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STREAM SEDIMENT SAMPLING IN COTTONWOOD CANYON, STILLWATER RANGE, PERSHING AND CHURCHILL COUNTIES

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This information should be considered preliminary. It has not been edited or checked for completeness or accuracy.

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Paul J. Lechler and Mario O. Desilets

OFR:

Introduction

Cottonwood Canyon is located in the northern part of the Stillwater Range near the boundary between Pershing County and Churchill County. The area is underlain mainly by gabbroic rocks of the Lower Jurassic Humboldt Lopolith and comagmatic basaltic and andesitic flows. The gabbros intrude Upper Triassic and Lower Jurassic metasedimentary rocks (Speed, 1962). The Bolivia mining district in the upper reaches of Cottonwood Canyon encompasses the Lovelock Mine and the Nickel Mine; both were Ni-Co producers in the late Nineteenth Century (Ferguson, 1939). Mineralization consists mainly of fault-controlled, epigenetic Ni and Co sulfides, arsenides, and sulfosalts. A close association of Ni-Co mineralization with gabbroic rocks and cogenetic mafic volcanics is prevalent throughout the district.

Preparatory to undertaking a reconnaissance-scale evaluation of the Ni-Co potential elsewhere in the Stillwater Range, an orientation survey was conducted in Cottonwood Canyon for the purpose of characterizing the stream sediment geochemical signal proximal to known mineralization. These orientation data along with nearby preliminary reconnaissance results are reported herein.

In order to sense the natural geochemical signal from mineralization rather than an abnormally strong signal resulting from contamination of the drainage by past mining activity, a special sampling technique was utilized, as described below.

Sampling and Analysis

Sampling of stream terraces rather than Recent stream sediments allows for the characterization of fluvial material which was dispersed to the drainage system prior to mining activities. The assumption is then made that the sampled medium is uncontaminated by that activity to any significant degree. Because it is impossible to correlate and sample specific horizons laterally within the stream system, a vertical 'channel' sample of the full terrace profile is taken at each locality.

The samples thus collected were sieved to minus 80 mesh, digested in a mixture of nitric and perchloric acids, and analyzed by atomic absorption spectrophotometry. Additional analytical work, including partial sample digestions and anion determinations, produced data (not reported here) suggestive of a clastic- rather than hydromorphic-dispersion mechanism being responsible for the large variations in element concentrations apparent in the data sets (see Figures 10-21). In other words, mechanical dispersion from outcropping mineralization rather than metal-enriched groundwater leakage from buried mineralization is probably the process responsible for producing

the anomalies reported.

The samples collected in this preliminary study came from the main drainages in Sections 22,23,26,27,34, and 35, Township 25N Range 36E, Pershing and Churchill Counties (Fig. 1). Workings of the abandoned Nickel Mine occur in the area of the tributary confluence at sample 5.1; the old Lovelock Mine workings are near the confluence at sample 6.5.

Elemental Distributions

Histograms of the element abundances are presented in Figures 2-5, the raw data are contained in Tables 1-3, and basic statistics are displayed in Table 4. The Pearson correlation matrix in Table 4 shows a strong interrelationship between cobalt, nickel, and copper, a moderate relationship between silver and nickel, and weak correlations between silver and copper and silver and cobalt.

A common method of evaluating element distributions in geochemical surveys is by describing those samples with abundances less than the mean-, mode-, or median-plus two standard deviations as background and those above this level as anomalous (this value is also referred to as the threshold). In a statistical context this means that those samples with concentrations above the threshold have a 95% chance of being anomalous and only a 5% chance that they belong to the background population, and vice versa. Samples may be measured by their distance in standard deviations from the mean; these quantities are called z-scores. Thus, for a sample population with, for example, mean=100ppm and standard deviation=20ppm, a sample whose concentration is 120ppm has a z-score of 1.0, a concentration of 140ppm is a z-score of 2.0, 90ppm is -0.5 z-score, etc. Thinking of element abundances in terms of z-scores is a convenient way of evaluating a data set in statistical terms, that is, of quickly assessing where a particular sample stands with respect to the overall population mean and statistical threshold. Any sample with z-score greater than 2.0 is statistically anomalous.

Figures 6-9 present the stream sediment element abundances for the Cottonwood Canyon drainages in terms of z-scores. Large solid circles represent samples with concentrations greater than two standard deviations above the mean for that element (z-score>2.0) and hence are statistically anomalous. A large open circle represents samples with concentration greater than one- but less than two-standard deviations above the mean (z-score between one and two); these samples have element abundances higher than the average but still have approximately a 33% chance that they belong to the background and only about a 66% chance that they are anomalous. Small solid circles show sample locations with element abundances less than 1.0 z-score (background samples).

Figure 6 indicates that samples having statistically anomalous nickel concentrations exist in the tributary to the North of the Nickel Mine in Sections 26 and 35. Figure 7 shows that a sample strongly anomalous in cobalt is present in the same tributary in Section 35. This same sample is also strongly anomalous in copper (Figure 8) and weakly anomalous in silver (Figure 9). The highest silver value occurs at sample 2-5 in Section 26, with several weakly anomalous samples showing up downstream in Section 35.

Element profiles for the main drainage and two tributaries are presented in Figures 10-21.

Concluding Remarks

Because of the very high element concentrations in a few samples in the tributary to the North of the Nickel Mine, the overall population means and standard deviations are high, and slightly elevated abundances do not appear statistically anomalous. For this reason, samples proximal to known mineralization in the main drainage of Cottonwood Canyon do not appear statistically anomalous although they exhibit somewhat higher element concentrations, i.e., nickel, copper, and silver in samples 5.1 and 5.3.

Thus, it is demonstrated that the technique of sampling stream terrace material is indeed successful in avoiding anthropogenic contamination (from past mining activity) and that it has some usefullness in evaluating geochemical response in otherwise contaminated mining districts. However, it is also not extremely sensitive to the presence of nearby mineralization for the metals studied, in a semi-arid environment (see Figures 10-13; LM=Lovelock Mine, NM=Nickel Mine). Therefore, the statistical metal anomalies described above for tributary samples to the North of the Nickel Mine should be regarded as very significant because of the weak response to known mineralization shown by terrace samples in the main drainage of Cottonwood Canyon.

References Cited

Ferguson, H.G., 1939. Nickel Deposits in Cottonwood Canyon, Churchill County, Nevada. Nev. Bur. Mines Geol. Bull., 32, 21pp.

Speed, R.C., 1962. Scapolitized Gabbroic Complex, West Hmboldt Range, Nevada: Unpubl. PhD Thesis, Stanford Univ., 227p.

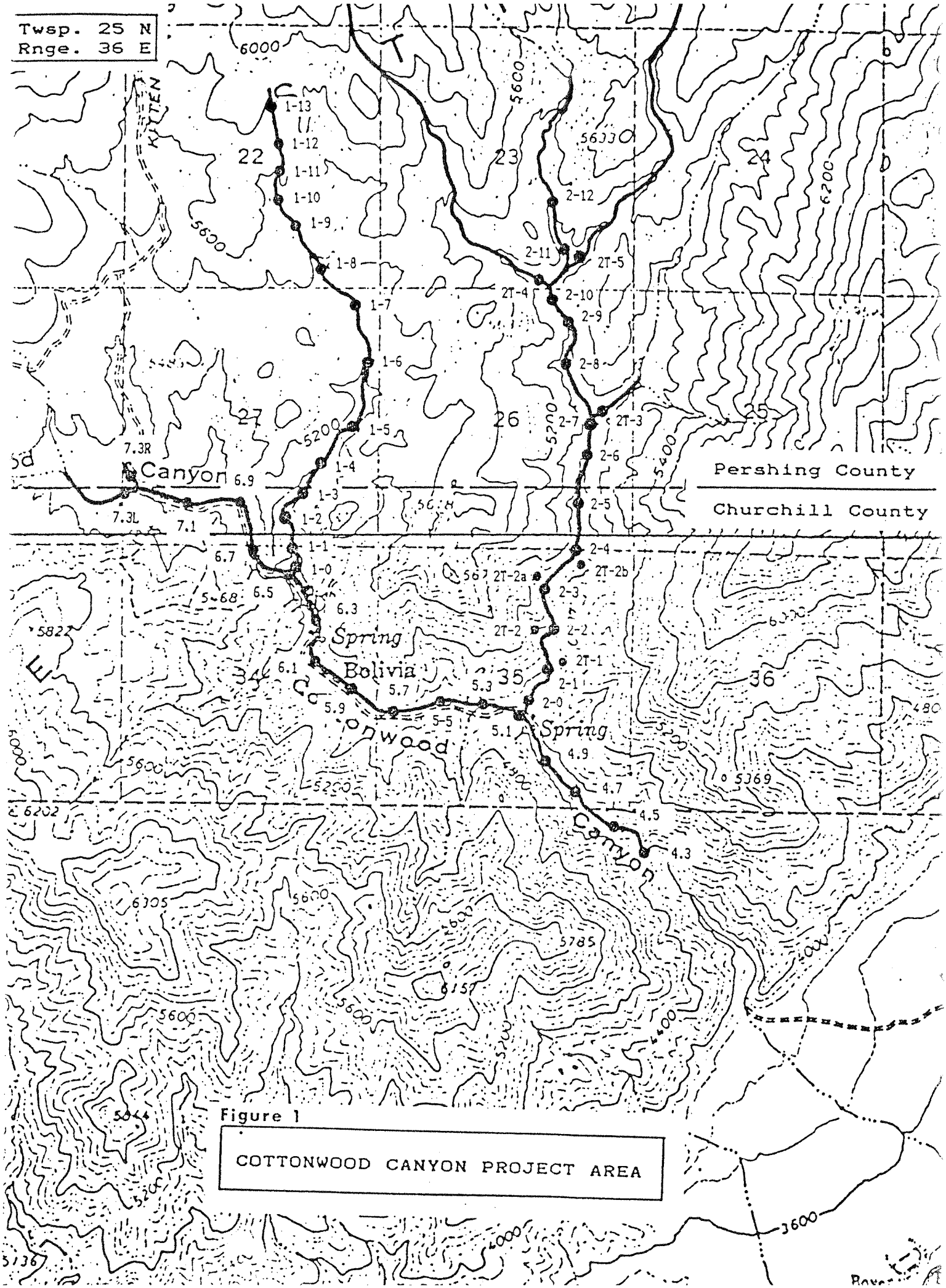


Figure 1

COTTONWOOD CANYON PROJECT AREA

gure 2

```
ROPORTION PER STANDARD UNIT                                                    COUNT
 1.0 +
     ¦
  .9 +        XX                                                               11
     ¦        XX
  .8 +        XX
     ¦   XX   XX                                                                9
  .7 +   XX   XX
     ¦ XXXX   XXXX                                                              8
  .6 + XXXX   XXXX
     ¦ XXXXXXXXXX                                                               7
  .5 + XXXXXXXXXX
     ¦ XXXXXXXXXX
  .4 + XXXXXXXXXX
     ¦ XXXXXXXXXX
  .3 + XXXXXXXXXX
     ¦ XXXXXXXXXXXX                                                             3
  .2 + XXXXXXXXXXXX
     ¦ XXXXXXXXXXXX
  .1 + XXXXXXXXXXXX
     ¦ XXXXXXXXXXXXXXXXXXXX                                          XX         1
-----+-------------------------------------------------------------------------
   14.00        ^          )                                         176.00
```

