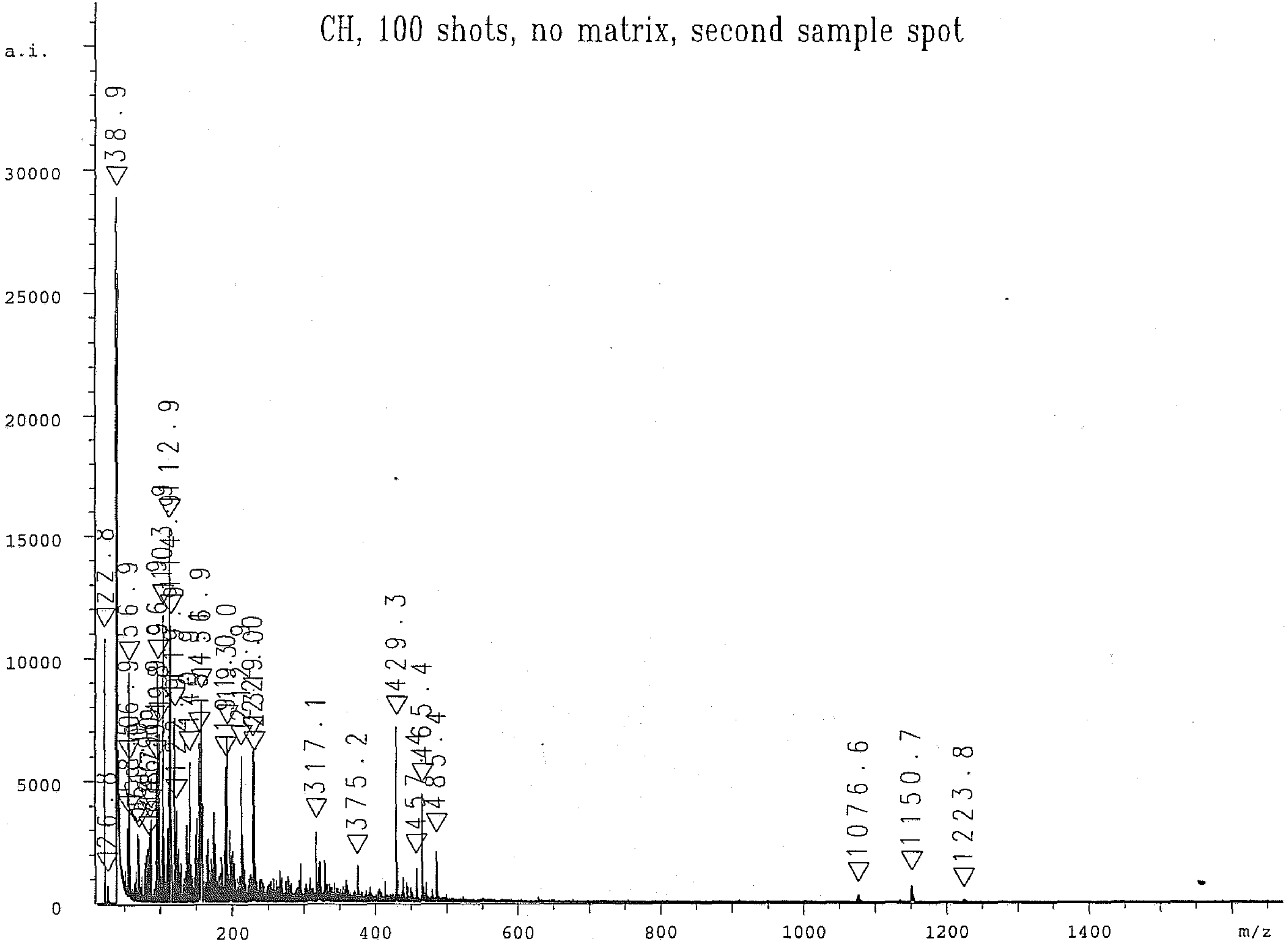
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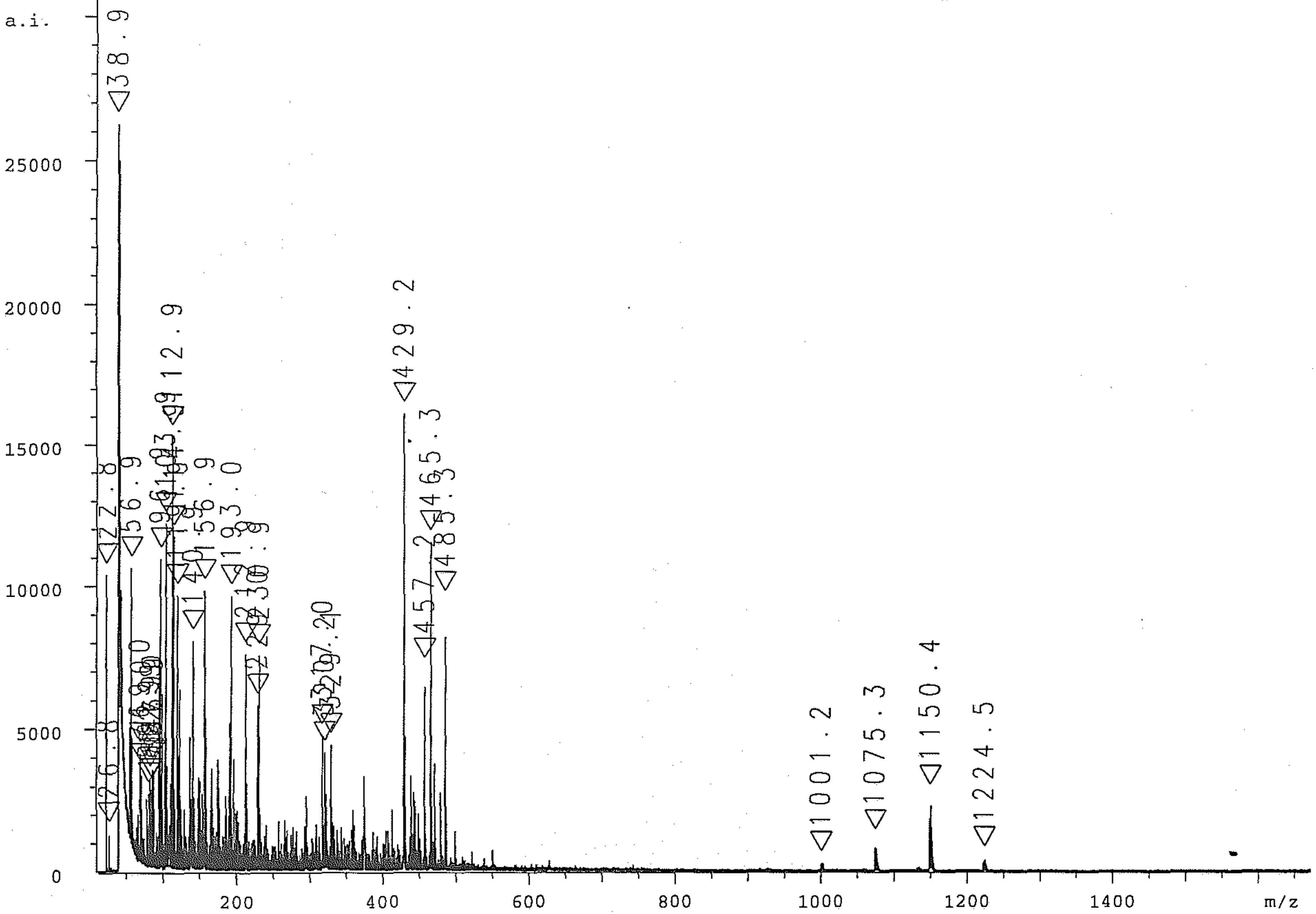

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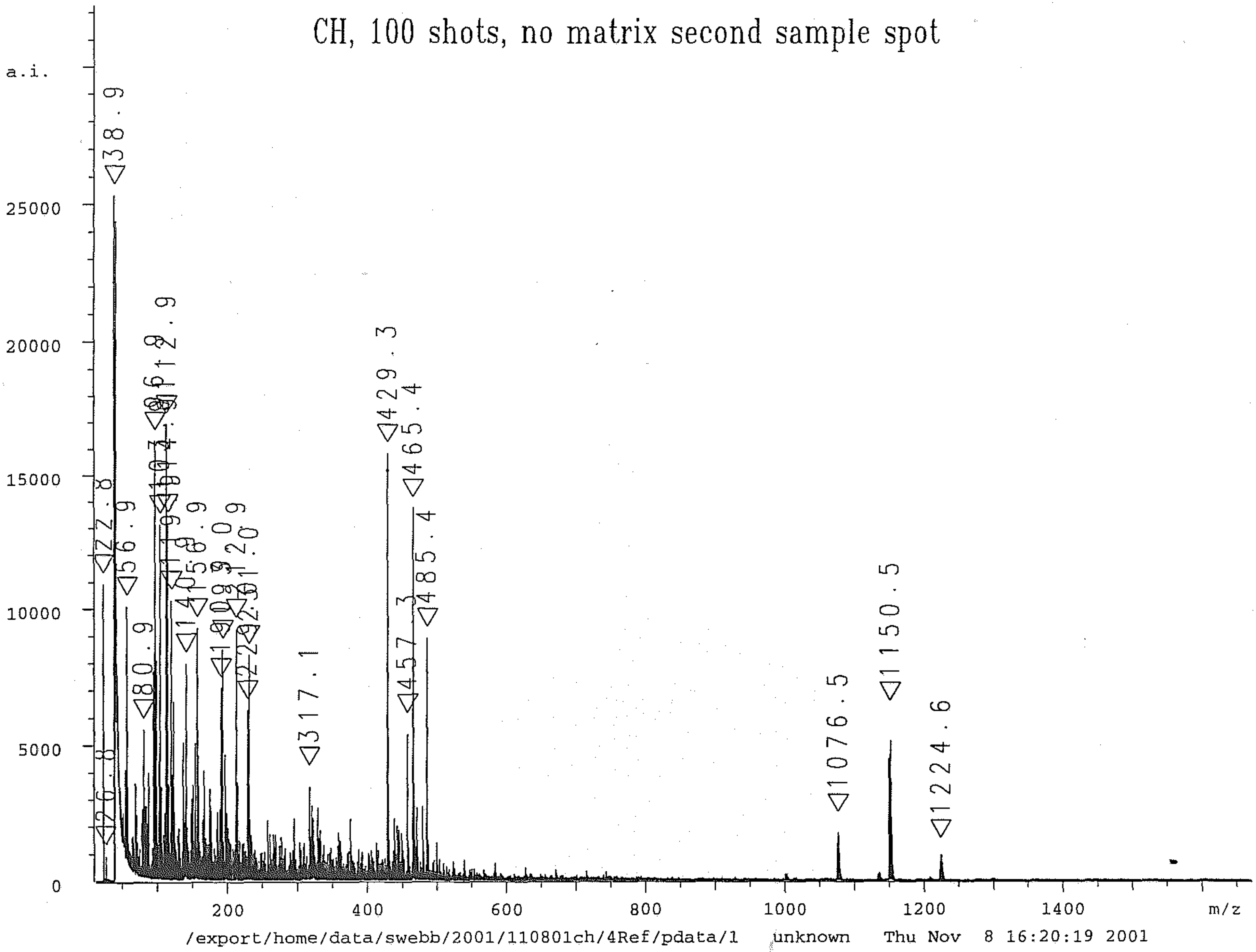
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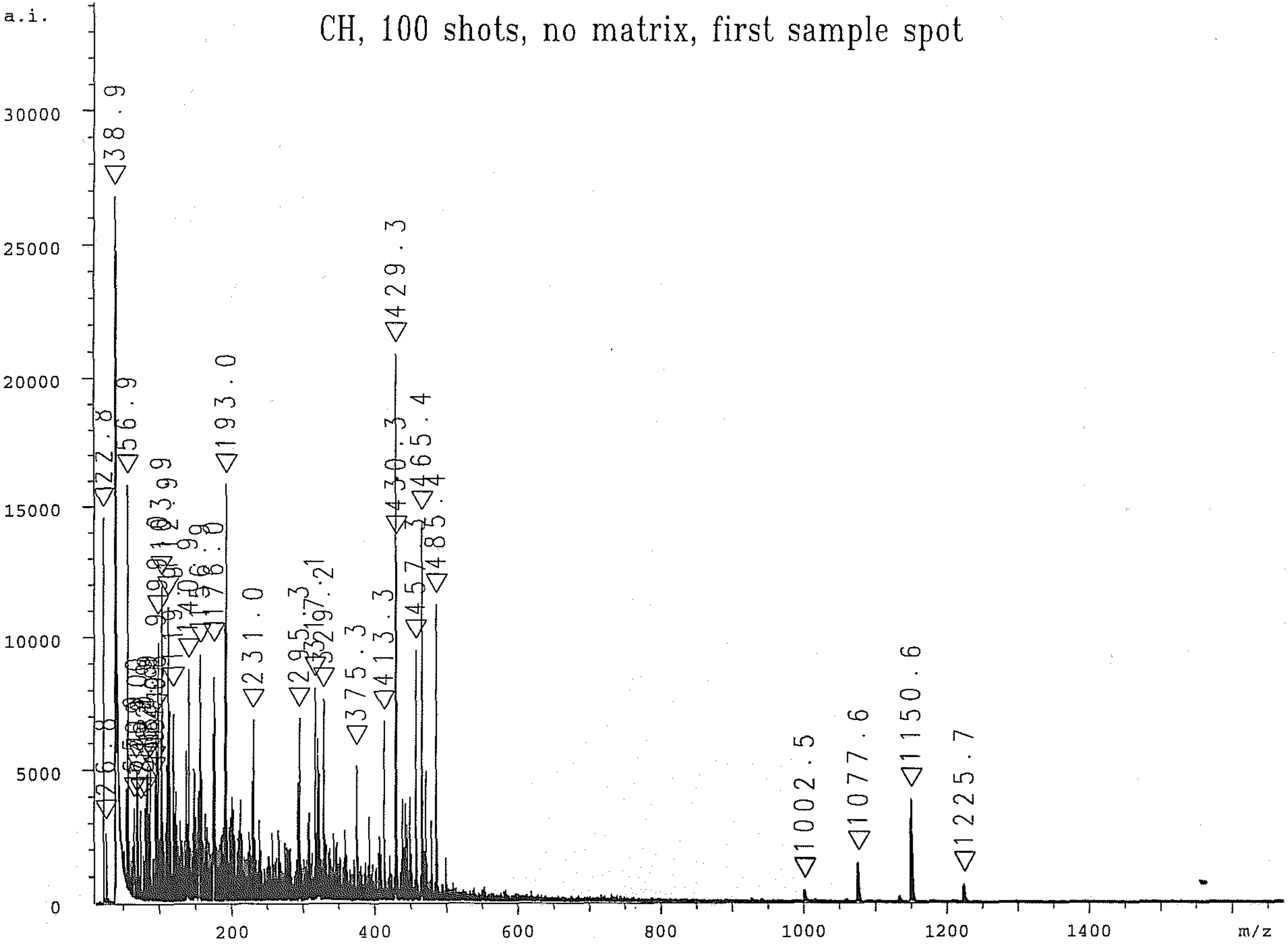