CU

gure 3

```
ROPORTION PER STANDARD UNIT                                                    COUNT
 1.0 + ^^^
     ¦ ^^^
  .9 + ^^^
     ¦ ^^^
  .8 + ^^^
     ¦ ^^^
  .7 + ^^^
     ¦ ^^^XXX                                                                   9
  .6 + ^^^XXX
     ¦ ^^^XXX
  .5 + ^^^XXX
     ¦ ^^^XXX
  .4 + ^^^XXX
     ¦ ^^^XXXXXXXXX                                                             5
  .3 + ^^^XXXXXXXXX
     ¦ ^^^XXXXXXXXX
  .2 + ^^^XXXXXXXXX   XXX       XXX                                            3
     ¦ ^^^XXXXXXXXX   XXX       XXX
  .1 + ^^^XXXXXXXXXXXXXXXXXXXXXXXXXX                                            2
     ¦ ^^^XXXXXXXXXXXXXXXXXXXXXXXXXX                                   XXX      1
-----+-------------------------------------------------------------------------
    0.90        ^           )                                           10.10
```

AG

igure 4

```
ROPORTION PER STANDARD UNIT                                                    COUNT
 1.0 + ^^
     ! ^^
  .9 + ^^
     ! ^^
  .8 + ^^XX                                                                      10
     ! ^^XX
  .7 + ^^XX
     ! ^^XX
  .6 + ^^XXXX                                                                     8
     ! ^^XXXX
  .5 + ^^XXXX
     ! ^^XXXX
  .4 + ^^XXXX
     ! ^^XXXX
  .3 + ^^XXXX
     ! ^^XXXX
  .2 + ^^XXXX
     ! ^^XXXX
  .1 + ^^XXXX
     ! ^^XXXXXX  XX                                                     XX      1
-----+-------------------------------------------------------------------------
   15.00  ^        )                                                   326.00

                                    CO
```

gure 5

```
ROPORTION PER STANDARD UNIT                                                    COUNT
 1.0 + ^^^^^^
     ! ^^^^^^
  .9 + ^^^^^^
     ! ^^^^^^
  .8 + ^^^^^^
     ! ^^^^^^
  .7 + ^^^^^^
     ! ^^^^^^  XX                                                                7
  .6 + ^^^^^^  XX
     ! ^^^^^^  XX
  .5 + ^^^^^^  XX
     ! ^^^^^^  XX
  .4 + ^^^^^^  XX
     ! ^^^^^^  XX
  .3 + ^^^^^^  XX
     ! ^^^^^^  XX
  .2 + ^^^^^^  XX
     ! ^^^^^^XXXX                                                                2
  .1 + ^^^^^^XXXX
     ! ^^^^^^XXXX      XX                          XX             XX      1
-----+-------------------------------------------------------------------------
   26.00      ^          )                                         350.00

                                    NI
```

Table 1: Main Drainage

COTTONWOOD CANYON PALEO-STREAM SEDIMENTS:

Sample	Co	Ni	Cu	Ag
4.3	23	51	33	1.3
4.5	21	38	24	1.1
4.7	21	40	40	1.4
4.9	23	48	34	1.7
5.1	27	51	47	1.3
5.3	25	52	46	1.6
5.5	23	43	35	0.9
5.7	23	39	26	0.9
5.9	22	37	23	0.9
6.1	24	39	29	1.1
6.3	27	49	25	1.1
6.5	22	44	27	1.0
6.7	22	52	23	1.0
6.9	24	46	24	1.1
7.1	23	42	25	0.9
7.3L	25	46	25	1.2
7.3R	22	57	22	1.0

Table 2: First Tributary

COTTONWOOD CANYON PALEO-STREAM SEDIMENTS:

Sample	Co	Ni	Cu	Ag
1-0	21	34	24	1.7
1-1	29	70	26	2.0
1-2	25	32	31	2.1
1-3	24	28	21	0.9
1-4	23	29	18	1.2
1-5	21	26	21	1.3
1-6	20	30	18	1.5
1-7	18	26	19	2.3
1-8	15	58	14	2.1
1-9	19	29	19	1.4
1-10	22	30	17	1.9
1-11	19	29	20	1.8
1-12	23	30	17	1.6
1-13	24	30	17	1.5

Table 3: Second Tributary

COTTONWOOD CANYON PALEO-STREAM SEDIMENTS:

Sample	Co	Ni	Cu	Ag
2-0	34	70	45	5.4
2-1	38	79	36	4.7
2-2	37	55	33	4.9
2-3	24	74	59	2.5
2-4	28	57	43	2.7
2-5	49	269	37	10.1
2-6	34	62	37	3.6
2-7	68	76	38	3.2
2-8	36	56	32	2.6
2-9	35	48	31	3.1
2-10	37	45	31	3.0
2-11	25	55	32	4.6
2-12	36	49	36	3.8
2T-1	31	67	35	4.2
2T-2	326	350	176	4.0
2T-2a	41	114	63	4.3
2T-2b	23	71	31	5.3
2T-3	39	76	56	2.3
2T-4	36	56	41	2.2
2T-5	33	47	37	3.5

Table 4

COTTONWOOD CANYON SEDIMENTS

Basic Statistics (n = 51):

	Cobalt	Nickel	Copper	Silver
Minimum	15	26	14	0.09
Maximum	326	350	176	10.1
Mean	33.7	59.4	33.7	2.41
Std.Dev.	42.7	54.5	23.1	1.71

Pearson Correlation Matrix:

	Co	Ni	Cu	Ag
Co	1			
Ni	0.825	1		
Cu	0.912	0.802	1	
Ag	0.264	0.612	0.301	1

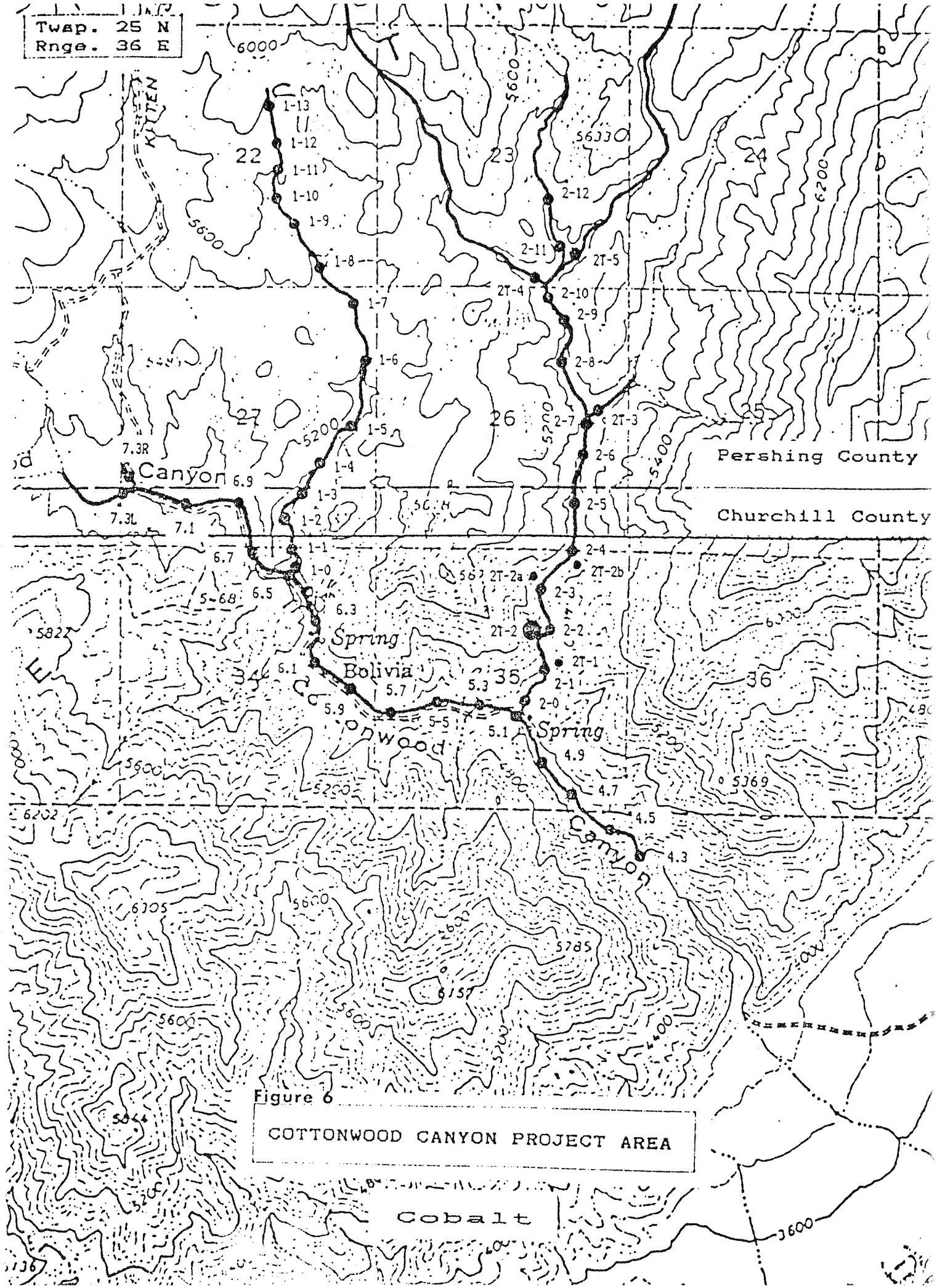
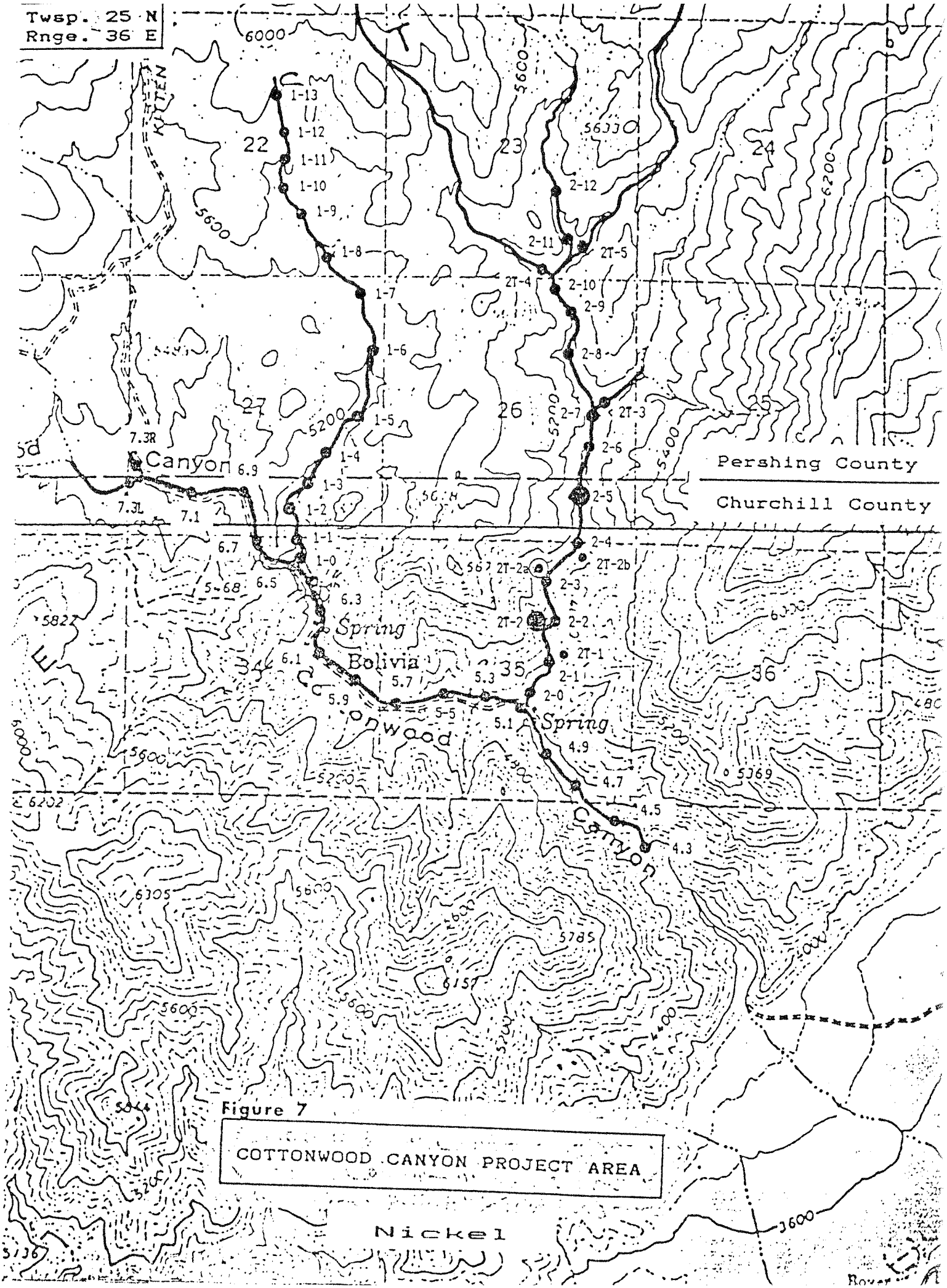


Figure 6

COTTONWOOD CANYON PROJECT AREA


Twsp. 25 N
Rnge. 36 E
Pershing County
Churchill County
Canyon
Spring
Bolivia
Cottonwood
Spring
Canyon
Nickel
22
23
24
27
26
25
34
35
36
1-13
1-12
1-11
1-10
1-9
1-8
1-7
1-6
1-5
1-4
1-3
1-2
1-1
1-0
2-12
2-11
2T-5
2T-4
2-10
2-9
2-8
2-7
2T-3
2-6
2-5
2-4
2T-2a
2T-2b
2-3
2T-2
2-2
2T-1
2-1
2-0
7.3R
7.3L
7.1
6.9
6.7
6.5
6.3
6.1
5.9
5.7
5.3
5.1
4.9
4.7
4.5
4.3
6000
5600
5200
5400
6200
5633
5822
5368
5369
6202
6305
5785
6157
5600
Figure 7
COTTONWOOD CANYON PROJECT AREA