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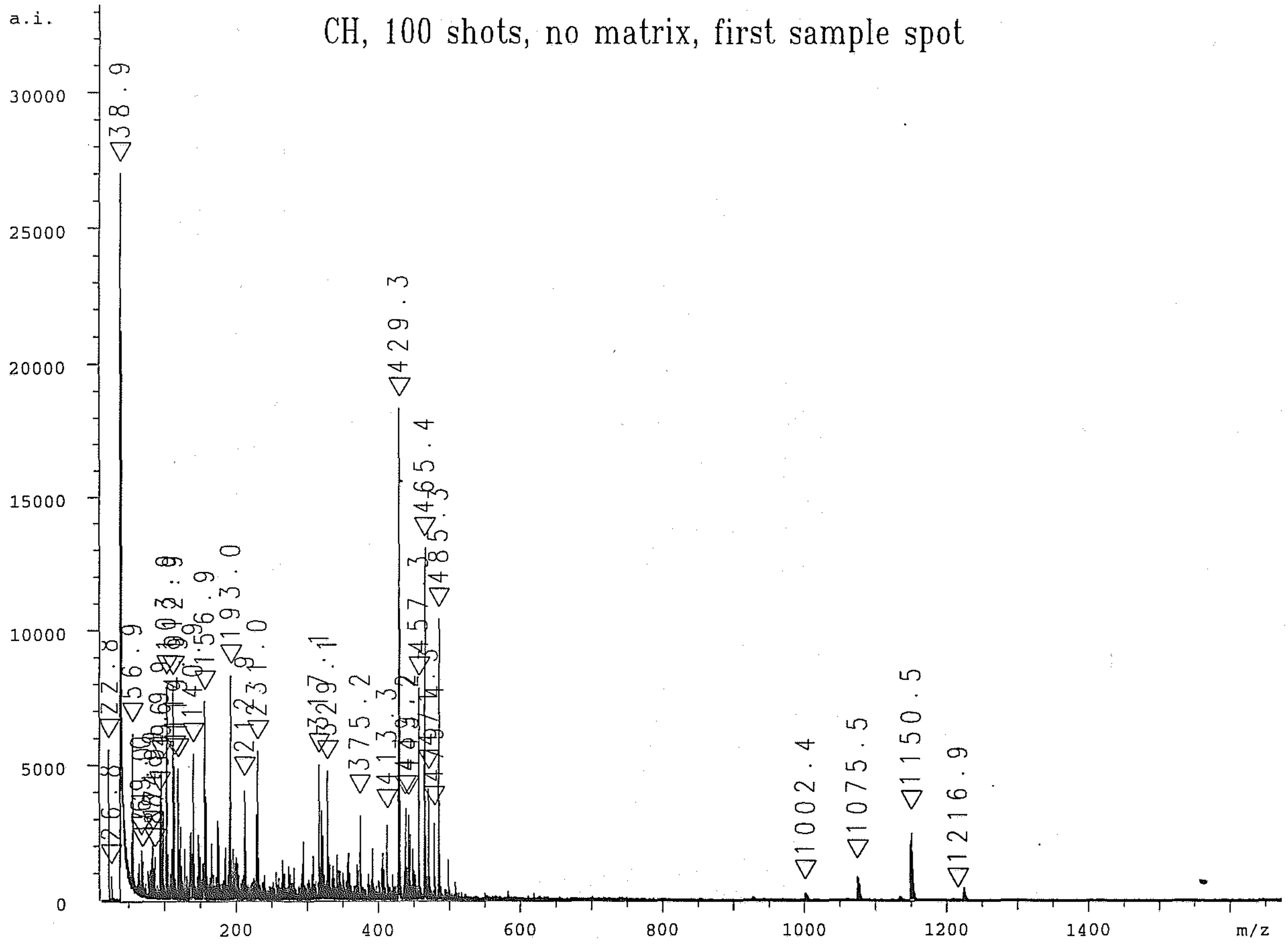

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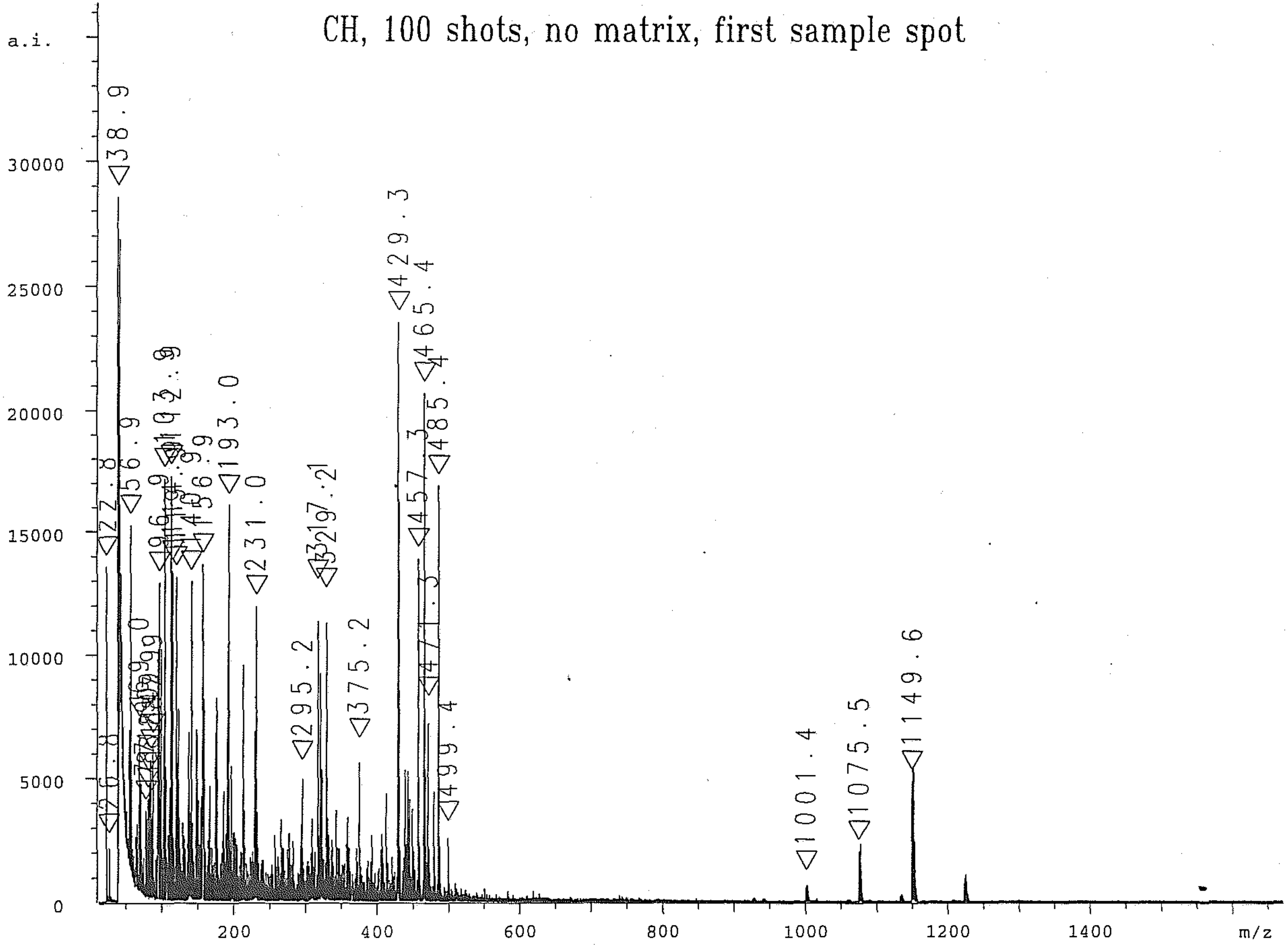