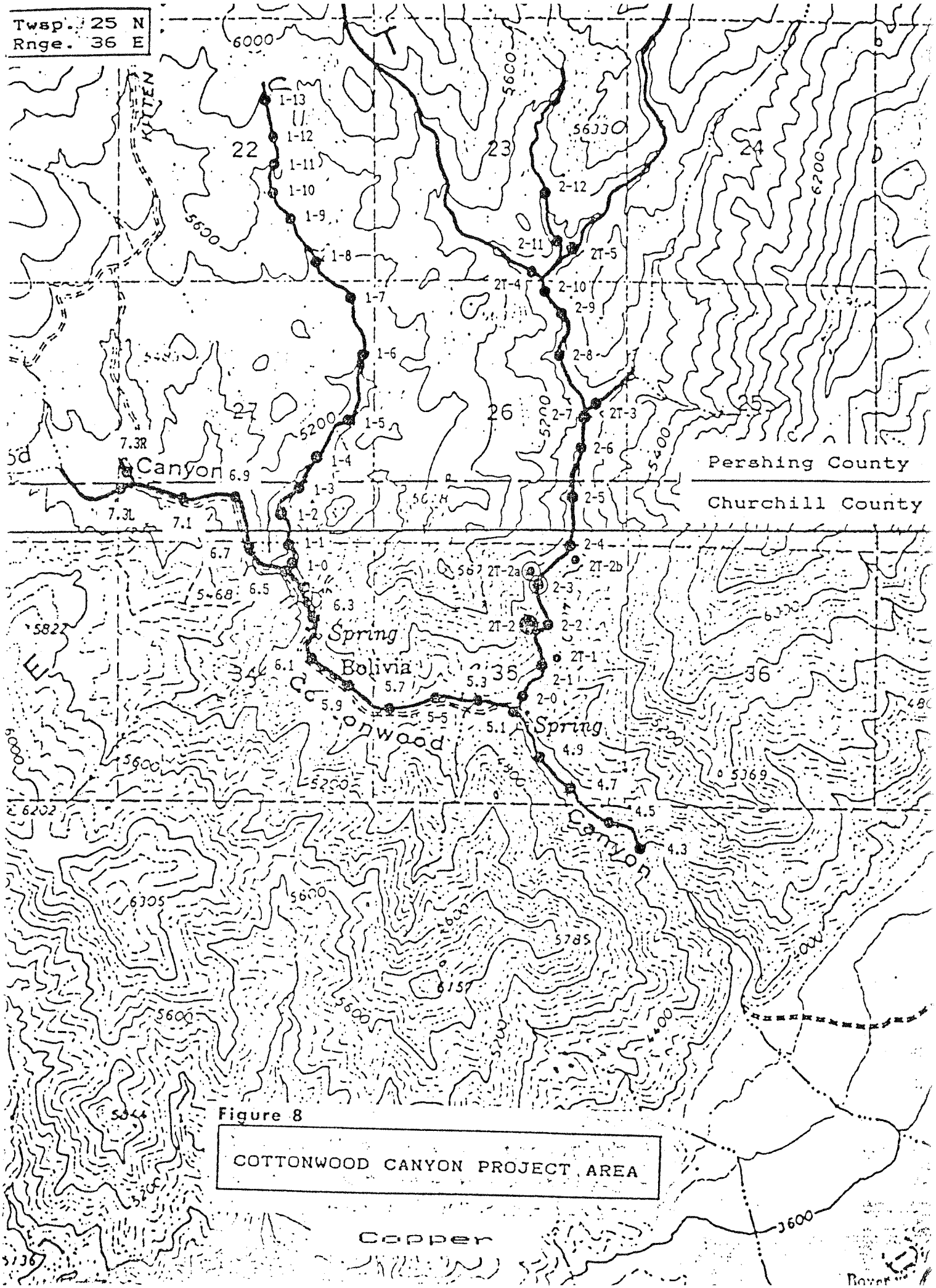


Figure 8

COTTONWOOD CANYON PROJECT AREA

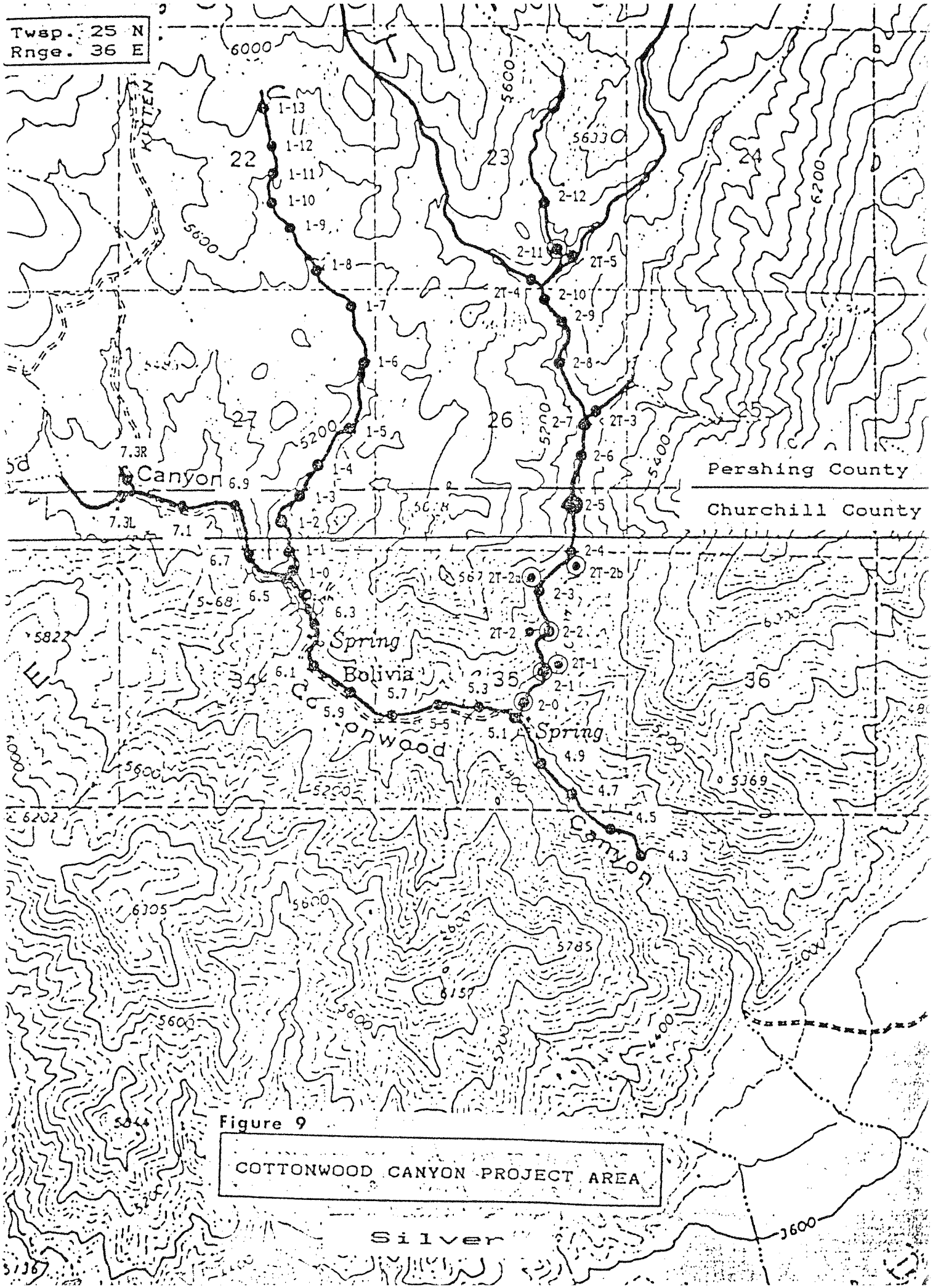


Figure 9

COTTONWOOD CANYON PROJECT AREA

Figure 10

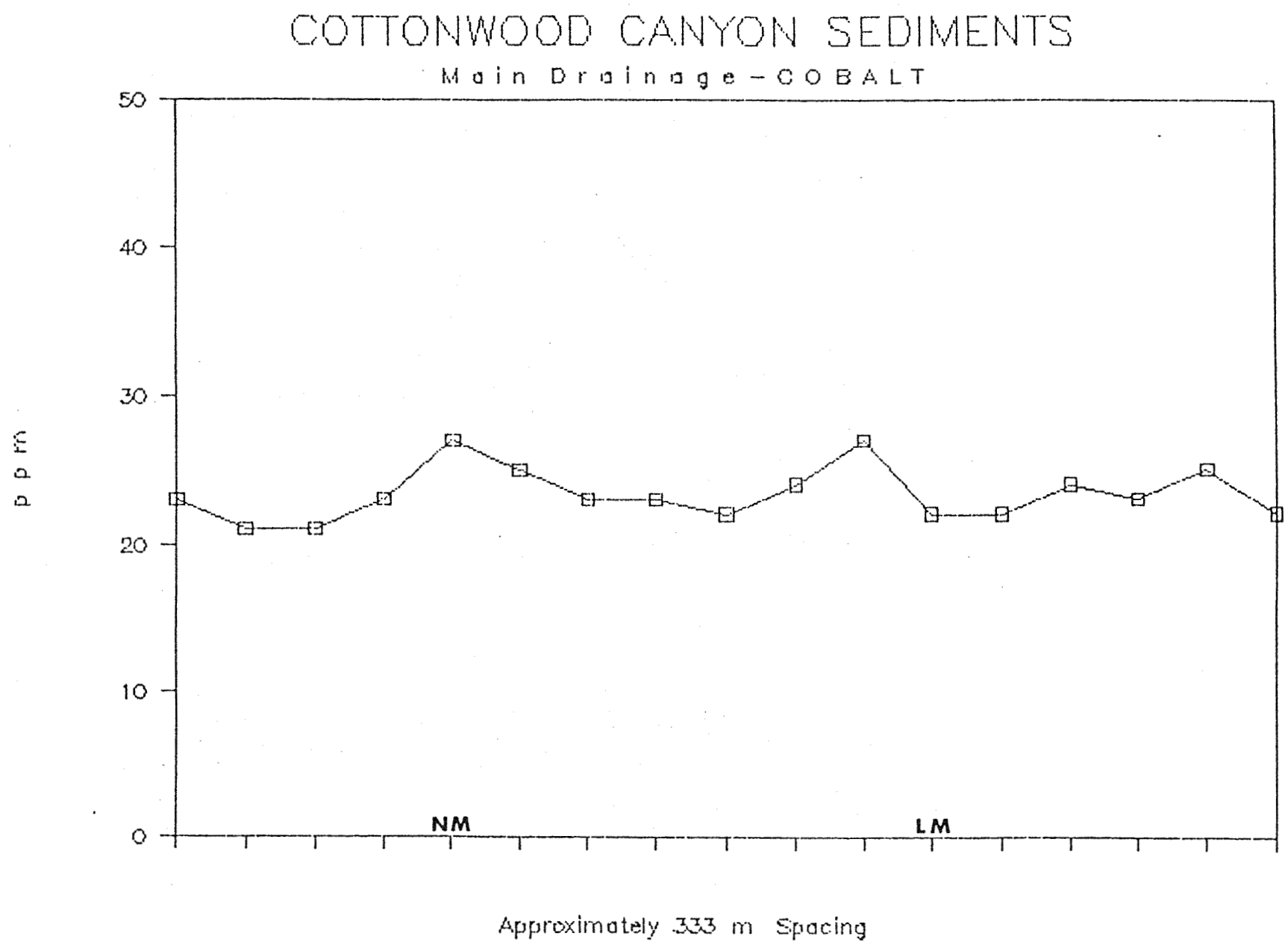

COTTONWOOD CANYON SEDIMENTS
Main Drainage - COBALT
50
40
30
20
10
0
ppm
NM
LM
Approximately 333 m Spacing

Figure 11

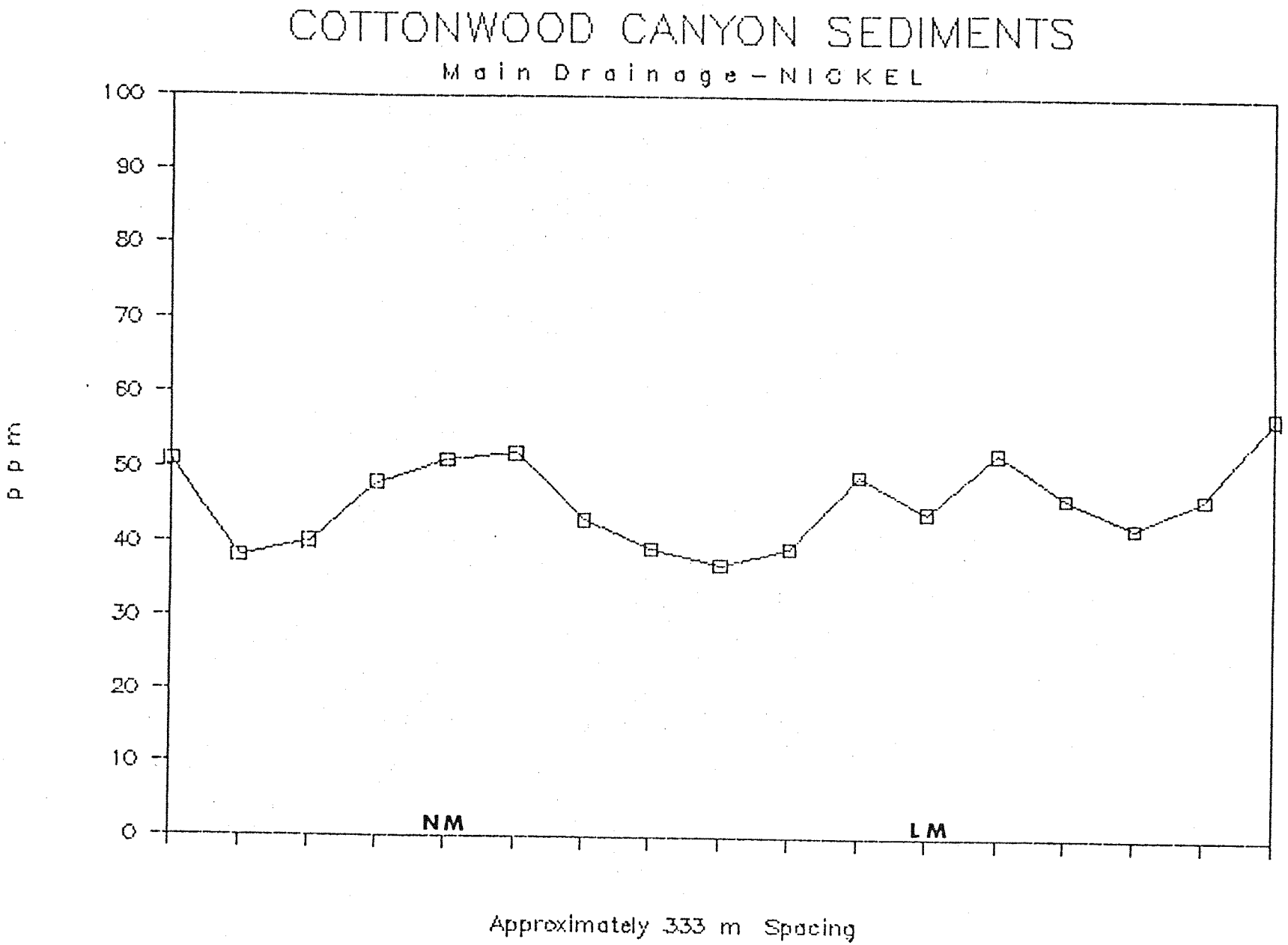

COTTONWOOD CANYON SEDIMENTS
Main Drainage - NICKEL
ppm
100
90
80
70
60
50
40
30
20
10
0
NM
LM
Approximately 333 m Spacing