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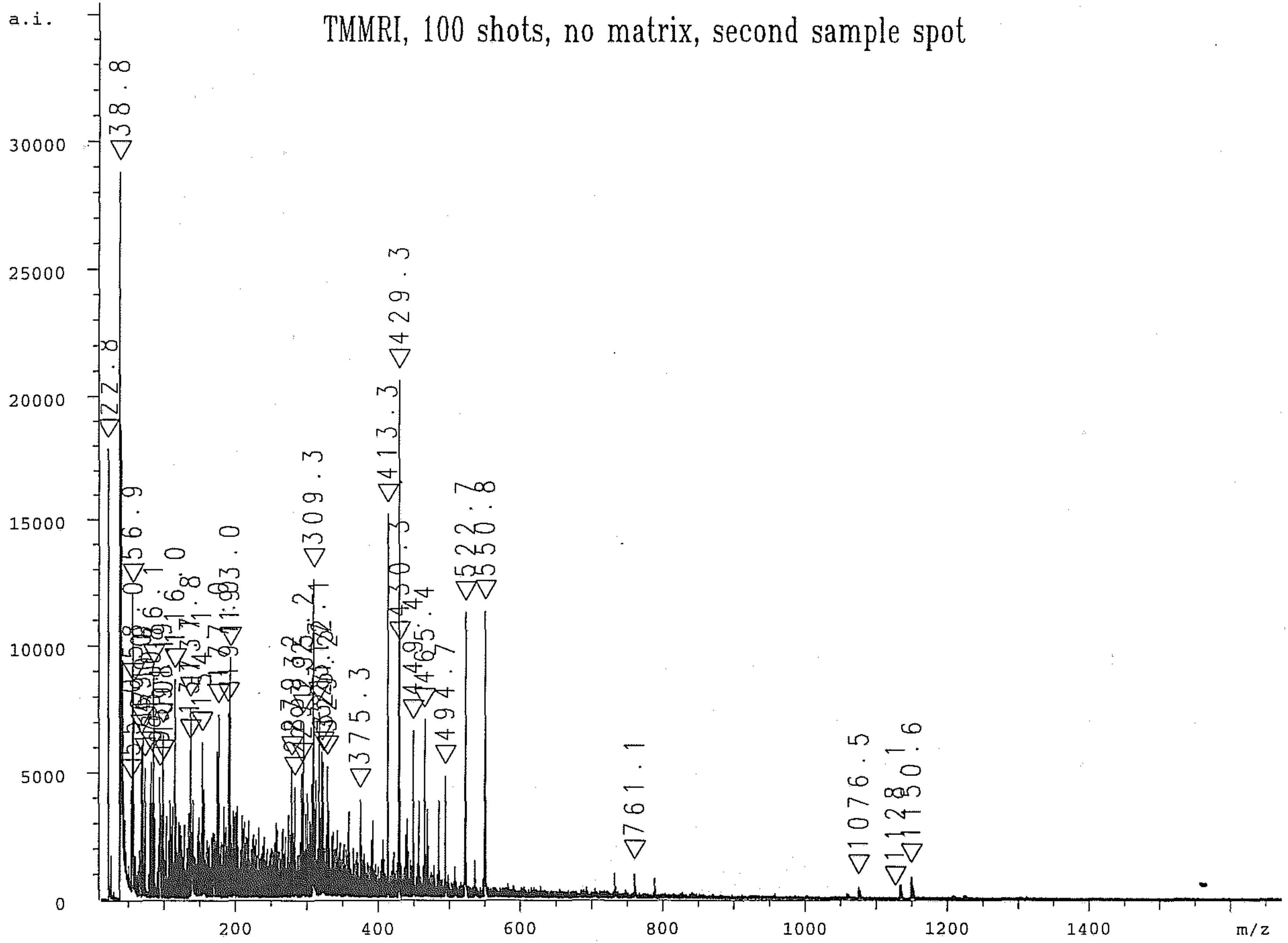

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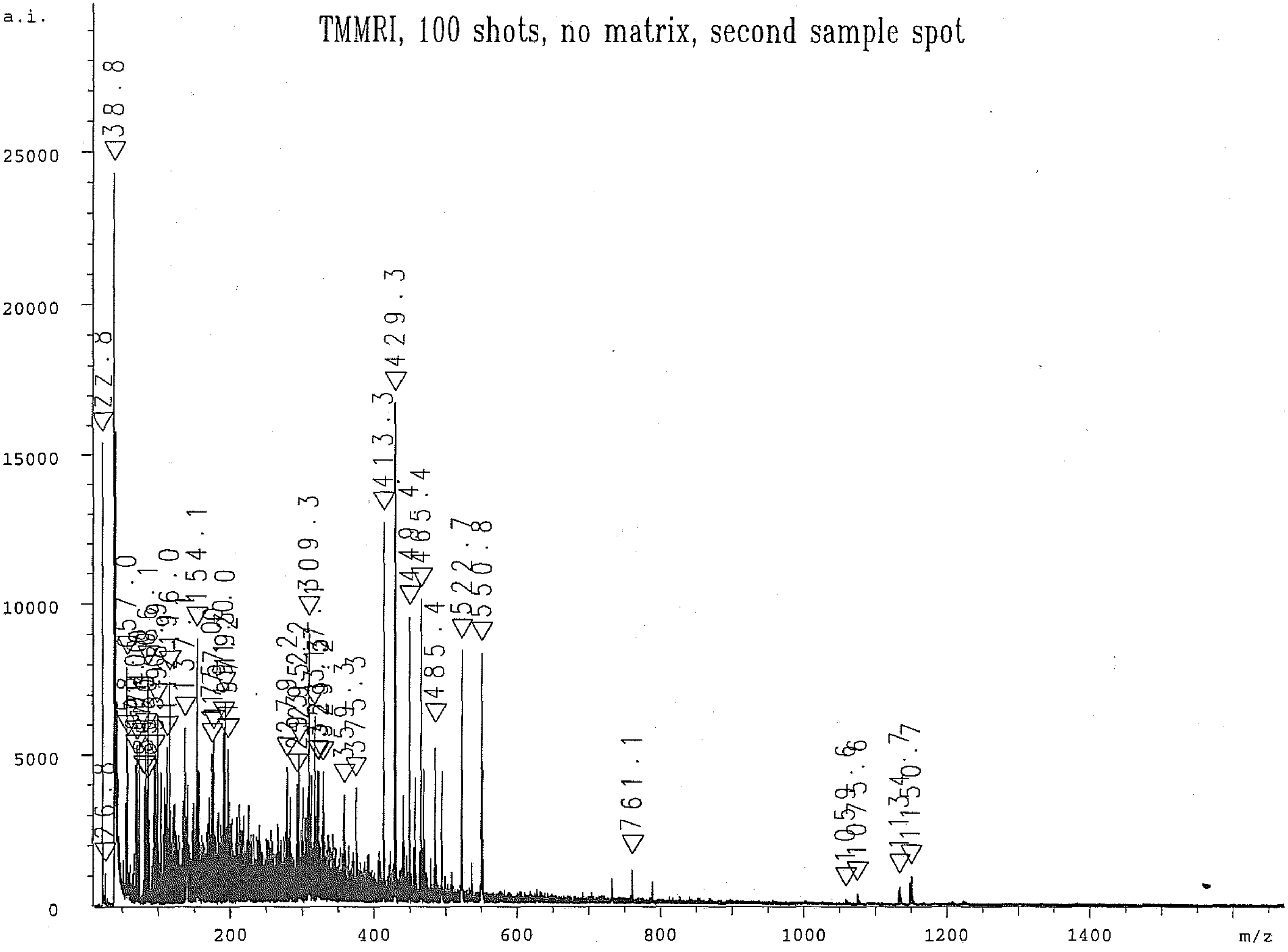

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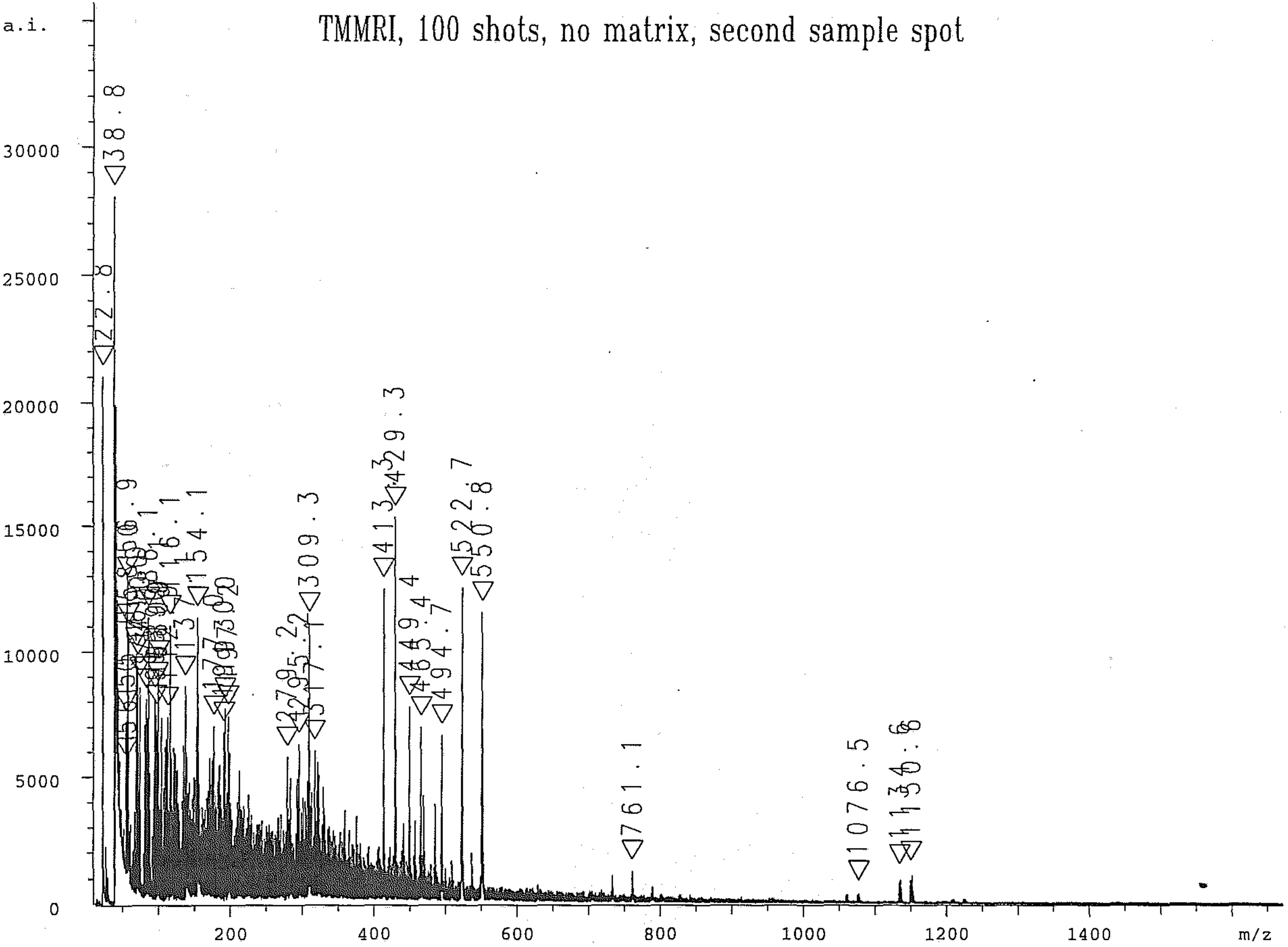

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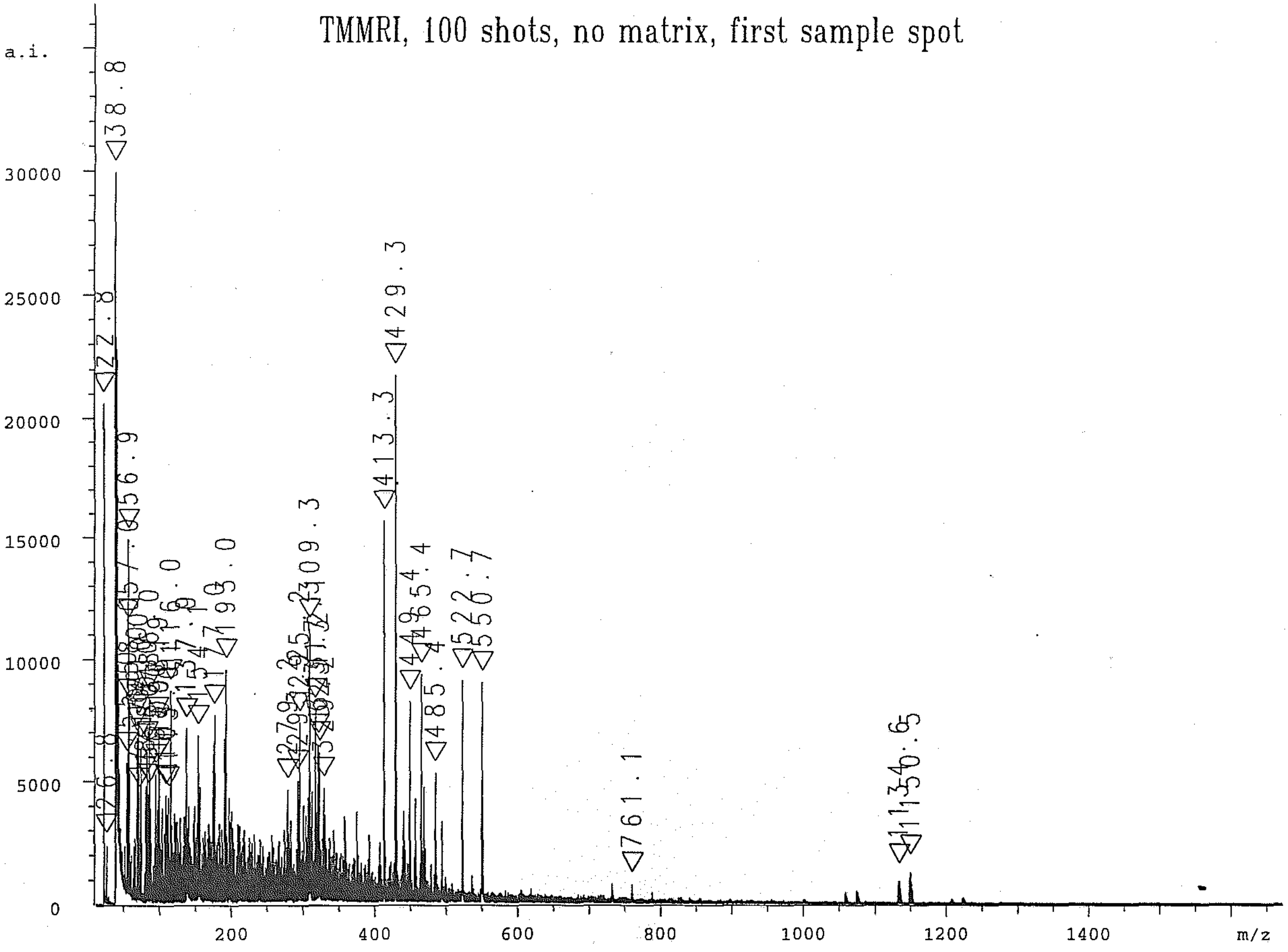

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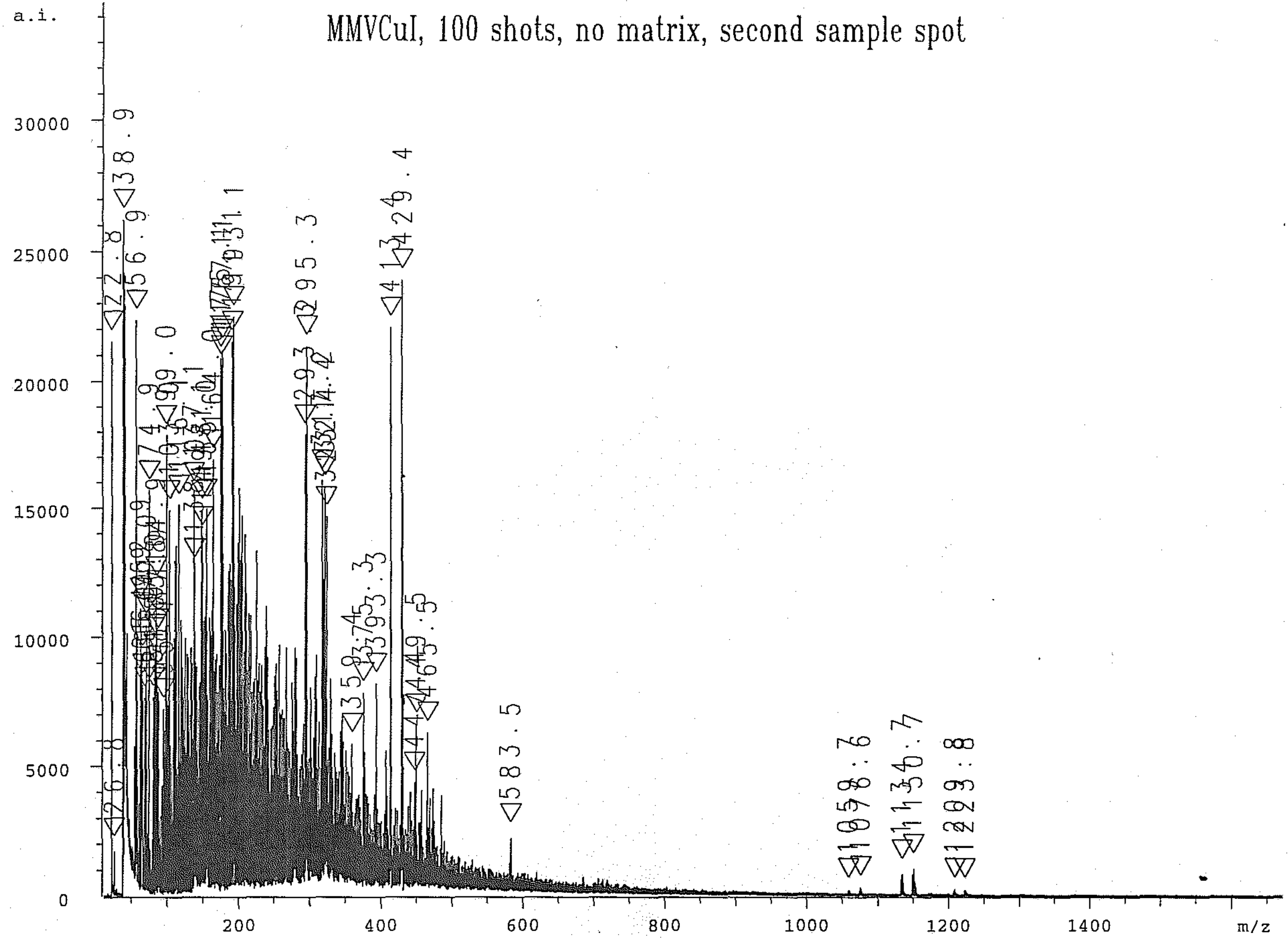

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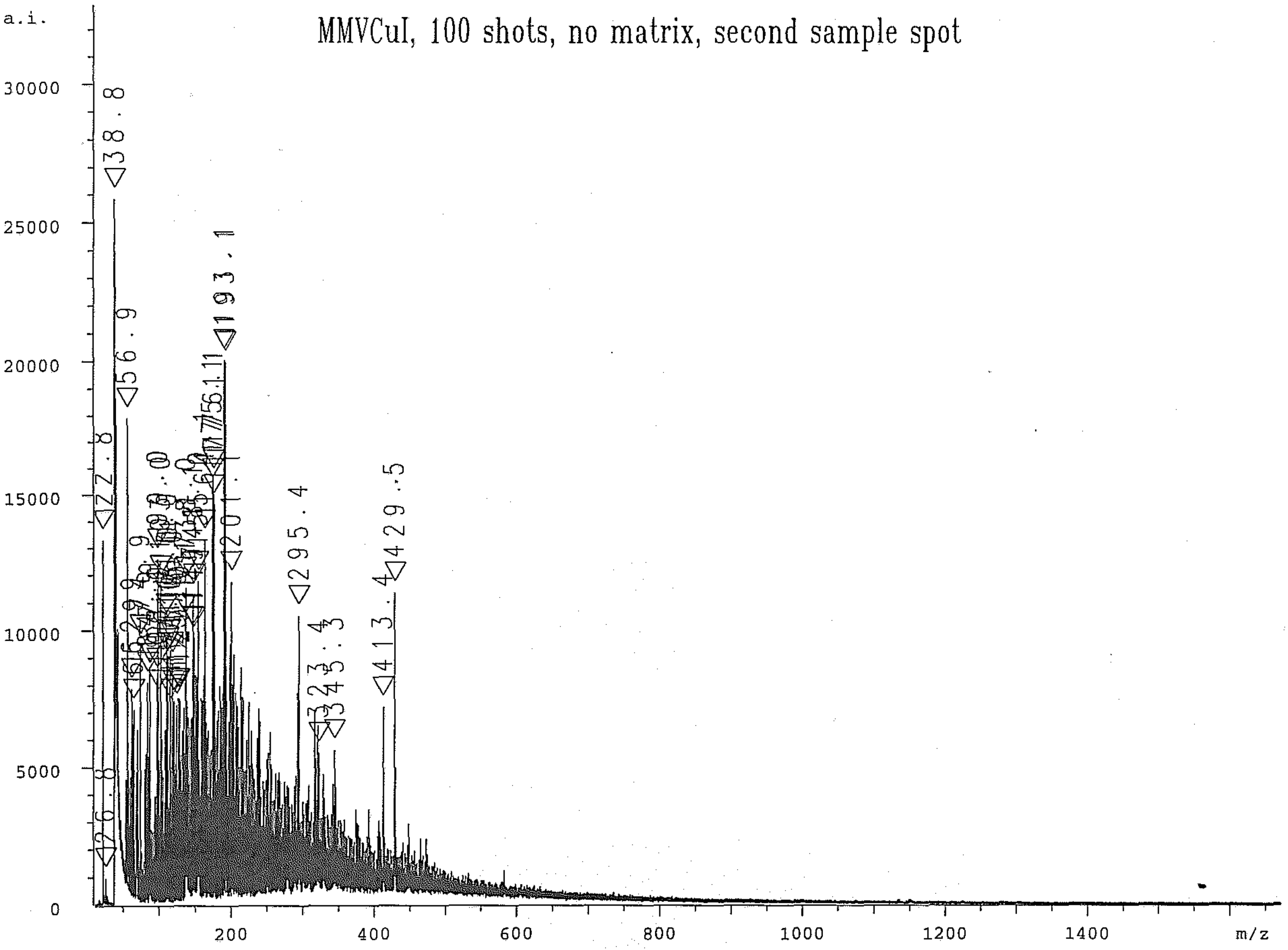
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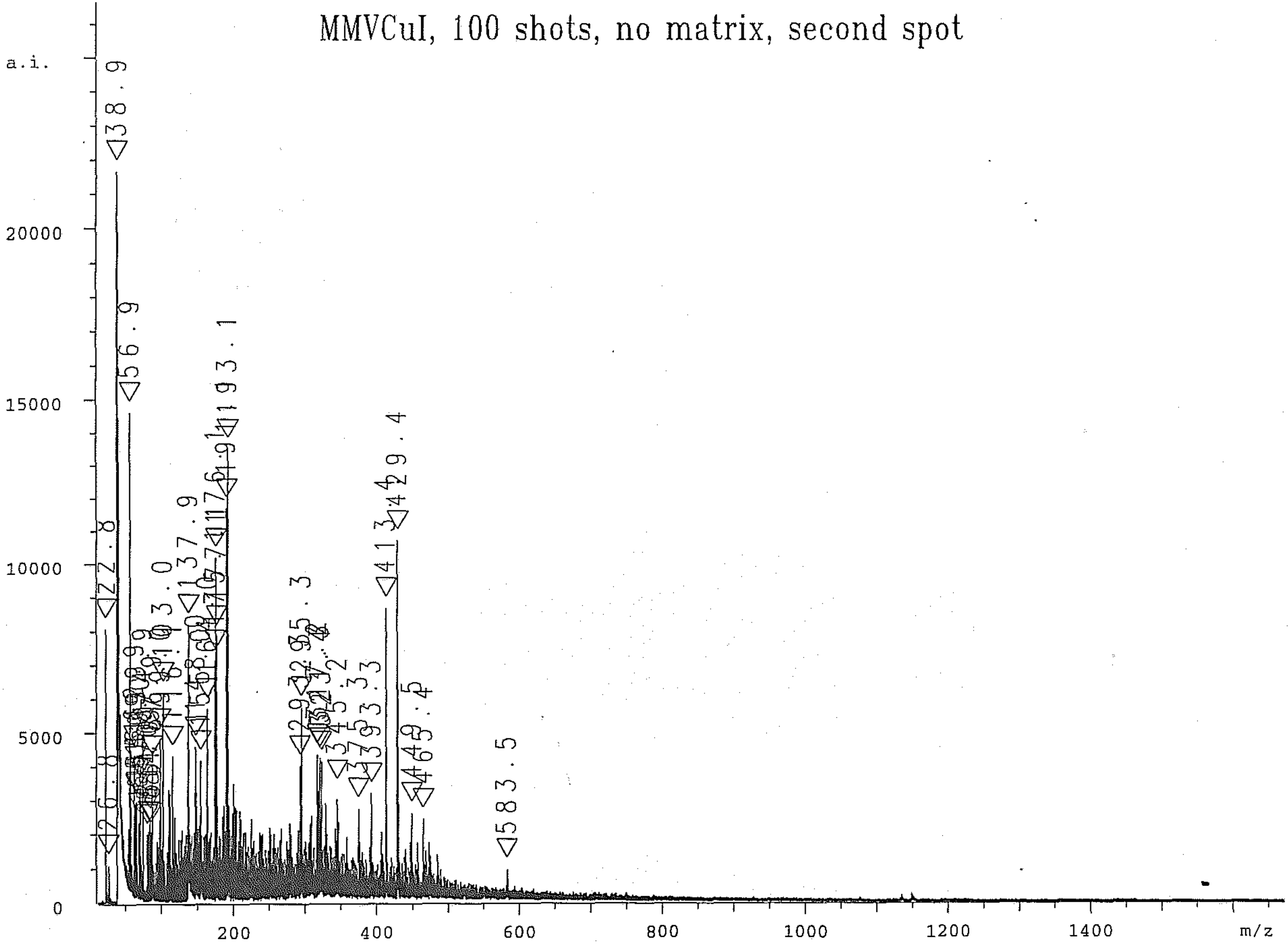