Figure 12

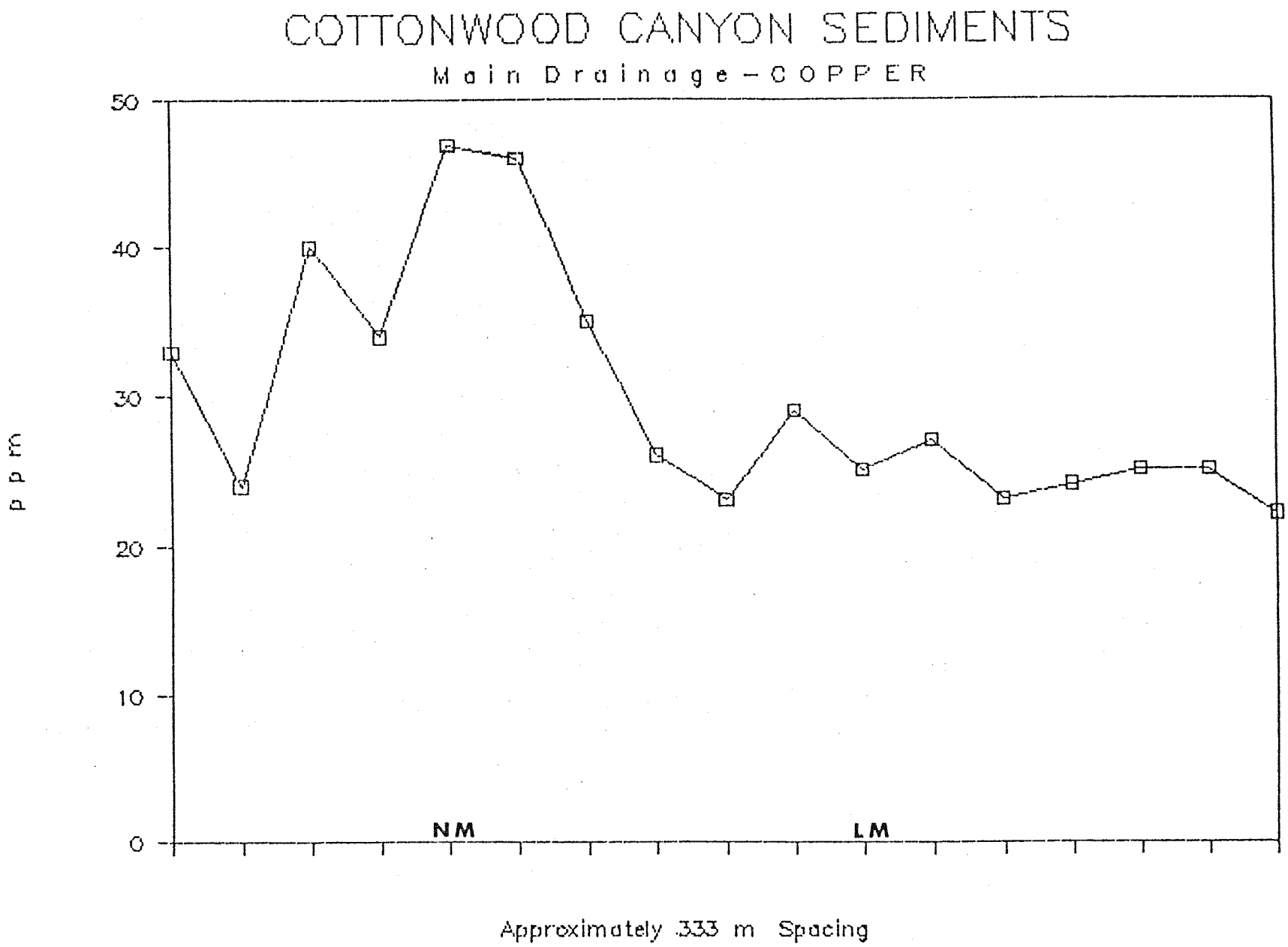

COTTONWOOD CANYON SEDIMENTS
Main Drainage - COPPER
ppm
50
40
30
20
10
0
NM
LM
Approximately 333 m Spacing

Figure 13

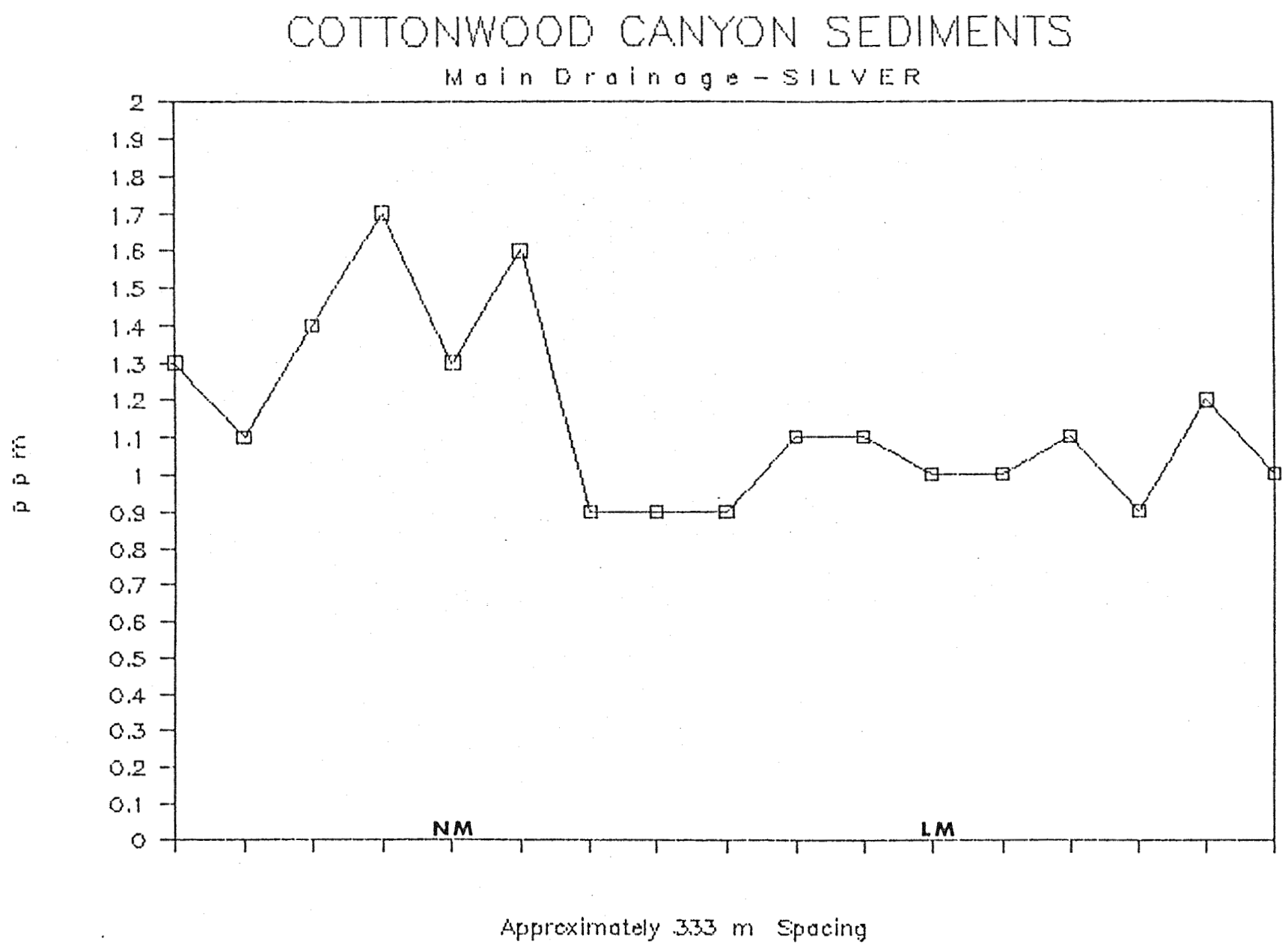

COTTONWOOD CANYON SEDIMENTS
Main Drainage - SILVER
ppm
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
NM
LM
Approximately 333 m Spacing