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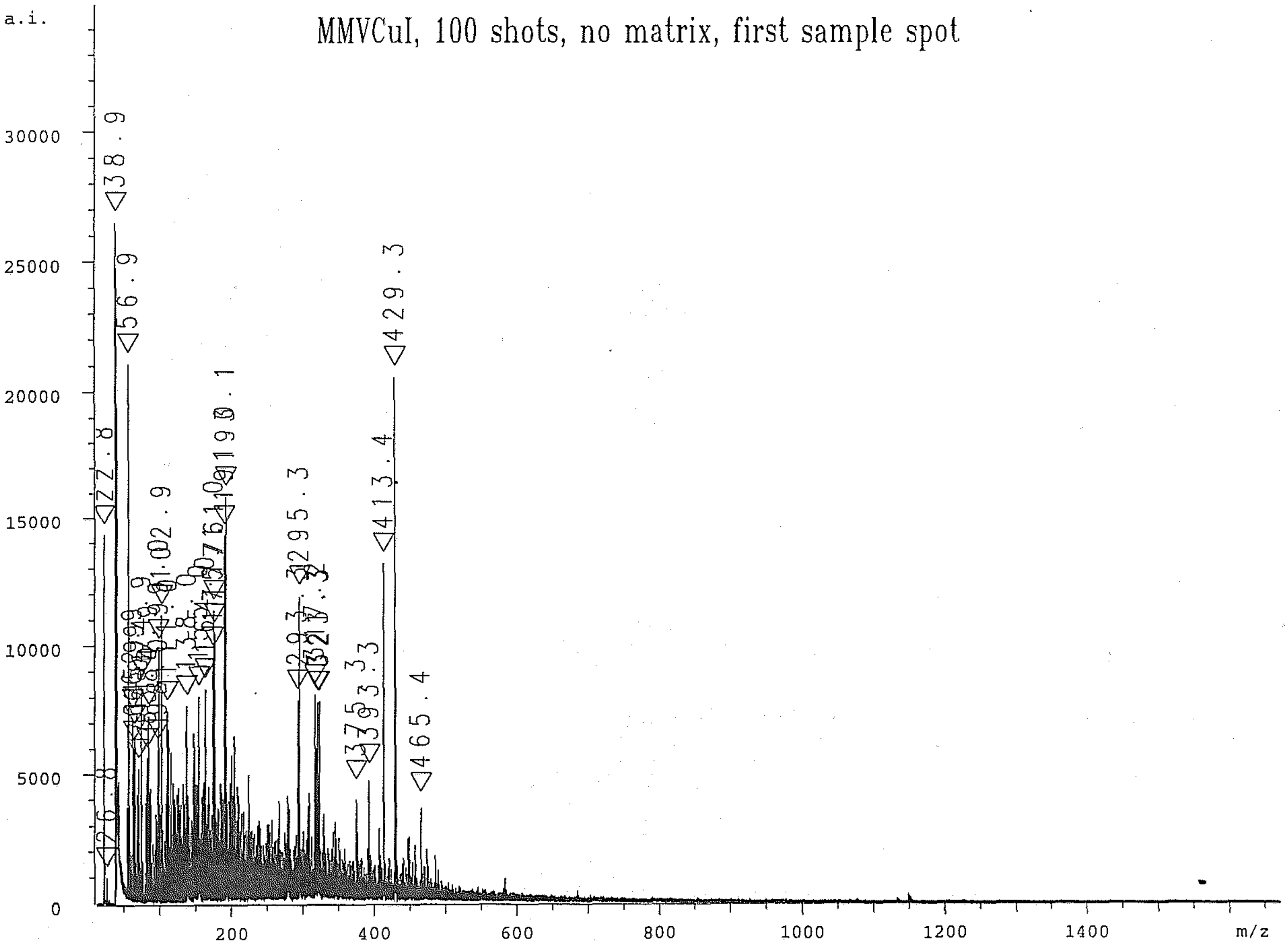

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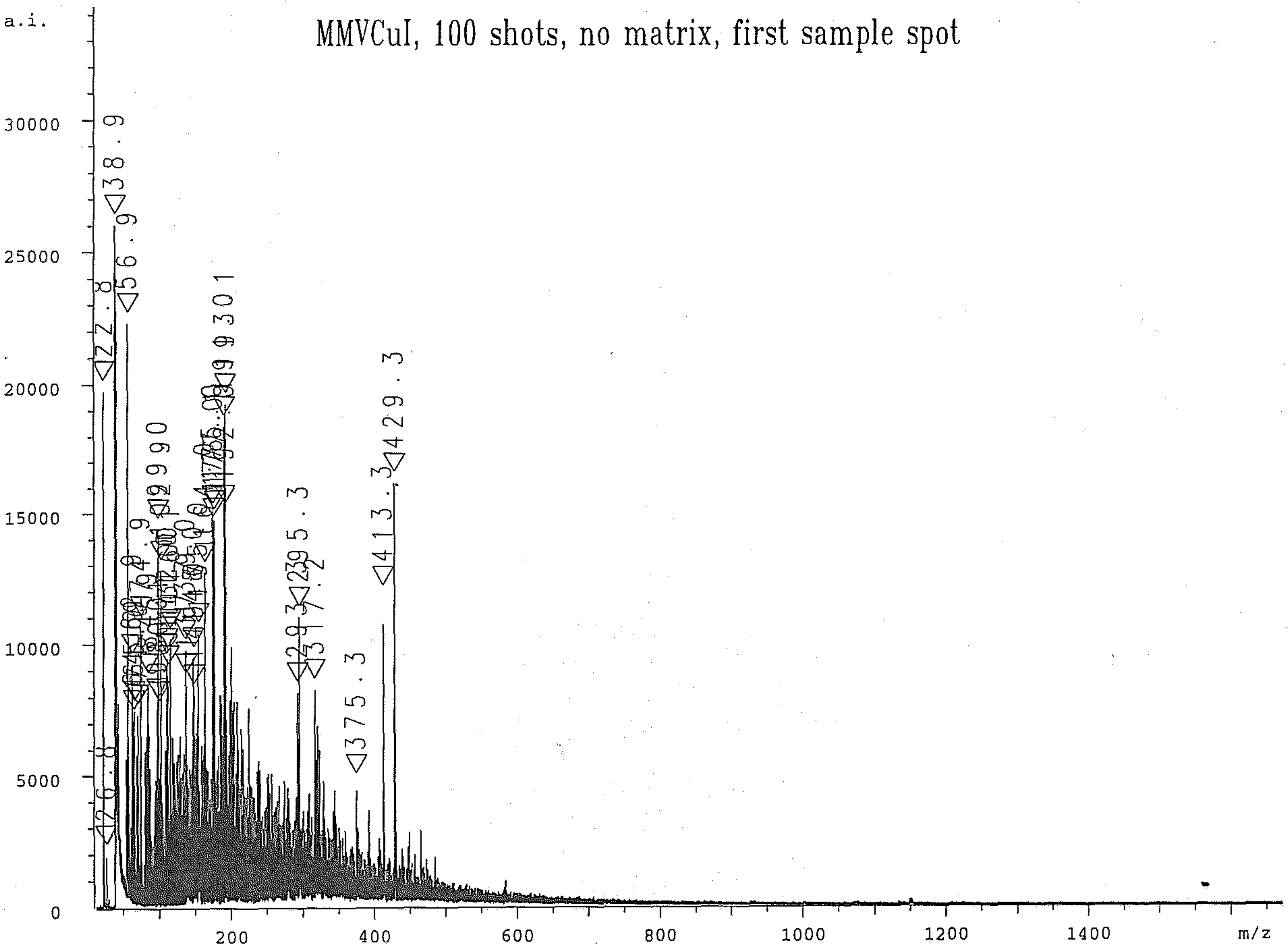

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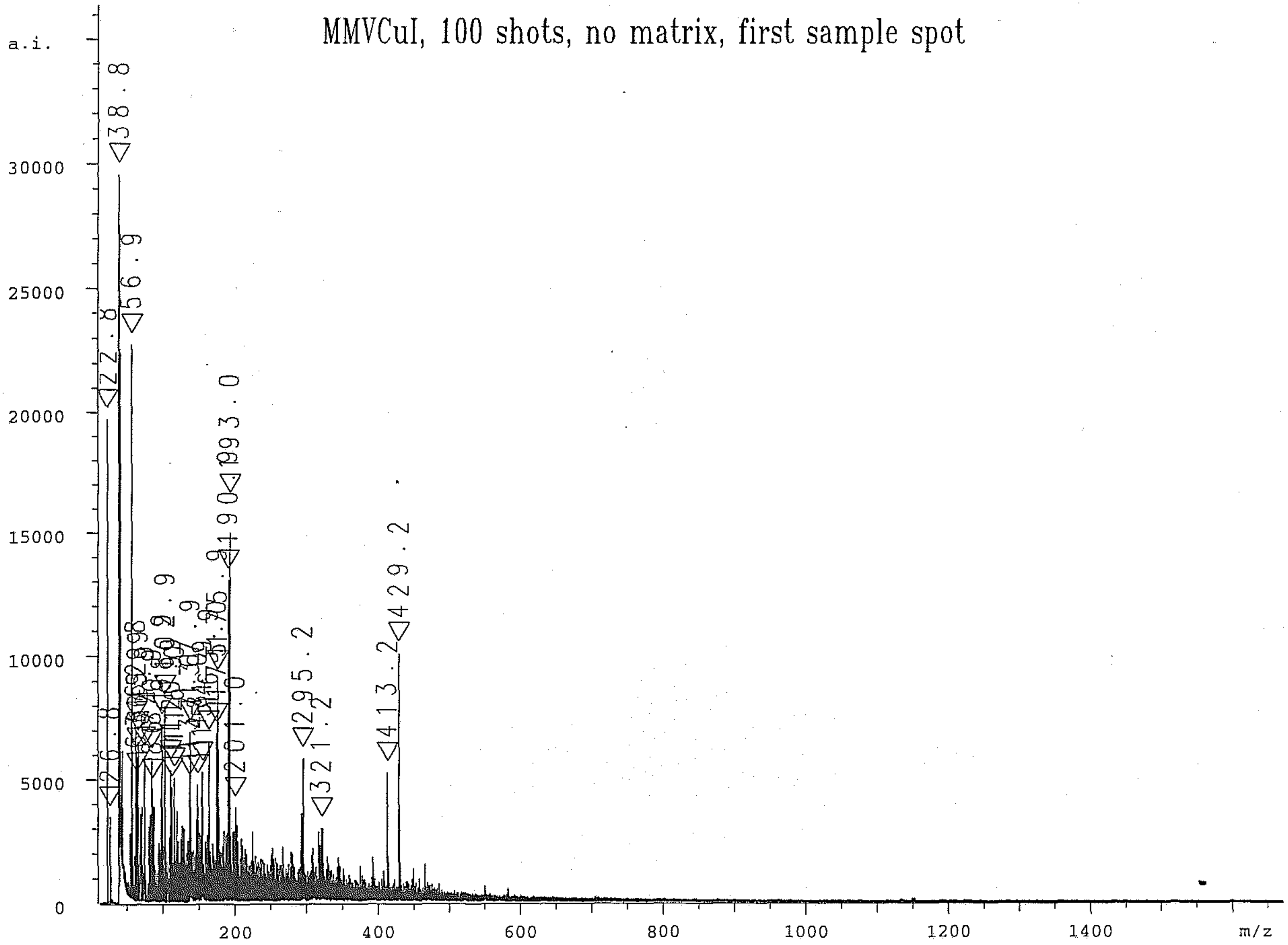