Figure 14

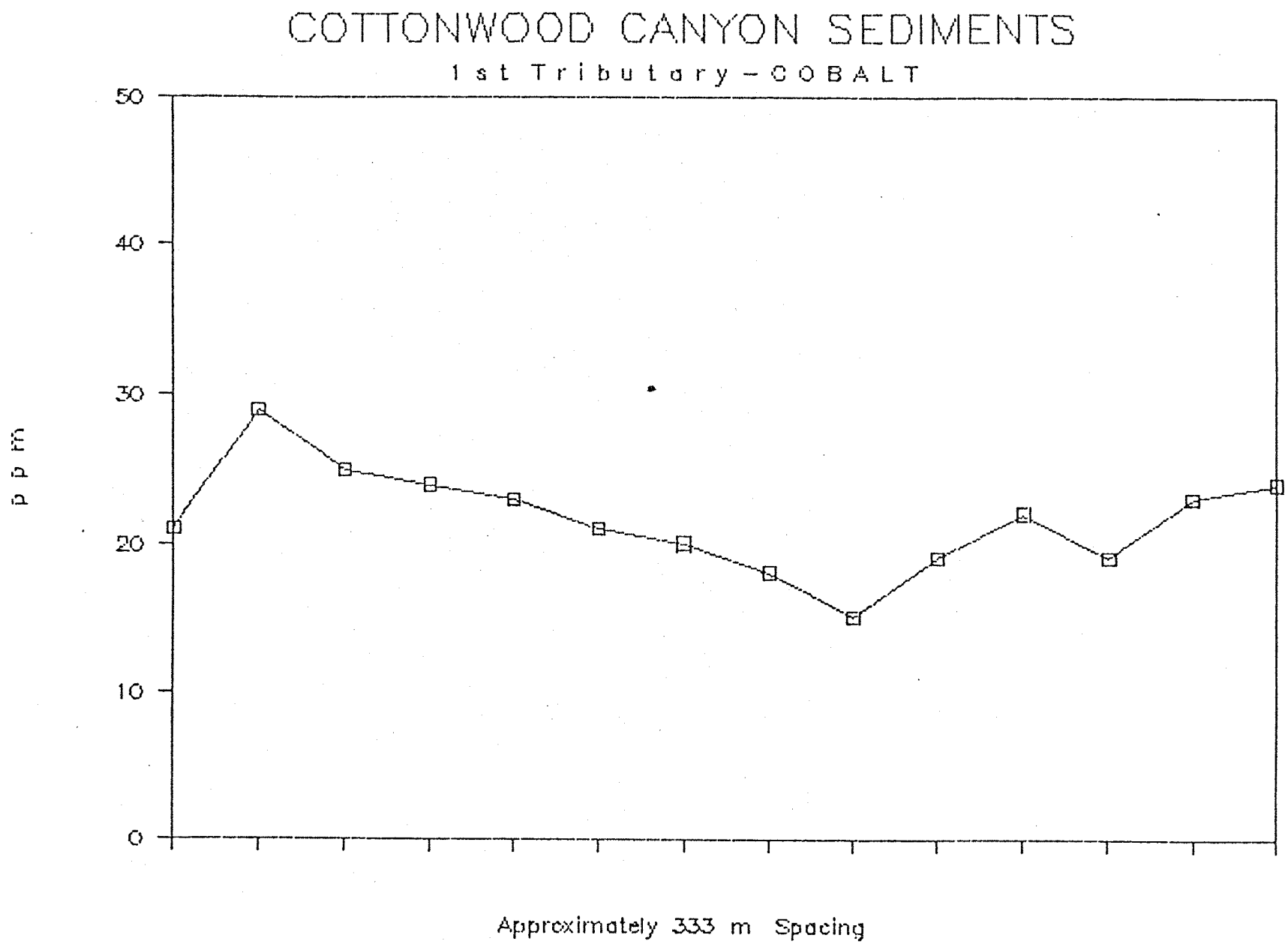

COTTONWOOD CANYON SEDIMENTS
1st Tributary - COBALT
50
40
30
20
10
0
ppm
Approximately 333 m Spacing

Figure 15

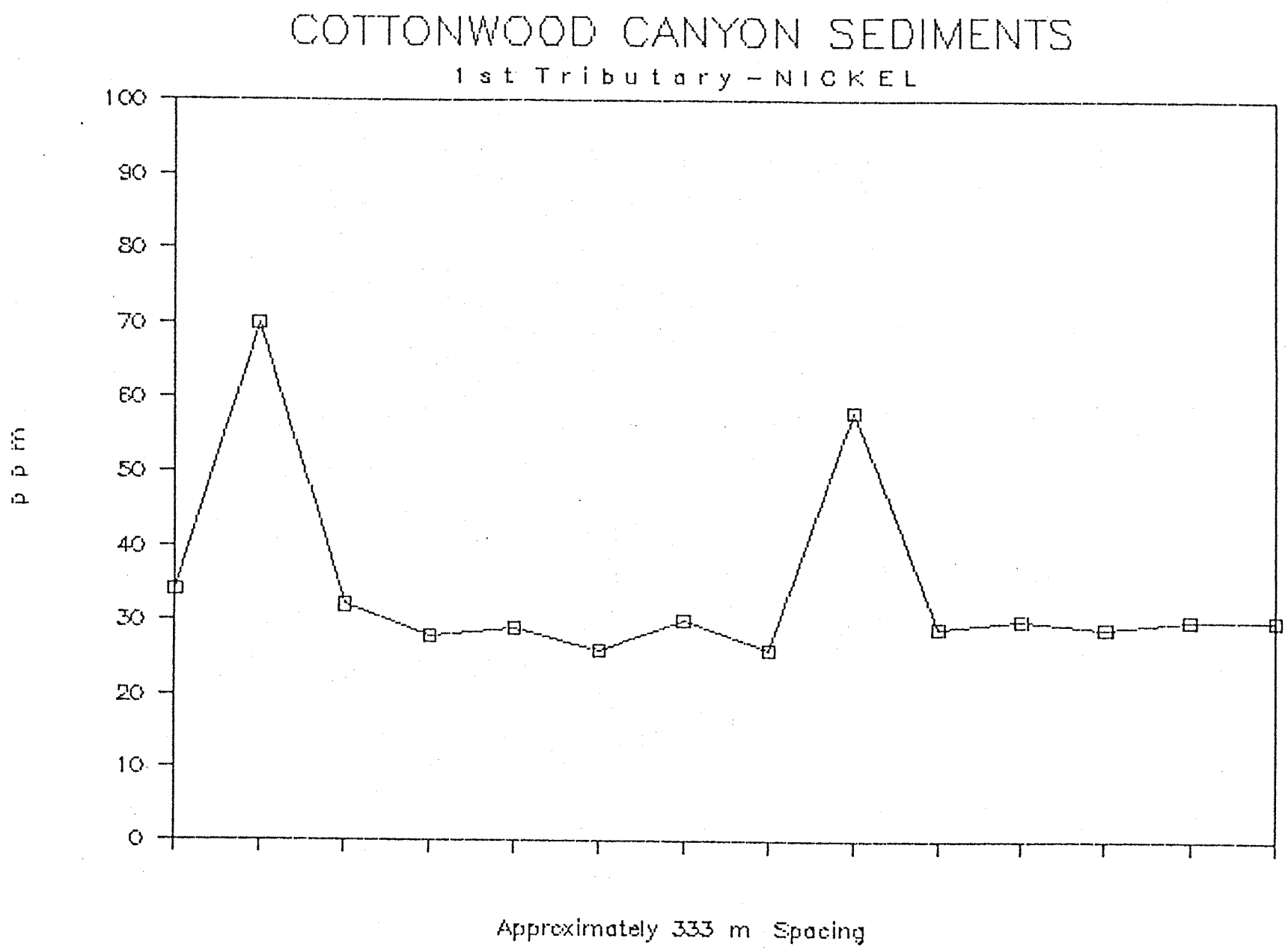

COTTONWOOD CANYON SEDIMENTS
1st Tributary - NICKEL
ppm
100
90
80
70
60
50
40
30
20
10
0
Approximately 333 m Spacing

Figure 16

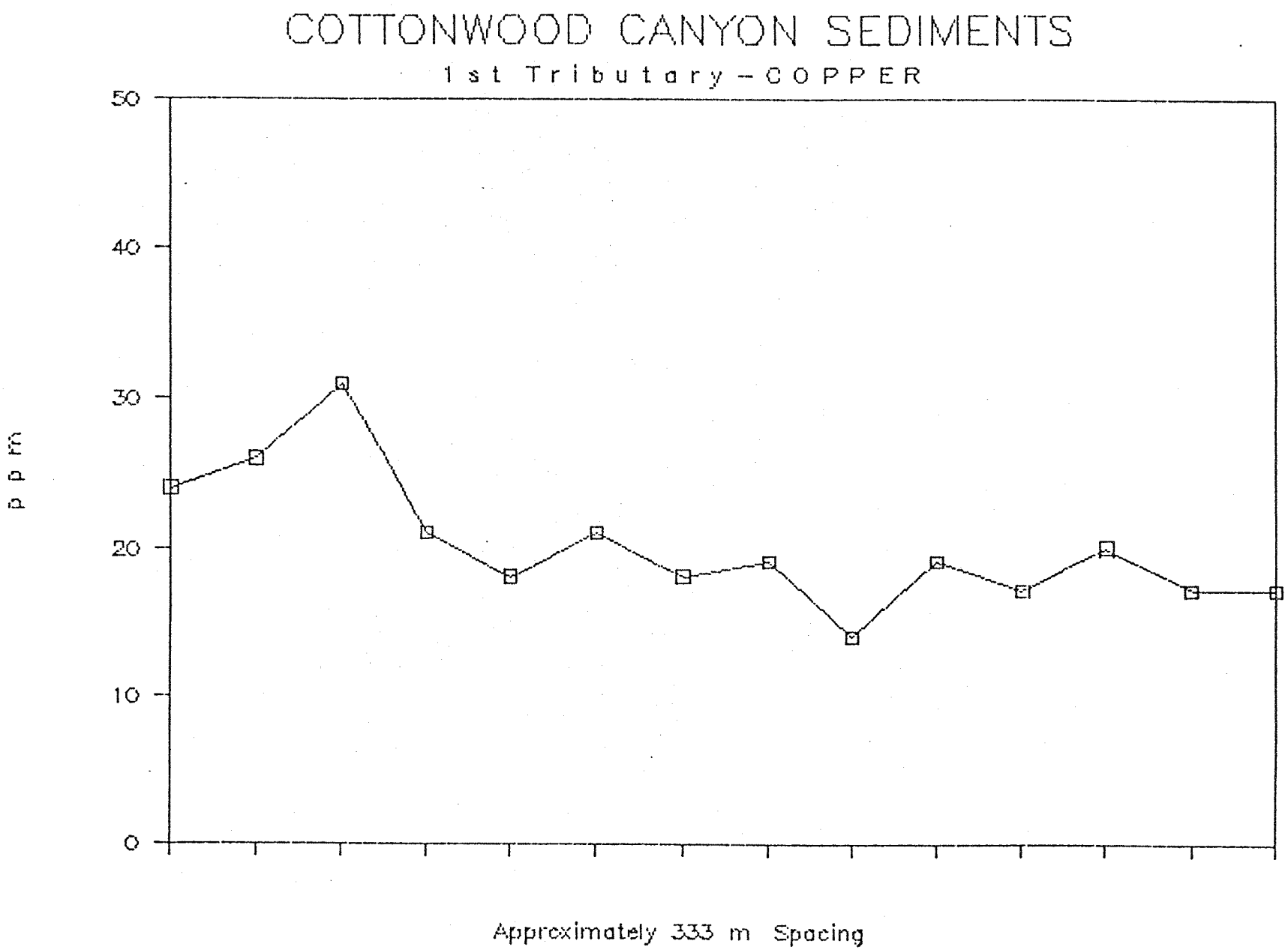

COTTONWOOD CANYON SEDIMENTS
1st Tributary - COPPER
50
40
30
20
10
0
ppm
Approximately 333 m Spacing

Figure 17

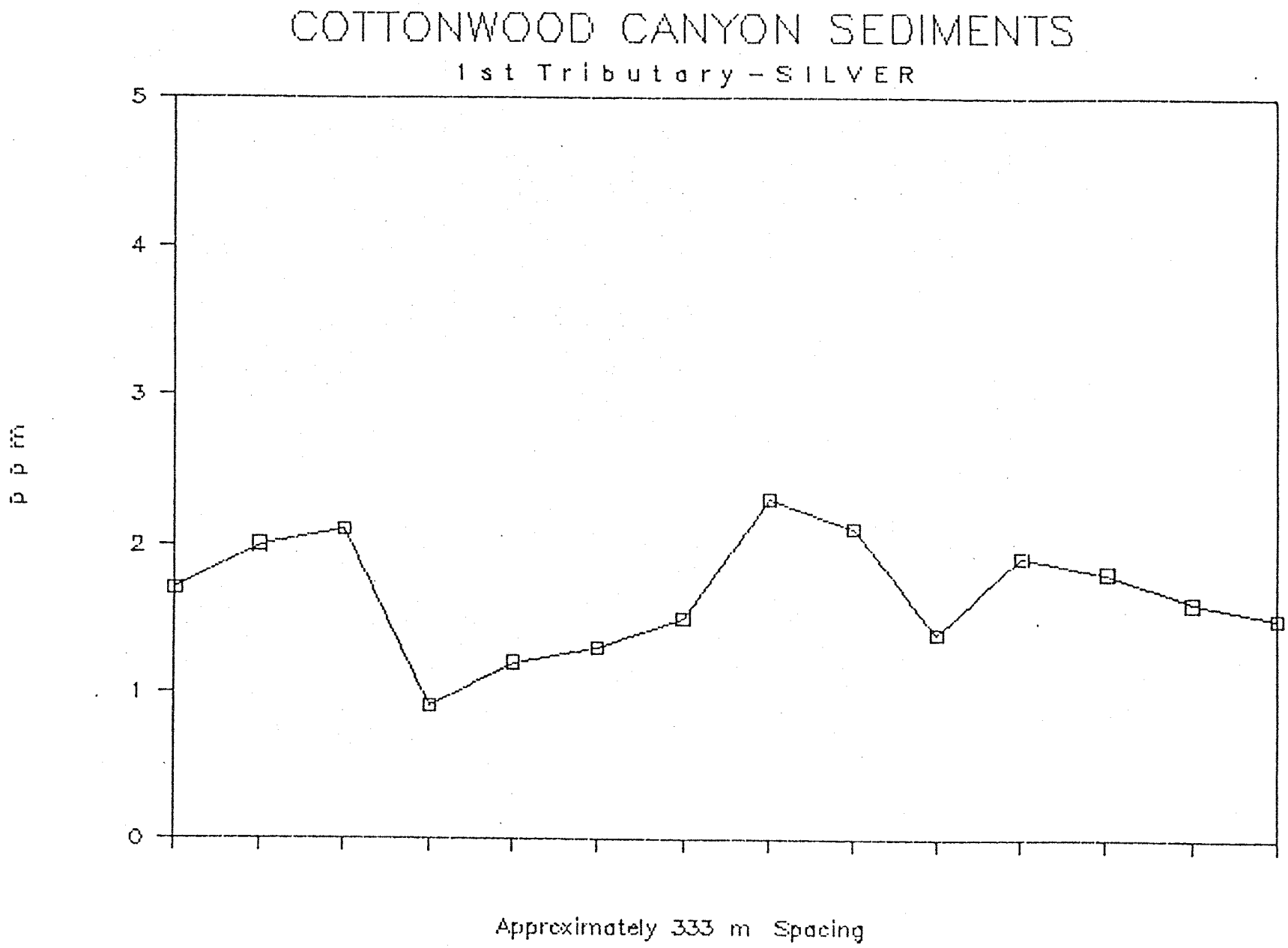

COTTONWOOD CANYON SEDIMENTS
1st Tributary - SILVER
ppm
5
4
3
2
1
0
Approximately 333 m Spacing

Figure 18

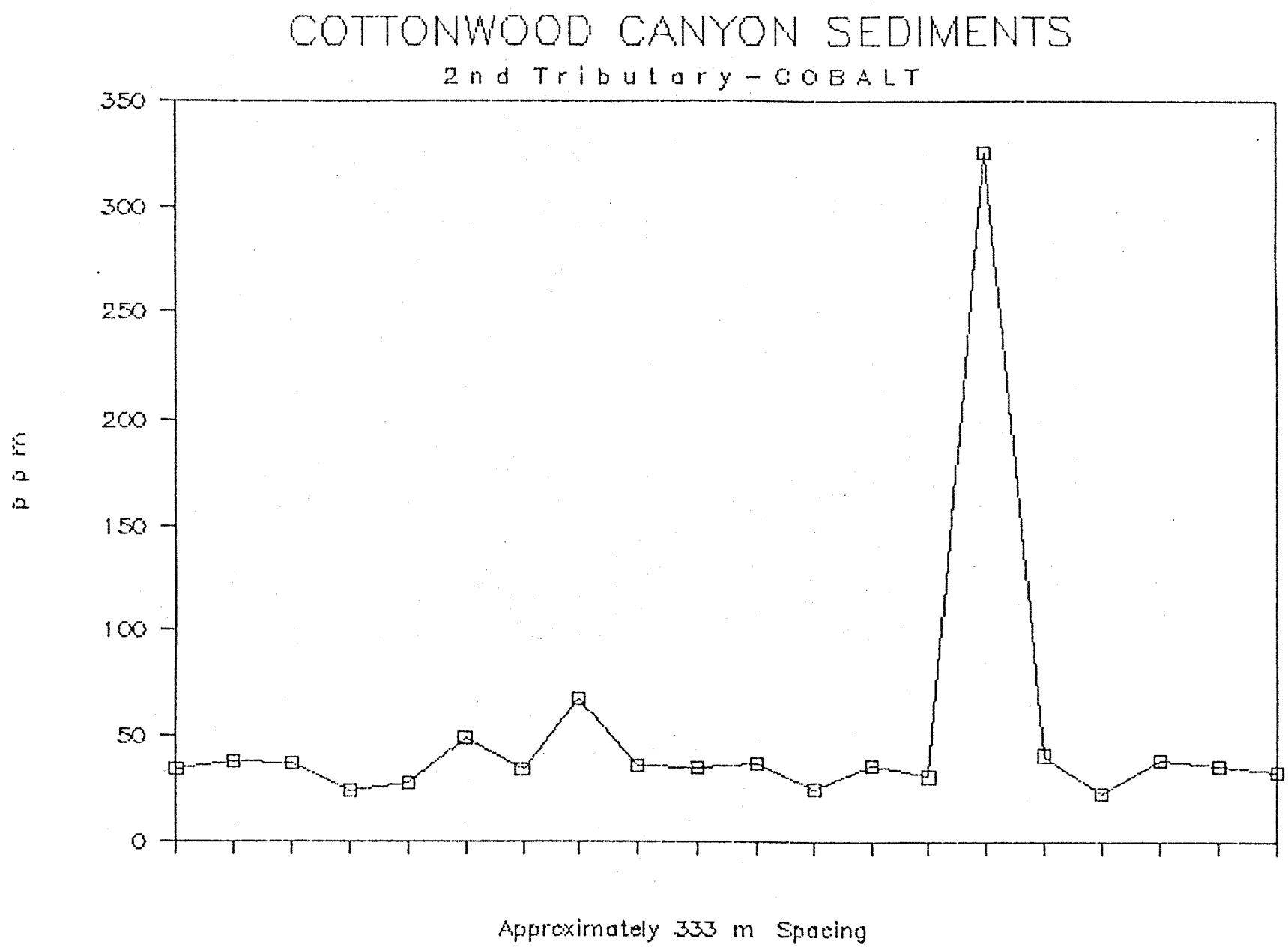

COTTONWOOD CANYON SEDIMENTS
2nd Tributary - COBALT
ppm
350
300
250
200
150
100
50
0
Approximately 333 m Spacing