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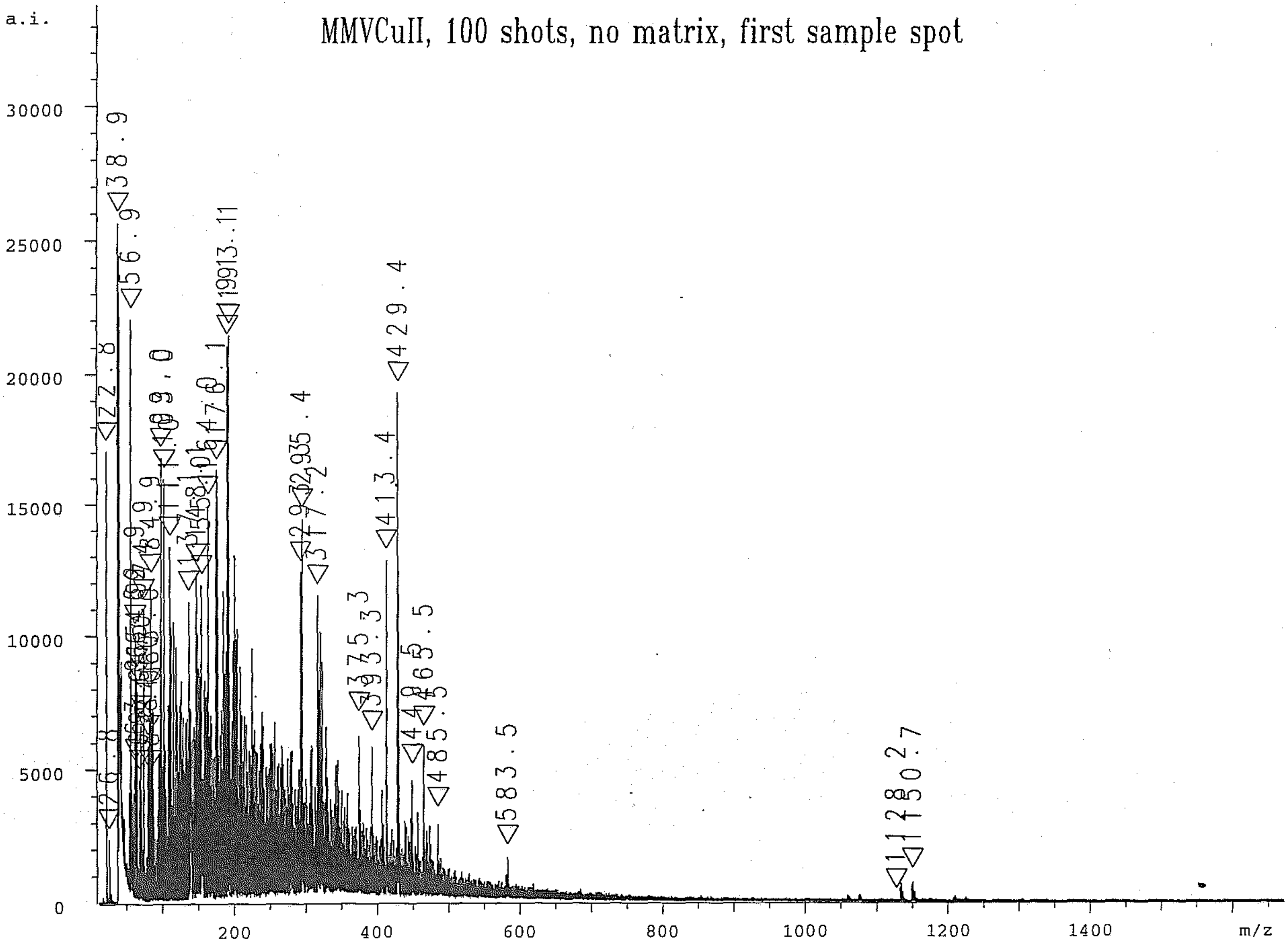

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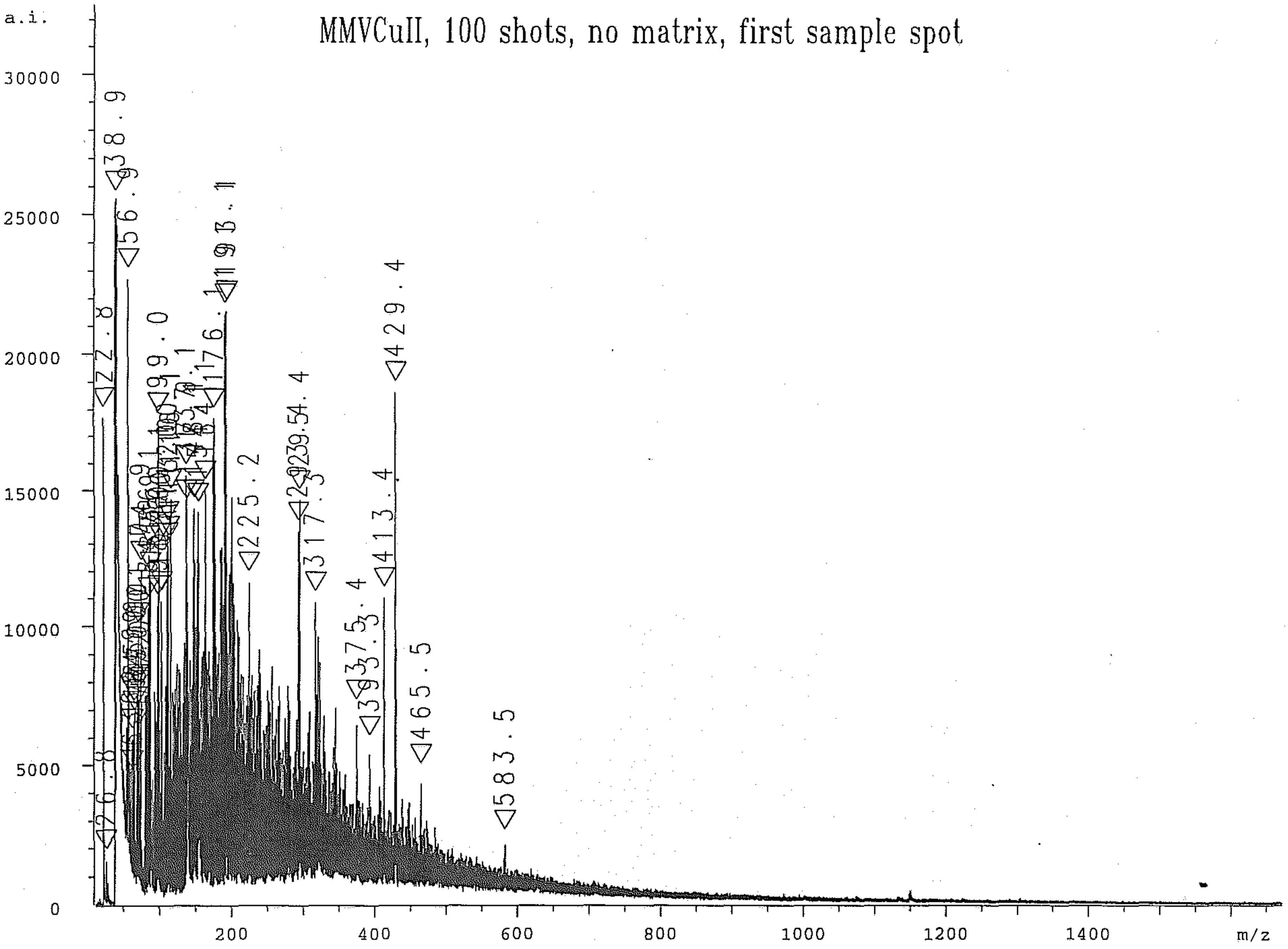

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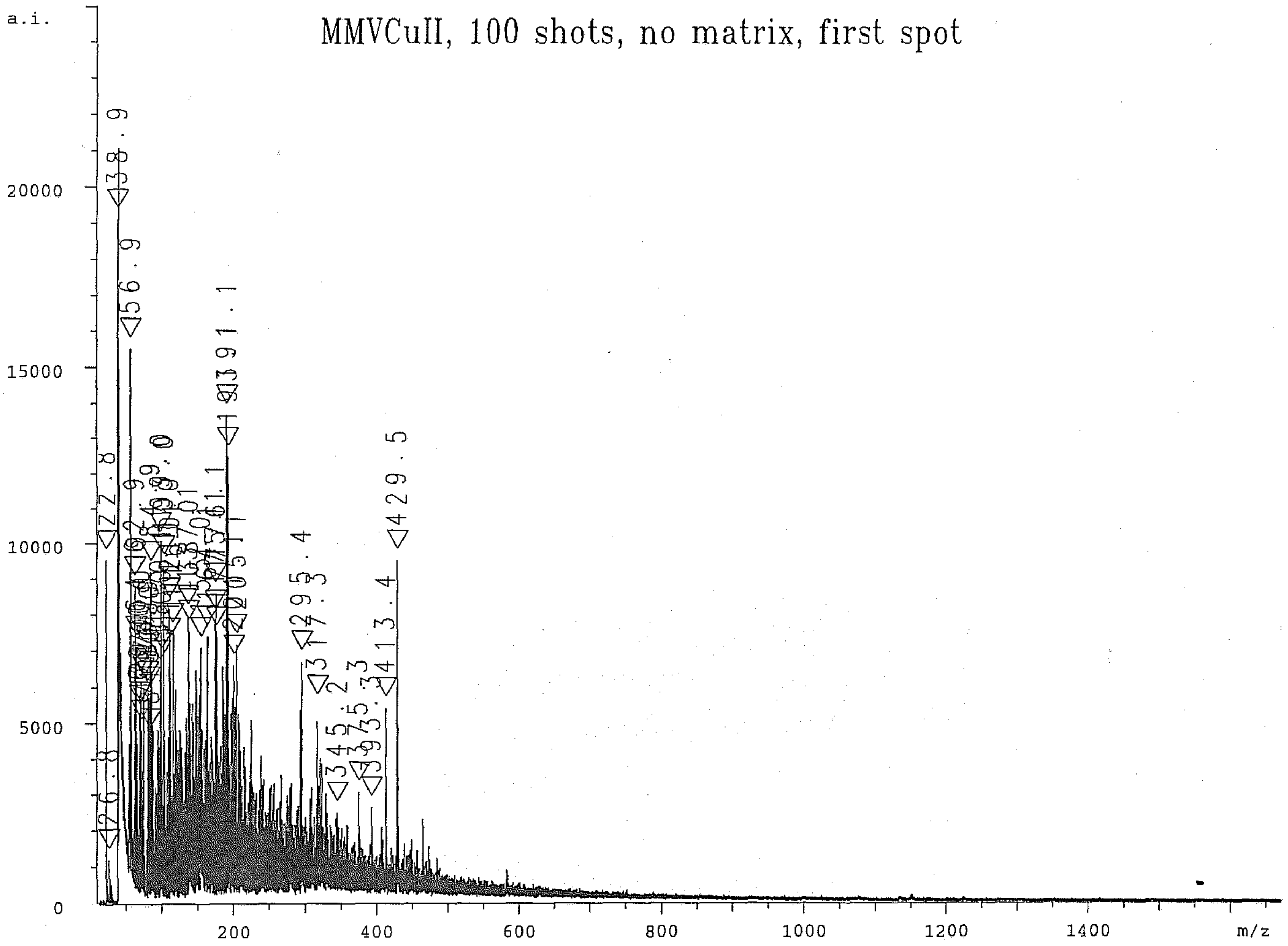

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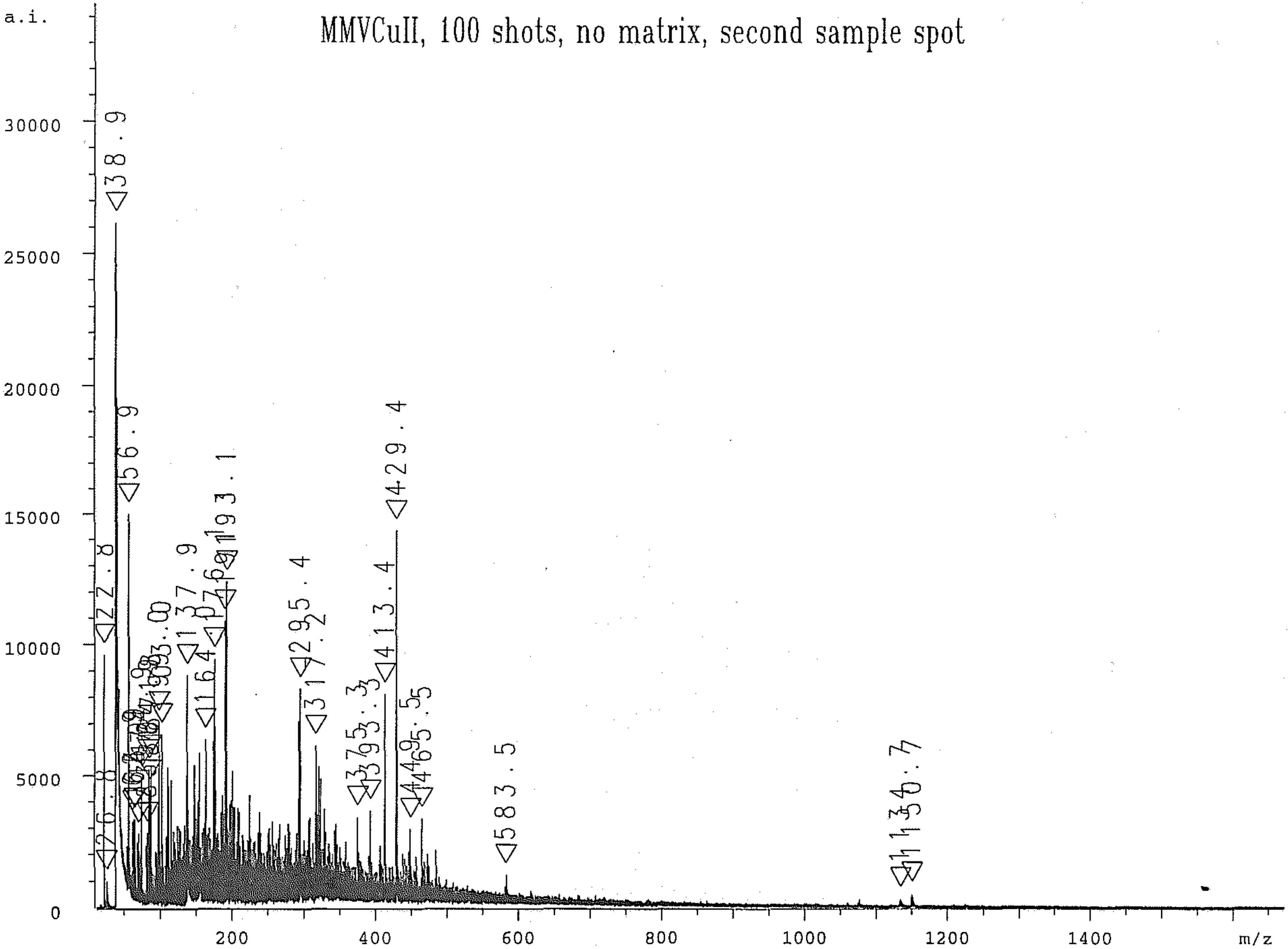
/export/home/data/swebb/2001/110901mmvcuII/1Ref/pdata/1 unknown Fri Nov 9 09:13:34 2001

MMVCuII, 100 shots, no matrix, second sample spot



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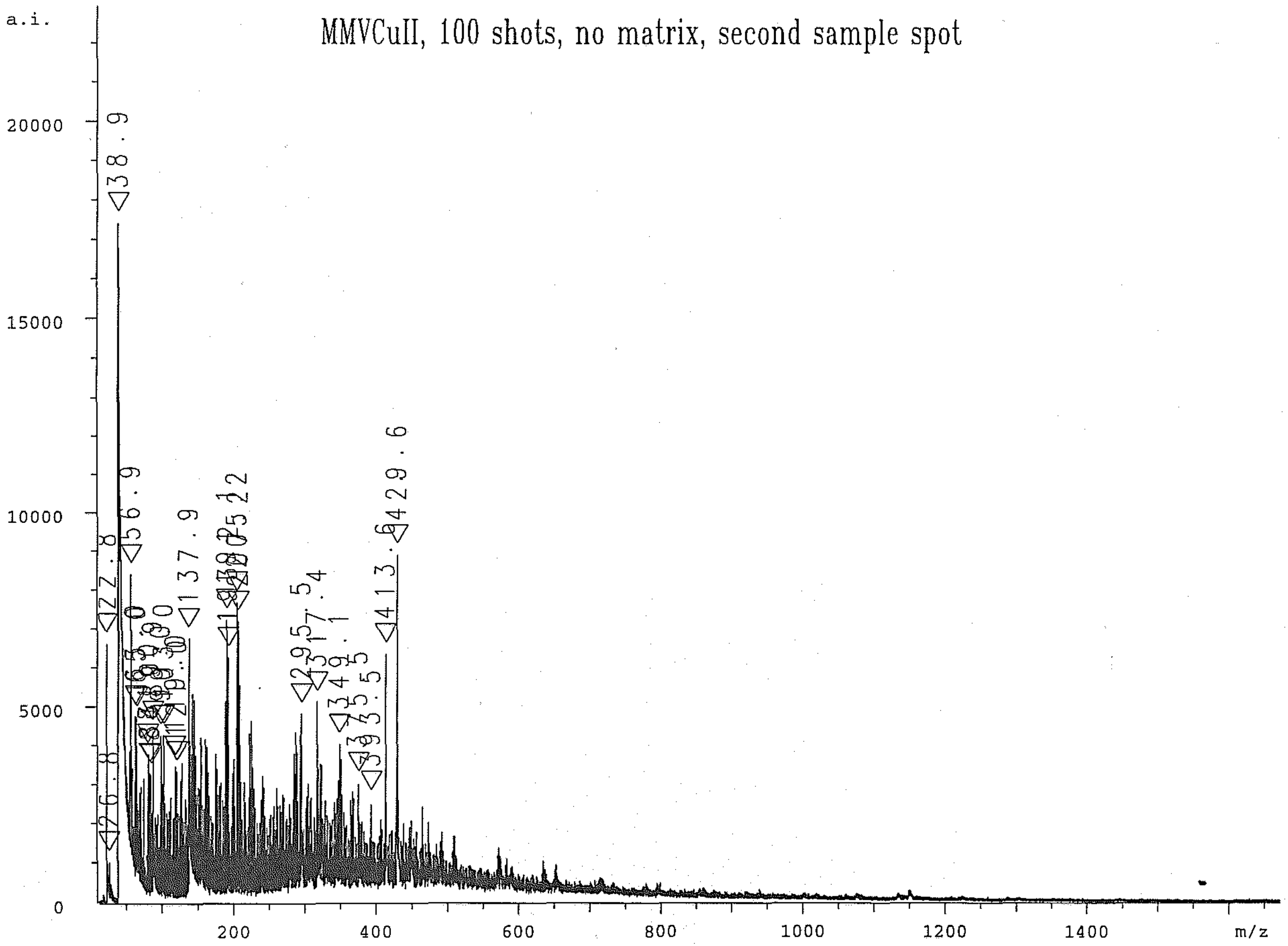
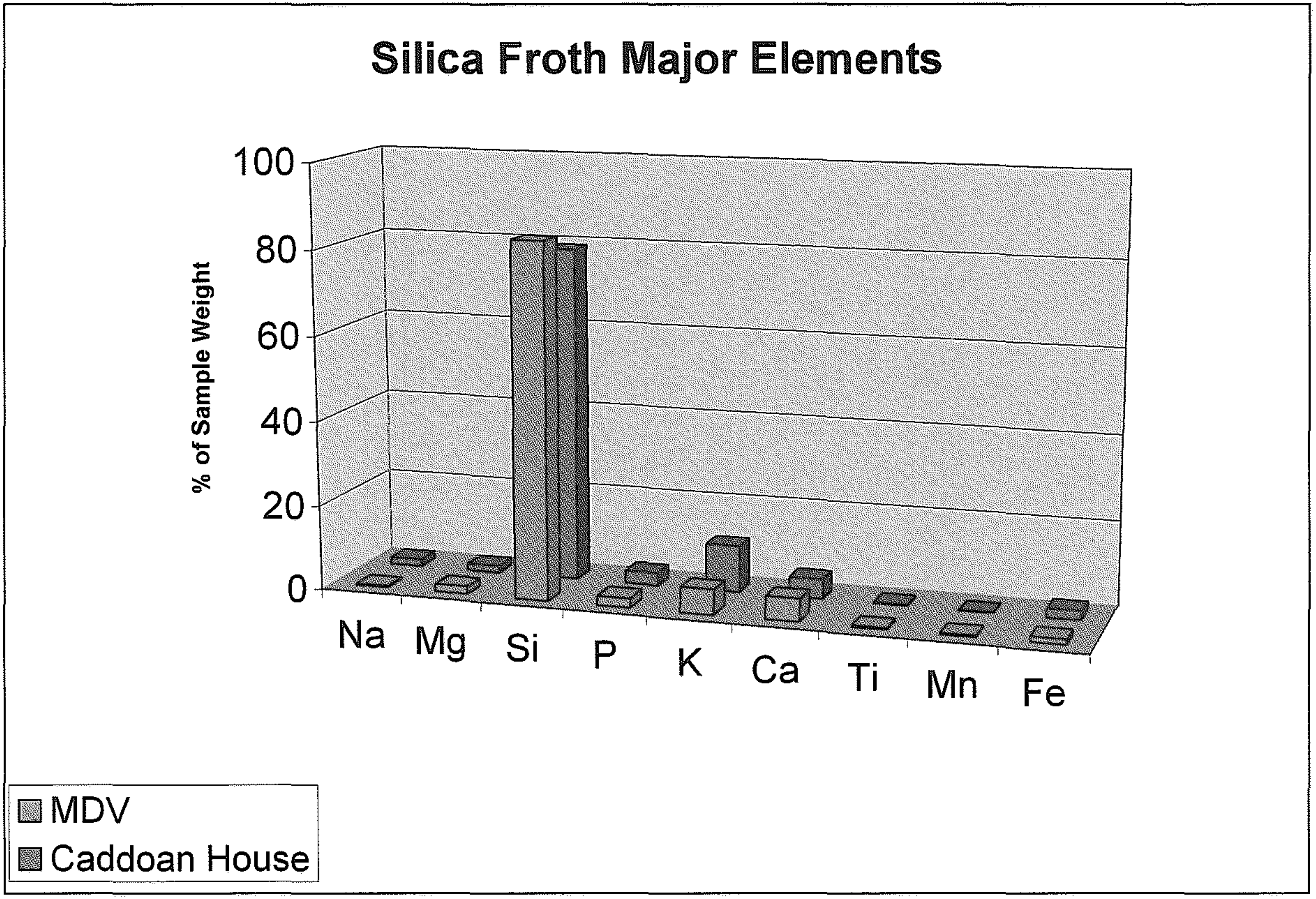
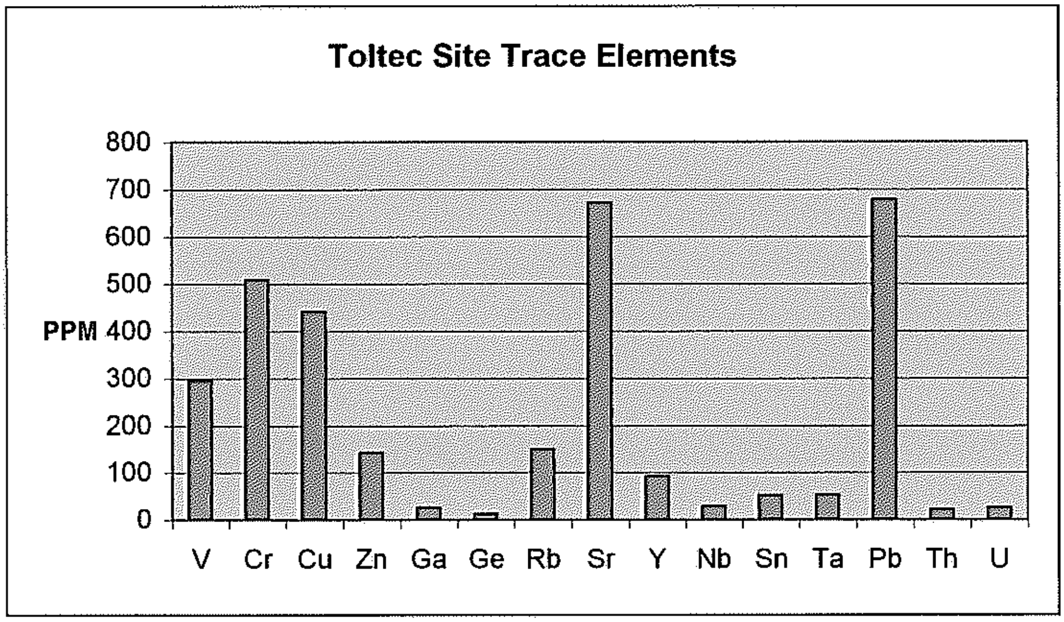
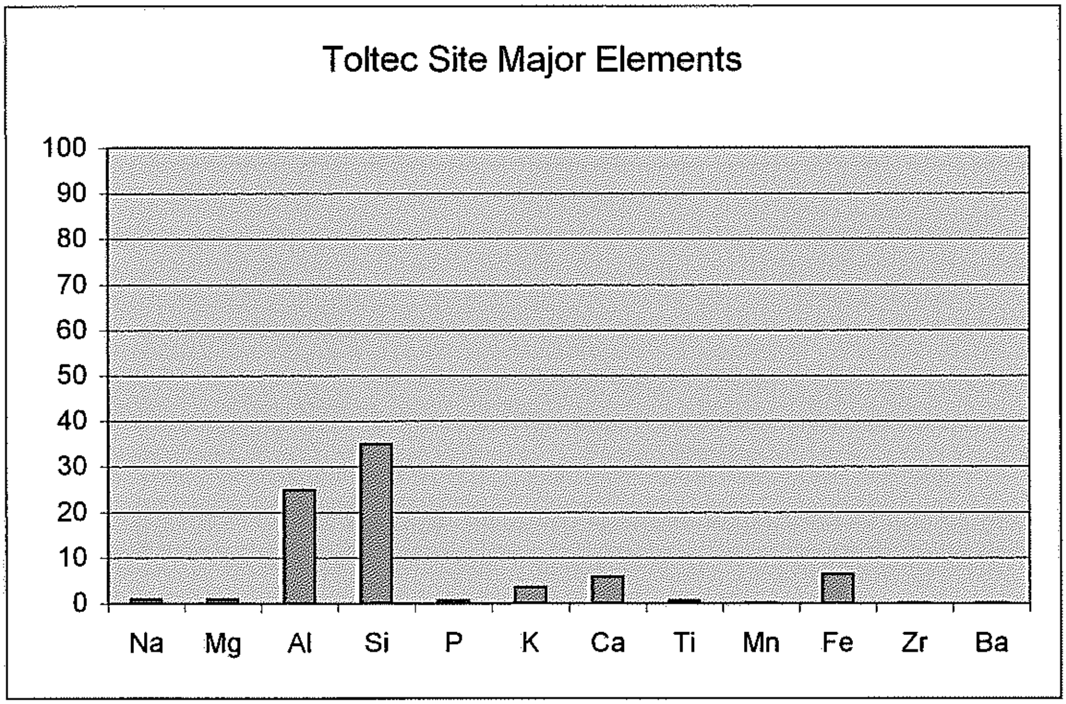
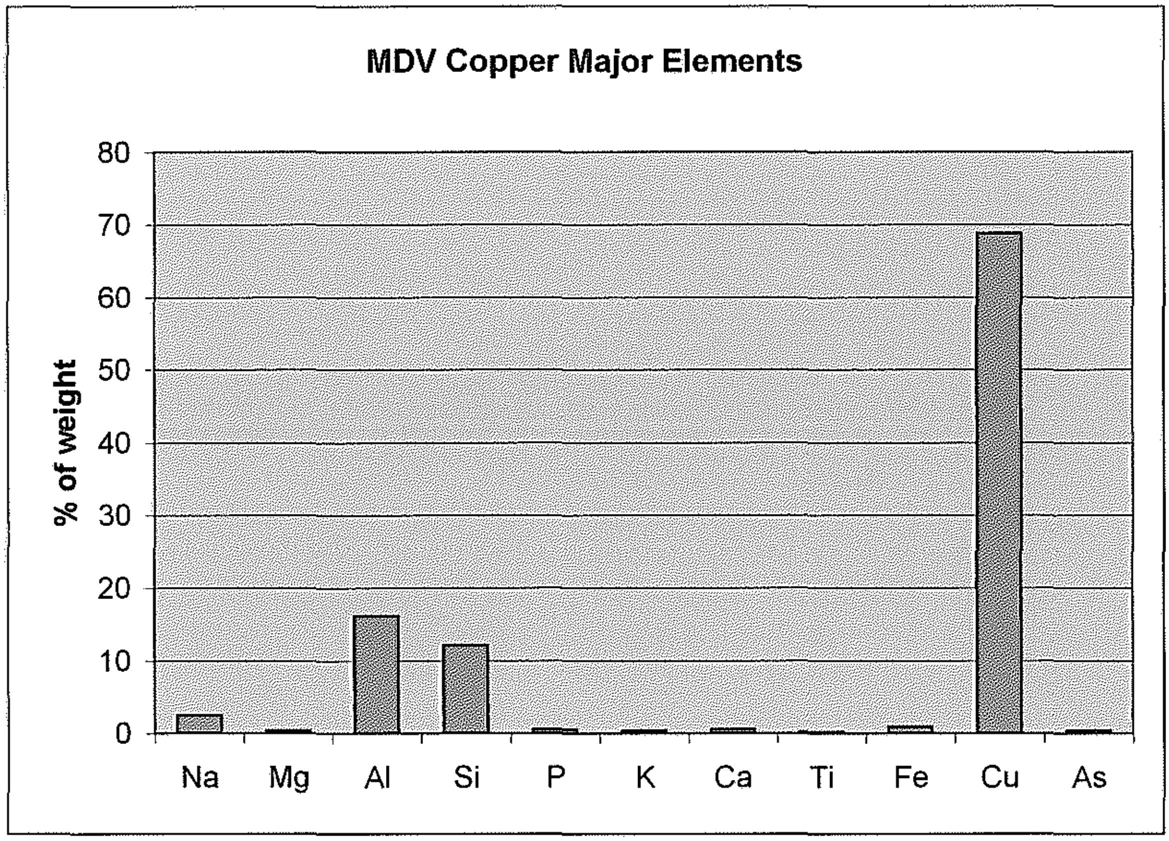