Figure 19

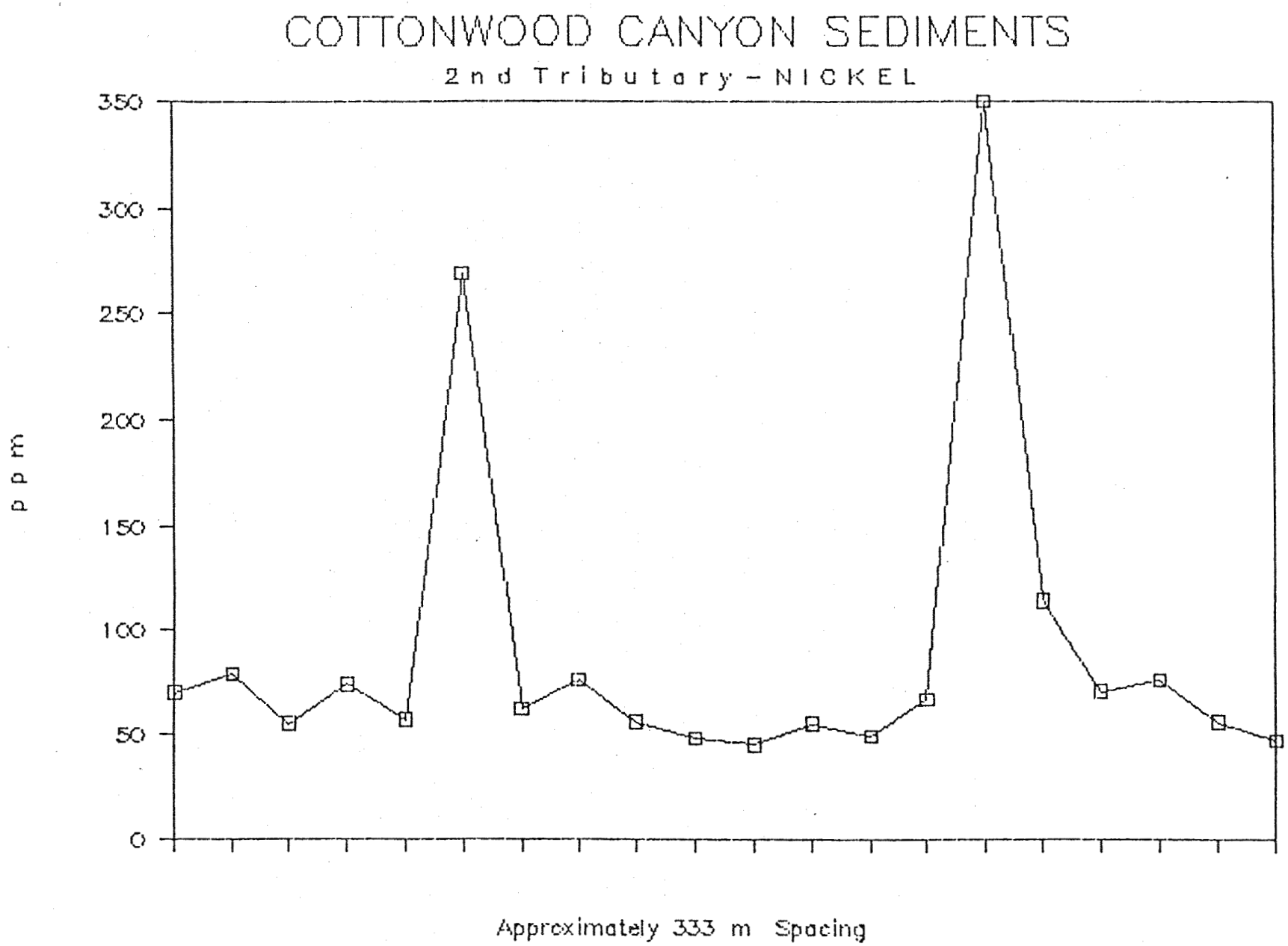

COTTONWOOD CANYON SEDIMENTS
2nd Tributary - NICKEL
ppm
350
300
250
200
150
100
50
0
Approximately 333 m Spacing

Figure 20

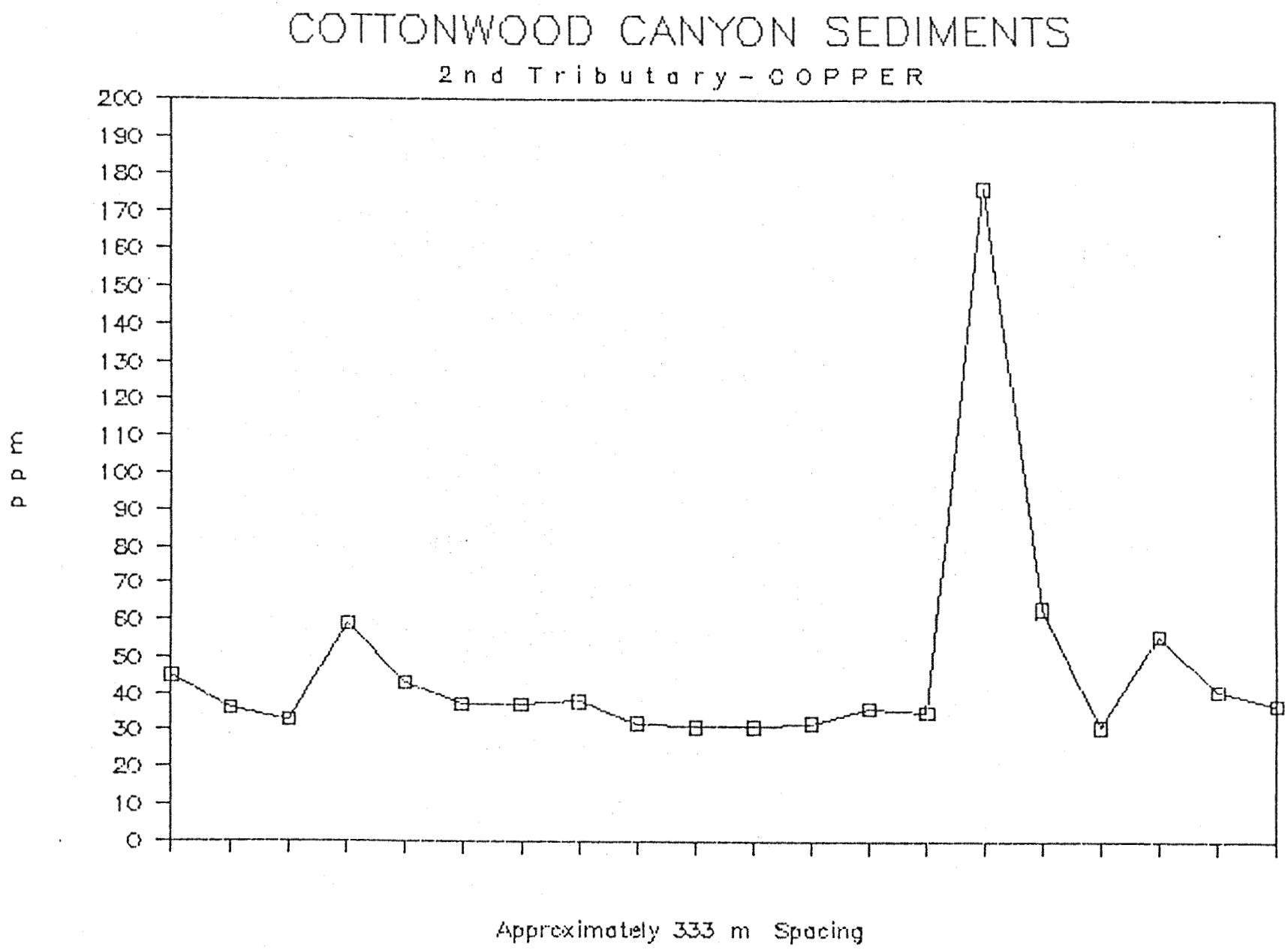
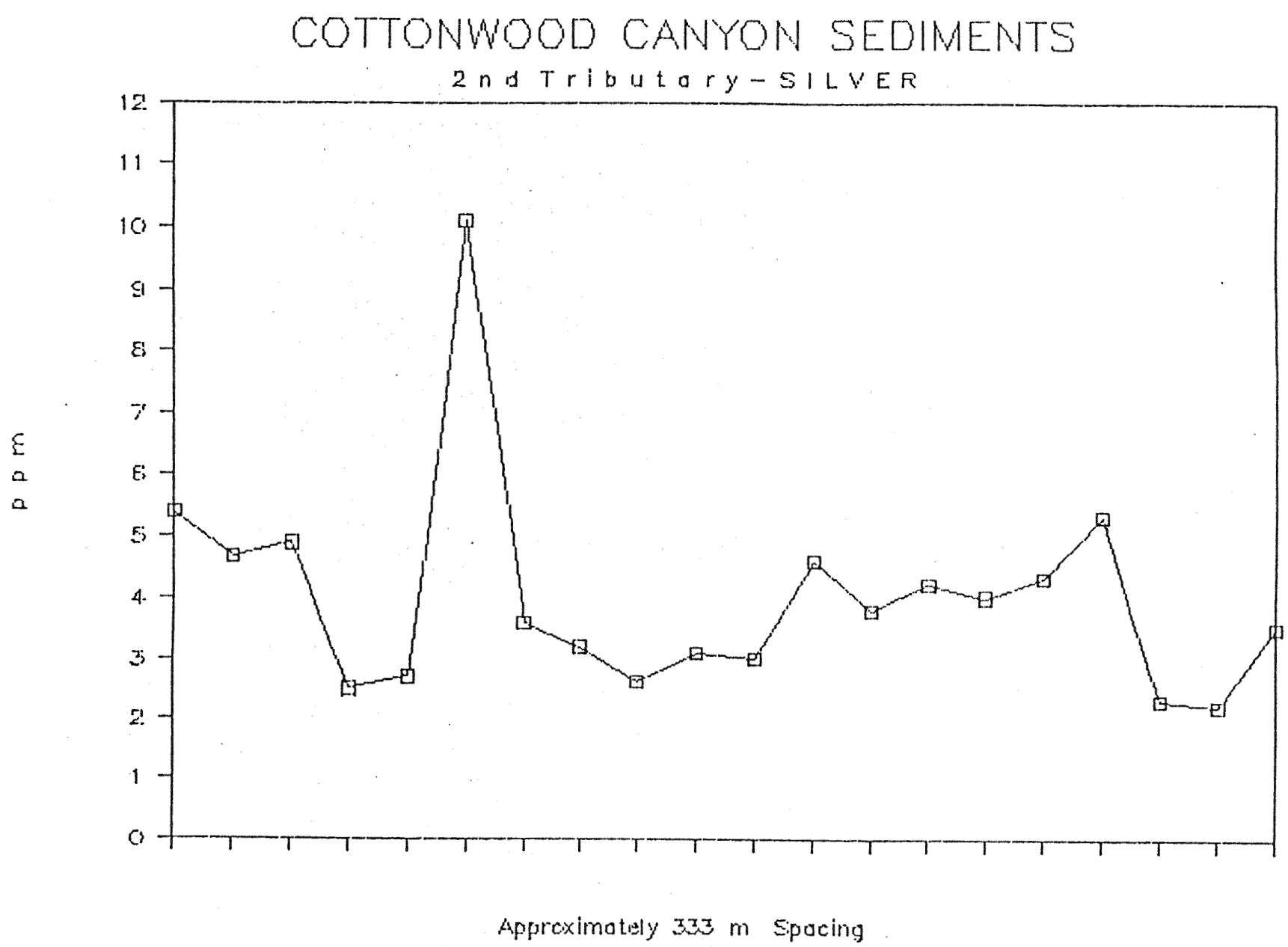

COTTONWOOD CANYON SEDIMENTS
2nd Tributary - COPPER
ppm
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Approximately 333 m Spacing

Figure 21


COTTONWOOD CANYON SEDIMENTS
2nd Tributary - SILVER
ppm
0
1
2
3
4
5
6
7
8
9
10
11
12
Approximately 333 m Spacing