MMVCuII, 100 shots, no matrix, second sample spot

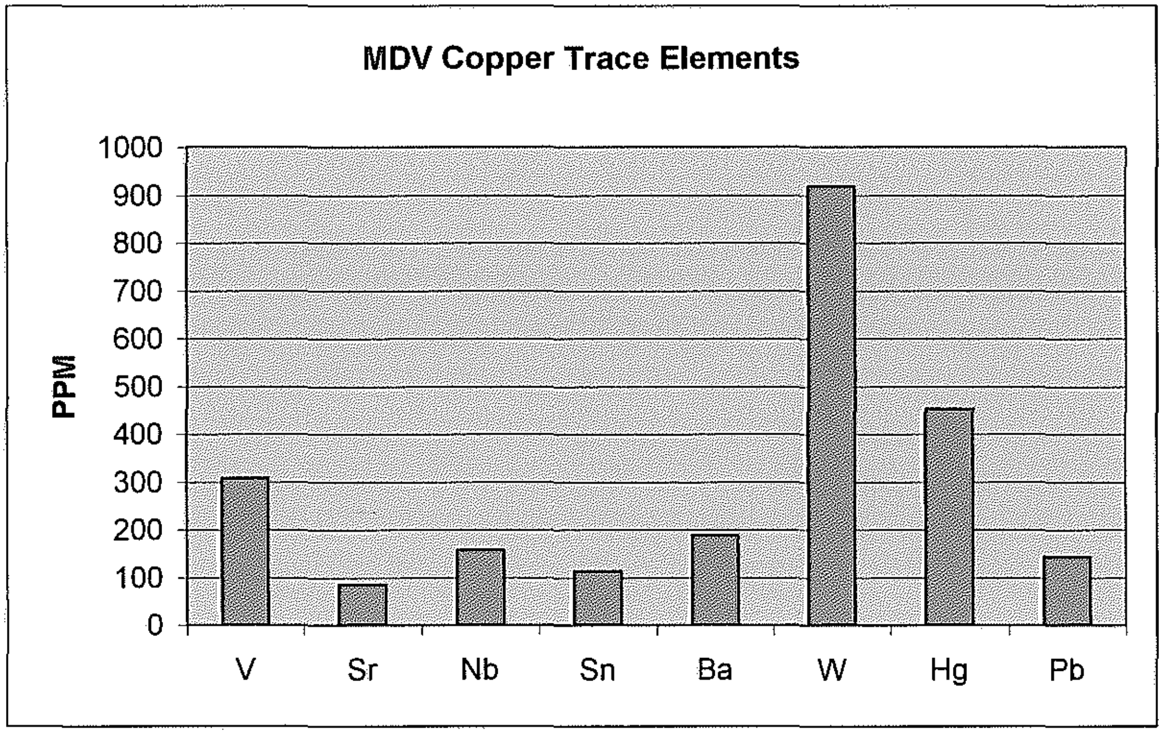
/export/home/data/swebb/2001/110901mmvcuII/6Ref/pdata/1 unknown Fri Nov 9 09:31:56 2001


Silica Froth Major Elements
% of Sample Weight
100
80
60
40
20
0
Na
Mg
Si
P
K
Ca
Ti
Mn
Fe
MDV
Caddoan House


Toltec Site Trace Elements
PPM
800
700
600
500
400
300
200
100
0
V
Cr
Cu
Zn
Ga
Ge
Rb
Sr
Y
Nb
Sn
Ta
Pb
Th
U


Toltec Site Major Elements
100
90
80
70
60
50
40
30
20
10
0
Na
Mg
Al
Si
P
K
Ca
Ti
Mn
Fe
Zr
Ba


MDV Copper Major Elements


MDV Copper Trace Elements

MDV-VII Silica

```
Sample: sherard #2
Mon 1/27/2003 at  8:13:50 AM
Method Name: Major Elements

Analyte Concentration       Counts/s
Na2O          0.34 Wt %        23.42
MgO           1.76 Wt %        85.05
Al2O3   <     0.00 Wt %        89.46
SiO2         83.56 Wt %      1780.19
P2O5          2.20 Wt %       302.38
K2O           5.95 Wt %      1962.96
CaO           5.40 Wt %       584.45
TiO2          0.39 Wt %        98.70
MnO           0.34 Wt %       301.01
Fe2O3         1.32 Wt %      1979.62
```

101.26

```
Sample: #4 Toltec
Thu 5/16/2002 at  9:55:13 AM
Method Name: Minerals as pressed pellets

Analyte Concentration      Counts/s
Na            0.80 Wt %       310.57
Mg            0.86 Wt %       504.07
Al           24.89 Wt %      4537.18
Si           34.92 Wt %      9019.43
P             0.63 Wt %       735.23
K             3.51 Wt %      3381.40
Ca            5.72 Wt %      1465.14
Ti            0.50 Wt %       343.24
V            294    ppm        26.24
Cr           509    ppm        67.39
Mn            0.17 Wt %       289.46
Fe            6.36 Wt %     13535.10
Cu           441    ppm        27.97
Zn           142    ppm        14.98
Ga            26    ppm         3.94
Ge            12    ppm         2.87
Rb           149    ppm        72.29
Sr           671    ppm       361.60
Y             92    ppm        54.43
Zr            0.20 Wt %      1284.95
Nb            29    ppm        19.70
Sn            52    ppm        19.45
Ba            0.14 Wt %       192.45
Ta            53    ppm         3.17
Pb           678    ppm       123.89
Th            22    ppm         5.77
U             26    ppm         6.73
```

Copper

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Sample: #1 MDV-VI
Thu 5/16/2002 at 10:07:03 AM
Method Name: Minerals as pressed pellets

Analyte Concentration      Counts/s
Na          2.44 Wt %        296.83
Mg          0.31 Wt %         54.53
Al         16.12 Wt %        957.24
Si         12.07 Wt %       1885.29
P           0.51 Wt %        576.30
K           0.34 Wt %        311.93
Ca          0.53 Wt %         18.48
Ti          0.21 Wt %         22.09
V         307    ppm           4.01
Fe          0.86 Wt %        247.59
Cu         68.81 Wt %      10294.21
As          0.33 Wt %         48.47
Sr         85    ppm           2.67
Nb        157    ppm           6.11
Sn        113    ppm          12.75
Ba        188    ppm           7.55
W         918    ppm           3.72
Hg        453    ppm           6.98
Pb        142    ppm           1.49
```

```
Sample: sherard #3
Mon 1/27/2003 at  7:58:48 AM
Method Name: Major Elements

Analyte Concentration      Counts/s
Na2O          1.63 Wt %       67.07
MgO           1.60 Wt %       78.92
Al2O3   <     0.00 Wt %       91.12
SiO2         78.89 Wt %     1645.35
P2O5          2.99 Wt %      407.44
K2O          10.97 Wt %     3636.15
CaO           4.56 Wt %      468.36
TiO2          0.31 Wt %       77.82
MnO           0.10 Wt %       89.31
Fe2O3         2.22 Wt %     3871.80
```

CADDOAN HOUSE

[illegible]